UN environment programme

Convention on the Conservation of Migratory Species of Wild Animals

CMS

7th Meeting of the Sessional Committee of the CMS Scientific Council (ScC-SC7)

Bonn, Germany, 17 – 20 September 2024

UNEP/CMS/ScC-SC7/Inf.15

RESPONSES TO DECISION 14.51 a)

ON DEEP-SEABED MINERAL EXPLOITATION ACTIVITIES AND MIGRATORY SPECIES

(Prepared by the Secretariat)

Summary:

Decision 14.51 a) requests Parties to *"inform the Secretariat by 30 June 2024 of any relevant scientific or other information, including any EIA guidance, that considers the impacts of deep-seabed mineral exploitation activities on migratory species, their prey and their ecosystems."*

Through *Notification 2024/013: Deep-Seabed Mineral Exploitation Activities and Migratory Species* sent on 3 June 2024, the Secretariat solicited comments from Parties, with a deadline of 30 June 2024.

Inputs were received from the Dominican Republic, the Netherlands, New Zealand and SPREP, and are attached to this document.

This document will be referred to under agenda item 3/Annex/Part B Programme of Work for the ScC: Aquatic Species Conservation Issues.

GOBIERNO DE LA REPÚBLICA DOMINICANA
MEDIO AMBIENTE

Santo Domingo, D.N.
13 de Agosto de 2024

MMARN-INT-2024-07641

Señora
Amy Fraenkel
Secretaria Ejecutiva
Convenio para la Conservación de Especies Migratorias de Animales Silvestres (CMS)
Su Despacho.-

Asunto: Respuesta solicitudes de contribuciones explotación minera en suelo marino, ruido marino y especies migratorias acuáticas

Distinguida Señora Fraenkel:

Cortésmente, el Ministerio de Medio Ambiente y Recursos Naturales de la República Dominicana, como Punto Focal Nacional del Convenio para la Conservación de Especies Migratorias de Animales Silvestres, comúnmente conocido como "Convenio de Bonn" o "CMS" por sus siglas en inglés, tiene a bien responder las siguientes notificaciones:

1. Notificación No. **2024/012**, de fecha 3 de junio de 2024, concerniente al "**Ruido marino**", cuya fecha límite fue el 30 de junio de 2024;

2. Notificación No. **2024/013**, de fecha 3 de junio de 2024, concerniente a las "**Actividades de explotación de minerales en aguas profundas y especies migratorias**", cuya fecha límite de respuesta fue el 30 de junio de 2024;

3. Notificación No. **2024/016**, de fecha 12 de junio de 2024, concerniente a la "**Evaluación de los efectos acumulativos**", cuya fecha límite de respuesta fue el 30 de junio de 2024;

Sobre el particular, amablemente se comparte en anexo un breve informe elaborado por el equipo técnico del Viceministerio de Cambio Climático y Sostenibilidad, que responde a las cuestiones más importantes sobre la explotación minera del suelo marino, el ruido marino y las especies migratorias en las aguas que se encuentran o transitan por las aguas de la República Dominicana.

Con sentimientos de consideración y estima, reciba saludos cordiales.

Atentamente,

Miguel Ceara Hatton
Ministro

Ministerio de Medio Ambiente y Recursos Naturales · R.D. ·

MCH/MDC/MC/ec
Anexo: Citado.

GOBIERNO DE LA
REPÚBLICA DOMINICANA

MEDIO AMBIENTE

Santo Domingo, D.N.
7 de agosto de 2024

Señora,
Amy Fraenkel
Secretario Ejecutivo
Convenio para la Conservación de Especies Migratorias de Animales Silvestres (CMS)
Su Despacho.-

Ref.: Respuesta a solicitudes de contribuciones sobre explotación minera en el suelo marino, ruido marino y especies migratorias acuáticas

Distinguida señora Fraenkel,

Luego de extenderle un cordial saludo, por medio del presente, el Ministerio de Medio Ambiente y Recursos Naturales de la República Dominicana, como Punto Focal Nacional del Convenio para la Conservación de Especies Migratorias de Animales Silvestres, comúnmente conocido como "Convenio de Bonn" o "CMS" por sus siglas en inglés, tiene a bien responder las siguientes notificaciones:

1. Notificación No. **2024/012**, de fecha 3 de junio de 2024, concerniente al "***Ruido marino***", cuya fecha límite fue el 30 de junio de 2024;
2. Notificación No. **2024/013**, de fecha 3 de junio de 2024, concerniente a las "***Actividades de explotación de minerales en aguas profundas y especies migratorias***", cuya fecha límite de respuesta fue el 30 de junio de 2024;
3. Notificación No. **2024/016**, de fecha 12 de junio de 2024, concerniente a la "***Evaluación de los efectos acumulativos***", cuya fecha límite de respuesta fue el 30 de junio de 2024;

Sobre el particular, les compartimos como anexo al presente un breve informe elaborado por nuestro equipo técnico que responde a las cuestiones más importantes sobre la explotación minera del suelo marino, el ruido marino y las especies migratorias en las aguas que se encuentran o transitan por las aguas de la República Dominicana.

Sin otro particular, y reiterándonos a la orden para continuar brindando apoyo en estos asuntos, se despide con alta estima y aprecio,

Atentamente,

Miguel Ceara Hatton
Ministro

MCH/MDC/MC/ec
Anexo: Informe con contribuciones del Ministerio de Medio Ambiente y Recursos Naturales sobre la explotación minera del suelo marino, el ruido marino y su relación con las especies migratorias en las aguas de la República Dominicana.

Informe sobre la explotación minera del suelo marino, el ruido marino y su relación con las especies migratorias en las aguas de la República Dominicana.

La exploración del fondo marino para la minería es una actividad que se realiza desde hace años en aguas internacionales, para estudiar la presencia de diversos recursos minerales esenciales para desarrollar las nuevas tecnologías emergentes del siglo XXI, siendo el cobre, níquel, cobalto y manganeso los más abundantes. Estos minerales se encuentran en "nódulos", "costras" y "sulfuros" distribuidos por toda la superficie del suelo marino, normalmente en aguas abisales que superan los tres mil metros de profundidad.

Esto ha llevado a la Organización de las Naciones Unidas a crear un organismo que se encargue de regular las actividades del fondo marino en aguas internacionales. La Autoridad de los Fondos Marino (en lo adelante "ISA", por sus siglas en inglés) fue fundada en 1994 con el propósito de dar cumplimiento a la parte XI de la Convención de las Naciones Unidas sobre el Derecho del Mar (CONVEMAR), incluyendo, regular la exploración y explotación de los recursos minerales del fondo marino para evitar daños ambientales y garantizar la distribución equitativa de los beneficios derivados de estas actividades. Durante los últimos años, estas actividades se han visto presionadas por algunos países y grandes capitales privados para acelerar la elaboración de la reglamentación faltante para las exploraciones con el fin de comenzar la explotación de estos recursos minerales. Existe una disputa internacional sobre el tema y actualmente la ISA se encuentra culminando la revisión e instrumentación de las regulaciones necesarias para comenzar con la explotación.

Estas actividades mineras y antropogénicas marinas como el transporte de bienes, la perforación de fuentes de hidrocarburos y la pesca indiscriminada, presentan riesgos ecológicos para la vida marina, pilar fundamental de la cadena trófica. Los océanos almacenan alrededor del veintitrés por ciento (23%) de los gases de efecto invernadero (GEI) y absorben un noventa por ciento (90%) del exceso de temperatura atmosférica causada por el cambio climático, según datos del Panel Intergubernamental para el Cambio Climático (en lo adelante, "IPCC" por sus siglas en inglés) (2021). Esta capacidad de los mares y océanos de contrarrestar los efectos del cambio climático depende altamente de su biodiversidad y ecosistemas.

La biodiversidad marina contribuye a la regulación del clima al influir en los ciclos de carbono y nutrientes. Se ha estudiado cómo estas actividades antropogénicas afectan esta capacidad de los ecosistemas marinos, siendo una de las preocupaciones el ruido marino y la destrucción de hábitats y rutas marinas de especies migratorias. Desde 2011, la Organización Mundial de la Salud (OMS) considera el ruido marino como un contaminante global, y en 2008, la Unión Europea incluyó el ruido submarino en la Directiva Marco sobre la Estrategia Marina como una forma específica de contaminación. Introdujeron el término "contaminación acústica marina" para

describir cualquier fuente sonora de origen humano que se emita en el medio marino y que pueda causar efectos negativos en la vida marina (Directive - 2008/56 - EN - EUR-LEX).

La República Dominicana es hábitat de varias especies de mamíferos acuáticos como la ballena jorobada y el manatí antillano, especies que no tienen un hábitat estacionario, sino que migran por los vastos mares y océanos a lo largo de su vida. Estos animales no solo representan una insignia turística y ecológica del país, sino que son parte fundamental de los ecosistemas marinos. Una de las amenazas para estas especies son las actividades antropogénicas mencionadas, incluido el ruido marino, el cual está bien documentado por su efecto negativo en las especies marinas, principalmente en peces y mamíferos marinos, generando un alto estrés que puede inducir hasta la muerte (Chahouri et al., 2022).

Explotación del suelo marino: ¿Qué se sabe?

La revolución industrial y tecnológica han acelerado en desmedida la producción científica con el propósito de poder tener más recursos para la humanidad. Uno de los problemas más grandes que hemos enfrentado debido a esto es el cambio climático. Las nuevas tecnologías emergentes del siglo XXI que tienen un foco renovable como paneles solares, baterías de carros eléctricos entre otras cosas, requieren la disponibilidad de los materiales necesarios para su creación. Desde hace más de un siglo que la cartografía oceánica empezó a ser un campo de estudio en el cual han intentado mapear el suelo marino de todo el planeta. Esto ha generado muchos descubrimientos importantes a los cuales podemos sacarle usos aprovechables para la humanidad, como los recursos minerales. La ISA desde su fundación ha creado diversas regulaciones que revisan anualmente sobre el manejo de estos recursos minerales encontrados en aguas internacionales, denominada como "La Zona" en la parte XI de la CONVEMAR.

La ISA regula las actividades de prospección y exploración de tres tipos de recursos:

1. **Nódulos Polimetálicos** (regulación desde el año 2000)
2. **Sulfuros Masivos Polimetálicos** (regulación desde el año 2010)
3. **Cortezas de Ferromanganeso Ricas en Cobalto** (regulación desde el año 2012)

Estos se encuentran distribuidos alrededor del mundo, pero hay una zona específica que se ha descubierto ser bastante rica en estos recursos, y es la zona de fractura Clarion-Clipperton (en lo adelante "CCZ") del Océano Pacífico, estrecho que va desde la costa oeste de México y la isla de Hawái (Ver anexo 1). Las investigaciones de Hein y Koschinsky (2014) revelan que en dicha zona existe una cantidad estimada de veintisiete millones de toneladas de nódulos metálicos.

Existen regulaciones para la exploración de los recursos minerales de La Zona. También existe un borrador de reglamento de explotación. Sin embargo, existen regulaciones indispensables que están pendientes de elaborar, tales como la repartición de los beneficios, en el entendido de que los recursos de La Zona se constituyen en un patrimonio común de la humanidad, umbrales de tolerancia ambientales para el ruido, toxicidad, luminosidad y turbidez, que garantizan la

explotación sostenible y el cumplimiento del principio de conservación ambiental contenido en la parte XI del CONVEMAR, entre otros. Además, no existe certeza científica sobre los impactos de la minería de aguas profundas y de las implicaciones sobre la biodiversidad asociada.

Las profundidades marinas abisales son uno de los ecosistemas menos estudiados de todo el mundo. Los esfuerzos de los científicos en conocer la actividad ecosistémica que sucede en la Zona vienen del interés de la extracción de los recursos presentes. Estudios recientes demuestran que los nódulos polimetálicos en la CCZ desempeñan un papel crucial en la ecología de la zona abisal, sustentando diversas comunidades microbianas y macrofaunales, y son esenciales para la integridad de la red trófica (J. R. Hein & Koschinsky, 2014). La minería de estos nódulos podría tener impactos ecológicos significativos, subrayando la necesidad de enfoques de gestión y conservación cuidadosos.

Científicos profesionales del área que han sido responsables de llevar a cabo las investigaciones de exploración en la zona publicaron una carta en el portal de revista *Nature*, advirtiendo sobre la pérdida de biodiversidad que representaría la minería en la zona, la cual no podría ser recuperada (J. R. Hein & Koschinsky, 2014). Esto es un riesgo alarmante que no se puede ignorar, la ISA trabaja activamente en las regulaciones necesarias para realizar las actividades de extracción mineral sostenible, sin llevarse el ecosistema.

Legislación internacional

La ISA ha firmado contratos de 15 años para la exploración de nódulos polimetálicos ("PMN", por sus siglas en inglés), sulfuros polimetálicos ("PMS", por sus siglas en inglés) y costras de ferromanganeso ricas en cobalto ("CFC", por sus siglas en inglés) en el lecho marino profundo con veintidós contratistas, y actualmente existen treinta contratos activos.

Antes de comenzar su programa de actividades bajo el contrato, cada contratista también debe presentar al secretario general un plan de contingencia para responder eficazmente a los incidentes que surjan de sus actividades en el área de exploración. Cada año, estos contratistas deben presentar los resultados de su investigación a la ISA en forma de reportes anuales con la intención de recoger la información necesaria en la redacción de las regulaciones.

Diecinueve de estos contratos son para la exploración de nódulos polimetálicos en la Zona de Fractura Clarion-Clipperton (17), la Cuenca del Océano Índico Central (1) y el Océano Pacífico Occidental (1). Además, existen siete contratos para la exploración de sulfuros polimetálicos en la Dorsal Suroeste del Índico, la Dorsal Central del Índico y la Dorsal Mesoatlántica, y cuatro contratos para la exploración de costras ricas en cobalto en el Océano Pacífico Occidental (International Seabed Authority, 2024) (Ver anexo 2).

Este acto creó un vacío legal, ya que la ISA se vio forzada a apresurar la creación de regulaciones o enfrentar la posibilidad de que las empresas mineras operen sin un marco regulatorio claro, lo cual ha generado preocupaciones significativas sobre la protección ambiental y la sostenibilidad de la explotación minera en el fondo marino, entre ellos, más de 20 países, científicos expertos, activistas climáticos, entre otros (Ver anexo 3).

La medida ha sido criticada por científicos y organizaciones ambientales que advierten sobre los riesgos de la minería en el fondo marino sin un marco regulatorio adecuado. Las preocupaciones incluyen la pérdida de biodiversidad, la destrucción de hábitats marinos y el impacto negativo en los ecosistemas.

Posicionamiento de la República Dominicana

La República Dominicana ha adoptado una postura firme contra la explotación minera en los fondos marinos, especialmente en la Zona de Fractura Clarion-Clipperton (CCZ), sin las garantías de cumplimiento del artículo 155 de la parte XI de la CONVEMAR, relativo a la protección del medio marino. Durante la sesión número 28 del Consejo de la Autoridad Internacional de los Fondos Marinos, el país instó a una pausa en las actividades mineras para asegurar que un marco legal adecuado esté en lugar, fundamentado en suficientes evidencias científicas y evaluaciones de impacto ambiental rigurosas.

El embajador dominicano Edward Aníbal Pérez Reyes, representante permanente de la República Dominicana ante la ISA, argumentó que la minería en aguas profundas podría llevar a la extinción de especies únicas y afectar gravemente la biodiversidad marina. La República Dominicana enfatiza la necesidad de administrar y conservar los recursos marinos de manera sostenible para el beneficio de las generaciones presentes y futuras, alineándose con principios ecológicos y legislativos nacionales.

Además, la nación caribeña subraya la importancia de aplicar el enfoque ecosistémico y el principio de "quien contamina paga", promoviendo la protección del medio ambiente marino ante la amenaza de actividades mineras no reguladas. Esta postura refleja un compromiso con la preservación de la biodiversidad y la sostenibilidad de los océanos.

La República Dominicana, junto con otros veintiséis (26) países, representan la principal fuerza en contra de estas actividades de explotación mineral, solicitando una pausa de precaución por quince (15) años, para dar tiempo a los expertos en recolectar la información necesaria sobre el hábitat y lo que representaría la extracción de minerales para el mundo (Ver anexo 3). La República Dominicana no ha emitido permisos de exploración minera y en su normativa nacional no lo contempla hasta la fecha dentro de sus aguas jurisdiccionales, sin embargo, este tipo de actividades pueden desarrollarse mediante la aplicación de las siguientes normativas: (i) Artículo 3 de la Ley 100-13, que Crea el Ministerio de Energía y Minas; (ii) título I de la Ley Minera 146 del año 1971; y (iii) el Capítulo I del Reglamento No. 207-98 para la aplicación de la Ley Minera antes mencionada.

Ruido Marino: Situación actual en RD

La República Dominicana, al ser una isla, gran parte de su territorio se encuentra rodeado de un cuerpo marino. Nuestras costas son hábitats para numerosas especies, siendo parte de un punto caliente de la biodiversidad del mundo (De Recursos Naturales, 2019) y a pesar de esto, no contamos con regulación marina sonora.

La administración pública se ha visto pobre en relación a este tema y ha generado dudas sobre la capacidad del Ministerio de Medio Ambiente y Recursos Naturales para gestionar adecuadamente estos recursos. También el turismo de ballenas en Samaná se ha visto descontrolado por la cantidad de lanchas que transitan la zona, aunque estas actividades se

encuentren reguladas, la población local ha visto como cada año aumentan la cantidad de turistas que visitan el área para ver a las ballenas. Esta actividad tan sublime atrae mucha inversión privada, y ya se han reportado planes de construcción de puertos turísticos para traer hasta más de medio millón de turistas al año (Listín Diario, 2023). Hasta el momento, se

desconoce si las ballenas jorobadas que visitan la bahía de Samaná se ven perturbadas por la contaminación acústica (Vallejo & Vallejo, 2024).

Medidas de mitigación

En la República Dominicana, se implementan varias medidas para mitigar el impacto turístico en las ballenas jorobadas en la Bahía de Samaná. Estas incluyen la navegación a baja velocidad de las embarcaciones al ingresar a la bahía, un protocolo estricto para la observación de ballenas que exige monitoreo y vigilancia, y un límite en el número de embarcaciones permitidas para estas actividades, con horarios específicos para la observación. Estas medidas buscan proteger a las ballenas y garantizar un turismo sostenible (Ver anexo 6).

A pesar de que la Ley 64-00 sobre Medio Ambiente y Recursos Naturales reconoce la interacción del ruido con el medio como un contaminante, estas regulaciones se limitan a la Bahía de Samaná, y en la actualidad el país no cuenta con una regulación general activa del ruido marino, por lo que se encuentra a disposición del Ministerio Ambiente junto a la Comisión Nacional Antruido desarrollar un plan de gestión y regulación que comprenda el ruido en el medio marino.

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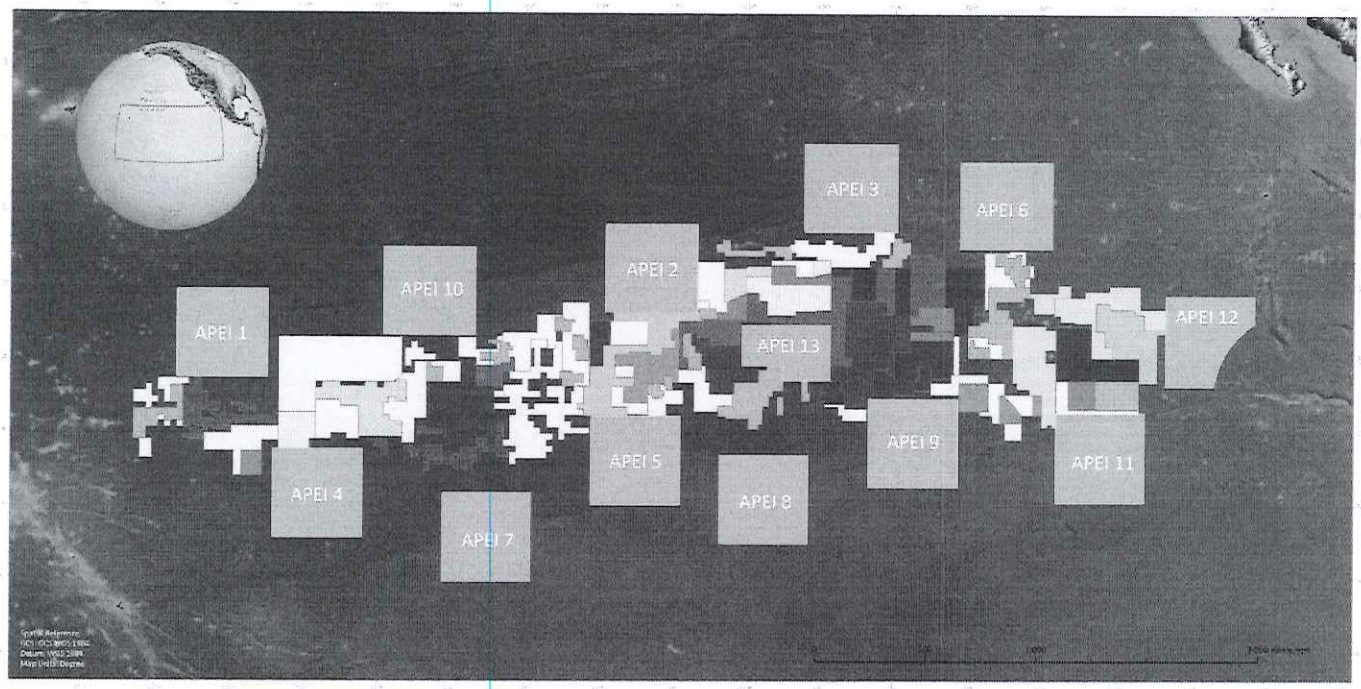
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ANEXOS

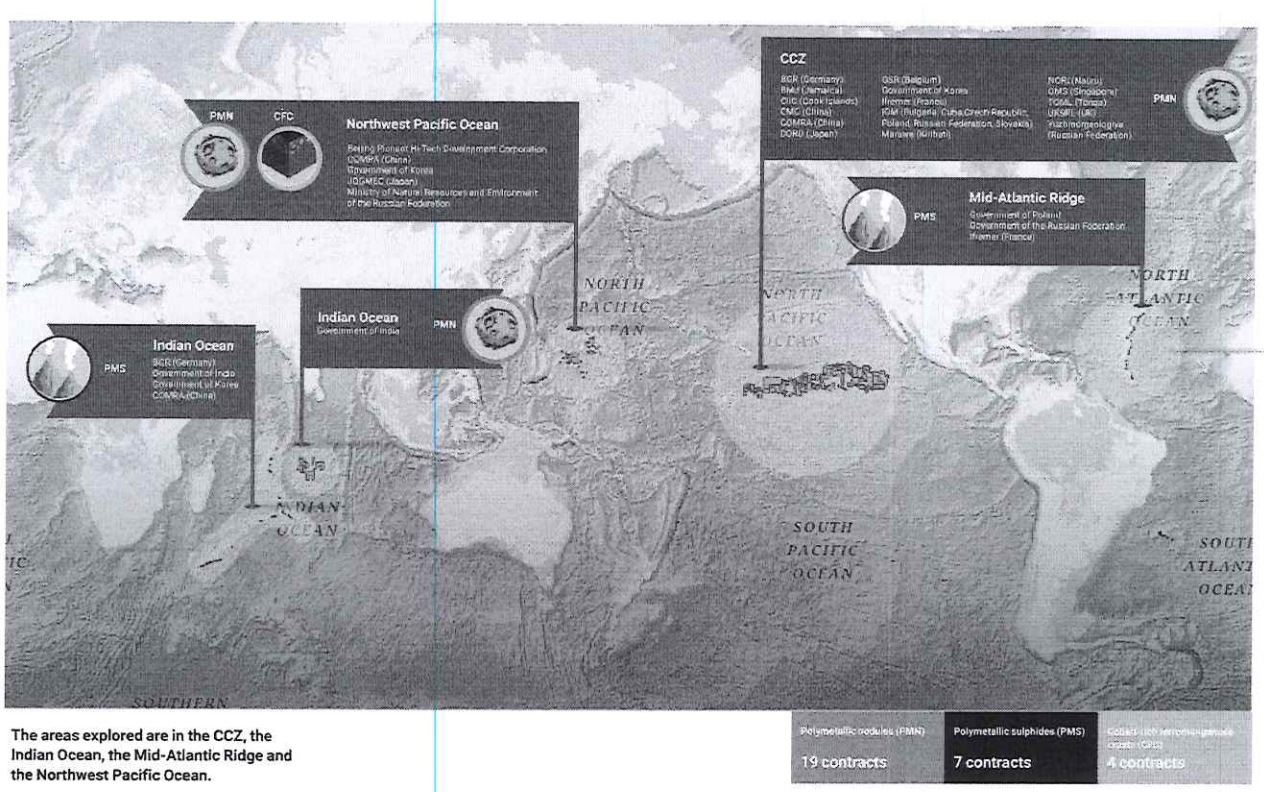
Anexo 1: Mapa del manejo de la zona Clarion-Clipperton (International Seabed Authority, 2024)



Clarion-Clipperton Fracture Zone Exploration and Reserved Areas for Polymetallic Nodules

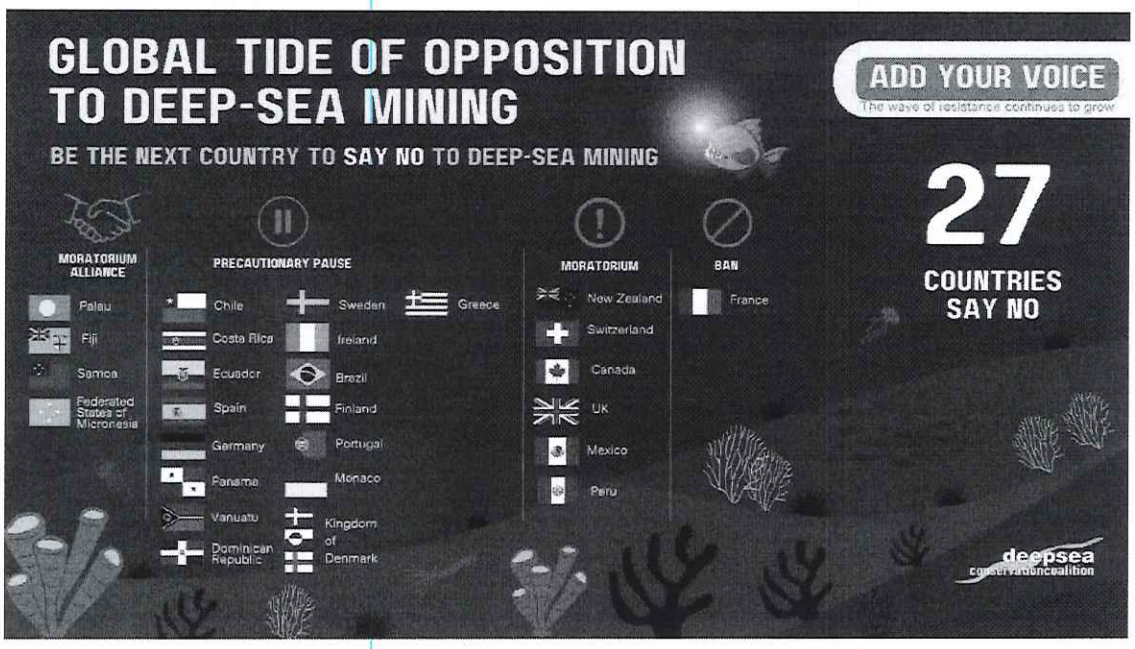
- Tonga Offshore Mining Limited (TOML; Tonga)
- Federal Institute for Geosciences and Natural Resources of the Federal Republic of Germany (BGR; Germany)
- Blue Minerals Jamaica Ltd (BMJ; Jamaica)
- Yuzhmorgeologiya (Russian Federation)
- Cook Islands Investment Corporation (CIIC; Cook Islands)
- China Minmetals Corporation (CMC; China)
- China Ocean Mineral Resources Research and Development Association (COMRA; China)
- Deep Ocean Resources Development Co. Ltd. (DORD; Japan)
- Global Sea Mineral Resources NV (GSR; Belgium)
- Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER; France)
- Interoceanmetal Joint Organization (IOM; Bulgaria, Cuba, Czechia, Poland, Russian Federation and Slovakia)
- Government of the Republic of Korea
- Marawa Research and Exploration Ltd (Kiribati)
- Nauru Ocean Resources Inc. (NORI; Nauru)
- Ocean Mineral Singapore PTE Ltd. (OMS; Singapore)
- UK Seabed Resources Ltd. (UKSRL; UK)
- Reserved Areas
- Areas of Particular Environmental Interest (APEIs)

Anexo 2: Áreas de exploración del fondo marino en aguas internacionales (International Seabed Authority, 2024)



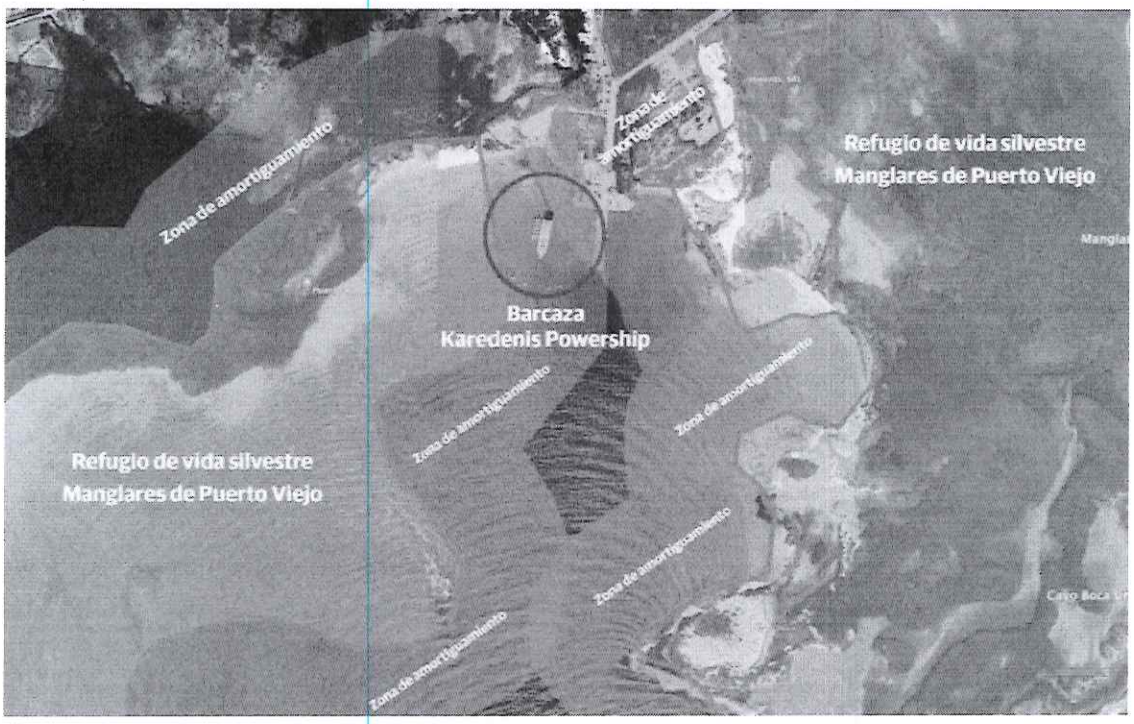
The areas explored are in the CCZ, the Indian Ocean, the Mid-Atlantic Ridge and the Northwest Pacific Ocean.

Anexo 3: Países en oposición parcial o total de la minería del fondo marino (Deep Sea Conservation Coalition, 2024)



Anexo 4: Video conceptual, minería del fondo marino - https://vimeo.com/898123651

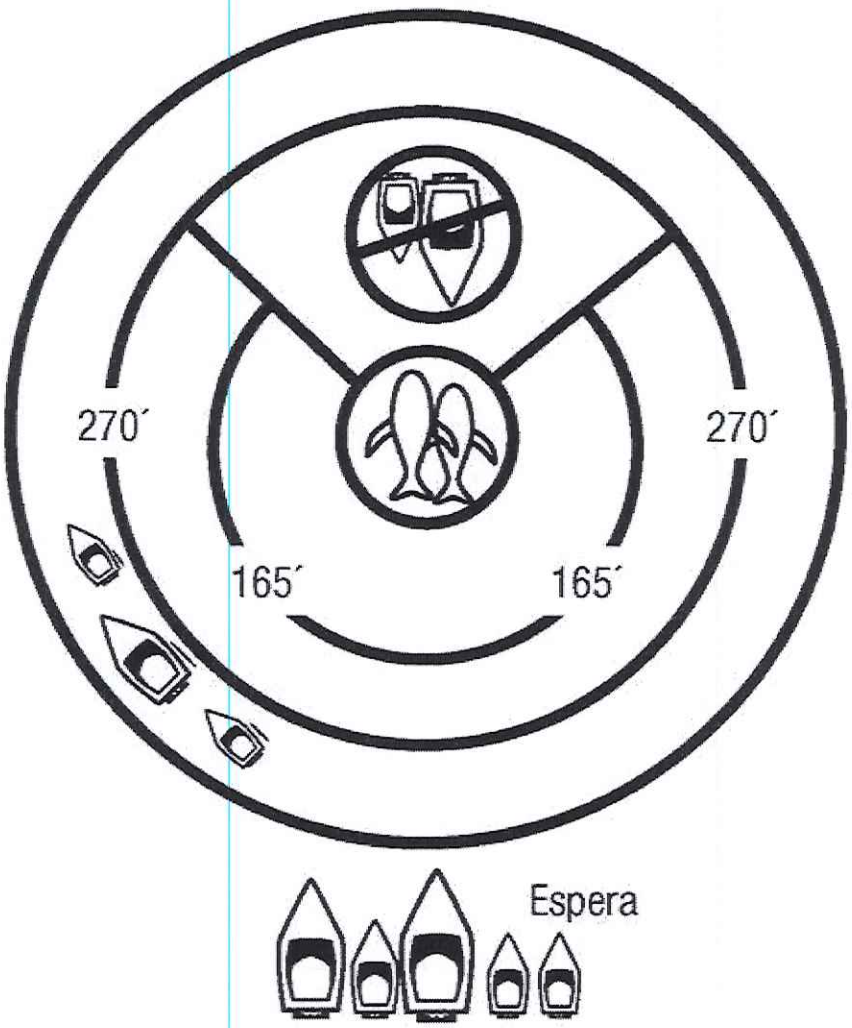
Anexo 5: Zona de amortiguamiento del Refugio de Vida Silvestre Manglares de Puerto Viejo (Brito, 2023)



Fuente: Publicación de Diario Libre, 2 de noviembre de 2022; *Barcazas de Azua: ¿estarán o no dentro de un área protegida?* (Por Marvin del Cid).

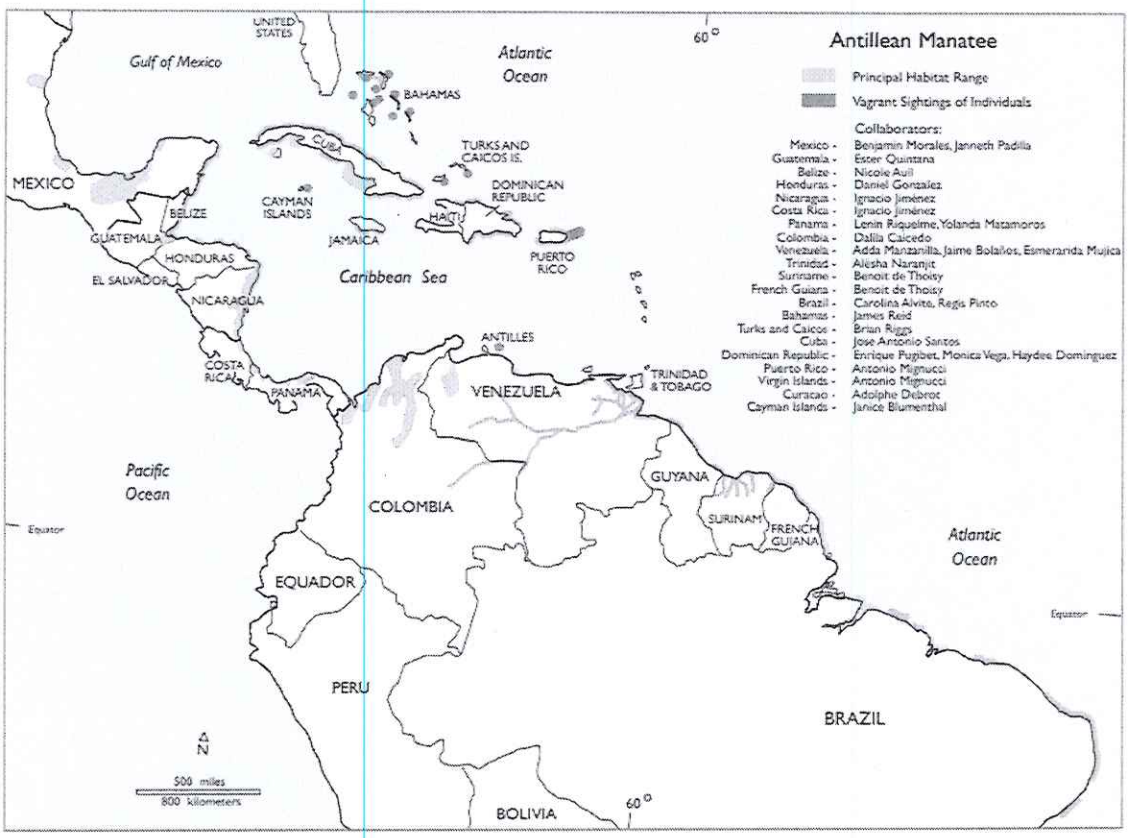
Anexo 6: Ilustración conceptual de las regulaciones de navegación al turismo de ballenas, Samaná (Vallejo & Vallejo, 2024)

Representación esquemática del sistema de regulaciones de observación de ballenas



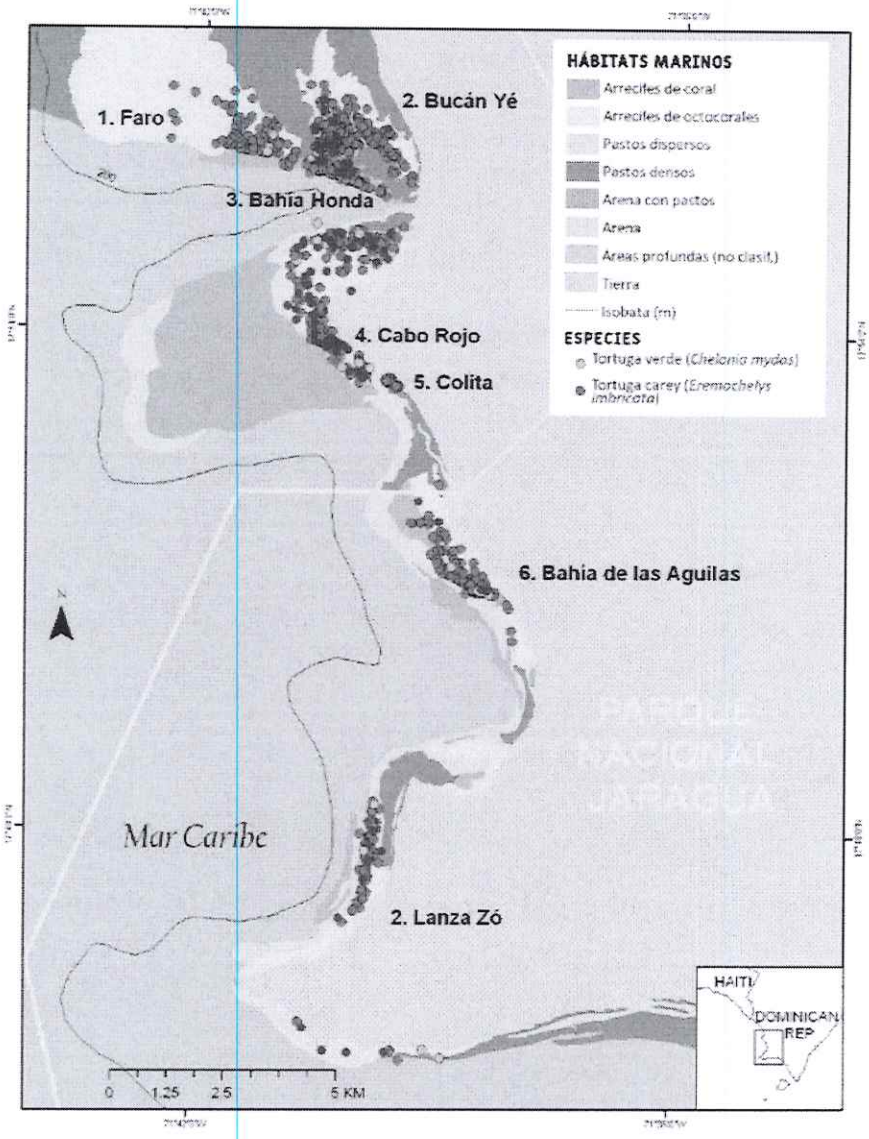
Fuente: Ministerio de Medio Ambiente y Recursos Naturales (MIMARENA) Adaptado por Lully Luis Reyes-elDinero

Anexo 7: Mapa de distribución del manatí antillano (*Trichechus manatus manatus*) (Hines, 2012)



Map 4.1. Antillean manatee distribution. (Map by Ellen McElhinny.)

Anexo 8: Distribución de capturas/recapturas de tortugas juveniles de carey y tortuga verde en el área del Oeste del PN Jaragua y Cabo Rojo (Grupo Jaragua).



Disclaimer: This document, originally prepared in Spanish, has been automatically translated using an online tool. Refer to the original Spanish content as the primary source of information.

Santo Domingo, D.N.
August 13, 2024

MMARN-INT-2024-07641

Madam
Amy Fraenkel
Executive Secretary
Convention for the Conservation of Migratory Species of Wild Animals (CMS) Your Office.

Subject: Replies to requests for contributions on seafloor mining, marine noise and aquatic migratory species

Distinguished Mrs. Fraenkel,

Politely, the Ministry of Environment and Natural Resources of the Dominican Republic, as National Focal Point of the Convention for the Conservation of Migratory Species of Wild Animals, commonly known as the "Bonn Convention" or "CMS", has or reply to the following notifications:

1. Notification No. **2024/012,** dated 3 June 2024, Relative to the **"Noise marine",** whose deadline was June 30, 2024;
2. Notification No. 2024/013, dated June 3, 2024, concerning **"Deep-sea mineral exploitation activities and** migratory species", whose response deadline was June 30, 2024;
3. Notification No. **2024/016,** dated June 12, 2024, concerning the **"Assessment of cumulative effects",** whose deadline for response was June 30, 2024;

In this regard, a brief report prepared by the technical team of the Vice-Ministry of Climate Change and Sustainability is kindly shared in the annex, which responds to the most important questions about the mining of the seabed, marine noise and migratory species in the waters that are or are not in the waters. transit through the waters of the Dominican Republic.

With sentiments of consideration and esteem, receive cordial greetings.

Atentamente,

Miguel Ceara Hatton
Ministro

Ministerio de Medio Ambiente y Recursos Naturales • R.D. •

Santo Domingo,
D.N. August 7,
2024

Madam
Amy Fraenkel
Executive
Secretary
Convention for the Conservation of Migratory Species of Wild Animals (CMS)
Your Office.

Ref.: Response to requests for contributions on seabed mining. Marine noise and aquatic migratory species

Distinguished Mrs. Fraenkel,

After extending a cordial greeting, through this letter, the Ministry of Environment and Natural Resources of the Dominican Republic, as National Focal Point of the Convention for the Conservation of Migratory Species of Wild Animals, commonly known as the "Bonn Convention" or "CMS", is kindly pleased to respond to the following notifications:

1. Notification No. **2024/012,** dated June 3, 2024, concerning the ***"Noise marine',*** whose deadline was June 30, 2024;
2. Notification No. **2024/013,** Date 3 June of 2024, concerning to the ***"Deep-water mineral exploitation activities and migratory species",*** whose deadline of Answer was on June 30, 2024;
3. Notification No. **2024/016,** dated June 12, 2024, concerning the ***"Assessment of cumulative effects",*** whose deadline for response was June 30, 2024;

In this regard, we share as an annex to this document a brief report prepared by our technical team that responds to the most important questions about the mining of the seabed, marine noise and migratory species in the world the waters that are in or transit through the waters of the Dominican Republic.

Without any other particular, and reiterating the order to continue providing support in these matters, it is said goodbye with high esteem and appreciation,

Kind regards

Miguel Ceara Hatton
Minister

Report on the mining of the seafloor, marine noise and its relationship with migratory species in the waters of the Dominican Republic.

The exploration of the seabed for mining is an activity that has been carried out for years in international waters, to study the presence of various essential mineral resources to develop the new emerging technologies of the 21st century, with copper, nickel, cobalt and manganese being the most abundant. These minerals are found in "nodules", "crusts" and "sulfides" distributed throughout the surface of the seabed, usually in abyssal waters that exceed three thousand meters deep.

This has led the United Nations to create an agency to regulate seabed activities in international waters. The Seabed Authority (ISA) was founded in 1994 with the purpose of comply with Part XI of the United Nations Convention on the Law of the Sea (UNCLOS), including regulating the exploration and exploitation of seabed mineral resources to avoid environmental damage and ensure the equitable distribution of the benefits derived from these activities. In recent years, these activities have been pressured by some countries and large private capitals to speed up the development of the missing regulations for exploration in order to begin the exploitation of these mineral resources. It exists an international dispute on the subject and the ISA is currently completing the review and implementation of the regulations necessary to begin exploitation.

These marine mining and anthropogenic activities such as the transport of goods, the drilling of hydrocarbon sources and indiscriminate fishing, present ecological risks to marine life, a fundamental pillar of the food chain. The oceans store about twenty-three percent (23%) of greenhouse gases (GHGs) and absorb ninety percent (90%) of the excess atmospheric temperature caused by climate change, according to data from the Intergovernmental Panel on Climate Change (IPCC) (2021). This ability of the seas and oceans to counteract the effects of climate change is highly dependent on their biodiversity and ecosystems.

Marine biodiversity contributes to climate regulation by influencing carbon and nutrient cycles. How these anthropogenic activities affect this capacity of marine ecosystems has been studied, with marine noise and the destruction of habitats and marine routes of migratory species being one of the concerns. Since 2011, the World Health Organization (WHO) has considered marine noise as a global pollutant, and in 2008, the European Union included underwater noise in the Marine Strategy Framework Directive as a specific form of pollution. They introduced the term "marine noise pollution" to describe any sound source of human origin emitted into the marine environment that may cause negative effects on marine life (Directive - 2008/56 - EN - EUR-LEX)).

The Dominican Republic is home to several species of aquatic mammals such as the humpback whale and the West Indian manatee, species that do not have a stationary habitat, but migrate through the vast seas and oceans throughout their lives. These animals not only represent a tourist and ecological emblem of the country, but are also a fundamental part of marine ecosystems. One of the threats to these species is the aforementioned anthropogenic activities, including marine noise, which is well documented for its negative effect on marine species, mainly fish and marine mammals, generating high stress that can even induce death (Chahouri et al., 2022).

Exploitation of the seafloor: What is known?

The industrial and technological revolution have disproportionately accelerated scientific production in order to have more resources for humanity. One of the biggest problems what we have faced because of is climate change. New emerging technologies of the twenty-first century that have a renewable focus such as solar panels, electric car batteries among other things, require the availability of the necessary materials for their creation. For more than a century, ocean mapping has become a field of study in which they have tried to map the seafloor of the entire planet. This has generated many important discoveries from which we can extract uses that can be exploited by humanity, such as mineral resources. Since its foundation, the ISA has created various regulations that annually review the management of these mineral resources found in international waters, referred to as "The Zone" in Part XI of UNCLOS.

The ISA regulates prospecting and exploration activities for three types of resources:

1. **Polymetallic Nodules** (regulation since 2000)
2. **Polymetallic Massive Sulphides** (regulation since 2010)
3. **Cobalt-rich Fermanganese barks** (regulation since 2012)

These are distributed around the world, but there is a specific area that has been found to be quite rich in these resources, and that is the Cyarian-Clipperton fracture zone (hereinafter "CCZ") of the Pacific Ocean, a strait that runs from the west coast of Mexico and the island of Hawaii (See annex 1). The research of Hein and Koschinsky (2014) reveals that there is an estimated amount of twenty-seven million tons of metal nodules in this area.

There are regulations for the exploration of the mineral resources of the Zone. There is also a draft operating regulation. However, there are essential regulations that are pending elaboration, such as the distribution of benefits, on the understanding that the resources of the Zone constitute a common heritage of humanity, environmental tolerance thresholds for noise, toxicity, luminosity and turbidity, that guarantee the sustainable exploitation and compliance with the principle of environmental conservation contained in the part XI of UNCLOS, among others. In addition, there is no scientific certainty about the impacts of deep-sea mining and the associated implications for biodiversity.

The deep-sea abyssal is one of the least studied ecosystems in the world. The efforts of scientists to know the ecosystem activity that occurs in the Zone come from the interest of the extraction of the present resources. Recent studies show that polymetallic nodules in the CCZ play a crucial role in the ecology of the abyssal zone, supporting diverse microbial and macrofaunal communities, and are essential for the integrity of the food web (J. R. Hein & Koschinsky, 2014). Mining these nodules could have significant ecological impacts, underscoring the need for sustainable approaches to of careful management and conservation.

Professional scientists in the area who have been responsible for carrying out exploration research in the area published a letter on the portal of the journal *Nature,* warning about the loss of biodiversity that mining in the area would represent, which could not be recovered (J. R. Hein & Koschinsky, 2014). This is an alarming risk that cannot be ignored, the ISA is actively working on the necessary regulations to carry out sustainable mineral extraction activities, without taking away the ecosystem.

International legislation

The ISA has signed 15-year contracts for the exploration of polymetallic nodules ("PMN "), polymetallic sulphides ("PMS") and cobalt-rich ferromanganese crusts ("CFCs") on the deep seabed with twenty-two contractors, and there are currently thirty active contracts.

Before starting its program of activities under the contract, each contractor must also submit to the Secretary General a contingency plan to respond effectively to incidents arising from its activities in the exploration area. Each year, these contractors are required to submit the results of their research to the ISA in the form of annual reports with the intention of collecting the necessary information in the drafting of regulations.

Nineteen of these contracts are for the exploration of polymetallic nodules in the Cyarian-Clipperton Fracture Zone (17), the Central Indian Ocean Basin (1) and the Western Pacific Ocean (1). Plus, they exist seven contracts for the exploration of polymetallic sulphides in the Southwest Indian Ridge, the Central Indian Ridge and the Mid-Atlantic Ridge, and four contracts for the exploration of cobalt-rich crusts in the Western Pacific Ocean (International Seabed Authority, 2024) (See Annex 2).

This act created a legal vacuum, as the ISA was forced to rush the creation of regulations or face the possibility of mining companies operating without a clear regulatory framework, which has raised significant concerns about the environmental protection and sustainability of seabed mining, including: more than 20 countries, expert scientists, climate activists, among others (See Annex 3).

The move has been criticized by scientists and environmental organizations who warn about the risks of seabed mining without an adequate regulatory framework. Concerns include biodiversity loss, destruction of marine habitats, and negative impact on ecosystems.

Positioning of the Dominican Republic

The Dominican Republic has taken a firm stance against deep-sea mining, especially in the Clarion-Clipperton Fracture Zone (CCZ), without the guarantees of compliance with article 155 of Part XI of UNCLOS, on the protection of the marine environment. During the 28th session of the Council of the International Seabed Authority, the country urged a pause in mining activities to ensure that an adequate legal framework is in place, based on sufficient scientific evidence and rigorous environmental impact assessments.

Dominican Ambassador Edward Aníbal Pérez Reyes, the Dominican Republic's permanent representative to the ISA, argued that deep-sea mining could lead to the extinction of unique species and severely affect marine biodiversity. The Dominican Republic emphasizes the need to manage and conserve marine resources in a sustainable manner for the benefit of present and future generations, aligning with national ecological and legislative principles.

In addition, the Caribbean nation underlines the importance of applying the ecosystem approach and the "polluter pays" principle, promoting the protection of the marine environment from the threat of unregulated mining activities. This stance reflects a commitment to preserving biodiversity and the sustainability of the oceans.

The Dominican Republic, along with twenty-six (26) other countries, represent the main force against these mineral exploitation activities, requesting a precautionary pause for fifteen (15) years, to give experts time to collect the necessary information about the habitat and what mineral extraction would represent for the world (See annex 3). The Dominican Republic has not issued permits for mining exploration and its national regulations do not contemplate it to date within its jurisdictional waters, however, this type of activity can be carried out through the application of the following regulations:

(i) Article 3 of Law 100-13, which creates the Ministry of Energy and Mines; (ii) Title I of Mining Law 146 of 1971; and (iii) Chapter I of Regulation No. 207-98 for the application of the aforementioned Mining Law.

Marine Noise: Current situation in the DR

The Dominican Republic, being an island, a large part of its territory is surrounded by a marine body. Our coasts are habitats for numerous species, being part of a hotspot of the world's biodiversity (De Recursos Naturales, 2019) and despite this, we do not have marine noise regulation.

The public administration has been poor in relation to this issue and has raised doubts about the capacity of the Ministry of Environment and Natural Resources to properly manage these resources. Whale tourism in Samaná has also been seen.

The number of tourists visiting the area to see whales increases every year. This sublime activity attracts a lot of private investment, and plans have already been reported to build tourist ports to bring up to more than half a million tourists a year (Listín Diario, 2023). So far, it has been it is unknown if humpback whales that visit Samaná Bay are disturbed by noise pollution (Vallejo & Vallejo, 2024).

Mitigation measures

In the Dominican Republic, several measures are implemented to mitigate the tourist impact on humpback whales in Samaná Bay. These include low-speed navigation of vessels when entering the bay, a strict protocol for whale watching that requires monitoring and surveillance, and a limit on the number of vessels allowed for these activities, with specific times for observation. These measures seek to protect whales and guarantee sustainable tourism (See Annex 6).

Despite the fact that Law 64-00 on the Environment and Natural Resources recognizes the interaction of noise with the environment as a pollutant, these regulations are limited to the Bay of Samaná, and currently the country does not have a general active regulation of marine noise, so it is at the disposal of the Ministry of Environment together with the National Anti-Noise Commission to develop a management and regulation plan that includes the noise in the marine environment.

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GOVERNMENT OF THE
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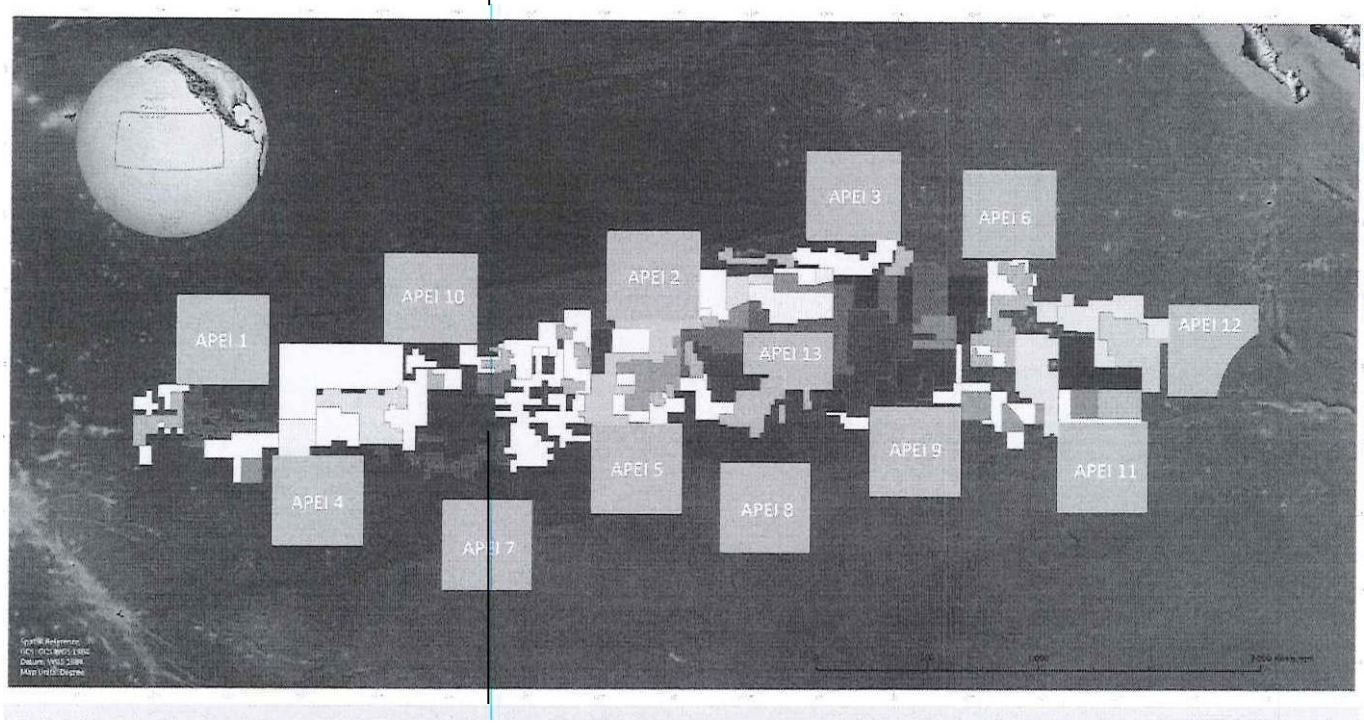
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ANNEXES

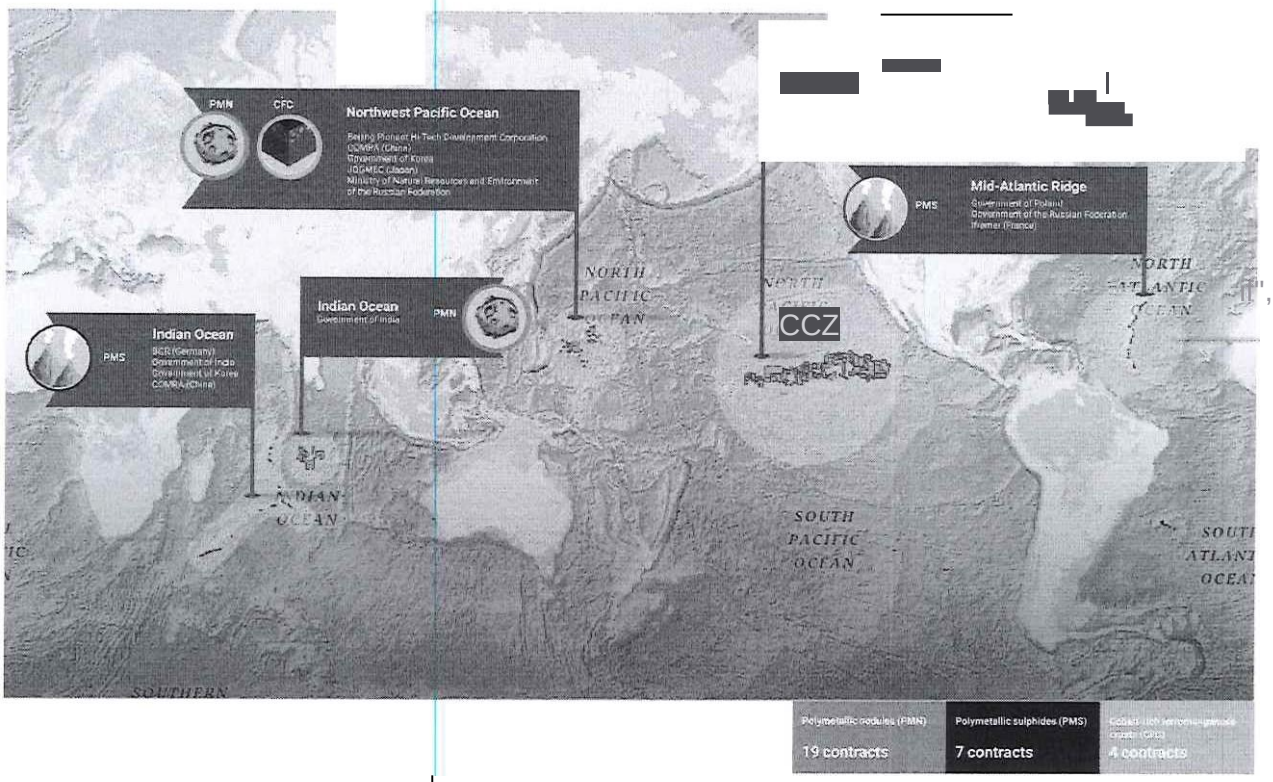
Annex 1: Map of the management of the Clarion-Clipperton zone (International Seabed Authority, 2024)



GOVERNMENT OF THE
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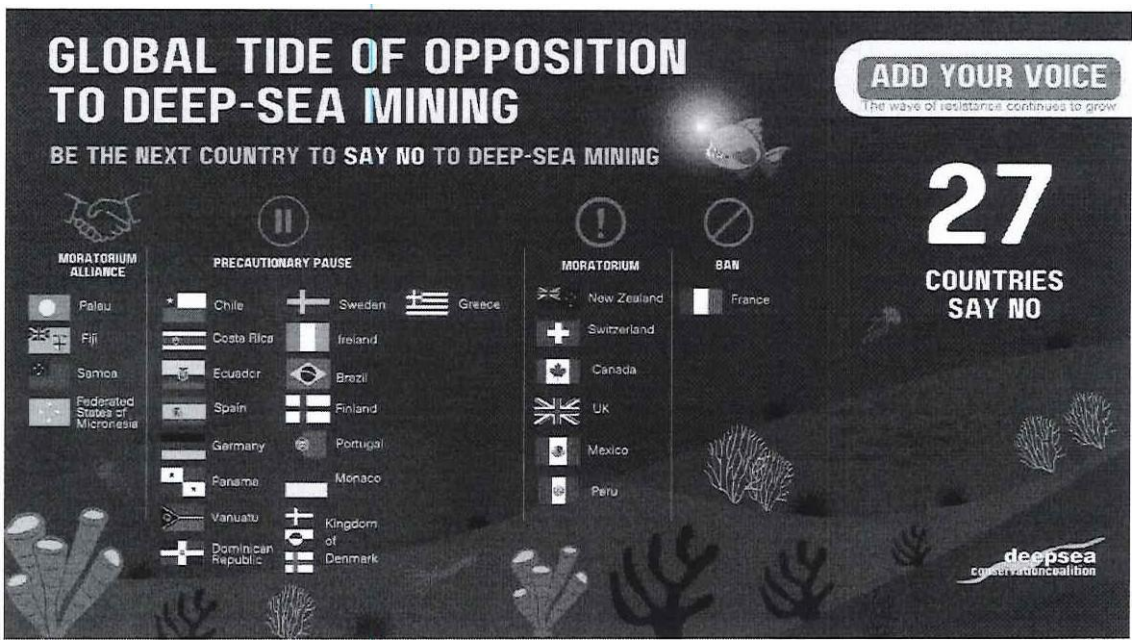
ENVIRONMENT

Annex 2: Seabed Exploration Areas in International Waters (International Seabed Authority, 2024)



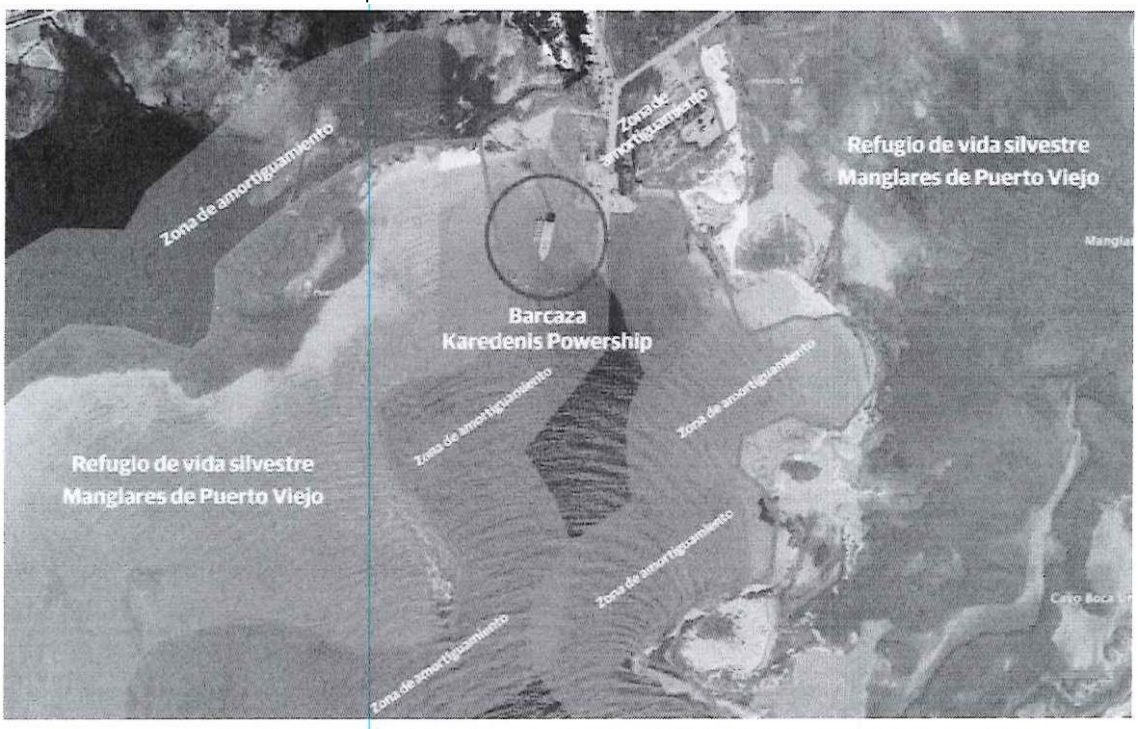
The areas explored are in the CCZ, the Indian Ocean, the Mid-Atlantic Ridge and the Northwest Pacific Ocean.

Annex 3: Countries in partial or total opposition to seafloor mining (Deep Sea Conservation Coalition, 2024)



Annex 4: Concept video, seabed mining- https://vimeo.com/898123651

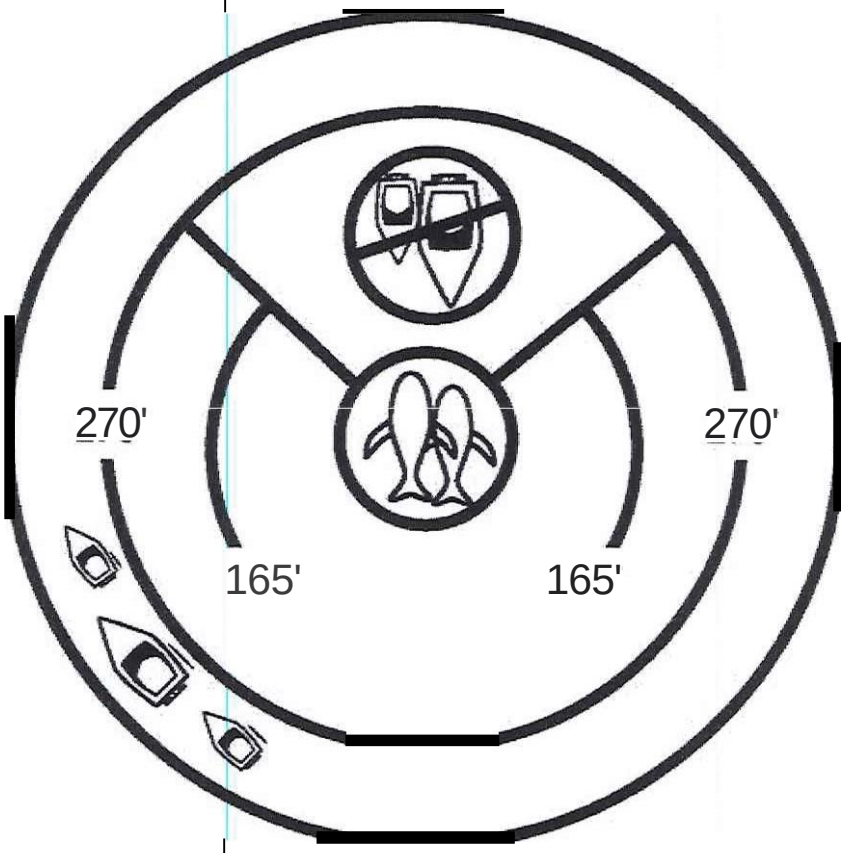
Annex 5: Buffer zone of the Puerto Viejo Mangrove Wildlife Refuge (Brito, 2023)



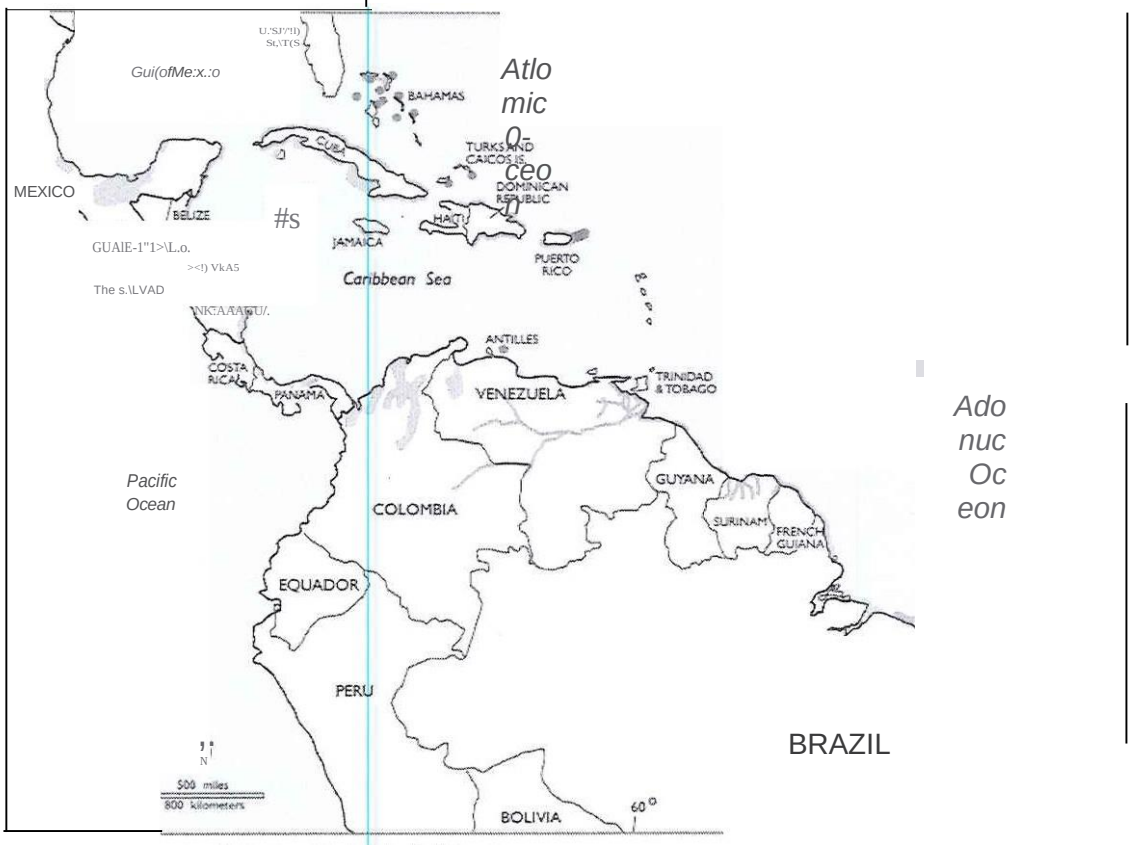
Fuente: Publicación de Diario Libre, 2 de noviembre de 2022; *Barcazas de Azua: ¿estarán o no dentro de un área protegida?* (Por Marvin del Cid).

Annex 6: Conceptual illustration of navigation regulations for whale tourism, Samaná (Vallejo & Vallejo, 2024)

Schematic representation of the whale watching regulation system



Annex 7: Distribution map of the West Indian manatee (*Trichechus manatus manatuS)* (Hines, 2012)

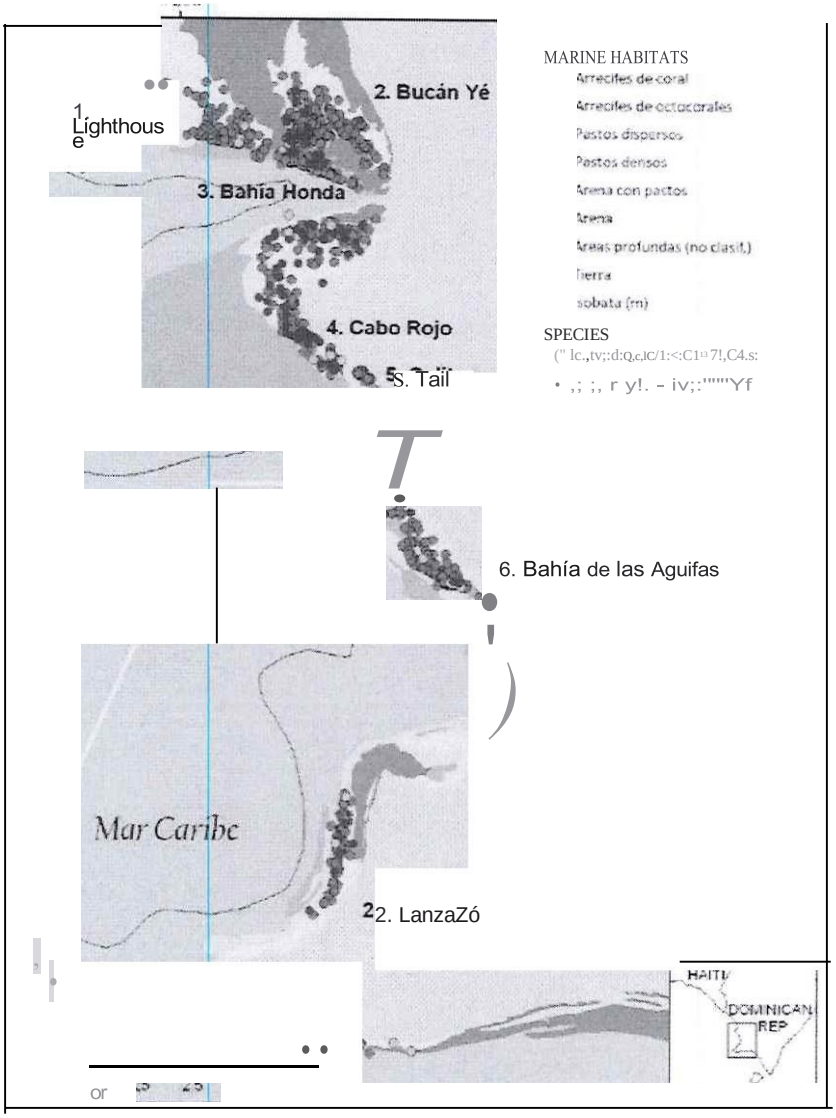


Mzp 4.1.Amíllean man.-itee distribution. (Map tl' Ellen McElhinny.)

GOVERNMENT OF THE
DOMINICAN REPUBLIC

ENVIRONMENT

Annex 8: Distribution of captures/recaptures of juvenile hawksbill and green turtle turtles in the western area of Jaragua and Cabo Rojo NP (Jaragua Group).



From:
To: CMS Secretariat
Subject: FW: CMS Notification 2024/013 | Notification de la CMS 2024/013 | Notificación de la CMS 2024/013
Date: Thursday, 6 June 2024 08:31:29

From:
Sent: 05 June 2024 17:00
To: CMS Secretariat <cms.secretariat@cms.int>
Subject: FW: CMS Notification 2024/013 | Notification de la CMS 2024/013 | Notificación de la CMS 2024/013

Dear Secretariat,

We have forwarded this question to the people responsible for deepsea mining and they have been in contact with our advisor from the Royal Institute for Ocean Research in the Netherlands. She sent the publication attached and this link to a different study: Noise from deep-sea mining may span vast ocean areas | Science. Possibly we will recieve more information later this year, which I will forward.

As you know, information on EIA's can be found on the ISA website: Environmental Impact Assessments - International Seabed Authority (isa.org.jm).

There is also the DeepData Database. The most important function of the database is hosting all data regarding deepseabed activities, especially data which have been gathered by contracters during exploration activities and other relevant data.

With kind regards,
Anne-Marie Svoboda

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ARTICLE OPEN

Climate change to drive increasing overlap between Pacific tuna fisheries and emerging deep-sea mining industry

Diva J. Amon[1,2✉], Juliano Palacios-Abrantes[3], Jeffrey C. Drazen[4], Hannah Lily[5], Neil Nathan[1], Jesse M. A. van der Grient[6] and Douglas McCauley[1]

In ocean areas beyond national jurisdiction, various legal regimes and governance structures result in diffused responsibility and create challenges for management. Here we show those challenges are set to expand with climate change driving increasing overlap between eastern Pacific tuna fisheries and the emerging industry of deep-sea mining. Climate models suggest that tuna distributions will shift in the coming decades. Within the Clarion-Clipperton Zone of the Pacific Ocean, a region containing 1.1 million km^2 of deep-sea mining exploration contracts, the total biomass for bigeye, skipjack, and yellowfin tuna species are forecasted to increase relative to today under two tested climate-change scenarios. Percentage increases are 10–11% for bigeye, 30–31% for skipjack, and 23% for yellowfin. The interactions between mining, fish populations, and climate change are complex and unknown. However, these projected increases in overlap indicate that the potential for conflict and resultant environmental and economic repercussions will be exacerbated in a climate-altered ocean. This has implications for the holistic and sustainable management of this area, with pathways suggested for closing these critical gaps.

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INTRODUCTION

The ocean constitutes 71% of the Earth's surface, and nearly two-thirds of this are areas beyond national jurisdiction (ABNJ, or for the water column 'the high seas'). Within ABNJ, there are different legal regimes and governance structures for the non-living resources (e.g., minerals) and the living resources (e.g., fishes). The United Nations Convention on the Law of the Sea (UNCLOS) created a central intergovernmental agency, the International Seabed Authority (ISA), that has responsibility to govern activities relating to minerals and the ABNJ seafloor, as well as the resulting potential environmental impacts[1]. The same Convention provides a legal regime for the use, conservation, and management of high-seas fishery resources[2]. These legal rules are generally implemented via regional fisheries management organisations (RFMOs), created to regulate economically-important highly-migratory fish stocks in ABNJ[3]. RFMOs themselves differ in their scope, approach, and mandate, with five RFMOs that address highly migratory tuna stocks and tuna-like species such as marlin or swordfish. While some stocks are considered healthy[4,5], there are significant gaps in coverage and ineffective management for others[6]. These multiple designations have diffused responsibility for ABNJ, creating challenges for the management of marine resources in the high seas, especially when the separate management of the living and non-living resources may result in conflicting strategies.

The Clarion-Clipperton Zone (CCZ) is a large area (4.5 million km^2) located between Hawai'i and Mexico in the eastern Pacific Ocean[7]. There is high environmental heterogeneity across this area, demonstrated by primary productivity increasing west to east and north to south, dissolved oxygen concentrations influenced by the presence of a mobile oxygen minimum zone in the water column, and high densities of polymetallic nodules on the seafloor[8,9]. These nodules have attracted commercial interest in deep-sea mining, with 17 exploration contracts currently issued across the region by the ISA, covering a quarter of the area of the CCZ seabed (1.125 million km^2) (https://www.isa.org.jm/exploration-contracts/exploration-areas/).

There are also commercial fish stocks of tuna in the CCZ, with this region falling under the jurisdiction of two tuna RFMOs: the Inter-American Tropical Tuna Commission (IATTC) and the Western and Central Pacific Fisheries Commission (WCPFC)[10]. These two RFMOs oversee three of the main Pacific tuna species: bigeye (*Thunnus obesus*), skipjack (*Katsuwonus pelamis*), and yellowfin (*T. albacares*) tuna. Together, fisheries targeting these species captured 3.5 million tonnes (IATTC 687,000 tonnes and WCPFC 2.9 million tonnes) in 2022, which was 66% of global tuna catches reported that year[5,11]. Within the CCZ and surrounding waters, catches for these species average 35,000 to 78,000 tonnes per year[10]. These are some of the most profitable fisheries in the world; market price (i.e., dock price) fluctuates between $1,000 USD per tonne for skipjack tuna to over $5,000 USD for bigeye tuna, reaching an end value of over $10,000 USD per tonne[12]. In total, the economic value of these three species within these two RFMOs fluctuate around $5.5 billion USD per year (WCPFC $4.3 billion USD, IATTC $1.2 billion USD)[13] (www.seaaroundus.org).

If deep-sea mineral exploration projects, currently operational in the CCZ, are permitted by the ISA to move to an exploitation phase, substantial environmental impacts would likely be caused[14–17]. Additionally, conflict between fisheries and deep-sea mining will likely occur given the existing spatial overlap within and around the CCZ[10]. There are at least four different mechanisms by which nodule mining in the CCZ could negatively impact fisheries specifically. However, the extent of these impacts is largely unknown and/or debated, especially given the significant scientific gaps in this region[18,19]. First, there will be two plumes, one where sediment is stirred up by the mining of

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the nodules at the seafloor, and a second where unwanted water and material separated from the nodules is discharged into the ocean from the surface mining vessel. The discharge plumes will raise the particle concentration in the water column. This could interfere and harm filter feeding apparatuses and gills of tuna and their prey (which include diurnal vertical migrators), reduce visual communication, and increase stress hormone levels[10,20]. This could extend the impacts of deep-sea mining horizontally for tens to hundreds of kilometres and vertically for hundreds to thousands of meters[10,21,22].

Second, the return-water discharge plume is expected to contain elevated concentrations of metals. As minerals are collected, they will likely fragment with some dissolving into seawater and some adhering to sediment or organic particles. Such particles could be ingested and incorporated into deep-sea food webs entering our seafood supply with bioaccumulation in tuna[21]. Even if there were only localised effects or low risks from toxic accumulation or contaminant presence, this could still have a high impact on tuna fisheries through a negative consumer/market reaction[19,23]. Further, the tuna species fished in the CCZ are highly migratory and any contamination of fish through the food chain could percolate through the wider stock distribution[19]. Third, mining noise could also be extensive and cause physiological impacts in tuna and their prey, leading them to alter their feeding and/or reproductive migrations, and potentially reducing catch rates[21,24,25]. Lastly, an increased density of mining vessels restricted in their ability to manoeuvre could limit fishing vessel operation, as well as result in changes to tuna behaviour (avoidance or attraction). These impacts may extend to further ABNJ biodiversity e.g., seabirds that are dependent on sub-surface facilitated feeding by tuna may themselves shift into higher degrees of overlap with mining activities with uncertain consequences for their health[26,27].

The ocean has absorbed 90% of the extra heat and 20–30% of the CO_2 released from anthropogenic activities over the last decades, resulting in profound geochemical changes[28,29]. As temperature and pH continue to increase, and oxygen concentration decreases, marine species have adopted different coping strategies, shifting their historical distributions, sometimes toward higher latitudes or deeper waters[30]. Specifically, yellowfin, bigeye and skipjack tunas in the Pacific Ocean are expected to shift distribution and abundance towards the equatorial eastern Pacific[31] and poleward, with some studies suggesting shifts are already occurring[32,33]. Such shifts are expected to continue within the current century regardless of the climate-change scenario[34,35], threatening catches of targeted species[36], jobs, and revenues[37], and challenging international fisheries management globally[38,39].

This paper was instigated by recent findings that three commercially-important species of tuna will experience climate redistribution, with the equatorial eastern Pacific acting as a future climate refugia[31]. These changes could have profound risks to the economies, livelihoods, and well-being of Pacific small island developing States and coastal States[31]. Given the emergence of deep-sea mining, a new ocean industry that has the potential to result in biodiversity and habitat loss across large scales in the same area of the Pacific, we explore here the future intersections between tuna fisheries and deep-sea mining under climate change in the CCZ specifically. We also discuss the challenges of effectively managing the living and non-living resources in this area, and end with recommendations to achieve holistic and sustainable management of this area in a rapidly changing ocean.

RESULTS AND DISCUSSION

Potential conflicts between fisheries, deep-sea mining, and climate change

Results show increases in biomass for all three tuna species within the CCZ by the mid-21st century relative to today under both climate-change scenarios tested (Fig. 1). When considering the overall percentage change in biomass for CCZ contract areas and the associated buffer zone, increases ranged from 10% for bigeye tuna under Representative Concentration Pathway (RCP) 4.5 to 31% for skipjack tuna under RCP 8.5, with an average of 21% for all three species for both RCPs (Fig. 1). Overall percentage increases in biomass for the CCZ by the mid-21st century are not projected to show much variation between RCP 4.5 and 8.5, suggesting that tuna will move to the CCZ regardless of the climate-change scenario (Fig. 1). The small difference in projected tuna biomasses

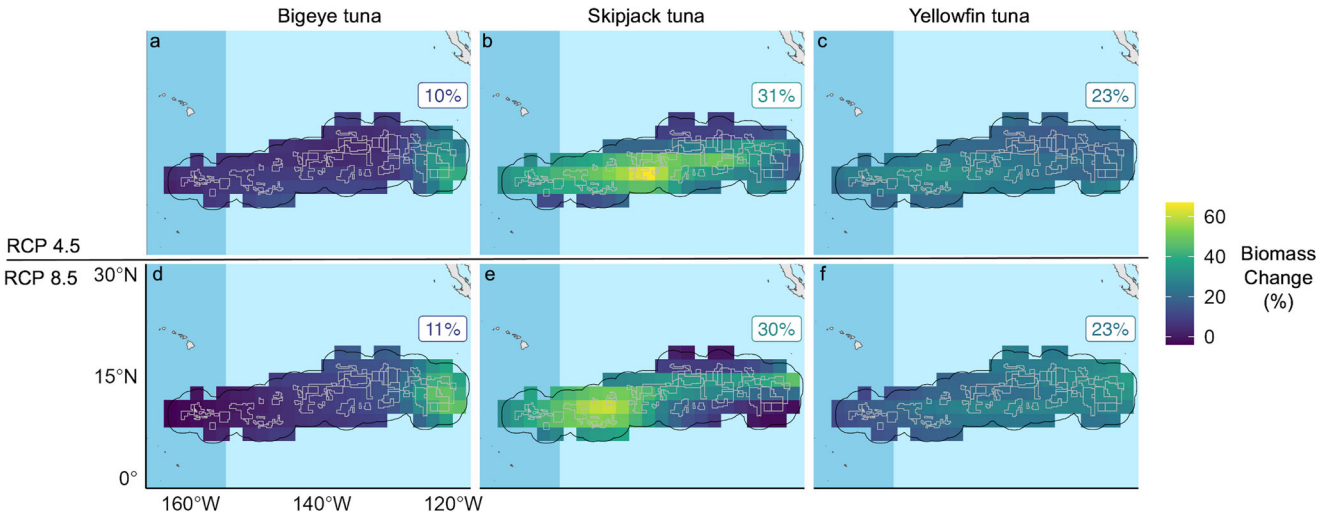


Fig. 1 Percentage change in the biomass of tuna for the Clarion-Clipperton Zone by the mid-21st century (average of 2044 to 2053) relative to present (average of 2009 to 2018). Three species of tuna are included from left to right: bigeye tuna (*Thunnus obesus*), skipjack tuna (*Katsuwonus pelamis*), and yellowfin tuna (*T. albacares*). The black line around the CCZ denotes 200 kilometers from deep-sea mining exploration contract-area boundaries. This buffer was used as several modelling studies have suggested that midwater sediment plumes may spread over such distances. The buffer was created using the geoprocessing tool Buffer in qGIS v3.8. All maps are split into the two relevant RFMOs: the Western and Central Pacific Fisheries Commission (WCPFC) (dark blue) and the Inter-American Tropical Tuna Commission (IATTC) (light blue). Percentage values on the top right of the CCZ in each panel represent the percentage changes in tuna biomass for the entire CCZ. **a**–**c** are under Representative Concentration Pathways (RCP) 4.5 and **d**–**f** represent RCP 8.5.

between scenarios can be seen for most ABNJ of the Pacific region[31] and may be attributed to little variation between RCP pathways throughout the first half of the 21st century[40].

The distribution of biomass change within the CCZ does, however, vary spatially and between species (Fig. 1). Specifically, there is an increase in skipjack and yellowfin tuna biomasses within most of the CCZ, regardless of the climate-change scenario (Fig. 1). On the other hand, bigeye tuna presents a reduction-to-no-change within most of the region, with the exception of the eastern zone where increases will be substantial in both climate-change scenarios (Fig. 1). Spatial patterns show a higher concentration of bigeye tuna in the eastern part of the CCZ under both climate-change scenarios, while skipjack shows a more central (RCP 8.5) or eastward (RCP 4.5) trend (Fig. 1). Finally, yellowfin tuna shows a more homogenous distribution (Fig. 1). However, such spatial variation should be approached cautiously given the high mobility of tuna species and the resolution of these results.

Taking into account the historical expansion of industrial-scale tuna fisheries and the shift in distribution driven by greenhouse-gas emissions by the mid-21st century, these commercially-important species will migrate into an area where deep-sea mining could be underway (Fig. 1)[31,41]. This could result in increasing conflict between the two industries if more tuna catches are obtained from mining areas[10].

Tuna fisheries in the CCZ may be impacted by deep-sea mining in several ways: the direct impacts of nodule mining are predicted to include noise, light, and movement of ships at the sea surface, as well as the benthic and discharge plumes. The level of interaction with and impact from the return-water discharge mining plumes and tuna fisheries will be influenced by the depth of the release of discharge. That is, the deeper the release depth, the smaller the spread of the plumes will likely be and the less chance to impact tunas and the life they depend on. Discharge depths below the mesopelagic zone (200–1000 m depth) will be more likely to avoid deep-diving tuna, such as bigeye tuna that are usually between 0 and 500 m and their prey which can live to 1500 m depth[9,21,42–45]. However, this is likely to be more costly and technically challenging for deep-sea mining operations. Additionally, deeper discharges of plumes will likely still affect non-tuna species present at deeper depths, including benthic species that may still be important components of the functioning and food webs of this area.

Further, differences in ecology, including mobility, distribution, associations with floating objects, diet, predatory behaviour, stock structures, and spawning patterns, could result in varied impacts to each tuna species. Oceanographic factors (such as current flow rates and direction) will also affect the likelihood of impact. In addition to the above specific direct impacts that may be caused to tuna from deep-sea mining, it is also possible that the cumulative environmental impacts of deep-sea mining serve to make the CCZ generally less hospitable for tuna, ultimately lessening their options for climate refugia[21,32].

Any impacts on tuna at a population or stock level could lead to effects on tuna-dependent economies that fish within and around the CCZ, presenting unresolved equity issues. The five countries that obtain the highest average annual tuna catches (in tonnes) in the CCZ are Mexico, Venezuela, Nicaragua, Panama, and Colombia, with Mexico and Venezuela obtaining 21% and 10% of their tuna there respectively[10]. Between 2009 and 2018, ABNJ fisheries of yellowfin, skipjack and bigeye tuna landed 250,000 tonnes, generating $512 million USD for these countries, with yellowfin creating the highest revenue of the three with 109,000 tonnes generating $281 million USD[13] (www.searoundus.org). While these values represent overall ABNJ catches, it demonstrates the economic importance of these species to these countries. As climate change shifts the distribution of Pacific tunas eastwards from Pacific Island national jurisdictions to high-seas areas[31] such as the CCZ, new fishing opportunities will likely arise for those countries fishing in the region. Additionally, nations that do not fish the most in the licensed mining areas of the CCZ may still derive a moderate proportion of their RFMO tuna catches there. For example, China obtains 17% of their RFMO-reported tuna catches in the mining areas and 200-km zone, while Belize and Nicaragua obtain 11%[10]. Given the shifting of these stocks due to climate change, and the potential overlap between fishing and mining activities within and around the CCZ, these percentages are likely to increase, which could represent a substantial economic risk for nations fishing in the region.

There may also be further socioeconomic impacts (e.g., loss of income, decreases in employment, lowered food security, and well-being) to nations surrounding the CCZ if tunas are impacted by mining and their migration patterns into neighbouring Exclusive Economic Zones are altered. Negative impacts to tuna stocks, or even increased consumer concern about toxic accumulation or contaminant presence, could have particularly devastating consequences for several countries whose economies are described as 'tuna-dependent'[23,31]. Ultimately, deep-sea mining by more economically developed States could lead to small island developing States and other developing coastal States being disenfranchised, with a resulting increased risk of legal challenges and/or conflict. While we focus specifically on the CCZ where deep-sea mining may be more likely to commence, it should be noted that fishery overlap with mining occurs in other regions and ocean basins, and future work is required to identify how industry overlap may be affected by climate change[10]. In addition, while tuna dominate catches obtained in the CCZ[10], there are other commercially-important species, such as billfishes, that occur in the CCZ, and there are other areas of potential mining-fishery overlap such as at encrusted seamounts for seamount-associated fish species.

Scientific gaps

Sustainable resource-management regimes generally rely upon a robust scientific understanding of the environment and the impacts from development activities. However, there is a lack of basic scientific knowledge about the CCZ, especially regarding deep-sea ecosystems[18]. There is also, at this nascent stage of the industry where no large-scale mining operations have yet commenced, little applied knowledge about how deep-sea mining will impact CCZ ecosystems and fisheries. This is linked to the lack of information on environmental baselines, potential responses to mining impacts, and specific deep-sea mining technology and mining processes (e.g., the depth of discharge)[18]. There is also little known about these three focal tuna species with regard to their sensitivities to deep-sea mining activities and climate change, in particular for juveniles and the communities these tuna depend on[31]. More scientific data is needed to understand the spatial and temporal dynamics of the mining discharge plume (including dissolved and particulate metals), their consequences for tuna and fisheries, and climate modelling to increase accuracy of future predictions. The cumulative and/or synergistic impacts of deep-sea mining, fisheries, and climate change are also unknown, but likely important[18].

Governance gaps

Governance of the CCZ is challenging for a number of reasons including, but not limited to, the significant scientific knowledge gaps discussed above and fragmented multi-sectoral governance in this region. These challenges will likely magnify as human activities increase and the impacts of climate change are felt more acutely[46]. The number of legal regimes (e.g., UNCLOS, UN Fish Stocks Agreement, UN Framework Convention on Climate Change, national laws) and governance structures (e.g., ISA, Food and Agriculture Organization, International Maritime Organization,

WCPFC, IATTC, those of individual States) applicable to the CCZ results in a fragmented patchwork that prevents a holistic approach to managing human activities in this area. However, it is only three of these organisations that are responsible for applying an ecosystem-based approach – the ISA, the WCPFC, and the IATTC.

UNCLOS continues to evolve, and in March 2023, a text was agreed between States, paving the way for a historic treaty to conserve and sustainably use marine biodiversity in ABNJ (the BBNJ Agreement). This treaty has been designed to avoid undermining existing governance regimes in ABNJ, so it remains to be seen how the new legal regime and structures will interact with management of fisheries and deep-sea mining, and components of the agreement related to area-based management[31,47–49]. Notwithstanding, there are a number of UNCLOS (and other international law) duties relevant to States and the ISA conserving and/or not adversely affecting biodiversity in the water column (including fish stocks), including as a result of deep-sea mining activities (e.g., UNCLOS Articles 145, 192, 194, 206, 209, and UN Straddling Fish Stocks Agreement, the International Convention for the Prevention of Pollution from Ships (MARPOL), the Convention on Biological Diversity Articles 3, 8, 14, and customary international law obligations to prevent transboundary harm).

Further uncertainty arises from the unsettled status of the ISA's rules, regulations, and procedures for exploitation of mineral resources in ABNJ (known as 'the Mining Code'). This complex matrix of rules and legal standards are currently under multilateral negotiation[50]. It has been noted that climate considerations were little featured in the draft text presented by the ISA's technical body to its member States for further negotiation[51]. UNCLOS requires that deep-sea mining must operate with 'reasonable regard for other activities in the marine environment' and vice versa, including fisheries, and specifies that deep-sea mining installations may not be established in areas of intense fishing activity (Article 147). The principle of 'reasonable regard' (often equated with 'due regard' used elsewhere in UNCLOS) requires consideration of a balance of interests on a case-by-case basis, often requiring dispute resolution and interpretation by the Courts[52]. It is not clear how ISA contractors' duty of 'reasonable regard' for fisheries will play out in practice, but would appear to require more detailed regulations to have operational effect, which are not currently in place at the ISA. Indeed, there has been surprisingly limited consideration, engagement, or consultation thus far between the ISA and fishing industries and/or RFMOs in relation to mining activities in the CCZ. The ISA's list of 69 observer organisations features no RFMOs or fishery groups (https://www.isa.org.jm/observers/). The FAO, which has a focus on fisheries, is an intergovernmental organisation observer to the ISA, but has neither attended nor made any submission to ISA proceedings in at least the past five years during which the Mining Code has been negotiated (Authors' own research, from ISA sessions' delegation lists: https://www.isa.org.jm/wp-content/uploads/2023/02/ISBA_27_A_INF_6-List-of-Delegations_Assembly_27th-Session-rev-11082022.pdf, https://www.isa.org.jm/wp-content/uploads/2022/06/ISBA_26_A_INF_3.pdf, https://www.isa.org.jm/wp-content/uploads/2022/06/isba25-a-crp5_0.pdf, https://www.isa.org.jm/wp-content/uploads/2022/06/isba-24a-crp-4_0.pdf). The Regional Environmental Management Plan (REMP) for the CCZ, one of the ISA's principal environmental management tools, does not include assessment of fish stocks or fishing activity in the region, does not consider potential impacts on fisheries, and does not require consultation by ISA contractors or organs with the fishery sector[53–55].

There have also been concerns raised about a lack of transparency at the ISA[56], and a lack of participatory approach in ISA decision-making[56,57]. As an example, Venezuela, one of the nations identified as particularly reliant upon fisheries in the CCZ area, is not a member of the ISA, and as such may need proactive outreach from the ISA in order to be informed about the regime and to engage in its deliberations (in a non-voting capacity). There is no evidence of such outreach, and Venezuela does not currently attend or engage in any way, in the ISA's meetings (Authors' own research, from ISA sessions' delegation lists: https://www.isa.org.jm/wp-content/uploads/2023/02/ISBA_27_A_INF_6-List-of-Delegations_Assembly_27th-Session-rev-11082022.pdf, https://www.isa.org.jm/wp-content/uploads/2022/06/ISBA_26_A_INF_3.pdf, https://www.isa.org.jm/wp-content/uploads/2022/06/isba25-a-crp5_0.pdf, https://www.isa.org.jm/wp-content/uploads/2022/06/isba-24a-crp-4_0.pdf). Additionally, at both the ISA and RFMOs, there are questions around abilities to address critical environmental-management issues given the level of influence by the interests and political will of their constituent members, rather than reflecting truly whole-of-government mandates. However, 16 of 20 States (plus the EU) in the IATTC and all except one in the WCPFC are members of the ISA. Five member States are Sponsoring States in the IATTC and seven within the WCPFC, while six in the IATTC and seven in the WCPFC have called for a ban, pause, or moratorium on deep-sea mining, pointing to a need for dual and holistic consideration.

The remoteness of the CCZ presents an additional challenge with regard to monitoring, control, and surveillance. The ISA has yet to agree on an inspection and monitoring regime for future activities in the CCZ[58], but currently relies upon self-reporting by its contractors without independent data verification[59]. Concerns already exist about inadequacies to combat, and therefore persistence of, illegal, unreported, and unregulated fishing globally[60]; deep-sea mining may be responsible for similarly challenging environmental infractions. It is unclear the extent to which fisheries activities could disrupt deep-sea mining activities in the same region, and what measures may be taken to prevent or remedy this. It is notable that the monitoring, surveillance, and control of fisheries on the high seas (which may include vessel monitoring systems, data collection and reporting, inspection schemes or observer programmes, and sanctions for non-compliant vessels) is largely dependent on the ability and willingness of individual flag States to exercise effective control over vessels flying their flag, and States may have differing degrees of capability in that regard[61,62].

The potential for deep-sea mining to affect fisheries also requires consideration of how the miners will be regulated. To ensure reasonable regard for fisheries operating in the same region, the ISA will need powers not only to monitor, but also to enforce compliance by miners with its Mining Code (once adopted). The practicalities of this part of the regime have received little attention to date at the ISA[63]. There are various legal and political complexities at play. The ISA itself, as an intergovernmental organisation, does not have jurisdiction to create or prosecute criminal offences, nor to conduct inspections, arrests, asset-freezing, etc. within national jurisdictions. The ISA must therefore rely on cooperation from individual States for such measures. However, analysis suggests that some States currently sponsoring ISA exploration contracts do not have relevant measures in place in their national legal regimes, nor clear procedures in their court systems to deal with disputes that may arise in relation to their contractors' actions[64]. An entity holding a deep-sea mining contract with the ISA may itself be a State, which may be unlikely to wish to impose such sanctions upon itself or its officers. An ISA contractor may also be a private-sector entity sponsored by a State. This sponsoring State is required to have its own measures in place to ensure contractor compliance, which can offer an additional layer of regulatory control within the overall ISA regime. There is however concern about a developing trend of 'sponsoring states of convenience' whereby a private-sector ISA contractor partners with a sponsoring State, which may have no meaningful relationship or control over that contractor, and/or may have very limited regulatory capacity in practice[65,66].

To further complicate the enforcement regime for deep-sea mining in ABNJ, the mining operations will occur from a vessel located in the high seas. According to the UNCLOS regime, such a vessel is under the exclusive jurisdiction of the flag State. There is no requirement in UNCLOS (or in the ISA rules currently) for that flag State to be the same State as the ISA contractor / contract's sponsoring State. Nor even for the flag State to be a member of the ISA, and thus bound by its regulations. It can therefore be seen that the compliance regime for deep-sea mining in ABNJ is complex and may be susceptible to governance gaps or abuse to evade monitoring and compliance measures.

Pathways to effective management

The decades ahead will herald a new seascape for ocean management, with many challenges to overcome for multiple marine sectors to be managed synergistically, sustainably, and equitably. Below are recommendations for pathways towards effective ecosystem-based and cooperative management of multi-sectoral human impacts in the CCZ. Given the many outstanding critical scientific gaps related to the impacts of deep-sea mining, fisheries, and climate change, as well as their interactions, in the CCZ, that must be closed through scientific research for effective management to be possible, it would be prudent for the ISA not to permit mining unless and until the likely impacts are properly understood, and manageable within agreed thresholds[18,67,68], including consideration of potential effects on tuna stocks. In this vein, there have been increasing calls for a precautionary pause or moratorium on deep-sea mining, from various sources, including downstream users of minerals, governments, ocean experts, civil society and, most recently and of particular relevance, fishery management organisations and downstream users of fisheries[69,70] (https://seabedminingsciencestatement.org/; https://www.noseabedmining.org/).

There is also the need for the development and evolution of relevant rules, regulations, and procedures of the ISA's Mining Code, as well as the ISA's management tools including the standardisation of the ISA's REMP process. These regional management planning processes should be expanded to ensure all marine life and uses (including fish stocks and fishery activities) are properly mapped and assessed. The planning processes should include future forecast scenarios that take into account climate modelling. All relevant stakeholders, including RFMOs, the fishing industry, and Pacific tuna-dependent States, should be brought into transparent, proactive, and consultative management processes. Generally, the development of mechanisms for information exchange and a formalised inclusive consultation process between the ISA and fishing industries and/or RFMOs, as well as between the WCPFC and IATTC themselves specifically for the CCZ, seems an urgent matter.

As suggested by Goodman, et al.[71], the IATTC and the WCPFC could develop an expanded framework for cooperation and collaboration that would allow them to fulfil their conservation and management responsibilities under international law. Specifically, these could include a formal mechanism for cooperation to enable effective and efficient decision-making and action by the two RFMOs on key issues, such as deep-sea mining and climate change[71]. Further cooperation will be needed on scientific research and modelling to better understand the biology and distributions of Pacific tuna stocks and how they will respond to individual and cumulative human impacts[71]. More seamless work between the two RFMOs will help to facilitate enhanced cooperation and collaboration with the ISA and ultimately could be a key pathway for effective management. Such dialogue could lead to targeted and collaborative scientific research, designed to fill some of the current knowledge gaps that prevent robust science-based rule-setting and decision-making. Better understanding of potential impacts upon fisheries and fish-dependent economies and populations, will in turn assist the individual member States of the ISA to take the difficult decisions facing them about what level of adverse impact from deep-sea mining is considered acceptable versus the forecasted benefits, and whether such impacts and benefits might be distributed in an equitable manner. If fish stocks do appear to be adversely impacted by deep-sea mining in ABNJ, then it seems likely that those affected would wish to seek compensation. However, the legal framework for actioning such a claim requires more robustness, with regards to where such a claim could be brought, by whom, against whom, what damages could be claimed, and what degree of fault and causation would need to be proven[72]. This suggests that litigation in this area could be complex, lengthy, expensive, and multi-party.

The BBNJ Agreement may also prove to be an effective management tool for marine ABNJ. Despite a commitment to "not undermine" existing agreements, without consensus on how this will be implemented in practice, the outcomes of the BBNJ Agreement have potential to influence both fisheries and deep-sea mining in a changing ocean[47]. The Agreement might indirectly strengthen the performance of the RFMOs and the ISA, due to the need to reduce the impact of fisheries and deep-sea mining on marine biodiversity, respectively[47]. Additionally, the BBNJ Agreement could broadly increase capacity building and technology transfer with regard to the ocean, which may enhance the effectiveness of the decision-making related to the use of marine genetic resources (MGRs), area-based management tools (ABMTs), and environmental impact assessments (EIAs)[47]. The BBNJ Agreement also has significant potential to increase cooperation among existing marine governance organizations, including the sharing of scientific data and information[47].

Finally, for the overall benefit of all fisheries and for the planet as a whole, all sustainable and equitable pathways for the reduction of greenhouse-gas emissions to limit warming to 1.5 °C by the end of the century should be considered and implemented[34,73].

METHODS

Study area and species

This study focused on ISA exploration contract areas for polymetallic nodules within the CCZ. The CCZ region was denoted by a spatial shapefile with a buffer zone of 200 kilometers from the border of outer contract areas as per van der Grient and Drazen[10], all falling between 110°W and 158°W and 5°N and 19°N (Fig. 1). The 200-km buffer was used as several modelling studies have suggested that midwater sediment plumes may spread over such distances[74–76] given that the processes of flocculation, which could minimise plume extent, are unlikely to occur in discharge plumes[22,76]. The buffer was created around exploration contract areas using the geoprocessing tool Buffer in qGIS v3.8[77]. Three Pacific tuna species (bigeye, skipjack, and yellowfin), which are overseen in the west Pacific Ocean by the WCPFC and in the east Pacific Ocean by the IATTC, were assessed. Other species captured and covered by these RFMOs were not included but are a small component of the catches.

Data on tuna biomass projections under climate change

We used published projections of the effects of climate change on the distribution and abundance of the three most commercially important Pacific tuna species[31] using the model SEAPODYM (Spatial Ecosystem and Population Dynamics Model; www.seapodym.eu). Briefly, SEAPODYM is a 3D numerical model that simulates changes in biomass over time based on environmental variables, life-history stages, prey density, and their age dimensions[78]. The model relies on underlying advection-diffusion-reaction equations, integrated on a 2° latitude-longitude grid. Fish

movements within the model are based on relationships with environmental variables (e.g., temperature, oxygen concentration, primary production) and dependent on life-history stage of the fish species (e.g., larvae and small juveniles drift with currents while adults have active movement based on habitat quality). The model accounts for both natural and fishing mortality and follows a maximum likelihood estimation (MLE) approach to resolve population dynamics, including the effects of fishing and environmental variability. It is important to acknowledge that SEAPODYM is one of the multiple ways that researchers have explored the impacts of climate change on tunas and billfishes, including their associated fisheries[5]. Unlike most existing models, SEAPODYM provides a mechanistic approach that includes both population dynamics and trophic interactions thus providing biomass estimates in the water column.

The environmental variables used to run SEAPODYM were temperature, dissolved oxygen concentration, zonal/meridional currents and primary production, and two-dimensional euphotic zone depth[31]. Environmental variables to simulate the historical oceanic environment (1979 − 2011) were taken from the Nucleus for European Modelling of the Ocean (NEMO) ocean framework[79], while future ocean projections (2011–2100) were taken from four Earth System Models (ESMs). Specifically, the Institute Pierre Simon Laplace Climate Model 5 (IPSL-CM5A)[80], the Model for Interdisciplinary Research on Climate (MIROC)[81], the Geophysical Fluid Dynamics Laboratory Earth System Models (GFDL-ESM2G)[82], and the Max Planck Institute for Meteorology Earth System Model (MPI-MR)[83]. Results are presented as the average of all four ESMs. The ESMs followed two Representative Concentration Pathways (RCPs, a high emission scenario (8.5))[84] and a medium emission scenario (4.5)[85]. RCPs are greenhouse gas concentration trajectories adopted by the Intergovernmental Panel on Climate Change. RCP 8.5 is considered a worst-case climate-change scenario where emissions continue to rise throughout the 21st century. RCP 4.5 is an intermediate scenario where emissions peak around 2040, then decline.

Estimating biomass change within the CCZ

The future percentage change in biomass within the CCZ relative to present was estimated. First, the yearly biomass outputs within the CCZ for each species and average for a present time (2009–2018) and mid of the 21st century (2044–2053) were aggregated by grid-cell within the CCZ. Biomass percentage change ($\Delta B_{i,j}$) was estimated for each tuna species j within a grid cell i as follow:

$$\Delta B_{i,j} = \frac{MB_{j,i} - PB_{j,i}}{PB_{j,i}} * 100 \quad (1)$$

where MB is the biomass in the grid cells at the middle of the 21st century and PB is the biomass in that same grid cell at present time. In addition, we estimate the percentage change within the whole area. For that, we first aggregated all pixels within the CCZ per species, then averaged by timeframe and applied the previous equation. All analyses were done in R-Studio version 4.2.0[86] using the packages *tidyverse*[87], *janitor*[88], *sf*[89], *sp*[90], *rnaturalearth*[91] and *viridis*[92].

DATA AVAILABILITY

The datasets generated during the current study are available in the repository ccz_tuna available at https://github.com/jepa/ccz_tuna. Original tuna distribution data analysed in the current study can be found in the repository Tuna_Redistribution and can be accessed via this link https://osf.io/qa8w4/.

CODE AVAILABILITY

The underlying code for this study is available in the repository *ccz_tuna* and can be accessed via this link https://github.com/jepa/ccz_tuna.

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AUTHOR CONTRIBUTIONS

Conceptualization—D.J.A., J.P.A. Methodology—D.J.A., J.P.A., J.V.G. Formal analysis—D.J.A., J.P.A. Writing—original draft—D.J.A., J.P.A. Writing—review and editing—D.J.A., J.P.A., J.D., H.L., N.N., J.V.G., D.J.M.

COMPETING INTERESTS

All authors declare no competing interests.

ADDITIONAL INFORMATION

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From:
Sent: Tuesday, 16 July 2024 04:07
To: CMS Secretariat; Jenny Renell
Cc:
Subject: RE: CMS Notification 2024/013 | Notification de la CMS 2024/013 | Notificación de la CMS 2024/013

You don't often get email from almacdonald@doc.govt.nz. Learn why this is important

Hi Jenny

I am responding with regard to CMS notification 2024/013 requesting information on Deep seabed mineral exploitation activities and migratory species. Apologies for the delay in getting back to you on this.

Here are three documents relating to New Zealand that are relevant to this request:

- Expert risk assessment of activities in the New Zealand Exclusive Economic Zone and Extended Continental Shelf | Ministry for the Environment
- Preparation of Environmental Impact Assessments: General guidelines for offshore mining and drilling with particular reference to New Zealand
- Decision on the marine consent application by Chatham Rock Phosphate to mine the seabed of the Chatham Rise - The application was declined after substantial evidence was presented in court. This is the only deep sea mining application we are aware of in New Zealand.

I am still waiting on a response from one of the New Zealand government departments involved in this work. If they send me any additional material, I will forward it on. Please let us know if you have any questions.

Kind regards

Alex

Alex Macdonald
Senior International Advisor – Kaitohu Matua Āorere
Department of Conservation | Te Papa Atawhai
✉ 18-32 Manners St, Wellington 6011, New Zealand | P.O. Box 10-420, Wellington 6143 |

Mon	Tues	Wed	Thurs	Fri
X	✓	✓	X	✓

✓ = In the office; 🏠 = Working remotely; X = Not working

From: CMS Secretariat <cms.secretariat@cms.int>
Sent: Tuesday, June 4, 2024 1:04 AM
To: CMS Secretariat <cms.secretariat@cms.int>
Subject: CMS Notification 2024/013 | Notification de la CMS 2024/013 | Notificación de la CMS 2024/013
Importance: High

Notification to the Parties:

A Notification to all Parties on Deep-Seabed Mineral Exploitation Activities and Migratory Species was posted on 3 June on the CMS webpage.

All CMS Notifications to Parties can be accessed here: Notifications | CMS

Kind regards,

CMS Secretariat

Notification aux Parties:

Une notification à toutes les Parties sur Activité d'exploitation minière des grands fonds marins et espèces migratrices a été publiée le 3 juin sur la page web de la CMS.

Toutes les notifications de la CMS aux Parties sont accessibles sur Notifications | CMS

Meilleures salutations,

Le Secrétariat de la CMS

Notificación a las Partes:

El 3 de junio se publicó en la página web de la CMS una Notificación a todas las Partes sobre Actividades de explotación de minerales en aguas profundas y especies migratorias.

Todas las notificaciones de la CMS a las Partes están disponibles en: Notifications | CMS

Cordialmente,

La Secretaría de la CMS

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From: Alexandra Macdonald
Sent: Tuesday, 23 July 2024 03:21
To: Jenny Renell; Heidrun Frisch-Nwakanma
Cc: Graeme Taylor; CMS Secretariat
Subject: CMS notifications on deep sea mining and cumulative impacts - further info from New Zealand

Hi Heidi and Jenny

I have received some further information with regard to how New Zealand deals with impacts on migratory species – this information is relevant to the information requests in the recent CMS notifications on deep sea mining and cumulative impacts. The information comes from the New Zealand Environmental Protection Authority. See below:

> Regarding deep-sea mining, the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (the EEZ Act) does not have specific requirements to consider the impacts of deep seabed mineral exploitation or other activities in the EEZ on migratory species, their prey, and their ecosystems. However, our consenting process mandates an Impact Assessment (IA), as outlined in Section 39 of the EEZ Act. While we do not provide specific IA guidelines, operators must comply with the legislation, which may address migratory species information under Sections 39(1)(e) and 39(1)(f):
>
> - **Section 39(1)(e)**: "Identify and describe the effects of the activity on the biological diversity and integrity of marine species, ecosystems, and processes, and on rare and vulnerable ecosystems and habitats of threatened species."
> - **Section 39(1)(f)**: Consideration of impacts on threatened species' habitats.
>
> Additionally, Section 59(2) of the EEZ Act requires the decision-makers to consider the potential effects on the environment or existing interests, including:
>
> - **Section 59(2)(d)**: "Biological diversity and integrity of marine species, ecosystems, and processes."
> - **Section 59(2)(e)**: "Rare and vulnerable ecosystems and the habitats of threatened species."
>
> Cumulative impacts are also addressed under Sections 39 and 59 of the EEZ Act:
>
> - **Section 39(1)(d)**: Identification and description of the activity's effects on the environment and existing interests, including cumulative effects.
> - **Section 59(2)(a)(i)**: Consideration of cumulative effects when allowing an activity.
>
> Although we do not have fixed guidelines on how to present or measure cumulative effects in the EEZ, the EPA adopts a "precautionary approach" and uses the "best available information" to assess these impacts.
> If it is determined that an activity could potentially harm the environment, including migratory species, we may:
>
> - Seek advice from technical experts and government agencies/ministries.
> - Decline the application.
> - Impose conditions on the consent to minimize harm.
> - Require the applicant to conduct further research or monitoring.

Conditions may include principles such as avoidance, mitigation, monitoring, and restoration. Additionally, the EEZ Act requires us to consider:

- **Section 59(2)(h)**: The nature and effect of other marine management regimes.
- **Section 59(2)(k)**: Relevant regulations (other than EEZ policy statements).
- **Section 59(2)(l)**: Any other applicable law (other than EEZ policy statements).
- **Section 59(2)(m)**: Any other matter deemed relevant and necessary by the marine consent authority.

Within these contexts, we may consult other government agencies, such as the Department of Conservation (DOC), for their views during the consultation process.

Kind regards

Alex

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NIWA
Taihoro Nukurangi

Expert Risk Assessment of Activities in the New Zealand Exclusive Economic Zone and Extended Continental Shelf

Prepared for the Ministry for the Environment

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Reviewed by

Dr Ashley Rowden



Approved for release by

Dr Charlotte Severne



Formatting checked by



Executive summary

- The Ministry for the Environment (the Ministry) is leading the development of the Exclusive Economic Zone and Extended Continental Shelf (Environmental Effects) Bill.
- The Bill will be underpinned by regulations that will set out, among other matters, how activities undertaken within the Exclusive Economic Zone (EEZ) and the Extended Continental Shelf (ECS) will be regulated taking into account existing legislation.
- NIWA was contracted by the Ministry to undertake a study and prepare a report that identifies current and potential activities in the EEZ and provides scientific advice on how activities in the EEZ and ECS might be classified (prohibited, discretionary, or permitted), based on the level of environmental risk involved.
- Our recommendations for classifications are based only on the level of environmental risk from activities. Other criteria will need to be considered when deciding on regulations.
- Levels of risk were established using a precautionary approach, taking into account the worst case scenario for environmental risks. We have also not taken into account how any mitigation measures might reduce environmental risk when recommending classifications. These recommendations should not be taken as a comprehensive assessment of how activities should be finally regulated. They serve primarily as an indication of the activities that might require special conditions and close monitoring, regardless of how they are ultimately classified.
- The approach taken by NIWA has been to carry out an expert Ecological Risk Assessment (ERA), which is a “Level 1” assessment in line with accepted New Zealand and Australian risk assessment standards.
- An ERA panel of NIWA experts progressed through 3 main steps:
    - the examination of sources of risk, their magnitudes, frequencies and intensities;
    - an assessment of the potential consequences of those risks; and
    - the likelihood of a particular level of consequence occurring from the various activities.
- Scores were given to the potential consequence (6 levels from negligible to catastrophic) and to the likelihood of that consequence (remote to likely) of an activity using a set of standard tables that described each level.
- Risk for each activity was then calculated as the product of consequence and likelihood. This approach is commonly referred to as the exposure – consequence risk assessment method. This process was repeated for each identified activity likely to occur in the EEZ and ECS.
- Using the tables of defined levels and scores of environmental consequences (Table 2-2) and likelihoods (Table 2-3) ecological risk can range from a minimum of 0 to a maximum of 30.

- Although we arrived at numerical scores of risk, the assessments underpinning the scores were made on qualitative assessments of likelihood and consequence.
- We considered that if environmental risk is the only criteria for classification activities with low risk levels of 6 or less across all five environmental categories should be categorised as permitted – these arise from the lowest two levels of consequence (0 - negligible and 1- minor) at all levels of likelihood (including 6, likely), from moderate levels of consequence (2) at unlikely (3) or lower levels of likelihood, from severe levels of consequence (3) at rare (2) or remote (1) levels of likelihood, or from major and catastrophic levels of consequence at remote levels of likelihood (see Table 3-1 for a summary of risk scores, their derivation and categorisation).
- From an ecological perspective we considered that if environmental risk is the only criteria for classification then activities with extreme risk levels (of 24 or more) for one or more of the 5 environmental categories should be provisionally classified as prohibited (Table 3-1) unless some means of avoiding or reducing the ecological consequences can be found. These levels of risk arise only from those activities judged to have major consequences (4) at the highest level of likelihood (6) and catastrophic consequences (5) at the two highest levels of likelihood (5 and 6).
- Activities over a broad range of moderate (7-12) and high (15-20) risk values for all of the five environmental categories, we considered, should be provisionally categorised as discretionary, if environmental risk is the only criteria for classification, (Table 3-1) and conditions applied that monitor and reduce the associated ecological risks.In this report we summarise the findings of the expert panel from their assessment of activities associated with13 present or potential industries as well as scientific exploration and sampling in the EEZ and ECS. These industries are:
    - Petroleum oil and gas exploration and production
    - Carbon sequestration
    - Gas hydrate extraction
    - Ironsand mining
    - Placer gold mining
    - Phosphorite nodule mining
    - Massive sulphide deposit mining
    - Polymetalic crust mining
    - Polymetalic nodule mining
    - Ocean basin telecommunications cabling
    - Offshore energy harvesting
    - Offshore aquaculture
    - Deep-sea ecotourism
    - Scientific exploration and sampling

- A total of 207 assessments were made of 42 identified activities across the industries. Of these 19 (9.2%) were assessed as having extreme risks to the environment and should be provisionally classified as prohibited unless there are conditions which avoid, mitigate or remedy their effects.
- A further 48 assessments (23.2%) identified high risk activities that should provisionally be classified as discretionary. Another 75 assessments (36.2%) identified moderate risk activities which should also be provisionally classified as discretionary. The ecological risks from both groups of discretionary activities could be reduced through imposition of conditions which avoid, mitigate or remedy their effects.
- Sixty-four assessments (30.1%) identified low risk activities which could be classified as permitted and standard conditions applied.
- A summary of categorisation of activities as extreme, high, moderate or low is provided in Table 5-1.
- The number of activities assessed for an industry ranged from 7 for offshore ecotourism to 17 for mining of massive sulphide deposits, polymetalic crusts and polymetalic nodules and renewable marine energy.
- Four industries had between 3 and 7 activities classified as posing an extreme risk to the environment. These industries were mining for phosphorite nodules, massive sulphides, polymetalic crusts, and polymetalic nodules.
- All industries had one or more activities that pose a high risk to the environment and 2-10 activities that pose a moderate risk.
- The industry with the highest percentage of activities in the low risk range was offshore aquaculture though there is a high risk in this industry to marine mammals from surface and sub-surface buoys, ropes and structures.
- There are often ways of avoiding, remedying or mitigating the effects of activities that would otherwise put marine species or ecosystems at extreme, high or moderate risk. In each section we discuss some useful mitigation strategies and some of the common strategies include:
    - Following non-mandatory Department of Conservation guidelines (2006 and 2011) to avoid or mitigate acoustic impacts on marine mammals.
    - Limiting unnecessary use of platform and vessel flood lights at night and ensuring that those that are required are directed approximately vertically onto work surfaces to avoid or mitigate seabird strikes. Visual checks of the super-structure at first light each day for the presence of dazed or injured birds and the provision of appropriate care may help to remedy this impact.
    - Avoidance or mitigation of vessels and underwater equipment as vectors for non-indigenous species is possible by appropriate checking, cleaning, and application of antifouling paints. We understand that Biosecurity New Zealand (MAF-BNZ) is developing an import health standard and legislation and relevant regulations may be put in place in next 2-3 years.

  - Pressure on fish stocks caused by the declaration of an exclusion zone around a drilling or mining site, pipeline or cable route, forcing fishing activities into the remainder of the quota management area can be reduced or eliminated by purchase and retirement of appropriate commercial fish quota for the duration of the production phase.

  - Avoidance or mitigation of seals hauling out on platform structures is possible by reducing access to potential haul-out areas but modifications to exploration platforms is unlikely given that they invariably come to NZ from overseas for a relatively short period of intense exploration activity.

  - Efforts should be made to avoid areas of protected deepwater corals within the footprint of the drilling, mining, energy, or aquaculture operation. Pipelines and cables should also be routed to avoid reef habitat and any other vulnerable benthic habitat.

  - Risks to seep communities during the exploratory drilling process or through methane extraction altering fluid flow at seep sites and/or direct damage from rig or production facilities can be avoided or minimised through careful selection of drilling sites.

  - Assuming that iron sands and placer gold deposits occur to depths of 20-30m below the seafloor, impacts on benthic fauna will be minimised if fewer deeper pits are dug to extract a prescribed tonnage of ore. This is because most fauna is restricted to the upper 10-15 cm of sediment. A wide shallow pit will cause the maximum ecological damage for the least gain in ore extraction.

  - Actions that increase the rate of recovery of benthic fauna from the impacts of mining will greatly reduce the risks associated with these industries. Recolonisation by larval settlement from adjacent populations may be increased by mining in a chequerboard or strip pattern or by leaving up current populations intact. So little is known about larval connectivity in these populations that the optimal size or placement of these mining patterns is unknown.

  - Impacts of tourism activities on vulnerable benthic species can be minimised by rotating visits around a number of sites. The appropriate rotation interval should be guided by the likely recovery time of the species concerned.

- For many of the activities associated with new or yet to be established industries there are insufficient details available to determine the best conditions to apply to avoid, remedy or mitigate their effects. These need to be determined during the consenting process.

- We have not assessed the environmental risks from oil spills in this report. Oil spill risk and response is managed under the Health and Safety in Employment Act 1992 and the Maritime Transport Act 1994. We have assessed the potential risk from other oil and gas extraction activities that are not already covered by existing legislation.

- We have not assessed the environmental risks from dumping of dredged sediments, explosives, old ships etc. The risks and responses to these activities are managed under the Maritime Transport Act 1994 and the London Convention on Dumping to which New Zealand is a signatory.

- We have not assessed the effects of fishing in the EEZ or ECS. Effects of fishing are managed under the Fisheries Act 1996.
- In our view the most effective way to manage ecological risk is to regulate the individual activities that together make up a marine industry taking place within defined marine habitats.

1 Introduction

1.1 Background

New Zealand has a large Exclusive Economic Zone (EEZ) and Extended Continental Shelf (ECS) (Figure1-1) that contains oil, gas, mineral and biological resources attractive for development (Figure 1-2).

The Ministry for the Environment (the Ministry or MfE) is developing the Exclusive Economic Zone and Extended Continental Shelf (Environmental Effects) Bill. The Minister for the Environment, The Hon. Dr Nick Smith, announced in June 2011 his intention to introduce this Bill to Parliament this year (2011), with the intention that the Bill will be passed on 1 July 2012.

This Bill will be underpinned by regulations that will set out, along with other matters, how activities undertaken within New Zealand's EEZ and ECS (Figure 1-1) will be regulated, taking into account existing legislation (see Figure 1-3 for a summary of the spatial extent of existing legislation in the EEZ). One aspect that will affect how activities in the EEZ should be classified is the potential environmental risk and opportunities for risk mitigation.

In August 2011, NIWA was contracted by MfE to undertake a study and prepare a report that provides scientific advice on how activities could be classified according to the level of environmental risk. The environmental effects are only one strand of evidence to be weighed in setting policy. Other criteria must also be considered before classifications are confirmed, including, among other things, the practicability and effectiveness of different regulatory approaches.

In line with legislation, such as the 1991 Resource Management Act (RMA) and also given the nature and extent of many of the activities, it is most appropriate to manage the environment based on the effects of activities in certain environments, rather than regulate the activities themselves. The acceptability of environmental effects depends upon a balanced combination of management objectives and the characteristics of the habitats in which the activities are proposed, so that highly valued or sensitive environments may require higher degrees of protection to prevent them from harm.

1.2 Approach

NIWA's approach to the work has been to first determine the activities likely to occur within the EEZ and ECS, and their nature and extent. This has highlighted the probable locations of activities and the habitats most likely to be affected since many of the activities are likely to be site-specific, targeting sea surface, seabed and/or subsurface resources that, because of biogeochemical and physical factors, are found only in particular locations. Likely environmental threats arising from these activities to the local habitats were identified. To assess the possible environmental consequences of these activities we adopted an Ecological Risk Assessment Framework, which is a means to formalise risk assessment as part of an integrated strategy of Ecological Risk Management. We undertook what is commonly referred to as a "Level 1" assessment in line with accepted New Zealand and Australian risk assessment standards (AS/NZ4360 standard 2004). An expert Ecological Risk Assessment (ERA) Panel progressed through 3 main steps:

(i) examination of sources of risk, their magnitudes, frequencies and intensities;

(ii) assessment of the potential consequences of those risks; and

(iii) likelihood of a particular level of consequence occurring from the various activities.

Scores were given to the potential consequence (6 levels from negligible to catastrophic, level 0 representing the lowest risk) and to the likelihood of that consequence (remote to likely) using a set of standard tables that described each level. Risk was then calculated as the product of consequence and likelihood. This is commonly referred to as the exposure – consequence risk assessment method (Fletcher 2005). This process was repeated for each identified activity likely to occur in the EEZ and ECS.

The approach we adopted for this study identified and ranked activities with a certain level of risk. The step-wise procedures under a general risk assessment framework will then allow high-risk activities to be investigated further under a "Level 2" assessment if required by MfE in the future. Activities classified as low risk will probably not require further consideration.

To assist the expert panel two industry representatives attended parts of its deliberations. Mr John Pfahlert of the Petroleum Exploration and Production Association of New Zealand (PEPANZ) sat in the session discussing petroleum oil and gas exploration and production and the session on carbon sequestration via deep well injection. Deep well injection of carbon may possibly use existing oil production platforms and infrastructure and oil or gas bearing structures once reserves are exhausted so Mr Pfahlert's knowledge of plans for the fate of existing production platforms off Taranaki was useful.

Mr Bernie Napp, a senior policy analyst of Straterra, an industry group representing New Zealand mining, attended sessions on mining of deposits of massive sulphides, iron sands, placer gold and gas hydrates.

These two industry representatives did not sit on the panel to offer expert input. Rather, their role was to assist the panel by reviewing an initial list of activities associated with their industries that NIWA had drawn together, to ensure the list was full and complete. While the expert panel was deliberating, the role of the industry representatives was to provide detailed advice and context for the likely magnitude, frequency and extent of commercial activities, with the likely environmental consequences considered by the NIWA panellists.

We have not assessed the risks from oil spills in this report. Oil spill risk and response is managed under the Health and Safety in Employment Act 1992 and the Maritime Transport Act 1994. We have assessed the potential risk from other oil and gas extraction activities that are not already covered by existing legislation.

We have not assessed the environmental risks from dumping of dredged sediments, explosives, old ships etc. The risks and responses to these activities are managed under the Maritime Transport Act 1994 and the London Convention on Dumping to which New Zealand is a signatory.

We have not assessed the effects of fishing in the EEZ or ECS. Effects of fishing are managed under the Fisheries Act (1996).

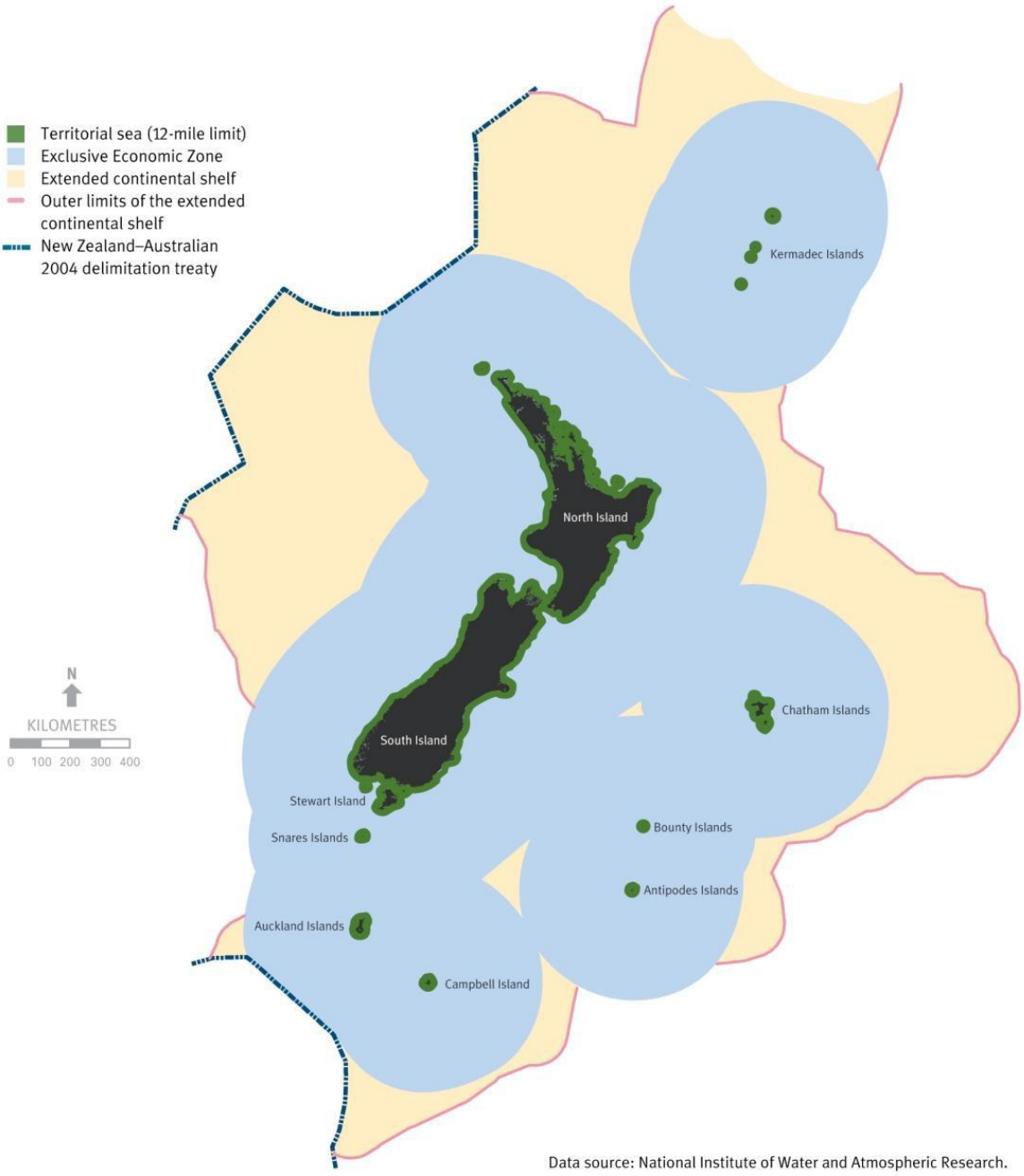


Figure 1-1: New Zealand's marine area.

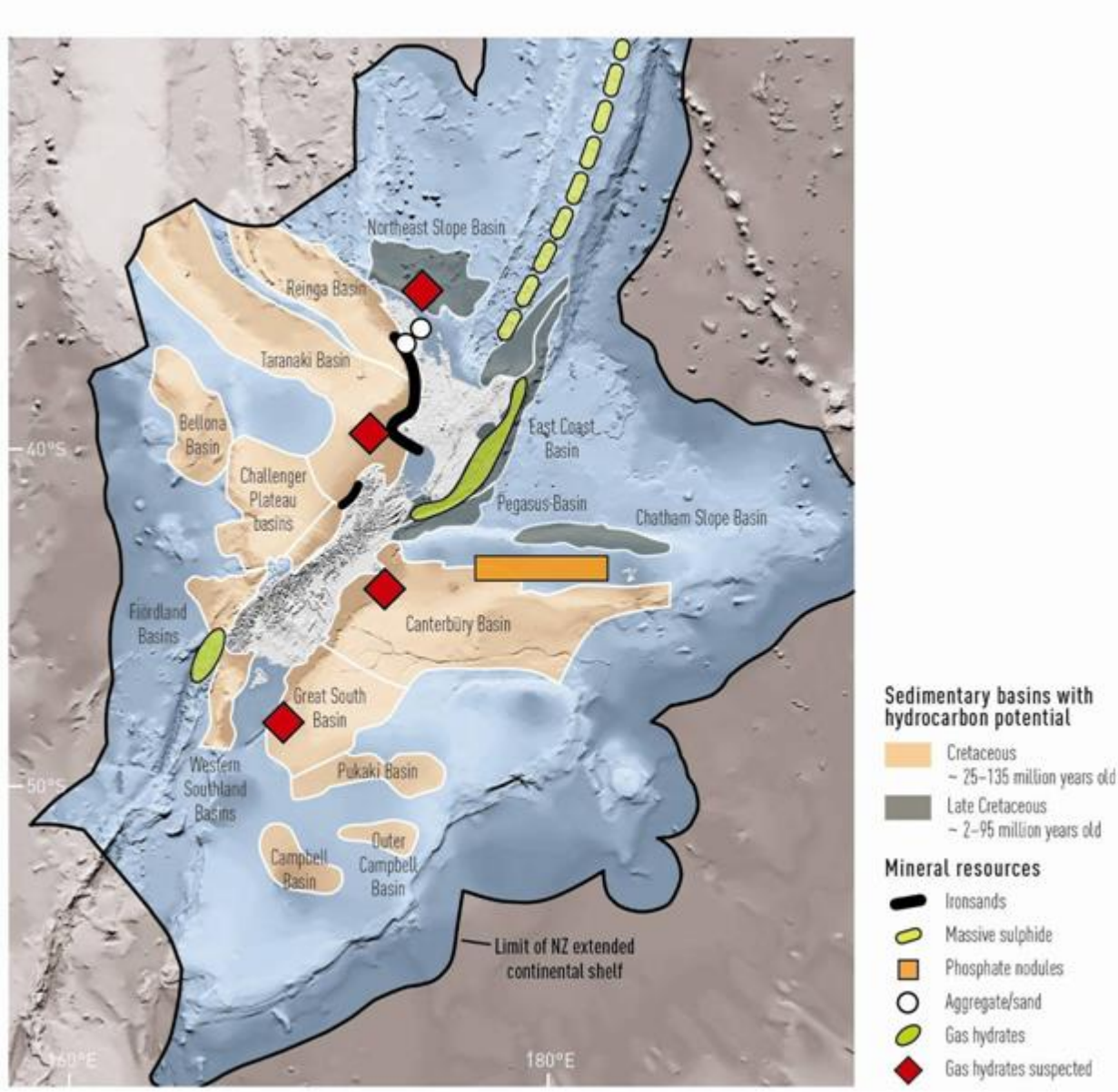


Figure 1-2: Distribution of sedimentary basins and some mineral resources in the EEZ and ECS

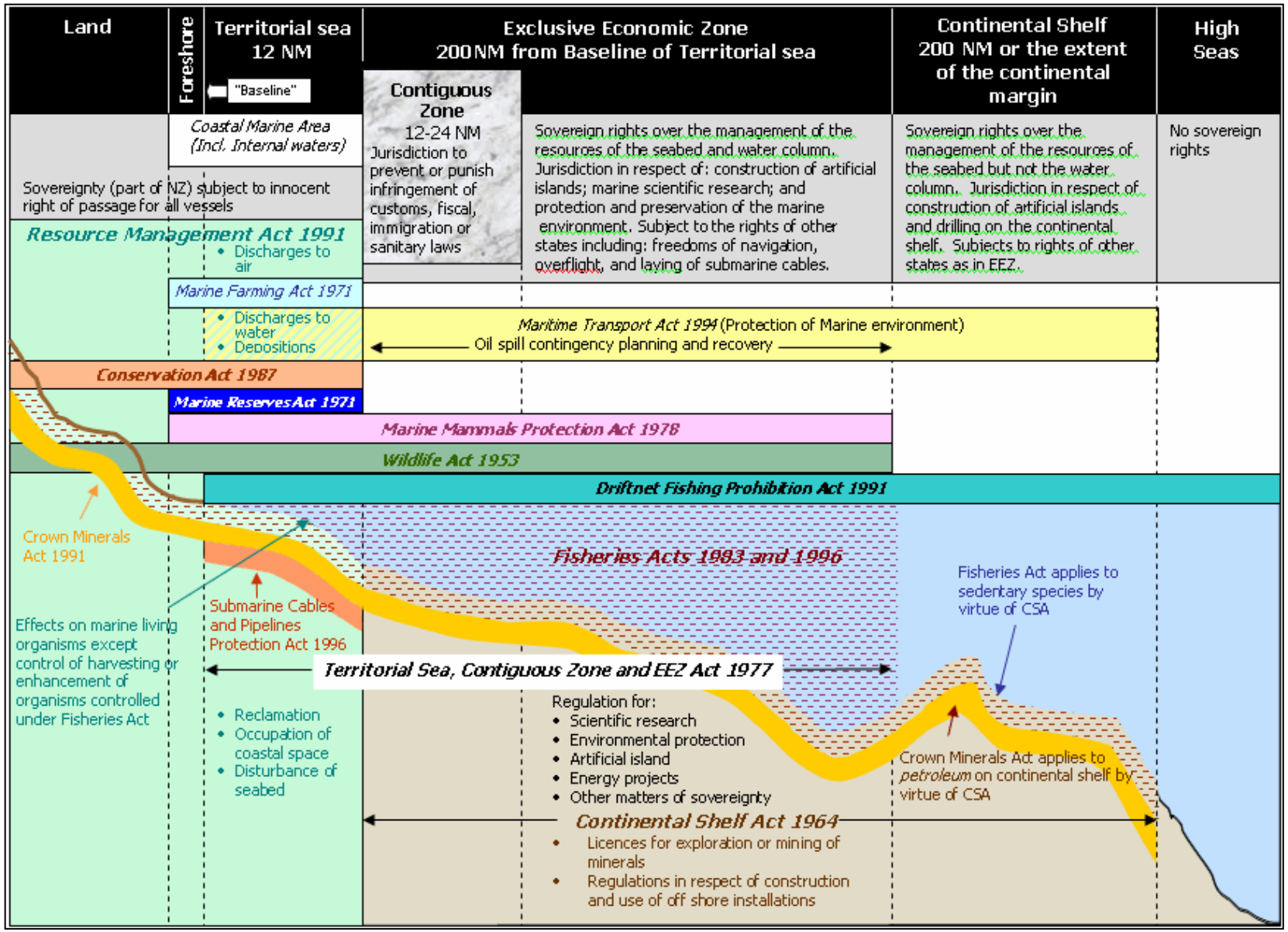


Figure 1-3: Spatial extent of relevant legislation and regulations (courtesy MfE).

2 Methods

The methodology included the following stages:

1) **Determination of the likely activities in the EEZ and ECS:** We drew up a list of present and potential industries, such as aquaculture, power generation, gas and oil activities, and minerals exploration and mining, likely to be carried out in the EEZ and ECS over a 20-30 year horizon. We subdivided these into their component phases and activities over the lifetime of an industrial operation to ensure that all relevant components were assessed.

   Early in the project an initial list of activities was circulated to the expert panellists as well as to the industry representatives and to MfE. An updated list of activities, incorporating feedback from the above group, was circulated again before the panel met. The activities were then discussed and updated as necessary during the panel deliberations.

2) **Determination of the probable locations of these activities**: We determined the probable location of activities, the methods likely to be used carrying out such activities, and thus the habitats likely to be influenced by them. This stage was informed by collation of available published and unpublished material identifying probable locations of these activities supplemented by the input of experts and stakeholders in the relevant industries. Probable locations of activities were further discussed during the workshop.

3) **Establishment of likely environmental threats arising from activities:** Given the tight timeframe for this work (i.e., one month), there was no scope for new research to better understand the environmental threats stemming from activities presently or likely to occur within New Zealand's EEZ and ECS, or capacity for significant desktop discovery via exhaustive literature searches for a wide range of international examples that may be directly translatable to New Zealand conditions. Instead we were limited to a brief literature review from two main sources: a) existing New Zealand environmental assessment studies and b) widely available international studies and policy. The panellist's expert knowledge supported by the limited literature review, provided the information to enable us to determine a broad-scale definition of the likely magnitude and frequency of environmental effects of certain activities, and their lifecycle components, on the ocean environment. Much of the literature was already familiar to NIWA staff from previous research and environmental studies.

   An initial list of activities and threats deriving from them was circulated to the expert panellists, as well as to the industry representatives and to MfE, for their feedback and input at an early stage of the project. An updated list of activities and threats incorporating feedback from the panellists was circulated again before the panel met. The activities and threats were then discussed and updated as necessary during the panel deliberations.

4) **Expert Panel:** We convened an Ecological Risk Assessment (ERA) panel of experts (the Panel), made up of available NIWA staff based at Wellington , including MfE staff as observers and industry representatives as advisors, to help assess the ecological consequences of threats arising from various activities in the EEZ and ECS as well as the likelihood of these threats occurring.

ERA panellists included those with a good level of knowledge of the activity as well as those with knowledge of consequences to particular aspects of the ecosystem. A core number of panellists assessed all activities while others were present for only those activities for which they had specific technical expertise. A list of experts, observers and advisors present for the assessment of each activity is provided in Table 2-1. The assessments were based on the expert judgement of the ERA Panel members and therefore were qualitative rather than quantitative.

5) **Threats, consequences and likelihood:** The method sequentially progressed through three main steps: (i) re-examination of activities and threats arising from them; (ii) an assessment of the potential consequences of those threats to five aspects of the environment and; (iii) the likelihood of a particular level of consequence occurring from the various activities. It is important that subsequent use of these ratings reflect all three of these steps to maintain the integrity and context within which risks were assessed.

   The panel considered consequences and likelihoods with regard to five aspects of the environment (adapted from Fletcher 1995): the time to recover if the threat stopped, impacts on key species, impacts on protected species, ecosystem functional impact, and the proportion of habitat affected by a threat. These are all key indicators of ecological response at a range of scales. The proportion of a habitat affected by an activity is critical to assessing the spatial extent of any impact. The ecological functional impact is likewise a broad indicator of the ecological significance of a disturbance. The impacts on protected and key species are more specific indicators highlighting socially and ecologically important species in the affected environment. Lastly recovery period provides an indication of the affected species and habitat ability to recover from the threat taking into account knowledge of the biology and ecology.

   The Panel discussed, evaluated and scored the consequences of the activities on a scale of 0 to 5, using a set of 6 prepared consequence descriptions ranging from negligible to catastrophic. Table 2-2 provides the descriptions of the consequence levels and scores for the five environmental categories. Since the nature of the potential consequences of exposure to the identified activities in the EEZ and ECS depends on the particular environmental component being considered, there are different sets of descriptions of consequence levels for each of the environmental categories. These descriptions were reviewed by the Panel prior to the workshop and some adjustments were made during the workshop when the original wording was found to be ambiguous. The consequence scores and the reasons for them were recorded by the workshop convener.

   Where data or information did not exist, a precautionary approach was necessarily adopted to reflect the uncertainty in the likely effects of the activity. For example, where the distribution of a particular relevant activity was known but the distribution of the environmental component was uncertain, there was an assumption that the potential risk was high because the ecological component under consideration may be exposed to the activity. This is likely to occur, for example, in relation to migratory species.

   Following the scoring of the consequence, the ERA Panel discussed, assessed and then scored the likelihood of that consequence occurring. Likelihood scores ranged

from 1 to 6, from remote to likely. The likelihood descriptions (Table 2-3) were reviewed by the ERA Panel prior to the workshop. The likelihood scores and the reasons for them were recorded by the workshop convener.

The assessments were based on the expert judgement of the ERA Panel members and therefore were qualitative rather than quantitative. However, quantitative data, scientific reports and other information collated during Stage 3 above were used to support and inform the risk assessments.

This process was repeated for each identified activity likely to occur in the EEZ or ECS.

6) **Confidence:** When it had completed the evaluation of each environmental component, the Panel rated its confidence in its assessment (high or low). Table 2-4 provides the confidence ratings together with a set of prepared rationales. These were reviewed by the Panel prior to the workshop. Note that within each confidence rating (low and high) confidence levels are not listed in rank order.

7) **Risk:** Risk was then calculated as the product of consequence and likelihood. This calculation is commonly referred to as the exposure – consequence risk assessment method. This process was repeated for each identified activity likely to occur in the EEZ or ECS. Risk scores ranged from 0 (negligible) to 30 (extreme).

Table 2-1: Expert panellists, observers and advisors. [1]Advisor; [2]Observer.

Oil and Gas & Carbon Sequestration	**Scientific exploration and sampling**	**Iron Sands & Placer Gold**	**Offshore aquaculture & Ecotourism**
Dr Alison MacDiarmid – Convener Dr Geoffroy Lamarche - Geologist Dr Helen Bostock - Geochemist Dr David Thompson – Seabirds Dr Leigh Torres – Marine mammals [1]Mr John Pfahlert – PEPANZ [2]Mr Joshua McLennan-Deans – MfE	Dr Alison MacDiarmid – Convener Dr Helen Bostock – Geochemist Dr Malcolm Clark – Deep-sea biologist Dr David Bowden – Benthic ecologist Dr David Thompson – Seabirds Dr Craig Stevens – Ocean physicist Dr Leigh Torres – Marine mammals	Dr Alison MacDiarmid – Convener Dr Alan Orpin – Geologist Dr David Thompson – Seabirds Dr Leigh Torres –Marine mammals Dr Jenny Beaumont – Benthic ecologist Dr Mark Hadfield – Sediment modeller [1]Mr Bernie Napp – Snr Policy Analyst, Straterra	Dr Alison MacDiarmid – Convener Dr Phil Heath – Aquaculture biologist Dr Craig Stevens – Ocean physicist Dr David Thompson – Seabirds Dr Leigh Torres – Marine mammals Dr David Bowden – Benthic ecologist Dr Scott Nodder – Sedimentologist
Massive Sulphides	**Polymetalic crusts & nodules**	**Gas (methane) hydrates**	
Dr Alison MacDiarmid – Convener Dr Malcolm Clark – Deep sea biologist Dr David Thompson – Seabirds Dr Leigh Torres – Marine mammals Dr Richard Wysoczanski – Vulcanologist Dr Jenny Beaumont – Benthic ecologist Dr Mark Hadfield – Hydrographic modeller [1]Mr Bernie Napp – Snr Policy Analyst, Straterra	Dr Alison MacDiarmid – Convener Dr Scott Nodder – Sedimentologist Dr Malcolm Clark – Deep-sea biologist Dr David Thompson – Seabirds Dr Helen Bostock – Geochemist Dr David Bowden – Benthic ecologist Dr Leigh Torres – Marine mammals Dr Mark Hadfield – Sediment modeller	Dr Alison MacDiarmid – Convener Dr David Bowden – Benthic ecologist Dr David Thompson – Seabirds Dr Leigh Torres – Marine mammals Dr Mark Hadfield – Sediment modeller [1]Mr Bernie Napp – Snr Policy Analyst, Straterra	
Phosphorite Nodules	**Telecommunications**	**Deep-sea energy**	
Dr Alison MacDiarmid – Convener Dr Scott Nodder – Sedimentologist Dr Jenny Beaumont – Benthic ecologist Dr David Thompson – Seabirds Dr Leigh Torres –Marine mammals Dr Mark Hadfield – Sediment modeller	Dr Alison MacDiarmid – Convener Dr David Thompson – Seabirds Dr Leigh Torres – Marine mammals Dr David Bowden – Benthic ecologist Dr Craig Stevens – Ocean physicist	Dr Alison MacDiarmid – Convener Dr Craig Stevens – Ocean physicist Dr David Thompson – Seabirds Dr Leigh Torres – Marine mammals Dr David Bowden – Benthic ecologist	

Table 2-2: Consequence levels. Summary descriptions of the six sets of consequence levels covering five environmental categories. Adapted from Fletcher (2005).

Consequence level	Recovery Period	Key species	Protected species	Ecosystem functional impact	Proportion of habitat affected
0 - Negligible	No recovery time needed	Undetectable for populations of these species	Almost none are impacted	Interactions may be occurring but it is unlikely that there would be any change outside of natural variation	Affecting <<1% of area of original habitat area
1 - Minor	Rapid recovery would occur if stopped - measured in weeks to months	Possibly detectable but little impact on population size and none on their dynamics	Some individuals impacted but no impact on population.	Affected species do not play a keystone role - only minor changes in relative abundance of other constituents	Measurable but localized; affects <1-5% of total habitat area
2 - Moderate	Recovery probably measured in months - years if activity stopped	Affected but long-term recruitment/ dynamics not adversely impacted	Level of interaction/ impact moderately affects population	Measurable changes to the ecosystem components without there being a major change in function (i.e. no loss of components)	Impacts more widespread; 5-20% of habitat area is affected
3 - Severe	Recovery measured in years if stopped	Affecting recruitment levels of populations or their capacity to increase	Level of impact severely affects population levels	Ecosystem function altered measurably and some function or components are missing/ declining/ increasing well outside historical acceptable range and/or allowed/ facilitated new species to appear.	Impacts very widespread; 20-60% of habitat is affected/ removed
4 - Major	Recovery period measured in years to decades if stopped	Likely to cause local extinctions if continues	Likely to cause local extinctions if continues	A major change to ecosystem structure and function. Different dynamics now occur with different species or groups now affected.	Activity may result in major changes to ecosystem; 60-90% affected
5 - Catastrophic	Long term recovery to former levels will be greater than decades or never, even if stopped	Local extinctions are imminent/immediate	Local extinctions are imminent/immediate	Total collapse of ecosystem processes. The diversity of most groups is drastically reduced and most ecological functional groups (primary producers, grazers etc.) have disappeared. Most ecosystem functions such as carbon cycling, nutrient cycling, flushing and uptake have declined to very low levels.	Entire habitat in region is in danger of being affected; >90% affected/ removed

Table 2-3: Consequence likelihood categories. Levels and descriptions for each likelihood category (used for all environmental components). Adapted from Fletcher (2005).

Level/score	Descriptor	Likelihood of exposure
1	Remote	Highly unlikely but theoretically possible
2	Rare	May occur in exceptional circumstances
3	Unlikely	Uncommon, but has been known to occur elsewhere
4	Possible	Some evidence to suggest this is possible.
5	Occasional	May occur occasionally
6	Likely	It is expected to occur

Table 2-4: Confidence. Confidence rating, score and description.

Confidence rating	Score	Rationale for confidence score
Low	1a	Data exists, but is considered poor or conflicting.
	1b	No data exists.
	1c	Agreement between experts, but with low confidence
	1d	Disagreement between experts
High	2a	Data exists and is considered sound.
	2b	Consensus between experts even though data may be lacking
	2c	High confidence - exposure to impact cannot occur (e.g. no spatial overlap of activity and species distribution)

3 Classification of activities and environmental risk

There are often ways of avoiding, remedying or mitigating the effects of activities that would otherwise put marine species or ecosystems at risk. If risks are high and there are no ways to avoid, remedy or mitigate the effects of an activity it should be prohibited.

Using the exposure – consequence risk assessment framework adopted in this study, ecological risk is defined as the product of consequence and likelihood. Using the tables of defined levels and scores of environmental consequences (Table 2-2) and likelihoods (Table 2-3) ecological risk can range from a minimum of 0 to a maximum of 30.

We consider that activities with low risk levels of 6 or less across all five environmental categories should be categorised as permitted – these arise from the lowest two levels of consequence (0 -negligible and 1- minor) (see Table 3-1) at all levels of likelihood (including 6, likely), from moderate levels of consequence (2) at unlikely (3) or lower levels of likelihood, from severe levels of consequence (3) at rare (2) or remote (1) levels of likelihood, or from major and catastrophic levels of consequence at remote levels of likelihood.

From an ecological perspective we consider that if environmental risk is the only criteria for classification activities with extreme risk levels of 24 or more for one or more of the 5 environmental categories should be provisionally classified as prohibited (Table 3-1) unless some means of avoiding or reducing the ecological consequences can be found. These levels of risk arise only from those activities judged to have major (4) consequences at the highest level of likelihood (6) and catastrophic consequences (5) at the two highest levels of likelihood (5 and 6)

If environmental risk is the only criteria for classification activities over a broad range of moderate (7-14) and high (15-20) risk values for all of the five environmental categories, we consider, should be categorised as discretionary (Table 3-1).. This classification does not take into account potential mitigation measures. If mitigation measures are taken into account and required as conditions it may be appropriate to downgrade the classification of some activities to permitted. We do not have full information to assess the degree to which mitigation measures might reduce the risk scores of the activities.

The recommended classifications should not be translated into firm recommendations about how the activities should be ultimately regulated. They are based purely on an assessment of environmental risk, with increased risk meaning the activity will need to be more closely controlled. Our recommendations do not take into account other criteria that policy makers are likely to use in deciding final classification of activities.

Table 3-1: Risk levels and categories.

Risk Level	Risk score range	Risk score derivation		Category
		Consequence level	Likelihood levels	
Low	0-6	0 – negligible 1 – minor 2 – moderate 3 – severe 4 – major 5 – catastrophic	1-6 (remote to likely) 1-6 (remote to likely) 1-3 (remote, rare or unlikely) 1-2 (remote or rare) 1 (remote) 1 (remote)	Permitted, with appropriate conditions.
Moderate	8-12	2 – moderate 3 – severe 4 – major 5 – catastrophic	4-6 (possible, occasional, likely) 3-4 (unlikely, possible) 2-3 (rare, unlikely) 2 (rare)	Discretionary (pending possible mitigation measures)
High	15-20	3 – severe 4 – major 5 – catastrophic	5-6 (occasional, likely) 4-5 (possible, occasional) 3-4 (unlikely, possible)	
Extreme	24-30	4 - major 5 – catastrophic	6 (likely) 5-6 (occasional or likely)	Prohibited

4 Results

4.1 Oil and gas

4.1.1 Background

New Zealand has at least 14 sedimentary basins of various ages with hydrocarbon potential (Figure 4-1). The Taranaki Basin is currently the only producing basin in New Zealand with over 400 onshore and offshore exploration and production wells have been drilled to date. No production wells have been drilled beyond the Taranaki shelf edge. The basin remains under-explored compared to many comparable rift complex basins of its size and there remains considerable potential for further discoveries, especially in deep parts of the basin.

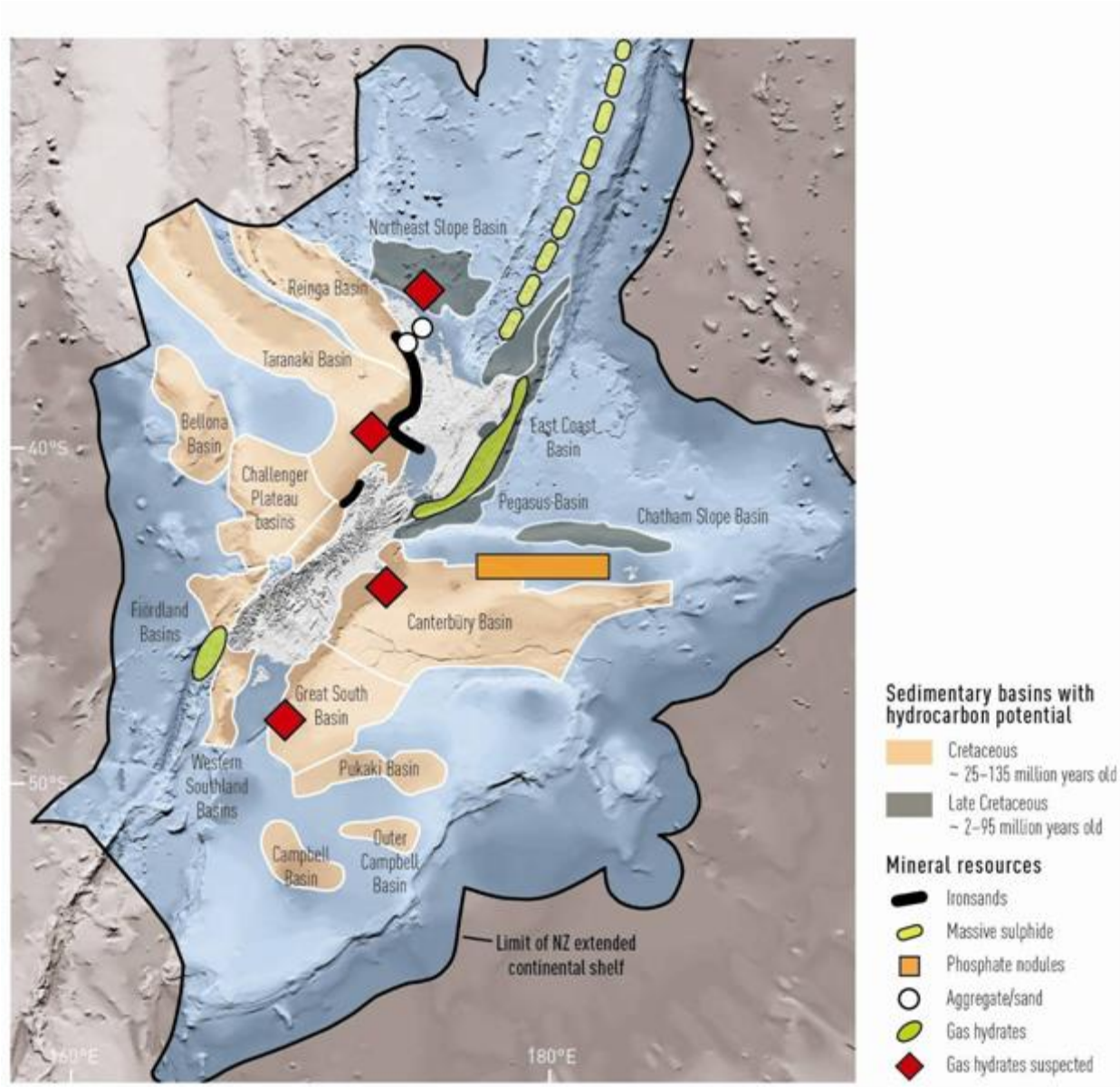


Figure 4-1: Distribution of sedimentary basins in the EEZ and ECS.

In 2010, New Zealand produced ~21 million barrels (mmbbls) of oil and LPG Production and 157 billion cubic feet (Bcf) of gas essentially originating from the Taranaki Basin. The ultimate proved reserves are estimated at ~560 mmbbls of oil and 6400 Bcf of gas (see www.nzpam.govt.nz/cms/petroleum).

The rest of New Zealand is severely under-explored; nevertheless, frontier basins drilled to date have all yielded discoveries confirming viable petroleum systems, such as in the Great South Basin off SE South Island. Given many untested structures mapped have closures bigger than the Maui field (New Zealand's largest field); there is considerable potential for commercial hydrocarbon discoveries under New Zealand's largely untouched seabed (Crown Minerals (2004).

Presently there are just over 30 offshore exploration permits delivered by New Zealand Petroleum and Mineral in Taranaki and west coast North Island, East Coast North Island, Raukumara Basin and SE South Island, with an additional five applications pending (Crown Minerals 2004, www.nzpam.govt.nz/cms/petroleum).

4.1.2 Assessment

We assessed four phases of New Zealand's marine oil and gas industry: prospecting, exploration, production and abandonment / decommissioning. For each phase we identified and assessed the ecological impact of several distinct activities (Table 4-1). Below we present the main results for each phase.

Prospecting

Surveying for likely oil or gas bearing geological structures using surface ships is the main activity in the EEZ during this phase.

The survey ship acquires bathymetric data using a multi-beam echo-sounder, and data about geological structures beneath the seafloor using a seismic source and a streamer comprising multiple hydrophones that may be up to 15 km long (usually 6-8 km). The streamer is typically deployed at ~2 knots and acquisition of data occurs at 5 knots. A very large area, perhaps approaching 100% of the prospecting licence area, may be surveyed during this phase though sequentially over a period of several weeks to a few months. We assume the habitat area under consideration is a particular sedimentary basin.

The acoustic impact of seismic surveys on marine mammals, in particular, is well documented (Gordon & Moscrop 1996, Cox et al. 2006, Brandon et al. 2008, Di Iorio and Clark 2010) but may also affect a range of marine reptiles, fish and invertebrates (e.g. Luyeye 2005). The consequences for marine mammals will vary from none to behavioural (may leave area) to acute injury (ear drum damage) to serious (death) depending on noise level encountered, species and habitat (Gordon & Moscrop 1996). Beaked whales are thought to be particularly at risk (Cox et al. 2006). There may also be cumulative effects from repeated exposure. Noise travels great distances underwater and so the footprint of this activity may be very broad though fatal impacts will be much more restricted in area as sound intensity typically falls as the square of the distance from the source. Acoustic depth sounders and multibeam echo-sounders used for swath mapping pose little risk but high energy seismic devices such as air guns used for mapping sub seafloor geological structures pose a much greater risk (Brandon et al. 2008). Using a precautionary approach our assessment assumed that air guns were used and the species affected was a nationally critical species such as southern right whales as these may occur throughout the EEZ though they occur in different areas at different times of the year. The risk from this activity was assessed to reach a score of 18 with a high level of confidence (Table 4-1).

Fur seals and sea lions may be attracted to the seismic streamer during deployment and retrieval and could become entangled and injured or drown (G. Lamarche personal observation). The number of individuals affected is likely to be small given the one-off nature

of a seismic survey and impacts will be largely restricted to locations where deployment and retrieval takes place at slow speeds. Using a precautionary approach our assessment assumed that the species affected was the New Zealand sea lion though few occur north of about 45^{o} S. The risk to sea lions during seismic streamer deployment and retrieval was assessed to reach a score of 3 but with a low level of confidence (Table 4-1) because few data exist about this effect. Populations are unlikely to be affected and ecosystem effects will be negligible.

Lights on survey ships at night typically attract and disturb seabirds and may cause them to collide with the ship (Black 2005). These effects are covered under the Maritime Transport Act (1994) and the Wildlife Act (1953).

Ship strikes on marine mammals, fish, and reptiles may occur during the survey and during transits to and from the survey area. These effects are covered under the Maritime Transport Act (1994) and the Marine Mammal Protection Act (1978) and although these threats were assessed (Table 4-1) the risks will not be considered further here.

We have not assessed the potential for survey ships to act as vectors for the introduction of non-indigenous species as this is already managed under existing legislation.

Exploration

A wider range of activities occur during this phase albeit over a much smaller area than during the prospecting phase (Table 4-1). Typically a drill ship or platform is used to assess the oil and/or gas reserves of specific rock strata. A single drill hole may take weeks to a few months to reach its target depth depending on the rock type encountered. One or more holes may be drilled on single exploration permit.

Lights on a drilling platform at night typically attract and disturb seabirds and may cause them to collide with the above sea surface structure (Black 2005). Although these frequently cause some seabird deaths, on average there will be little impact on most seabird populations as the duration of this phase in any one place is short (months), but even a few deaths could affect the recovery of populations of some nationally critical species. Only seabirds in the area at night will be affected. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk from this activity was assessed to reach a score of 10 with a high level of confidence (Table 4-1) indicating the need for this to be a discretionary activity.

Marine mammals potentially may interact with a drilling platform, or be affected by surface or subsurface activity and lights. Rigs also attract prey species. Seal haul-outs are possible on the leg bracing struts on some platforms (John Pfahlert personal comment). If the interaction is with a threatened species then the impact potentially may be more severe. In deeper parts of basins, species such as sperm whales and beaked whales may be affected. In southern oil basins sea lions and elephant seals may be affected. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to marine mammals from this activity was assessed to reach a score of 5 with a high level of confidence (Table 4-1) indicating that this activity could be classified as permitted.

The benthic ecosystem on the seafloor will be impacted by exploratory drilling but the affected proportion of the benthic habitat in the licence area and the oil basin is likely to be very small. At the drill site itself the legs of the drill platform may directly impact the seafloor,

as will the drill head of ~5-10 m^2 and any mooring chain used that may be up to 1-2 km long with or without an anchor. When new oil or gas wells are drilled, the lubricant used is of three types: oil-based, synthetic, or water-based (in order of decreasing severity of impact on the environment). The type of drilling lubricant used has a large bearing on the toxicity of drill cuttings that were formerly dumped on the seabed and the time for the benthos to recover (Addy et al. 1984, Olsgard & Grey 1995, Patin 1999). Cuttings from new wells will likely be collected and stored during exploratory phase and ultimately be disposed of on land (John Pfahlert personal comment) but this is not yet 100% certain. Discharges from the drilling platform or ship are already managed under existing legislation and so are not evaluated here. The level of benthic impact will be low for most areas but impacts could be higher in some areas if they contain protected species of deep-water corals or vulnerable benthic species. Risk levels for recovery of the benthos, impacts on key species, protected benthic species such as deepwater corals, and the functioning of the ecosystem were 15, 12, 12 and 12 respectively. The speed of recovery of the benthos after completion of drilling will depend on the type of lubricant used in the drilling process but is likely to take years (Olsgard & Grey 1995, Daan & Mulder 1996, Patin 1999).

Drilling activities will produce some level of underwater noise from the drill itself, and any submersed cutters, pumps or other machinery that could affect marine mammals but probably at the lower end of the impact range (Gordon & Moscrop 1996).

Exploratory drilling platforms brought in to New Zealand from Australia or further afield may act as vectors for non-indigenous species. The functional impacts on the ecosystem surrounding the rig is probably minor as vectored species are unlikely to survive independently of the rig in deep offshore waters. The rig may act as a stepping stone for non-indigenous species to invade shallow coastal habitats.

Production

The production phase for oil and gas may or may not involve a surface production platform and a pipeline to shore. It is possible that a seabed facility could be put in place leading directly to a pipeline to shore or to a surface mooring for transfer of oil or gas to tankers.

If a production platform is used, then as during the exploratory drilling phase, lights on the platform at night will typically attract and disturb seabirds and may cause them to collide with the above sea-surface structure. Although these frequently cause some seabird deaths, on average there will be little impact on most seabird populations, but even a few deaths could affect the recovery of populations of some nationally critical species. Only seabirds in the area at night will be affected but the production platform may be in place for decades. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk from this activity was assessed to reach a score of 15 with a high level of confidence (Table 4-1) indicating the need for this to be a discretionary activity.

Marine mammals may interact with a production platform. Seal haul-outs are possible on the leg bracing struts on some platforms. Rigs attract fish and marine predators. Mitigation is possible by reducing access to potential haul-out areas and this is recommended for production platforms that may be in place for decades. If the interaction is with a threatened species then the impact potentially may be more severe. In deeper parts of basins, species such as sperm whales and beaked whales may be affected. In southern oil basins, sea lions and elephant seals may be affected. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to protected marine mammals from this activity was assessed

to reach a score of 5 with a high level of confidence (Table 4-1). Recovery once the platform was removed may take months to years.

Production platforms are likely to be purpose built in New Zealand or overseas. New Zealand built platforms should pose little risk. Platforms brought in to New Zealand from Australia or further afield may act as vectors for non-indigenous species but the likelihood is low for a new platform with fresh antifouling. The functional impacts on the ecosystem surrounding the platform is probably minor as vectored species are unlikely to survive independently of the rig in deep offshore waters. However, the platform may act as a stepping stone for non-indigenous species to invade shallow coastal habitats.

The benthic ecosystem on the seafloor will be impacted by a single platform during the long production phase but the affected proportion of the benthic habitat in the licence area and the oil basin is likely to be very small. Regulators need to be mindful, however, of the possibility for multiple production facilities and pipelines to occur in a single region and benthic impacts to increase accordingly. This is a serious issue in some regions (Kingston 1992). At the well site itself the legs of the production platform may directly impact the seafloor, as will the well head of ~5-10 m^2 and any mooring chain used that may be up to 1-2 km long with or without an anchor. If a submerged pipeline is built to bring the oil or gas onshore then the seabed will be impacted during construction and trenching. Discharges from the platform are already managed under existing legislation. The level of benthic impact will be low for most areas but impacts could be higher in some areas if they contain protected species of deepwater corals. Risk levels for recovery of the benthos, impacts on key species, protected benthic species such as deepwater corals, and the functioning of the ecosystem were 6, 6, 12 and 12 respectively.

Installation of the production platform, pipeline construction and trenching, underwater inspection using ROVs or submersibles as well as routine maintenance and pumping will regularly produce some level of underwater noise in the vicinity of the production platform and more intermittently along the pipeline route. This underwater noise may affect marine mammals, mainly causing then to avoid the area (Gordon & Moscrop 1996), but we assessed this to pose low risk (6) and that recovery would occur almost immediately after the noise stopped.

Oil and gas production may affect stocks of fished species in two ways. There may be some direct effects during the construction of the well head, installation and anchoring of a platform and construction and trenching of a pipeline. These structures will also alienate an area (albeit small) of seafloor so that it no longer provides foraging habitat for demersal fishes. These same structures may also provide a new artificial reef-like surfaces and increase reef habitat in the area for reef associated fishes (Dauterive 2000). Production platforms and pipelines invariably have a zone of restricted access around them that restricts fishing access to these areas. Unless commercial fish quota is purposefully bought by the production company and retired for the duration of the production phase then commercial fishing will be displaced into the remainder of the quota management area (QMA). The resulting fishing pressure has the potentail to affects some fish stocks, especially sedentary species with limited migrations. However, the area of a QMA likely affected by a single production platform will be small and we assessed there to be low risk (5) from this threat. Regulators need to be mindful, however, of the possibility for multiple production facilities and pipelines to occur in a single region and for fishing to be forced into an ever decreasing proportion of a QMA. The region most likely to be affected in this way over the next 20-30 years is off Taranaki.

Abandonment / Decommissioning

The ecological risks associated with this phase will depend on whether the production platform and equipment is dismantled and removed, sunk to the seafloor and abandoned, or left intact for another use such as carbon sequestration (see section 4.2). Active discussion of these alternatives is underway within New Zealand's oil and gas production community as the Maui platforms off Taranaki are now nearing the end of production. If left intact for another use then the ecological risks will be largely the same as during the production phase and are not considered further here. The impacts of platform dismantlement and abandonment are considered below. We assumed that any buried pipeline and anchor chains will be left in place as the cost of recovery would be high and the ecological impacts of removal would be equivalent to their initial installation.

Regardless of whether the production platform is dismantled and removed or sunk and abandoned there will be a great deal of preparatory work on the platform to prepare it for either fate. Cleaning the structure of oils and toxic substances in preparation for planned sinking in the EEZ is mandatory under the Maritime Transport Act (1994). Preparatory work is likely over a period of months and may require the use of lights on the platform at night. These typically attract and disturb seabirds and may cause them to collide with the remaining super-structure. Although these frequently cause some seabird deaths, on average there will be little impact on most seabird populations, but even a few deaths could affect the recovery of populations of some nationally critical species. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk from this activity was assessed to reach a score of 10 with a high level of confidence (Table 4-1). Marine mammals may also be affected during this phase by the increased activity around the platform for a period of months to remove it or abandon it. We assumed no underwater explosions would be used for either scenario. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to protected marine mammals from this activity was assessed as low (5) with a high level of confidence (Table 4-1). Recovery once the platform is removed may take months to years.

We assessed the risks to seafloor ecosystem of removal of the platform to be minor (6) and that recovery of benthic organisms would take on the order of months to years.

Sinking of a steel platform will have lasting impacts on the local benthic ecosystem as the platform slowly rusts and disintegrates over a period of ~100 years and so recovery is likely to be very long-term taking many decades. However, the overall area impacted is very likely to be only a small proportion of the benthic ecosystem in the licence area or the oil basin so the overall risk to ecosystem functioning, protected benthic species and key species is low (6).

Risk summary for oil & gas extraction

There were no activities associated with oil and gas extraction considered to represent an extreme environmental risk provisionally indicating prohibited status.

The following activities were considered to be of high environmental risk (15-20) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Surface flood lights at night
- Operation of airguns and streamers during seismic surveys

- Survey vessel activity causing strikes on marine mammals (regulated under the Maritime Transport Act (1994) and the Marine Mammal Protection Act (1978)).
- Drilling activities

The following activities were considered to be of moderate environmental risk (7-12) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Presence of seafloor structures and anchors
- Boomer surveys
- Provision of biofouling surfaces
- Presence of platform structure
- Underwater pipeline laying and trenching
- Well capping
- Recovery of underwater equipment, plant and machinery
- Underwater lights
- Incidental underwater noise
- Abandonment, sinking of platform and equipment
- Material degradation

The following activities were considered to be of low environmental risk (0-6) and should be categorised as permitted:

- Single and multibeam echo sounding
- Declaration of exclusion zone

4.1.3 Avoidance, mitigation, remediation

There are often ways of avoiding, remedying or mitigating the effects of activities that would otherwise put marine species or ecosystems at risk. Below we briefly discuss those relevant to oil and gas exploration and exploitation.

Non-mandatory Department of Conservation guidelines (2006 and 2011) should be followed to avoid or mitigate acoustic impacts on marine mammals.

Avoidance or mitigation of seabird strikes on drilling platforms is possible by limiting unnecessary use of platform lights at night and ensuring that those that are required are directed approximately vertically onto work surfaces. Visual checks of the platform structure at first light each day for the presence of dazed or injured birds and the provision of appropriate care may help to remedy this impact.

Avoidance or mitigation of seals hauling out on platform structures is possible by reducing access to potential haul-out areas but modifications to exploitation platforms is unlikely given that they invariably come to NZ from overseas for a relatively short period of intense exploration activity.

Efforts should be made to avoid areas of vulnerable benthic fauna such as protected deepwater corals within the footprint of the production platform and its anchors. Pipelines should also be routed to avoid reef habitat and any other vulnerable benthic habitat.

Avoidance or mitigation of exploratory or production platforms acting as vectors for non-indigenous species is possible by appropriate checking, cleaning, and application of antifouling paints. We understand that Biosecurity New Zealand (MAF-BNZ) is developing an import health standard to cover the import of drilling rigs and legislation and relevant regulations may be put in place in next 2-3 years.

Table 4-1: Expert Panel Assessment: Oil & Gas Extraction. Levels of consequence, likelihood, risk and confidence associated with this activity in the EEZ and ECS. Activities are listed (a, b, c, etc) after each threat to which they contribute. The maximum possible level of environmental risk is 30. Extreme environmental risks are highlighted in red, high in yellow, and moderate in green. Low risk activities are not highlighted. *Threats managed under the Maritime Transport Act (1994). NA = not applicable as species assessed are all protected.

Expert Panel Assessment: Oil and Gas		Recovery period				Key species				Protected species				Ecosystem functional impact				Proportion of habitat affected			
Activity	**Threat**	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence
Acoustic prospecting / Seismic surveying a) Surface flood lights & noise b) Single and multi-beam echo sounder c) Air gun & streamers d) Ship activities	*Seabird attraction, disturbance, collision with survey ship (a)	1	6	6	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	1	6	6	2b
	Acoustic impact from multi-beam echo sounders on marine mammals, reptiles, fish and invertebrates (b)	0	5	0	2a	0	6	0	2a	1	5	0	2a	0	6	0	2a	0	6	0	2a
	Acoustic impact of air gun on marine mammals, reptiles, fish and invertebrates (c)	3	6	18	2a	3	6	18	1c	3	6	18	2a	0	6	0	2a	3	6	18	2a
	Fur seal and sea lion attraction during streamer deployment and retrieval (c)	1	6	6	2b	NA	NA	NA	NA	1	3	3	1c	0	6	0	2b	0	6	0	2b
	*Ship strikes on marine mammals, fish, and reptiles (d)	3	6	18	2a	2	2	4	2b	2	2	4	1c	0	6	0	2b	0	6	0	2b
Exploratory drilling e) Platform flood lights and noise f) Drilling activities g) Platform structure h) Provision of biofouling surfaces i) Sea floor structures including anchors & moorings j) Site surveys using swath mapping k) Underwater lights l) Boomer surveys m) Support vessel activity	Seabird attraction, disturbance, collision with platform (e)	0	6	0	2b	NA	NA	NA	NA	2	5	10	2b	0	6	0	2b	0	6	0	2b
	Marine mammal interaction (g, i)	1	6	6	2a	NA	NA	NA	NA	1	5	5	2a	0	6	0	2b	0	6	0	2b
	Impact on benthos (f, i)	3	5	15	2b	2	6	12	2b	2	6	12	2b	2	6	12	2b	0	6	0	2b
	Acoustic impact from boomer surveys (l)	1	4	4	2a	0	2	0	1c	2	4	8	2a	0	6	0	2a	1	6	6	1b
	Acoustic impact from multibeam echo sounders (j)	1	6	6	2b	1	6	6	2b	1	6	6	2b	0	6	0	2b	0	6	0	2b

	Vector for non-indigenous species (h)	3	4	12	2b	1	4	4	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b
	*Ship strikes on marine mammals, fish, and reptiles from support vessels (m)	3	6	18	2a	2	2	4	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b
Oil or gas production n) Platform flood lights and noise o) Platform structure p) Import and provision of biofouling surfaces q) Seabed structures r) Support vessel activity s) Underwater pipeline laying, trenching, inspection and maintenance t) Underwater lights u) Underwater noise v) Platform and pipeline exclusion zone	Seabird attraction, disturbance, collision (n)	0	6	0	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	0	6	0	2b
	Marine mammal interaction (o, q, r, s, t, u)	2	6	12	2b	NA	NA	NA	NA	1	5	5	2a	0	6	0	2b	0	6	0	2b
	Vector for non-indigenous species (p)	3	4	12	2b	1	4	4	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b
	Impact on benthos (q, s)	1	6	6	2b	1	6	6	2b	2	6	12	2b	2	6	12	2b	1	6	6	2b
	Acoustic impact (u)	0	6	0	2b	0	6	0	1c	1	6	6	1c	0	6	0	2b	1	6	6	2b
	Impact on fished species (o, q, s)	0	6	0	2b	0	6	0	2b	0	6	0	2b	0	6	0	2b	0	6	0	2b
	Effects of spatial displacement of fishing on commercial fish stocks (v)	1	5	5	2b	1	5	5	2b	NA	NA	NA	NA	0	4	0	2b	1	5	5	2b
	*Ship strikes on marine mammals, fish, and reptiles (r)	3	6	18	2a	2	2	4	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b
Abandonment/ decommissioning w) Surface flood lights and noise x) Well capping y) Recovery of all equipment, plant & machinery z) Abandonment, sinking of platform and equipment aa) Underwater lights bb) Underwater cc) noise dd) Material degradation ee) Support vessel activity	Seabird attraction, disturbance, collision (w)	0	6	0	2b	NA	NA	NA	NA	2	5	10	2b	0	6	0	2b	0	6	0	2b
	Marine mammal interaction (y, z, aa, bb)	2	6	12	2b	NA	NA	NA	NA	1	5	5	2b	0	6	0	2b	0	6	0	2b
	Impact on benthos of removal of platform etc. (x,y)	2	6	12	2b	1	6	6	2b	1	6	6	2b	1	6	6	2b	0	6	0	2b
	Impact on benthos of sinking and abandonment of platform etc. (x, z, dd)	2	6	12	2b	1	6	6	2b	1	6	6	2b	1	6	6	2b	1	6	6	2b
	*Ship strikes on marine mammals, fish, and reptiles (ee)	3	6	18	2a	1	2	2	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b

4.2 Carbon sequestration

4.2.1 Background

Carbon capture and sequestration (CCS) is the process of capturing carbon dioxide (CO_2) and then storing it as a means of mitigating the contribution of fossil fuel emissions to global warming. CCS usually involves injecting CO_2, generally in supercritical form, directly into underground geological formations, such as oil fields, gas fields, saline formations, un-mineable coal seams (Herzog and Golomb 2004, Zenz House et al. 2006). CO_2 has also been injected into declining oil fields to increase the pressure in the field and improve oil recovery (Moritis 2006). A major concern of CCS is the leakage of stored CO_2 (Benson 2005). For this reason abandoned oil and gas fields are considered good candidates as they have stored hydrocarbons for millions of years, and there is often good geological information about the size of the reservoir, and cap rock sealing the reservoir. A number of successful pilot projects have been undertaken over the past decade, including the monitoring of the CO_2 movement within the reservoir using seismic surveys. For example, Sleipner Oil Field, Statoil, Norway, has injected 1 Mt CO_2/yr since 1996 (Solomon 2006).

In New Zealand the oil and gas fields off Taranaki are potential candidates for CCS over the next 20-30 years especially as some of the fields are nearing the end of their production and have suitable infrastructure already in place.

4.2.2 Assessment

Our assessment of the ecological risks associated with CCS in New Zealand's EEZ assumed that existing oil and gas facilities and geological structures off Taranaki will be utilised and that little in the way of new infrastructure will be required. Thus there may be two phases to this industry – injection and final decommissioning once the reservoir is full of carbon.

Injection

As in the oil and gas production phase, lights on the injection platform at night will typically attract and disturb seabirds and may cause them to collide with the above sea-surface structure (Black 2005). Although these frequently cause some seabird deaths, on average there will be little impact on most seabird populations, but even a few deaths could affect the recovery of populations of some nationally critical species. Only seabirds in the area at night will be affected but the injection platform may be in place for decades. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk from this activity was assessed to reach a score of 15 with a high level of confidence (Table 4-2).

Marine mammals may interact with an injection platform, or be affected by surface or subsurface activity and lights. Rigs also attract prey species. Seal haul-outs are possible on the leg bracing struts on some platforms. If the interaction is with a threatened species then the impact potentially may be more severe. In deeper parts of the Taranaki basin, species such as sperm whales and beaked whales may be affected. Sea lions and elephant seals are unlikely to be affected in this region. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to protected marine mammals from this activity was assessed to reach a score of 5 with a high level of confidence (Table 4-2). Recovery was assessed to be in the range of months to years.

If existing infrastructure is utilised then there is little risk of the injection platform being a vector for entry on non-indigenous fauna to New Zealand waters. However, in exceptional circumstances this may occur, perhaps by transfer from and to other vessels and recovery may take years.

Impacts on the benthic community during the carbon injection phase were assessed as minor to moderate (Table 4-2) as the footprint of the facilities will be small as a proportion of the licence area or areas of similar habitat.

Underwater inspection using ROVs or submersibles as well as routine maintenance and pumping will regularly produce some level of underwater noise in the vicinity of the injection platform and more intermittently along the pipeline route. This underwater noise may affect marine mammals, mainly causing then to avoid the area, but we assessed this to pose low risk (6) and that recovery would occur almost immediately after the noise stopped.

CCS may affect stocks of fished species in two ways. Seafloor infrastructure will alienate an area (albeit small) of seafloor so that it no longer provides foraging habitat for demersal fishes. These same structures may also provide a new artificial reef-like surfaces and increase reef habitat in the area for reef associated fishes. Sea platforms and pipelines invariably have a zone of restricted access around them that prevent fishing access to these areas. Unless commercial fish quota is purposefully bought by the CCS company and retired for the duration of the injection phase then commercial fishing will be displaced into the remainder of the quota management area (QMA). The resulting increased fishing pressure has the potential to affect some commercial fish stocks, especially sedentary species with limited migrations.The resulting fishing pressure has the potentail to affects some fish stocks, especially sedentary species with limited migrations. However, the area of a QMA likely affected by a single injection platform will be small and we assessed there to be low risk (5) from this threat.

Abandonment / Decommissioning

The ecological risks associated with this phase will depend on whether the injection platform and equipment is dismantled and removed or sunk to the seafloor and abandoned. The impacts of platform dismantlement and abandonment are considered below. We assumed that any buried pipeline and anchor chains will be left in place as the cost of recovery would be high and the ecological impacts of removal would be equivalent to their initial installation.

Regardless of whether the injection platform is dismantled and removed or sunk and abandoned there will be a great deal of preparatory work on the platform to prepare it for either fate. This is likely over a period of months to require the use of lights at night. These typically attract and disturb seabirds and may cause them to collide with the remaining super-structure. Although these frequently cause some seabird deaths, on average there will be little impact on most seabird populations, but even a few deaths could affect the recovery of populations of some nationally critical species. Using a precautionary approach our assessment assumed that the species affected will be a nationally critical species as these may occur throughout the EEZ. The risk from this activity was assessed to reach a score of 10 with a high level of confidence (Table 4-2). Marine mammals may also be affected during this phase by the increased activity around the platform for a period of months to remove it or abandon it. We assumed no underwater explosions would be used for either scenario. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to protected

marine mammals from this activity was assessed as low (5) with a high level of confidence (Table 4-2). Recovery once the platform is removed may take months to years.

We assessed the risks to seafloor ecosystem of removal of the platform to be minor (6) and that recovery of benthic organisms would take on the order of months to years.

Sinking of a steel platform would have lasting impacts on the local benthic ecosystem as it slowly disintegrated over a period of 50-100 years and so recovery would be very long-term taking many decades with a high level of risk (20). However, the overall area impacted is very likely to be only a small proportion of the benthic ecosystem in the licence area or broadly similar habitats so the overall risk to ecosystem functioning, protected benthic species and key species is low (6).

Risk summary for carbon sequestration

There were no activities associated with carbon sequestration that were considered to represent an extreme environmental risk provisionally indicating prohibited status.

The following activities were considered to be of high environmental risk (15-20) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Support vessel activity causing strikes on marine mammals, fish and reptiles
- Surface lights at night

The following activities were considered to be of moderate environmental risk (7-12) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Underwater pipelines
- Presence of seafloor structures and anchors
- Presence of platform structure
- Well capping
- Recovery of underwater equipment, plant and machinery
- Abandonment sinking of platform and equipment
- Underwater noise

The following activities were considered to be of low environmental risk (0-6) and should be categorised as permitted:

- Vector for non-indigenous species
- Underwater lights
- Declaration of exclusion zone

4.2.3 Avoidance, mitigation, remediation

There are often ways of avoiding, remedying or mitigating the effects of activities that would otherwise put marine species or ecosystems at risk. Below we briefly discuss those relevant to carbon sequestration by deep well injection.

Non-mandatory Department of Conservation guidelines (2006 and 2011) should be followed to avoid or mitigate acoustic impacts on marine mammals.

Avoidance or mitigation of seabird strikes on platforms is possible by limiting unnecessary use of platform lights at night and ensuring that those that are required are directed approximately vertically onto work surfaces. Visual checks of the platform structure at first light each day for the presence of dazed or injured birds and the provision of appropriate care may help to remedy this impact.

Avoidance or mitigation of seals hauling out on platform structures is possible by reducing access to potential haul-out areas. This is recommended for injection platforms that may be in place for decades

Efforts should be made to avoid areas of protected deepwater corals within the footprint of the injection platform and its anchors. Pipelines should also be routed to avoid reef habitat and any other vulnerable benthic habitat.

Avoidance or mitigation of platforms acting as vectors for non-indigenous species is possible by appropriate checking, cleaning, and application of antifouling paint. We understand that Biosecurity New Zealand (MAF-BNZ) is developing an import health standard to cover the import of drilling rigs and legislation and relevant regulations may be put in place in next 2-3 years.

Table 4-2: Expert Panel Assessment: Carbon sequestration. Levels of consequence, likelihood, risk and confidence associated with this activity in the EEZ and ECS. Activities are listed (a, b, c, etc) after each threat to which they contribute. The maximum possible level of environmental risk is 30. Extreme environmental risks are highlighted in red, high in yellow, and moderate in green. Low risk activities are not highlighted. *Threats managed under the Maritime Transport Act (1994). NA = not applicable as species assessed are all protected.

Expert Panel Assessment: Carbon Sequestration		Recovery period				Key species				Protected species				Ecosystem functional impact				Proportion of habitat affected			
Activity	**Threat**	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence
Injection a) Platform flood lights and noise b) Platform structure c) Provision of biofouling surfaces d) Seabed structures e) Anchors/moorings f) Pipeline inspection and maintenance g) Underwater noise h) Support vessel activity i) Platform and pipeline exclusion zone	*Seabird attraction, disturbance, collision (a)	0	6	0	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	0	6	0	2b
	Marine mammal interaction (b, d, e, f, h)	1	6	6	2a	NA	NA	NA	NA	1	5	5	2a	0	6	0	2a	0	6	0	2a
	Vector for non-indigenous species (c)	3	2	6	2b	1	4	4	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b
	Impact on benthos (b, d, e, f)	2	6	12	2b	1	6	6	2b	2	6	12	2b	2	6	12	2b	1	6	6	2b
	Acoustic impact (g)	0	6	0	2b	0	6	0	1c	1	6	6	1c	0	6	0	2b	1	6	6	2b
	Impact on fished species (b, c, d, e)	0	6	0	2b	0	6	0	2b	0	6	0	2b	0	6	0	2b	0	6	0	2b
	Effects of spatial displacement of fishing on commercial fish stocks (i)	1	5	5	2b	1	5	5	2b	NA	NA	NA	NA	0	4	0	2b	1	5	5	2b
	*Ship strikes on marine mammals, fish and reptiles from support vessels (h)	3	6	18	2a	2	2	4	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b
Abandonment/decommissioning j) Surface flood lights & noise k) Well capping l) Recovery of equipment, plant and machinery m) Abandonment, sinking of platform, equipment n) Underwater lights o) Underwater noise p) Material degradation q) Support vessel activity	*Seabird attraction, disturbance, collision (j)	0	6	0	2b	NA	NA	NA	NA	2	5	10	2b	0	6	0	2b	0	6	0	2b
	Marine mammal interaction (k, l, m, n, o)	1	6	6	2b	1	5	5	2b	1	5	5	2b	0	6	0	2b	0	6	0	2b
	Impact on benthos of removal of platform etc (l, m)	2	6	12	2b	1	6	6	2b	1	6	6	2b	1	6	6	2b	0	6	0	2b
	Impact on benthos of sinking and abandonment of platform etc (m, p)	4	5	20	2b	1	6	6	2b	1	6	6	2b	1	6	6	2b	1	6	6	2b
	*Ship strikes on mammals, fish and reptiles (q)	3	6	18	2a	1	2	2	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b

4.3 Gas (methane) hydrates

4.3.1 Background

Gas hydrate is a frozen crystalline solid consisting of “cages” of water molecules that surround and hold gas molecules (essentially methane) inside. New Zealand has one of the largest single offshore gas hydrate provinces in the world, along the east coast of the North Island (Hikurangi Margin) and the south-west coast of the South Island (Fiordland Margin) (CAENZ. 2009, Pecher and Henrys 2003). Other deposits are suspected from at least four areas (Figure 4-1). Gas hydrates occur in specific pressure-temperature conditions. Offshore, these conditions are met within the upper 500 m of sediments beneath the seafloor and in water depths of at least 500 m. Most usually the free gas is contained within a stability zone well beneath the seafloor by the layer of solid gas hydrates which acts as a "seal" (Pecher and Henrys 2003). Rupture of the gas hydrate stability zone, by e.g. geological faulting or large landslides may however result in gas hydrates and free gas reaching the seafloor forming cold (methane) seeps with associated specialised fauna.

Initial estimates indicate a potential immense source of natural gas with 820 trillion cubic feet of natural equivalent for the Hikurangi Margin alone (Pecher and Henrys 2003). For comparison, New Zealand energy consumption from natural gas in 2008 was 0.18 tcf equivalent (www.med.govt.nz).

Current research on methane hydrate is focusing on: (1) quantifying the resource potential; (2) understanding gas formation to improve operational safety and avoid hazards (e.g., placement of infrastructure on seafloor, drilling and production scenarios); and (3) develop environmentally and economically sound exploitation protocols (Pecher and Henrys 2003).

Exploitation remains a great challenge because of the offshore location and most remarkably because about 160 times the volume of gas is released from hydrate when it is brought to the surface. Exploitation requires drilling infrastructure, such as rigs, production platforms and pipelines, capable of resisting extreme environmental and pressure conditions and at present these are only at the experimental stages in Japan and the USA (CAENZ 2009).

In addition to their energy potential, gas hydrates are of interest because they may affect seafloor instability and therefore represent a hazard. Because methane is a greenhouse gas, release in the atmosphere may potentially have an adverse effect on global climate.

4.3.2 Assessment

Similar to the petroleum oil and gas industry there are likely to be four phases to the exploitation of gas hydrates; prospecting, exploration, production and abandonment / decommissioning. For each phase we identified and assessed the ecological impact of several distinct activities (Table 4-3). Below we present the main results for each phase.

Prospecting

Seismic prospecting using surface ships is the main activity in the EEZ during this phase. The survey ship acquires bathymetric information using a multi-beam echo-sounder, and information about underlying geological structures using seismic air guns and a streamer comprising multiple hydrophones that may be up to 15km long. The streamer is typically deployed at ~2 knots and acquisition of data occurs at 5 knots. A very large area, perhaps approaching 100% of the prospecting licence area, may be surveyed during this phase though sequentially over a period of several weeks to a few months. We assume the habitat

area under consideration will be either the Hikurangi Margin or the Fiordland margin (see Figure 4-1).

The acoustic impact of seismic surveys on marine mammals, in particular, is well documented (Gordon & Moscrop 1996, Cox et al. 2006, Brandon et al. 2008, Di Iorio and Clark 2010) but may also affect a range of marine reptiles, fish and invertebrates. The consequences for marine mammals will vary from none to behavioural (may leave area) to acute injury (ear drum damage) to serious (death) depending on noise level encountered, species and habitat. Beaked whales are thought to be particularly at risk. There may also be cumulative effects from repeated exposure. Noise travels great distances underwater and so the footprint of this activity may be very broad though fatal impacts will be much more restricted in area as sound intensity typically falls as the square of the distance from the source. Acoustic depth sounders and multibeam echo-sounders used for swath mapping pose little risk but high energy seismic devices such as air guns used for mapping sub seafloor geological structures pose a much greater risk. Using a precautionary approach our assessment assumed that air guns were used and the species affected was a nationally critical species such as southern right whales as these may occur throughout the EEZ though they occur in different areas at different times of the year. The risk from this activity was assessed to reach a score of 18 with a high level of confidence (Table 4-3) indicating the need for this to be a discretionary activity.

Fur seals and sea lions may be attracted to the seismic streamer during deployment and retrieval and could become entangled and injured or drown. The number of individuals affected is likely to be small given the one-off nature of a seismic survey and impacts will be largely restricted to locations where deployment and retrieval takes place at slow speeds. Using a precautionary approach our assessment assumed that the species affected was the New Zealand sea lion though few occur north of about 45^{o} S. The risk from this activity was assessed to reach a score of 12 principally because the recovery of any affected population will be slow (Table 4-3). However, ecosystem effects will be negligible.

Lights on survey ships at night typically attract and disturb seabirds and may cause them to collide with the ship (Black 2005). These effects are covered under the Maritime Transport Act (1994) and the Wildlife Act (1953).

Ship strikes on marine mammals, fish, and reptiles may occur during the survey and during transits to and from the survey area. These effects are covered under the Maritime Transport Act (1994) and the Marine Mammal Protection Act (1978).

We have not assessed the potential for survey ships to act as vectors for the introduction of non-indigenous species as this is already managed under existing legislation.

Exploration

A wider range of activities occur during this phase albeit over a much smaller area than during the prospecting phase (Table 4-3). Typically a drill ship or platform is used to assess the reserves of specific rock strata. A single drill hole may take weeks to a few months to reach its target depth depending on the rock type encountered. A number of holes may be drilled on single exploration permit.

Lights on a drilling platform at night typically attract and disturb seabirds and may cause them to collide with the above sea surface structure (Black 2005). Although these frequently cause some seabird deaths, on average there will be little impact on most seabird populations as the duration of this phase in any one place is short (months), but even a few

deaths could affect the recovery of populations of some nationally critical species. Only seabirds in the area at night will be affected. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk from this activity was assessed to reach a score of 10 with a high level of confidence (Table 4-3) indicating the need for this to be a discretionary activity.

Marine mammals may interact with a drilling platform, or be affected by surface or subsurface activity and lights. Rigs also attract prey species. Seal haul-outs are possible on the leg bracing struts on some platforms. If the interaction is with a threatened species then the impact potentially may be more severe. Along slope margins species such as sperm whales and beaked whales may be affected. In southern areas sea lions and elephant seals may be affected. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to marine mammals from this activity was assessed to reach a score of 6 with a high level of confidence (Table 4-3) indicating that this activity could be classified as permitted.

The benthic ecosystem on the seafloor will be impacted by exploratory drilling (assuming drilling activity is similar to that for oil & gas, Patin 1999) but the affected proportion of the benthic habitat in the licence area and the slope margin is likely to be very small (<1-5%). At the drill site itself the legs of the drill platform may directly impact the seafloor, as will the drill head of ~5-10 m^2 and any mooring chain used that may be up to 1-2 km long with or without an anchor. When a well is drilled, the lubricant used is of three types: oil-based, synthetic, or water-based (in order of decreasing severity of impact on the environment). The type of drilling lubricant used has a large bearing on the toxicity of drill cuttings (Addy et al. 1984, Olsgard & Grey 1995, Patin 1999). In the oil and gas industry these were formerly dumped on the seabed and it is likely in this industry drill cuttings will be collected and stored during exploratory phase and ultimately disposed of on land (John Pfahlert personal comment). It is strongly recommended that drill cuttings in the gas hydrate industry are collected, processed and disposed of in a similar fasion. Discharges from the drilling platform or ship are already managed under existing legislation. The level of benthic impact will be low for most areas but impacts could be higher in some areas if they contain protected species of deepwater corals or specialised cold (methane) seep communities (which include a nationally critical clam species that is among the marine invertebrate species most at risk from extinction in NZ, Freeman et al 2010). Our functional impact assessment is contingent upon seep communities being affected during the exploratory drilling process and through methane extraction altering fluid flow at seep sites and/or direct damage from rig or production facilities. Clearly, careful placement of drilling sites to avoid this occurring would greatly reduce the risk. Under this assumption, risk levels for recovery of the benthos, and impacts on key species, protected benthic species such as deepwater corals, and the functioning of the ecosystem were all high (Table 4-3). Recovery of affected benthos after completion of exploratory drilling is likely to take years to decades as some potentially affected species such as seep tube worms are thought to be very long-lived and slow growing (Fisher et al 2007).

Drilling activities will produce some level of underwater noise from the drill itself, and any submersed cutters, pumps or other machinery. This underwater noise may affect marine mammals, mainly causing then to avoid the area, but we assessed this to pose low risk (6) and that recovery would be rapid after the noise stopped.

Exploratory drilling platforms brought in to New Zealand from Australia or further afield may act as vectors for non-indigenous species. The functional impacts on the ecosystem surrounding the rig is probably minor as vectored species are unlikely to survive independently of the rig in deep offshore waters. The rig may act as a stepping stone for non-indigenous species to invade shallow coastal habitats.

Production

The production phase for gas hydrates may or may not involve a surface production platform and a pipeline to shore. It is possible that a seabed facility could be put in place leading directly to a pipeline to shore or to a surface mooring for transfer of oil or gas to tankers. This technology is still under development and so there is a high degree of uncertainty in assessing potential effects.

If a production platform is used, then as during the exploratory drilling phase, lights on the platform at night will typically attract and disturb seabirds and may cause them to collide with the above sea-surface structure. Although these frequently cause some seabird deaths, on average there will be little impact on most seabird populations, but even a few deaths could affect the recovery of populations of some nationally critical species. Only seabirds in the area at night will be affected but the production platform may be in place for decades. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk from this activity was assessed to reach a score of 15 with a high level of confidence (Table 4-3). Marine mammals may interact with a production platform. Seal haul-outs are possible on the leg bracing struts on some platforms. Rigs attract prey species. If the interaction is with a threatened species then the impact potentially may be more severe. Along deep slope margins species such as sperm whales and beaked whales may be affected. In southern areas sea lions and elephant seals may be affected. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to protected marine mammals from this activity was assessed to reach a score of 5 with a high level of confidence (Table 3-3). Recovery once the platform was removed may take months.

Production platforms are likely to be purpose built in New Zealand or overseas. Platforms brought in to New Zealand from Australia or further afield may act as vectors for non-indigenous species but the likelihood is low for a new platform with fresh antifouling. New Zealand built platforms should pose little risk. The functional impacts on the ecosystem surrounding the platform is probably minor as vectored species are unlikely to survive independently of the rig in deep offshore waters. However, the platform may act as a stepping stone for non-indigenous species to invade shallow coastal habitats.

The benthic ecosystem on the seafloor will be impacted during the long production phase (Fisher et al 2007) but the affected proportion of the benthic habitat in the licence area is likely to be very small. At the production site itself the legs of the production platform may directly impact the seafloor, as will the well head of ~5-10 m^2 and any mooring chain used that may be up to 1-2 km long with or without an anchor. If a submerged pipeline is built to bring the gas onshore then the seabed will be impacted during construction and trenching. Discharges from the platform are already managed under existing legislation. The level of benthic impact will be low for most areas but impacts could be higher in some areas if they contain protected species of deepwater corals or specialised cold (methane) seep communities. We have taken a precautionary approach and assumed that the production well, production platform and any pipelines are sited near or among seep communities and

deep reef communities which will recieve direct damage. Moreover, methane extraction may alter fluid flow at seep sites and as the associated fauna is very long lived (in excess of 100 years); recovery of this fauna will be very long term (many decades) or may never occur. Away from seep sites the benthic fauna on soft sediments is probably broadly similar over a wide area. Under the above sceanrio, during the production phase of gas hydrate extraction risk levels for recovery of the benthos, and impacts on key species, protected benthic species such as deepwater corals, and the functioning of the ecosystem is high (Table 4-3).

Installation of the production platform, pipeline construction and trenching, underwater inspection using ROVs or submersibles as well as routine maintenance and pumping will regularly produce some level of underwater noise in the vicinity of the production platform and more intermittently along the pipeline route. This underwater noise may affect marine mammals, mainly causing then to avoid the area, but we assessed this to pose low risk (6) and that recovery would occur almost immediately after the noise stopped (Table 4-3).

Gas hydrate production may affect stocks of fished species in two ways. There may be some direct effects during the construction of the well head, installation and anchoring of a platform and construction and trenching of a pipeline. These structures will also alienate an area (albeit small) of seafloor so that it no longer provides foraging habitat for demersal fishes. These same structures may also provide a new artificial reef-like surfaces and increase reef habitat in the area for reef associated fishes. Production platforms and pipelines invariably have a zone of restricted access around them that restricts fishing access to these areas. Unless commercial fish quota is purposefully bought by the production company and retired for the duration of the production phase then commercial fishing may be displaced into the remainder of the quota management area (QMA). The resulting increased fishing pressure has the potential to affect some commercial fish stocks, especially sedentary species with limited migrations. However, the area of a QMA likely affected by a single production platform will be small and we assessed there to be low risk (5) from this threat (Table 4-3). Regulators need to be mindful, however, of the possibility for multiple production facilities and pipelines to occur in a single region and for fishing to be forced into an ever decreasing proportion of a QMA.

Abandonment / Decommissioning

The ecological risks associated with this phase will depend on whether the production platform and equipment is dismantled and removed, sunk to the seafloor and abandoned, or left intact for another use such as carbon sequestration (see section 4.2). If left intact for another use then the ecological risks will be largely the same as during the production phase and are not considered further here. The impacts of platform dismantlement and abandonment are considered below. We assumed that any buried pipeline and anchor chains will be left in place as the cost of recovery would be high and the ecological impacts of removal would be equivalent to their initial installation.

Regardless of whether the production platform is dismantled and removed or sunk and abandoned there will be a great deal of preparatory work on the platform to prepare it for either fate. This is likely over a period of months to require the use of lights at night. These typically attract and disturb seabirds and may cause them to collide with the remaining super-structure. Although these frequently cause some seabird deaths, on average there will be little impact on most seabird populations, but even a few deaths could affect the recovery of populations of some nationally critical species. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may

occur throughout the EEZ. The risk from this activity was assessed to reach a score of 10 with a high level of confidence (Table 4-3). Marine mammals may also be affected during this phase by the increased activity around the platform for a period of months to remove it or abandon it. We assumed no underwater explosions would be used for either scenario. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to protected marine mammals from this activity was assessed as low (5) with a high level of confidence (Table 4-3). Recovery, once the platform is removed, may take months to years.

We assessed the risks to seafloor ecosystem of removal of the platform to be minor (6) and that recovery of benthic organisms from this activity would take on the order of months to years.

Sinking of a steel platform would have lasting impacts on the local benthic ecosystem as it slowly disintegrated over a period of 50-100 years and so recovery would be very long-term taking many decades with a moderately high level of risk (20). However, the overall area impacted is very likely to be only a small proportion of the benthic ecosystem in the licence area or broadly similar habitats along the slope margin so the overall risk to ecosystem functioning, protected benthic species and key species is low (6).

Risk summary for gas hydrate extraction

There were no activities associated with gas hydrate extraction that were considered to represent an extreme environmental risk provisionally indicating prohibited status.

The following activities were considered to be of high environmental risk (15-20) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Deployment of airguns and streamers during seismic surveys
- Surface flood lights at night
- Support vessel activity causing strikes on marine mammals, fish and reptiles
- Sea floor structures
- Installation of pipelines
- Drilling activities
- Gas hydrate extraction
- Well capping
- Platform abandonment

The following activities were considered to be of moderate environmental risk (7-12) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Vector for non-indigenous species
- Recovery of underwater equipment, plant and machinery
- Use of underwater lights

- Production of incidental underwater noise
- Material degradation

The following activities were considered to be of low environmental risk (0-6) and should be categorised as permitted:

- Single and multibeam echo sounding
- Declaration of exclusion zone

4.3.3 Avoidance, mitigation, remediation

There are often ways of avoiding, remedying or mitigating the effects of activities that would otherwise put marine species or ecosystems at risk. Below we briefly discuss those relevant to gas hydrate exploitation.

Non-mandatory Department of Conservation guidelines (2006 and 2011) should be followed to avoid or mitigate acoustic impacts on marine mammals.

Entanglement of fur seals and sea lions during deployment and retrieval of the seismic streamer can be minimised by keeping a close watch for them around the stern of the vessel and halting operations if seals are in danger.

Avoidance or mitigation of seabird strikes on drilling and production platforms is possible by limiting unnecessary use of platform lights at night and ensuring that those that are required are directed approximately vertically onto work surfaces. Visual checks of the platform structure at first light each day for the presence of dazed or injured birds and the provision of appropriate care may help to remedy this impact.

Avoidance or mitigation of seals hauling out on platform structures is possible by reducing access to potential haul-out areas but modifications to exploration platforms is unlikely given that they invariably come to NZ from overseas for a relatively short period of intense activity.

Risks to seep communities during the exploratory drilling process or through methane extraction altering fluid flow at seep sites and/or direct damage from rig or production facilities can be avoided or minimised through selection of drilling sites and production wells least likely to cause damage to these vulnerable communities.

Efforts should be made to avoid areas of protected deepwater corals and other vulnerable species within the footprint of the production platform and its anchors. Pipelines should also be routed to avoid reef habitat and any other vulnerable benthic habitat.

Avoidance or mitigation of exploratory or production platforms acting as vectors for non-indigenous species is possible by appropriate checking, cleaning, and application of antifouling paints. We understand that Biosecurity New Zealand (MAF-BNZ) is developing an import health standard to cover the import of drilling rigs and legislation and relevant regulations may be put in place in next 2-3 years.

Table 4-3: Expert Panel Assessment: Gas hydrate extraction. Levels of consequence, likelihood, risk and confidence associated with this activity in the EEZ and ECS. Activities are listed (a, b, c, etc) after each threat to which they contribute. The maximum possible level of environmental risk is 30. Extreme environmental risks are highlighted in red, high in yellow, and moderate in green. Low risk activities are not highlighted. *Threats managed under the Maritime Transport Act (1994). NA = not applicable as species assessed are all protected.

Expert Panel Assessment: Gas (methane) hydrates		Recovery period				Key species				Protected species				Ecosystem functional impact				Proportion of habitat affected			
Activity	**Threat**	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence
Acoustic prospecting / Seismic surveying a) Surface flood lights and noise b) Acoustic sounder c) Multibeam echo sounder d) Air gun & streamers e) Ship activities	*Seabird attraction, disturbance, collision (a)	1	6	6	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	1	6	6	2b
	Acoustic impact from multi-beam echo sounders on marine mammals, reptiles, fish and invertebrates (b, c)	0	5	0	2a	0	6	0	2a	1	5	0	2a	0	6	0	2a	0	6	0	2a
	Acoustic impact from air guns on marine mammals, reptiles, fish and invertebrates (d)	3	6	18	2a	3	6	18	1c	3	6	18	2a	0	6	0	2a	3	6	18	2a
	Fur seal and sea lion attraction during streamer deployment and retrieval (d)	2	6	12	2b	NA	NA	NA	NA	1	3	3	1c	0	6	0	2b	0	6	0	2b
	*Ship strikes on marine mammals, fish, and reptiles (e)	2	6	12	2b	2	2	4	2b	2	2	4	1c	0	6	0	2b	0	6	0	2b
Exploratory drilling f) Platform flood lights and noise g) Platform structure h) Sea floor structures including anchors & moorings i) Site surveys using swath mapping j) Underwater lights & noise k) Support vessel activities l) Drilling activities	*Seabird attraction, disturbance, collision (f)	0	6	0	2b	NA	NA	NA	NA	2	5	10	2b	0	6	0	2b	0	6	0	2b
	Marine mammal interaction (g, h, j)	1	6	6	2a	NA	NA	NA	NA	1	5	5	2a	0	6	0	2b	0	6	0	2b
	Acoustic impact from multi-beam echo sounders on marine mammals, reptiles, fish and invertebrates (i)	0	5	0	2a	0	6	0	2a	1	5	0	2a	0	6	0	2a	0	6	0	2a
	Impact on benthos (h, l)	4	5	20	2b	4	4	16	1c	4	4	16	1c	4	4	16	1c	1	5	5	1c
	Vector for non-indigenous species (g)	3	4	12	2b	1	4	4	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b

	*Ship strikes on marine mammals, fish, and reptiles from support vessels (k)	3	6	18	2a	2	2	4	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b
Gas hydrate production m) Platform flood lights and noise n) Platform structure o) Seabed structures p) Anchors/moorings q) Pipeline laying, trenching r) Underwater lights s) Underwater noise t) Support vessel activities u) Platform and pipeline exclusion zone v) Gas hydrate extraction	*Seabird attraction, disturbance, collision (l)	0	6	0	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	0	6	0	2b
	Marine mammal interaction (n, o, p, q,r)	1	6	6	2a	NA	NA	NA	NA	1	5	5	2a	0	6	0	2b	0	6	0	2b
	Vector for non-indigenous species (n)	3	4	12	2b	1	4	4	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b
	Impact on benthos (o, p, q v)	5	4	20	1c	4	4	16	1c	4	4	16	1c	4	4	16	1c	1	5	5	1c
	Acoustic impact (s)	0	6	0	2b	0	6	0	1c	1	6	6	1c	0	6	0	2b	1	6	6	2b
	Spatial displacement of fishing activities (u)	0	6	0	2b	0	6	0	2b	0	6	0	2b	0	6	0	2b	0	6	0	2b
	*Ship strikes on marine mammals, fish, and reptiles from support vessels (t)	3	6	18	2a	2	2	4	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b
Abandonment/ decommissioning w) Surface flood lights and noise x) Well capping y) Recovery of all equipment, plant & machinery z) Abandonment, sinking of platform and equipment aa) Underwater lights and noise bb) Material degradation cc) Support vessel activities	*Seabird attraction, disturbance, collision (w)	0	6	0	2b	NA	NA	NA	NA	2	5	10	2b	0	6	0	2b	0	6	0	2b
	Marine mammal interaction (x, z, aa)	1	6	6	2b	NA	NA	NA	NA	1	5	5	2b	0	6	0	2b	0	6	0	2b
	Impact on benthos of removal of platform etc (x, y)	2	6	12	2b	1	6	6	2b	1	6	6	2b	1	6	6	2b	0	6	0	2b
	Impact on benthos of sinking and abandonment of platform etc (x,z)	4	5	20	2b	1	6	6	2b	1	6	6	2b	1	6	6	2b	1	6	6	2b
	*Ship strikes on marine mammals, fish, and reptiles (cc)	3	6	18	2a	1	2	2	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b

4.4 Ironsand mining

4.4.1 Background

Ironsands are the largest known reserve of metalliferous ore in New Zealand. Ironsand is a general term for sand-sized grains of heavy iron-rich minerals, principally magnetite (Fe_3O_4), titanomagnetite (Fe_2TiO_3), and ilmenite ($FeTiO_3$). New Zealand's iron sands occur extensively in coastal dunes and the adjacent continental shelf of the western North Island (see Figure 4-1), and have been successfully mined onshore for over 35 years.

Offshore surficial deposits of ironsand have been known since the early 1960's, but estimates of their reserves are poorly constrained and to date remain largely unexploited. The coastal ironsands of the central North Island west coast are primarily derived from erosion of the Taranaki volcanics, but local fluxes of ironsand, for example off the Mokau River, suggest input from other sources, such as recycling of older, onshore dunes. The geometry of the ironsand deposits is locally influenced by paleo-topographic features on the shelf from the post-last glacial sea level rise. Underlying ironsand-rich deposits might also occur, reflecting older Quaternary shorelines and changes in sea level. The continental shelf of the North Is west coast is subject to a vigorous wave climate driven by the prevailing westerly winds and southerly storms, and accordingly, the seabed of the inner and mid-shelf is naturally subjected to frequent resuspension and energetic near-bed currents, as evidenced by the extensive occurrence of sand sheets, gravels, and sediment bedforms (e.g. dunes and ripples).

The marine iron sand industry is still at an early stage. Prospecting and Exploration licences have been granted for large areas off the west coast of the North Island to a number of different companies but none have yet progressed to the production phase. To date, extraction methods will likely utilise well established suction-cutter dredge technology, removing or disturbing significant quantities of the top few to tens of metres of seabed sediment. Other technologies are developing in response to international demand. Extraction methods will be guided by the depth and three-dimensional distribution of the resource, in combination with logistical practicalities and environmental considerations. Mining targets currently constitute only of a small fraction of the total permit areas.

4.4.2 Assessment

We assessed three phases of New Zealand's fledgling iron sand mining industry; prospecting, exploration, and production. Compared to the oil industry where the production facilities may be largely static for decades, decommissioning in the iron sand mining industry is likely to be a relatively routine part of on-going production as equipment is moved around the mining site once ore-bearing sands in one part have been exhausted and any pit created in the process has been backfilled with de-ored sediments. Thus we have not considered decommissioning as a separate phase in this industry. For each phase we identified and assessed the ecological impact of several distinct activities (Table 4-4). Below we present the main results for each phase.

Prospecting

This phase is likely to involve aerial or towed magnetometer surveys over a large proportion of the prospecting licence areas. Ship strikes on marine mammals, fish, and reptiles may occur during the survey and during transits to and from the survey area. These effects are covered under the Maritime Transport Act (1994) and the Marine Mammal Protection Act (1978).

Lights on survey ships at night typically attract and disturb seabirds and may cause them to collide with the ship (Black 2005). These effects are covered under the Maritime Transport Act (1994).

The magnetometer device is passive; merely recording variations in the local magnetic field so poses no threat to any part of the marine ecosystem.

Acoustic swath mapping may be used to define the bathymetry of promising areas and high resolution seismic (e.g. Boomer, CHIRP) may be used to define the sub-seafloor geological strata. Use of air guns to obtain deeper seismic information in these surveys is unlikely. The acoustic impact of seismic surveys on marine mammals, in particular, is well documented (Gordon & Moscrop 1996, Cox et al. 2006, Brandon et al. 2008, Di lorio and Clark 2010) but may also affect a range of marine reptiles, fish and invertebrates. The consequences for marine mammals from the seismic gear likely to be used for these surveys will vary from none to behavioural (may leave area) perhaps to acute injury (ear drum damage) depending on noise level encountered, species and habitat. Beaked whales are thought to be particularly at risk. There may also be cumulative effects from repeated exposure.

Noise travels great distances underwater and so the footprint of this activity may be very broad though the greatest impacts will be much more restricted in area as sound intensity typically falls as the square of the distance from the source. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species such as southern right whales as these may occur throughout the EEZ though they occur in different areas at different times of the year. The risk from this activity was assessed to reach a moderate score of 8 with a high level of confidence (Table 4-4). Use of air guns, though inappropriate for defining these near seabed surface deposits, would considerably increase this risk.

Obtaining cores of sediment through the ore bearing strata to quantify ore concentrations at various depths is likely to occur over a wide area during this phase. Cores are likely to be about 12-15cm in diameter and affect a very small proportion of the sediment habitats in the area. The risk to benthic habitats and organisms from this activity is likely to be negligible (Table 4-4).

Exploration

In this phase more intensive evaluation of potential mining sites will take place. The focus is likely to be on areas of 30-50 km^2 capable of sustaining mining for a decade or more.

Within the more promising areas multi-beam echo-sounders are likely to be used to define the bathymetry and high resolution seismic (e.g. Boomer, CHIRP) may be used to better define the sub-seafloor geological strata. The area affected is likely to be a small proportion (<1-5%) of the licence area or the area of broadly similar habitat. The risk to marine

mammals and other organisms from this activity was assessed to reach a score of 8 with a high level of confidence (Table 4-4). Use of air guns, though inappropriate for defining near seabed surface deposits, would considerably increase this risk.

Obtaining sediment core/drill logs to better quantify ore concentrations at various depths is likely to continue during this phase but will probably be most concentrated over a small proportion (<1-5%) of the licence area, or areas of broadly similar habitat. The risk to benthic habitats and organisms from this activity is likely to be minor (Table 4-4).

Production

The extraction methods for deeper areas in the EEZ are still unclear in detail but may involve some form of seabed suction-dredge that pumps a slurry of sandy sediment and seawater to a surface vessel that extracts and concentrates the ore, and via a second pipeline returns the unwanted sediment back to the seafloor for stock-piling or back filling of the excavation pit that may be up to 10 m deep (Bernie Napp pers. com.). This activity will require large ships, which may moor to 'permanent' anchors blocks or anchor moorings. There is likely to be a sediment plume originating from the active mine face as well as from the slurry pipe depositing deored sediments. This arrangement is more probable than mining of ironsands in the shallower territorial sea where a variety of standard dredges could be used. Where iron sands lie well below the surface sediments it is possible that "keyhole" technologies are available or may develop where resources could be removed from within the ore bearing sediment thereby minimising disruption at the seabed containing the majority of benthic organisms, but some slumping may still occur.

To be profitable many millions of tons of ore bearing sands will need to be extracted each year by a mining operation. Mr Bernie Napp of Straterra noted during the workshop that some industry estimates of 100 million tonnes per year (Mt/y) were perhaps overly optimistic, and suggested that 30-50 Mt/y were likely achievable. This equates approximately to an area of 1-2 km^2 mined to a depth of 10 m each year, possibly for decades. Impressive though this sounds, this is likely to be a relatively small proportion of the total ironsand habitat in the EEZ.

The benthic ecosystem on the seafloor in and around the mining operations will be sequentially and severely impacted during the long production phase as areas are mined and backfilled with de-ored sediment and an area downstream of the mining operations will be affected by smothering from sediments falling out of suspension from sediment plumes. An idea of the likely impacts on the benthos can be gained from studies of sand and gravel extraction in North America and Europe (e.g. Boyd et al. 2005). Course grains will settle quickly but the fine-grained suspended fraction (finer silts and clays) may be carried some distance depending on current strength and resuspension due to wave activity. Smothering from the plume will decrease as the distance from the plume source increases. In areas being actively mined we surmise that probably close to 100% of the benthic organisms will be killed during the mining or ore concentration process. However, the affected proportion of the benthic habitat in the licence area and areas of broadly similar habitat is likely to be small. Thus, the functional impact on the benthic ecosystem as a whole, as well impacts on key species, are likely to be moderate (Table 4-4).

Although there are few data from offshore ironsand habitats it is quite possible that recovery of the benthic ecosystem on the ore depleted sediments will be moderately quick, on the order of months for the smaller meiofanua to years for the longer lived, slower growing

macro-fauna such as bivalves, gastropods, crustaceans and echinoderms (e.g. Boyd et al 2005) (Table 4-4). This is a reflection of high levels of natural background disturbance due to the high wave environment on the west coast of the North Island that likely favours benthic species with fast to moderate growth, early maturation and high fecundity.

The sediment plumes may also impact the water column ecosystem by increasing turbidity, thereby shading phytoplankton, or through the irritation of gills of fish and invertebrates. The area affected may reach 5-20% of the licence area but effects on key species, protected species and ecosystem function possibly will be minor (Table 4-4). Recovery of the pelagic ecosystem is expected to be rapid once sediment plumes stop.

Mining ironsands in the EEZ close to the outer limit of the territorial sea, by altering the seafloor typography offshore, might affect the nearshore wave climate, and thus rates of beach accretion or erosion (e.g. Roos and van der Werf 2010). Storing de-ored sediment in very large stockpiles (i.e. building a shoal) could have a greater effect nearshore than digging pits to extract the ore. Rapid backfilling of pits as mining progresses will minimise any nearshore effects, although this could occur naturally with wave-driven resuspension. Only a small proportion of the shoreline is likely to be affected (<<1%) but recovery will possibly be moderate taking months to years once mining stopped (Table 4-4).

Mining activities on the seabed will produce some level of underwater noise from the suction head, and any submersed cutters, pumps, anchoring or tethering systems, or other machinery. This underwater noise may affect marine mammals, mainly causing then to avoid the area, but we assessed this to pose low risk (8) and that recovery would take weeks to months after the noise stopped.

Entanglement of megafauna in subsurface equipment including anchor lines, mooring lines, marker buoy lines, power cabling or hydraulic lines is a possibility. Only a tiny fraction of the area (<<1%) is likely to have such hazards to fauna. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to protected marine mammals from this activity was assessed as moderate (9) with a high level of confidence (Table 4-4). Recovery of affected populations should these entanglement hazards be removed is expected to take years as the species concerned are slow growing, late maturing with low fecundity.

Ships brought in to New Zealand from Australia or further afield to concentrate ores may act as vectors for non-indigenous species but the likelihood is low for a vessel with fresh antifouling. New Zealand modified ships should pose little risk. The functional impact on the ecosystem surrounding the ore concentration vessel is probably minor as vectored species are unlikely to survive independently of the ship in deep offshore waters. However, the ship may act as a stepping stone for non-indigenous species to invade shallow coastal habitats.

Mining ironsands in the EEZ may affect stocks of fished species in two ways. There may be some direct effects on fish during extraction of the ore-bearing sand, and redeposited sands may take several years before they provide the full range of prey species to benthic foraging fish. Additionally fish may move away from the area of active mining and plume influence. Mining areas will invariably have a zone of restricted access around them that prevents fishing activity. Unless commercial fish quota is purposefully bought by the mining company and retired for the duration of the production phase then commercial fishing will be displaced into the remainder of the quota management area (QMA). The resulting fishing pressure has

the potentail to affects some fish stocks, especially sedentary species with limited migrations. While the area of a QMA affected by direct effects on fish stocks is likely to be small, the effects of displaced fishing will be felt over a much greater area. We assessed there to be low (5) risks to key fish stocks and moderate (10) risks to ecosystem functioning from direct effects on fish stocks, and low risk (5) from displaced fishing to key fish stocks and ecosystem functioning (Table 4-4). Regulators need to be mindful, however, of the possibility for multiple mining operations to occur in a single region and direct and indirect effects on fish stocks to proportionally increase within a QMA.

Risk summary for iron sand mining

There were no activities associated with iron sand mining that were considered to represent an extreme environmental risk provisionally indicating prohibited status.

The following activities were considered to be of high environmental risk (15-20) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Support vessel activity causing strikes on marine mammals, fish and reptiles
- Surface flood lights at night
- Testing and operation of undersea mining equipment with associated hydraulic lines, power cables and umbilical's creating an entanglement hazard

The following activities were considered to be of moderate environmental risk (7-12) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Seafloor suction / extraction
- Use of high resolution seismics e.g. Boomer, CHIRP
- Creation of sea floor pits or sediment stock piles
- Discharge of sediments causing plumes
- Placement of seafloor structures, anchors or moorings
- Import and provision of biofouling surfaces
- Seafloor slurry pipes
- Underwater flood lights
- Incidental underwater noise
- Declaration of mining area exclusion zone

The following activities were considered to be of low environmental risk (0-6) and should be categorised as permitted:

- Single and multibeam echo sounding
- Magnetometer surveys
- Small scale coring operations

4.4.3 Avoidance, mitigation, remediation

There are often ways of avoiding, remedying or mitigating the effects of activities that would otherwise put marine species or ecosystems at risk. Below we briefly discuss those relevant to iron sand mining.

Non-mandatory Department of Conservation guidelines (2006 and 2011) should be followed to avoid or mitigate acoustic impacts on marine mammals.

Avoidance or mitigation of seabird strikes is possible by limiting unnecessary use of vessel flood lights at night and ensuring that those that are required are directed approximately vertically onto work surfaces. Visual checks of the vessel super-structure at first light each day for the presence of dazed or injured birds and the provision of appropriate care may help to remedy this impact.

Avoidance or mitigation of vessels and underwater equipment acting as vectors for non-indigenous species is possible by appropriate checking, cleaning, and application of antifouling paints. We understand that Biosecurity New Zealand (MAF-BNZ) is developing an import health standard and legislation and relevant regulations may be put in place in next 2-3 years.

Pressure on fish stocks caused by a mining exclusion zone forcing fishing activities into the remainder of the quota management area can be reduced or eliminated by purchase and retirement of appropriate commercial fish quota for the duration of the production phase.

Assuming that iron sands occur to depths of 20-30m below the seafloor, impacts on benthic fauna will be minimised if fewer deeper pits are dug to extract a prescribed tonnage of ore. This is because most fauna is restricted to the upper 10-15 cm of sediment. A wide shallow pit will cause the maximum ecological damage for the least gain in ore extraction.

Table 4-4: Expert Panel Assessment: Ironsand mining. Levels of consequence, likelihood, risk and confidence associated with this activity in the EEZ and ECS. Activities are listed (a, b, c, etc) after each threat to which they contribute. The maximum possible level of environmental risk is 30. Extreme environmental risks are highlighted in red, high in yellow, and moderate in green. Low risk activities are not highlighted. *Threats managed under the Maritime Transport Act (1994). NA = not applicable as species assessed are all protected.

Expert Panel Assessment: Ironsand mining		Recovery period				Key species				Protected species				Ecosystem functional impact				Proportion of habitat affected			
Activity	**Threat**	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence
Prospecting phase a) Surface flood lights & noise b) Aerial or towed magnetometer surveys c) Acoustic swath mapping d) High resolution seismics e.g. Boomer, CHIRP (use of air guns is unlikely) e) Core drilling over a wide area f) Survey vessel activities	*Seabird attraction, disturbance, collision (a, b)	1	6	6	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	1	6	6	2b
	Acoustic impact from multi-beam echo sounders on marine mammals, reptiles, fish and invertebrates (c)	0	5	0	2a	0	6	0	2a	1	5	0	2a	0	6	0	2a	0	6	0	2a
	Acoustic impact from high resolution seismics on marine mammals, reptiles, fish and invertebrates (d)	1	4	4	2a	0	2	0	1c	2	4	8	2a	1	4	4	1c	1	6	6	1c
	*Ship strikes on marine mammals, fish, and reptiles (b, f)	3	6	18	2a	0	1	0	2b	3	3	9	2a	1	2	2	1c	1	6	6	2b
	Impact on benthos from coring operations (e)	0	4	0	1c	0	5	0	2b	NA	NA	NA	NA	0	6	0	2b	0	6	0	2b
	Impact on water column ecosystem (e)	0	4	0	2b	0	4	0	1c	0	4	0	1c	0	4	0	1c	0	5	0	1c
Exploration g) Surface flood lights & noise h) Core drilling at fewer sites i) Test pit excavation using different methods j) Sediment plume k) Incidental underwater	*Seabird attraction, disturbance, collision (g)	1	6	6	2b	NA	NA	NA	NA	2	5	10	2b	0	6	0	2b	1	6	6	2b
	Impact on benthos (h, i, j)	1	4	4	1c	1	5	5	2b	NA	NA	NA	NA	1	6	6	2b	1	6	6	2b
	Acoustic impact on marine mammals, reptiles, fish and invertebrates (k)	1	4	4	1c	0	2	0	1c	2	4	8	2a	1	4	4	1c	1	5	5	1c
	Entanglement of megafauna (h, i)	3	6	18	2b	1	3	3	2b	3	3	9	2b	0	6	0	2b	0	6	0	2b

noise l) Survey and support vessel activities	Impact on water column ecosystem (j)	1	4	4	2b	1	4	4	1c	1	4	4	1c	1	4	4	1c	1	5	5	1c
	*Ship strikes on marine mammals, fish and reptiles (l)	3	6	18	2a	2	2	4	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b
Mining phase m) Surface flood lights & noise n) Sea floor suction o) Extraction plume p) Sea floor slurry pipes q) Deposition of tailings in stock piles or pits r) Deposition plume s) Underwater lights and noise t) Mooring blocks or anchors u) Wash water return v) Swath mapping to determine change in bathymetry w) Bulk ore carrier x) Support vessel activities y) Mining exclusion zone	*Seabird attraction, disturbance, collision (m)	1	6	6	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	1	6	6	2b
	Impact on water column ecosystem from plume sediments (p, r, u)	1	4	4	1c	1	4	4	1c	1	4	4	1c	1	4	4	1c	2	5	10	1c
	Acoustic impact on marine mammals, reptiles, fish and invertebrates (s, v)	1	4	4	2a	0	2	0	1c	2	4	8	2a	1	4	4	1c	1	5	5	1c
	Vector for non-indigenous species (w)	3	4	12	2b	1	4	4	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b
	Direct impact on fished species (n, o, p, q, r, s, t, u)	2	6	12	2b	1	5	5	2b	NA	NA	NA	NA	2	5	10	2b	1	6	6	2b
	Effects of spatial displacement of fishing on commercial fish stocks (y)	1	5	5	2b	1	5	5	2b	NA	NA	NA	NA	0	4	0	2b	2	5	10	2b
	*Ship strikes on marine mammals, fish and reptiles from support vessels (w, x)	3	6	18	2a	2	2	4	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b
	Nearshore impact of altered wave climate (m, q)	2	4	8	2a	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	4	0	2a
	Entanglement of megafauna (n, p, q, r, s, t)	3	6	18	2b	1	3	3	2b	3	3	9	2b	0	6	0	2b	0	6	0	2b
	Impact on benthos (n, o, p, q, t)	3	4	12	1c	2	5	10	2b	NA	NA	NA	NA	2	6	12	2b	1	6	6	2b

4.5 Placer gold

4.5.1 Background

Placer gold deposits share a similar genesis to ironsands, but rather than being sourced from volcanic rocks, gold is the product of fluvial or glacial erosion of gold-bearing metamorphic rocks, which are most prominent along the Southern Alps. Buried river channels, submerged shorelines and glacial outwash deposits from Quaternary sea-level change on the South Island West Coast shelf are likely targets for the highest concentrations of placer-gold. The continental shelf of the South Island west coast is narrow, and subject to a vigorous wave climate driven by the prevailing westerly winds and southerly storms, and accordingly, the seabed of the inner and mid-shelf is naturally subjected to frequent resuspension and energetic near-bed currents. South Westland also receives sediment from several large rivers with significant sediment-carrying capacity (e.g. Arawata, Haast, and Hokitika rivers), which collectively deliver around 30% of the riverine sediment to the New Zealand coast today (Hicks and Shankar, 2003).

4.5.2 Assessment

We assessed three phases of New Zealand's fledgling placer gold mining industry; prospecting, exploration, and production. Compared to the oil industry where the production facilities may be largely static for decades, decommissioning in the placer gold mining industry is likely to be a relatively routine part of on-going production as equipment is moved around the mining site once ore-bearing sands and gravels in one part have been exhausted and any pit created in the process has been backfilled with de-ored sediments. Thus we have not considered decommissioning as a separate phase in this industry. For each phase we identified and assessed the ecological impact of several distinct activities (Table 4-4). Below we present the main results for each phase.

Prospecting

Obtaining cores of sediment through the ore bearing strata to quantify gold concentrations at various depths is likely to occur over a wide area during this phase. These cores are likely to be conducted from specially equipped small ships rather than from drill or coring platforms. Cores are likely to be about 12-15cm in diameter and affect a very small proportion of the sediment habitats in the area. The risk to benthic habitats and organisms from this activity is likely to be negligible (Table 4-5).

Ship strikes on marine mammals may occur during transits among coring sites. These effects are covered under the Maritime Transport Act (1994) and the Marine Mammal Protection Act (1978).

Lights on ships at night typically attract and disturb seabirds and may cause them to collide with the coring vessel (Black 2005). These effects are covered under the Maritime Transport Act (1994) and the Wildlife Act (1953).

Acoustic swath mapping may be used to define the bathymetry of promising areas and high resolution seismic (e.g. Boomer, CHIRP) may be used to define the sub-seafloor geological strata. Use of air guns to obtain deeper seismic information in these surveys is unlikely. The acoustic impact of seismic surveys on marine mammals, in particular, is well documented (Gordon & Moscrop 1996, Cox et al. 2006, Brandon et al. 2008, Di Iorio and Clark 2010) but

may also affect a range of marine reptiles, fish and invertebrates. The consequences for marine mammals from the seismic gear likely to be used for these surveys will vary from none to behavioural (may leave area) perhaps to acute injury (ear drum damage) depending on noise level encountered, species and habitat. Beaked whales are thought to be particularly at risk. There may also be cumulative effects from repeated exposure.

Noise travels great distances underwater and so the footprint of this activity may be very broad though the greatest impacts will be much more restricted in area as sound intensity typically falls as the square of the distance from the source. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species such as southern right whales as these may occur throughout the EEZ though they occur in different areas at different times of the year. The risk from this activity was assessed to reach a moderate score of 8 with a high level of confidence (Table 4-5) indicating the need for this to be a discretionary activity. Use of air guns, though inappropriate for defining these near seabed surface deposits, would considerably increase this risk.

Exploration

In this phase more intensive evaluation of potential mining sites will take place. The focus is likely to be on areas of 30-50 km^2 capable of sustaining mining for a decade or more.

Within the more promising areas multi-beam echo-sounders are likely to be used to define the bathymetry and high resolution seismic (e.g. Boomer, CHIRP) may be used to define the sub-seafloor geological strata. The area affected is likely to be a small proportion (<1-5%) of the licence area or the area of broadly similar habitat. The risk to marine mammals and other organisms from this activity was assessed to reach a score of 8 with a high level of confidence (Table 4-5) indicating the need for this to be a discretionary activity. Use of air guns, though inappropriate for defining these near seabed surface deposits, would considerably increase this risk.

Obtaining of sediment cores to quantify gold concentrations at various depths is likely to continue during this phase but are very likely to be concentrated over a small proportion (<1-5%) of the licence area or area of broadly similar habitat. The risk to benthic habitats and organisms from this activity is likely to be minor (Table 4-5).

Production

The details of extraction methods for deeper areas in the EEZ are still unclear but may involve a seabed digger that pumps a slurry of sand and seawater to a surface vessel that extracts and concentrates the gold, and via a second pipeline sends the unwanted sediment back to the seafloor for stock-piling or back filling of the excavation pit that may be up to 10 m deep. The larger vessels may moor to ‘permanent’ anchors blocks or anchor moorings. There is likely to be a sediment plume originating from the active mine face as well as from the slurry pipe depositing sediments after the gold has been extracted. This style of extraction is more feasible in deeper water than in the shallower territorial sea, where a variety of standard suction-dredges might be used. Where placer gold deposits lie well below the seabed (many tens of metres) it is possible they could be removed via “keyhole” technologies *in situ* from within the gold bearing layers thereby minimising disruption of the top layers of sediment containing the majority of benthic organisms, but some slumping may still occur.

To be profitable many millions of tons of placer-gold bearing sands and gravels will need to be extracted each year by a mining operation but the exact tonnage is very uncertain as it is

highly dependent on gold concentrations and ore grade. However, the area mined in any one operation is likely to be a relatively small proportion of the total habitat off the West Coast of the South Island.

The benthic ecosystem on the seafloor in and around the mining operations will be sequentially and severely impacted during the long production phase as areas are mined and backfilled with deored sediment and an area downstream of the mining operations will be affected by smothering from sediments from sediment plumes. Course grains will settle quickly but the fine-grained suspended component (finer silts and clays) may be carried some distance depending on current strength and resuspension due to wave activity. An idea of the likely impacts on the benthos can be gained from studies of sand and gravel extraction in North America and Europe (e.g. Boyd et al. 2005).In areas being actively mined we surmise probably close to 100% of the benthic organisms will be killed during the mining or ore concentration process. Smothering from the plume will decrease with distance from the plume source increases. However, the affected proportion of the benthic habitat in the licence area and areas of broadly similar habitat is likely to be small. Thus, the functional impact on the benthic ecosystem as a whole, as well impacts on key species, are likely to be moderate and the risk level consistent with the need for iron sand mining to be classified as discretionary (Table 4-5).

Although there are few data from offshore placer gold habitats it is quite possible that recovery of the benthic ecosystem on the ore depleted sediments will be moderately quick, on the order of months for the smaller meiofanua to years for the longer lived, slower growing macro-fauna such as bivalves, gastropods, crustaceans and echinoderms (Table 4-5). This is a reflection of high levels of natural background disturbance due to the high wave environment on the west coast of the South Island that likely favours benthic species with fast to moderate growth, early maturation and high fecundity.

The sediment plumes may also cause disruption to the water column ecosystem by increasing turbidity, thereby shading phytoplankton, or through the irritation of gills of fish and invertebrates. The area affected may reach 5-20% of the licence area but effects on key species, protected species and ecosystem function possibly will be minor (Table 4-5). Recovery of the pelagic ecosystem is expected to be rapid once sediment plumes stop.

Mining placer gold in the EEZ close to the outer limit of the territorial sea, by altering the seafloor typography offshore, has the potential to affect the nearshore wave climate and thus rates of beach accretion or erosion (e.g. Roos and van der Werf 2010). Storing tailings in very large stockpiles is likely to have a greater effect nearshore than digging pits to extract the gold. Rapid backfilling of pits as mining progresses will minimise any nearshore effects. Only a small proportion of the shoreline is likely to be affected (<<1%) but recovery will possibly be moderate taking months to years once mining stopped (Table 4-4).

Mining activities on the seabed will produce some level of underwater noise from the suction head, and any submersed cutters, pumps or other machinery. This underwater noise may affect marine mammals, mainly causing then to avoid the area, but we assessed this to pose low risk (8) and that recovery would take weeks to months after the noise stopped.

Entanglement of megafauna in subsurface equipment including anchor lines, mooring lines, marker buoy lines, power cabling or hydraulic lines is a possibility. Only a tiny fraction of the area (<<1%) is likely to have such hazards to fauna. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to protected marine mammals from this activity was assessed as moderate (9) with a high level of confidence (Table 4-5). Recovery of affected

populations should these entanglement hazards be removed is expected to take years as the species concerned are slow growing, late maturing with low fecundity.

Ships brought in to New Zealand from Australia or further afield to separate the gold from other sediments may act as vectors for non-indigenous species but the likelihood is low for a vessel with fresh antifouling. New Zealand modified ships should pose little risk. The functional impact on the ecosystem surrounding the gold concentration vessel is probably minor as vectored species are unlikely to survive independently of the ship in deep offshore waters. However, the ship may act as a stepping stone for non-indigenous species to invade shallow coastal habitats.

Mining placer gold deposits in the EEZ may affect stocks of fished species in two ways. There may be some direct effects on fish during extraction of the ore-bearing sand, and redeposited sands may take several years before they provide the full range of prey species to benthic foraging fish. Additionally fish may move away from the area of active mining and plume influence. Mining areas will invariably have a zone of restricted access around them that prevents fishing access. Unless commercial fish quota is purposefully bought by the mining company and retired for the duration of the production phase then commercial fishing will be displaced into the remainder of the quota management area (QMA). The resulting fishing pressure has the potentail to affects some fish stocks, especially sedentary species with limited migrations. While the area of a QMA affected by direct effects on fish stocks is likely to be small, the effects of displaced fishing will be felt over a much greater area. We assessed there to be low (5) risks to key fish stocks and moderate (10) risks to ecosystem functioning from direct effects on fish stocks, and low risk (5) from displaced fishing to key fish stocks and ecosystem functioning (Table 4-5). Regulators need to be mindful, however, of the possibility for multiple mining operations to occur in a single region and direct and indirect effects on fish stocks to proportionally increase with a QMA.

As mining placer gold deposits is very likely to utilise ships rather the specialised production platforms and though lights on these vessels will typically attract and disturb seabirds at night and may cause them to collide with the ship, These effects are covered under the Maritime Transport Act (1994) and the Wildlife Act (1953).

Risk summary for placer gold mining

There were no activities associated with placer gold mining that were considered to represent an extreme environmental risk provisionally indicating prohibited status.

The following activities were considered to be of high environmental risk (15-20) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Support vessel activity causing strikes on marine mammals, fish and reptiles
- Surface flood lights at night
- Testing and operation of undersea equipment with associated hydraulic lines, power cables and umbilical's creating an entanglement hazard

The following activities were considered to be of moderate environmental risk (7-12) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Seafloor suction / extraction
- Use of high resolution seismics e.g. Boomer, CHIRP
- Creation of sea floor pits or sediment stock piles
- Discharge of sediments causing plumes
- Placement of seafloor structures, anchors or moorings
- Import and provision of biofouling surfaces
- Seafloor slurry pipes
- Underwater flood lights
- Incidental underwater noise
- Declaration of mining area exclusion zone

The following activities were considered to be of low environmental risk (0-6) and should be categorised as permitted:

- Single and multibeam echo sounding
- Small scale coring operations

4.5.3 Avoidance, mitigation, remediation

There are often ways of avoiding, remedying or mitigating the effects of activities that would otherwise put marine species or ecosystems at risk. Below we briefly discuss those relevant to placer gold mining.

Non-mandatory Department of Conservation guidelines (2006 and 2011) should be followed to avoid or mitigate acoustic impacts on marine mammals.

Avoidance or mitigation of seabird strikes is possible by limiting unnecessary use of vessel flood lights at night and ensuring that those that are required are directed approximately vertically onto work surfaces. Visual checks of the vessel super-structure at first light each day for the presence of dazed or injured birds and the provision of appropriate care may help to remedy this impact.

Avoidance or mitigation of vessels and underwater equipment acting as vectors for non-indigenous species is possible by appropriate checking, cleaning, and application of antifouling paints. We understand that Biosecurity New Zealand (MAF-BNZ) is developing an import health standard and legislation and relevant regulations may be put in place in next 2-3 years.

Pressure on fish stocks caused by the mining exclusion zone forcing fishing activities into the remainder of the quota management area can be reduced or eliminated by purchase and retirement of appropriate commercial fish quota for the duration of the production phase.

Assuming that placer gold deposits occur to depths of 20-30m below the seafloor, impacts on benthic fauna will be minimised if fewer deeper pits are dug to extract a prescribed tonnage of gold. This is because most fauna is restricted to the upper 10-15 cm of sediment. A wide shallow pit will cause the maximum ecological damage for the least gain in gold extraction.

Table 4-5: Expert Panel Assessment: Placer gold mining. Levels of consequence, likelihood, risk and confidence associated with this activity in the EEZ and ECS. Activities are listed (a, b, c, etc) after each threat to which they contribute. The maximum possible level of environmental risk is 30. Extreme environmental risks are highlighted in red, high in yellow, and moderate in green. Low risk activities are not highlighted. *Threats managed under the Maritime Transport Act (1994). NA = not applicable as species assessed are all protected.

Expert Panel Assessment: Placer gold mining		Recovery period				Key species				Protected species				Ecosystem functional impact				Proportion of habitat affected			
Activity	**Threat**	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence
Prospecting phase a) Surface flood lights and noise b) Acoustic swath mapping c) High resolution seismics e.g. Boomer, CHIRP. (Use of air guns is unlikely) d) Core drilling over a wide area e) Survey vessel activities	*Seabird attraction, disturbance, collision (a)	1	6	6	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	1	6	6	2b
	Acoustic impact from multi-beam echo sounders on marine mammals, reptiles, fish and invertebrates (b)	0	5	0	2a	0	6	0	2a	1	5	0	2a	0	6	0	2a	0	6	0	2a
	Acoustic impact from high resolution seismics on marine mammals, reptiles, fish and invertebrates (c)	1	4	4	2a	0	2	0	1c	2	4	8	2a	1	4	4	1c	3	5	15	1c
	*Ship strikes on marine mammals, fish, and reptiles (e)	3	6	18	2a	0	1	0	2b	3	3	9	2a	1	2	2	1c	1	6	6	2b
	Impact on benthos from coring operations (d)	0	4	0	1c	0	5	0	2b	NA	NA	NA	NA	0	6	0	2b	0	6	0	2b
	Impact on water column ecosystem (d)	0	4	0	2b	0	4	0	1c	0	4	0	1c	0	4	0	1c	0	5	0	1c
Exploration f) Surface flood lights and noise g) Core drilling at fewer sites h) Test pit excavation using different methods i) Sediment plume j) Underwater noise k) Support vessel activities	*Seabird attraction, disturbance, collision (f)	1	6	6	2b	NA	NA	NA	NA	2	5	10	2b	0	6	0	2b	1	6	6	2b
	Impact on benthos (g, h, i)	1	4	4	1c	1	5	5	2b	NA	NA	NA	NA	1	6	6	2b	1	6	6	2b
	Acoustic impact on marine mammals, reptiles, fish and invertebrates (j)	3	6	18	2a	0	2	0	1c	2	4	8	2a	1	4	4	1c	1	5	5	1c
	Entanglement of megafauna (h)	3	6	18	2b	1	3	3	2b	3	3	9	2b	0	6	0	2b	0	6	0	2b
	Impact on water column ecosystem (j)	1	4	4	2b	1	4	4	1c	1	4	4	1c	1	4	4	1c	1	5	5	1c

	*Ship strikes on marine mammals, fish and reptiles (k)	3	6	18	2a	2	2	4	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b
Mining phase l) Surface flood lights and noise m) Sea floor suction n) Extraction plume o) Sea floor slurry pipes p) Deposition of tailings in stock piles or pits q) Deposition plume r) Incidental underwater lights and noise s) Temporary mooring blocks or anchors t) Waste water return u) Swath mapping to determine change in bathymetry v) Support vessel activities w) Mining exclusion zone	*Seabird attraction, disturbance, collision (l)	1	6	6	2b	NA				3	5	15	2b	0	6	0	2b	1	6	6	2b
	Impact on water column ecosystem from plume sediments (n, q, t)	1	4	4	1c	1	4	4	1c	1	4	4	1c	1	4	4	1c	2	5	10	1c
	Acoustic impact on marine mammals, reptiles, fish and invertebrates (r)	1	4	4	2a	0	2	0	1c	2	4	8	2a	1	4	4	1c	1	5	5	1c
	Impact on fished species (m, n, o, p, q, s, t)	2	6	12	2b	1	5	5	2b	NA	NA	NA		2	5	10	2b	2	6	12	2b
	Vector for non-indigenous species (v)	3	4	12	2b	1	4	4	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b
	Effects of spatial displacement of fishing on commercial fish stocks (w)	1	5	5	2b	1	5	5	2b	NA	NA	NA		0	4	0	2b	1	5	5	2b
	*Ship strikes on marine mammals, fish and reptiles (v)	3	6	18	2a	2	2	4	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b
	Nearshore impact of altered wave climate (m, p)			0		NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA			0	
	Entanglement of megafauna (m, o, p, s)	3	6	18	2b	1	3	3	2b	3	3	9	2b	0	6	0	2b	0	6	0	2b
	Impact on benthos (m, n, o, p, q, s)	3	4	12	1c	2	5	10	2b	NA	NA	NA	NA	2	6	12	2b	1	6	6	2b

4.6 Phosphorite nodules

4.6.1 Background

Phosphorite nodules (Figure 4-2) form potentially the most economically important and well-studied marine mineral deposit in the New Zealand EEZ (Cullen 1987; Glasby and Wright, 1990). These patchily distributed deposits occur in water depths of about 400 m on the crest of the Chatham Rise, especially between 179°E and 180°. The Chatham Rise phosphorites formed by the phosphatisation of fragmented hard ground chalk pebbles about 12-7 million years ago under conditions of low to no sedimentation, the development of a pronounced oxygen minimum zone and intensified flow and upwelling of P-rich waters over the ridge crest. Subsequent biological and iceberg activity disrupted the fragmented hard ground and led to the patchy distribution of phosphorite nodules within the top 1 m of the surficial glauconite-rich sandy muds on the crest of the Chatham Rise. Very minor phosphorite deposits have also been reported from shallow coastal environments, such as Raglan Harbour, Hauraki Gulf and off the Northland shelf (Glasby and Wright, 1990).

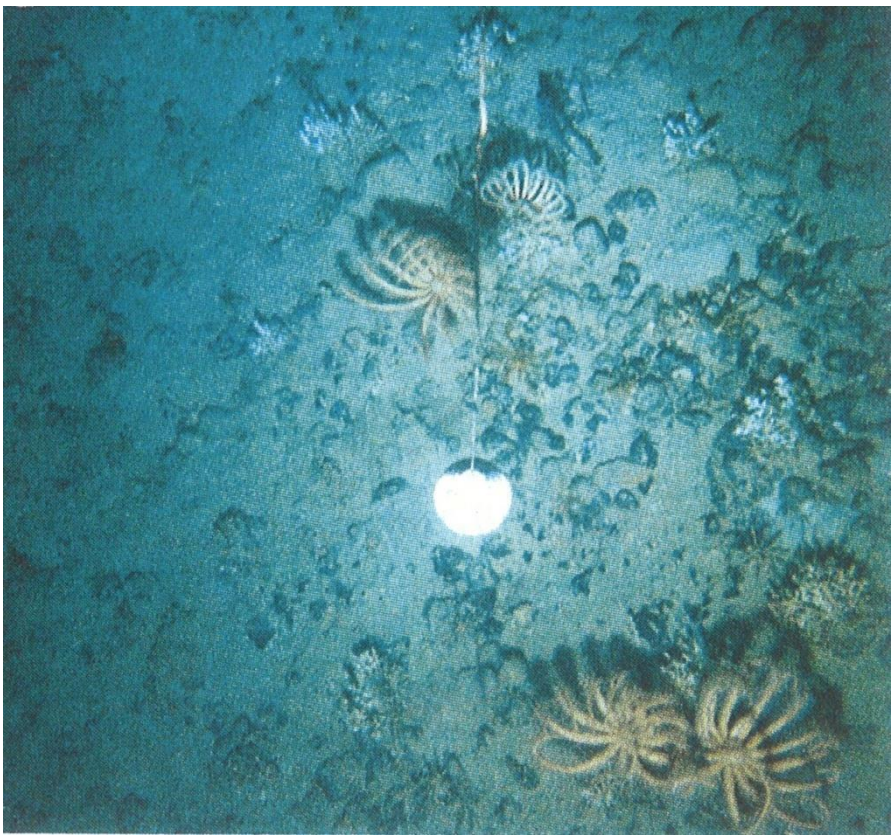


Figure 4-2: Phosphorites nodules. Dark, gavel-sized nodules exposed on the Chatham Rise seafloor, with feathery starfish, deepwater corals and small clumps of brachiopods.

Methods, similar to those proposed for extracting Polymetalic nodules, could be applied to the phosphorite deposits on the Chatham Rise, such as hydraulic suction dredging connected to a mining platform via a flexible hose and rigid pipe string for transporting the nodules from the seafloor to the sea surface (Cullen, 1987; ISA, 2008a). However, given the environmental concerns and potential impacts on other economic activities, especially fisheries, mining systems would need to be developed that minimise the direct and indirect impacts of the mining activities on the benthic and pelagic ecosystems of the Chatham Rise.

4.6.2 Assessment

We assessed three phases of New Zealand's fledgling phosphorite nodule mining industry; prospecting, exploration, and production. Compared to the oil industry where the production facilities may be largely static for decades, decommissioning in the phosphorite nodule mining industry is likely to be a relatively routine part of on-going production as equipment is moved around the mining site once nodules in one part have been exhausted. Thus we have not considered decommissioning as a separate phase in this industry. For each phase we identified and assessed the ecological impact of several distinct activities (Table 4-6). Below we present the main results for each phase.

Prospecting

Surveys using short cores, rock dredges, and camera systems to quantify nodule distribution and concentrations, are likely to occur over a wide area (~100s of km^2) during this phase. This sampling is likely to be conducted from specially equipped vessels rather than from drill or coring platforms. Cores are likely to be about 12-15cm in diameter while dredges may be up to 1-2 m wide and affect a very small proportion of the sediment habitats in the area. The risk to benthic habitats and organisms from this activity is likely to be minor to moderate but the recovery of directly impacted habitat patches is likely to take months to years (Table 4-6).

Acoustic swath mapping may be used to define the bathymetry of promising areas and high resolution seismic reflection techniques (e.g., CHIRP) may be used to define the sub-seafloor geological strata. Use of air guns to obtain deeper seismic information in these surveys is very unlikely. The acoustic impact of seismic surveys on marine mammals, in particular, is well documented (Gordon & Moscrop 1996, Cox et al. 2006, Brandon et al. 2008, Di Iorio and Clark 2010) but may also affect a range of marine reptiles, fish and invertebrates. The consequences for marine mammals from the seismic gear likely to be used for these surveys will vary from none to behavioural (may leave area) perhaps to acute injury (ear drum damage) depending on noise level encountered, species and habitat. Beaked whales are thought to be particularly at risk. There may also be cumulative effects from repeated exposure.

Noise travels great distances underwater and so the footprint of this activity may be very broad though the greatest impacts will be much more restricted in area as sound intensity typically falls as the square of the distance from the source. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species, such as southern right whales, as these may occur throughout the EEZ, but typically they occupy different areas at different times of the year. The risk from this activity was assessed to reach a score of 8 with a high level of confidence (Table 4-6) indicating the need for this to be a discretionary activity. Use of air guns, while inappropriate for defining these near seabed surface deposits, would considerably increase this risk.

Ship strikes on marine mammals may occur during transits among coring and dredging sites. These effects are covered under the Maritime Transport Act (1994) and the Marine Mammal Protection Act (1978).

Lights on ships at night typically attract and disturb seabirds and may cause them to collide with the sampling vessel (Black 2005). These effects are covered under the Maritime Transport Act (1994) and the Wildlife Act (1953).

Exploration

In this phase more intensive evaluation of potential mining sites will take place. The focus is likely to be on areas of 50-100 km^2 capable of sustaining mining for a decade or more.

Within the these areas multi-beam echo-sounders are likely to be used to define the bathymetry and high resolution seismics (e.g. CHIRP) may be used to define the sub-seafloor geological strata. The area affected is likely to be a very small proportion (<<1%) of the Chatham Rise nodule habitat. The risk to marine mammals and other organisms from this activity was assessed to reach a score of 12 with a high level of confidence (Table 4-6) indicating the need for this to be a discretionary activity. Use of air guns, though inappropriate for defining these near seabed surface deposits, would considerably increase this risk.

Further surveys using short cores, rock dredges, and camera systems to quantify nodule distribution and concentrations, are likely to occur during this phase but are very likely to be concentrated over a small proportion (<<1%) of the licence area or area of broadly similar habitat. There will also be some trials of extraction methods and bulk sampling. The risk to benthic habitats and organisms from this activity is likely to be minor to moderate depending on the quantities of sediment sampled but the recovery of directly impacted benthic habitat patches is likely to take decades given the slow growth of many species (Table 4-6).

Entanglement of megafauna in subsurface equipment including anchor lines, mooring lines, marker buoy lines, power cabling or hydraulic lines is a possibility during trials of extraction methods. Only a tiny fraction of the area (<<1%) is likely to have such hazards to fauna and these will probably be in place for only weeks to months. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to protected marine mammals from this activity was assessed as low (3) with a high level of confidence (Table 4-4). Recovery of affected populations should these entanglement hazards be removed is expected to take years as the species concerned are slow growing, late maturing with low fecundity.

Production

The methods for extracting phosphorite nodules may involve a seabed hydraulic suction head perhaps attached to a crawler that pumps a slurry of surface sediments and nodules and seawater to a surface vessel that extracts the nodules and via a second pipeline sends the unwanted sediment back to the seafloor for back filling of the shallow excavation pit that may be approximately 1m deep. The larger vessels may moor to 'permanent' anchors blocks or anchor moorings. There is likely to be a sediment plume originating from the active mining face as well as from the slurry pipe depositing unwanted sediments. To be profitable a large area, perhaps 10km^2, will need to be mined each year to a depth of about 1m, possibly for decades. Over the lifetime of the mining operation it is possible that a significant proportion (20-50%) of the total phosphorite nodule habitat in the EEZ could be affected.

The benthic ecosystem on the seafloor in and around the mining operations will be sequentially and severely impacted during the long production phase as areas are mined and backfilled with sediment and an area downstream of the mining operations will be affected by smothering from sediments from sediment plumes. Course grains will settle quickly but finer silts, muds and clays may be carried some distance depending on current strength. In areas being actively mined probably close to 100% of the benthic organisms will be killed during

the mining or nodule concentration process. Smothering from the plume will decrease as the distance from the plume source increases. As the total area affected is likely to be a significant proportion of the total nodule habitat, the functional impact on the benthic ecosystem as a whole, as well as impacts on key species, such as sponges, and protected benthic species, such as deepwater corals, is likely to be severe. Because the benthic fauna includes slow growing, long-lived species recovery is likely to be very long-term. If species are dependent on the presence of phosphorite nodules then recovery may never occur because these fauna relie up the nodules for attachment in an otherwise soft sediment environment (Dawson 1984). Overall, the risks of phosphorite nodule mining to the benthic ecosystems on the Chatham Rise were judged to be high (Table 4-6).

Sediment plumes arising from the mining face or slurry pipe depositing sediments may also cause disruption to the water column ecosystem by increasing turbidity, thereby restricting light availability for phytoplankton, or through the irritation of the gills of fish and invertebrates. The area affected at any one time is likely to be very small and effects on key species, protected species and ecosystem function possibly will be minor to moderate (Table 4-6). Recovery of the pelagic ecosystem is expected to be reasonably quick once sediment plumes stop.

Mining activities on the seabed will produce some level of underwater noise from the suction head, and any submersed cutters, pumps or other machinery. This underwater noise may affect marine mammals, mainly causing then to avoid the area, but we assessed this to pose moderate risk (12) and that recovery would be quick after the noise stopped.

Entanglement of megafauna in subsurface equipment, including anchor lines, mooring lines, marker buoy lines, power cabling or hydraulic lines, is a possibility. Only a tiny fraction of the area (<<1%) is likely to have such hazards to fauna. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to protected marine mammals from this activity was assessed as low (3) with a high level of confidence (Table 4-6). Recovery of affected populations should these entanglement hazards be removed is expected to take years as the species concerned are slow growing, late maturing with low fecundity.

Mining phosphorite nodules on the Chatham Rise may affect stocks of fished species in two ways. There may be some direct effects on fish during extraction of the nodules, and redeposited sediment may take years before they provide the full range of prey species to benthic foraging fish. Additionally fish may move away from the area of active mining and plume influence. Mining areas will invariably have a zone of restricted access around them that prevents fishing access. Unless commercial fish quota is purposefully bought by the nodule mining company and retired for the duration of the production phase then commercial fishing will be displaced into the remainder of the quota management area (QMA). The resulting fishing pressure has the potentail to affects some fish stocks, especially sedentary species with limited migrations. While the area of a QMA affected by direct effects on fish stocks is likely to be small, the effects of displaced fishing will be felt over a much greater area. We assessed there to be moderate (15) risks to key fish stocks and ecosystem functioning from direct effects on fish stocks, and lower risk from displaced fishing effort to key fish stocks (10) and ecosystem functioning (8). Recovery of affected fish stocks, e.g. ling, from direct and indirect effects may take years to decades since some species are moderate growing (Table 4-6).

Ships brought in to New Zealand from Australia or further afield to separate the nodules from other sediments may act as vectors for non-indigenous species, but the likelihood is low for a vessel with fresh antifouling. New Zealand-modified ships should pose little risk. The functional impact on the ecosystem surrounding the nodule separation vessel is probably minor as vectored species are unlikely to survive independently of the ship in deep offshore waters. However, the ship may act as a stepping stone for non-indigenous species to invade shallow coastal habitats.

Since mining nodules is very likely to utilise ships rather the specialised production platforms and though lights on these vessels will typically attract and disturb seabirds at night and may cause them to collide with the ship. These effects are covered under the Maritime Transport Act (1994) and the Wildlife Act (1953).

Risk summary for phosphorite nodule mining

Several activities associated with phosphorite nodule mining were considered to represent an extreme environmental risk and should be prohibited if no way can be found to avoid, mitigate or remedy their impact. These activities include:

- Sea floor cutting/fragmentation/extraction
- Extraction plume
- Deposition of tailings in stock piles or pits
- Deposition plume

The following activities were considered to be of high environmental risk (15-20) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Support vessel activity causing strikes on marine mammals, fish and reptiles
- Surface flood lights at night
- Bulk sampling of deposits
- Testing and operation of undersea equipment with associated hydraulic lines, power cables and umbilical's
- Declaration of a mining area exclusion zone
- Slurry pipes

The following activities were considered to be of moderate environmental risk (7-12) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Use of high resolution seismics e.g. Boomer, CHIRP
- Spot sampling using ROV, submersible, or rock dredge
- Provision of biofouling surfaces

- Underwater flood lights
- Underwater noise

The following activities were considered to be of low environmental risk (0-6) and should be categorised as permitted:

- Single and multibeam echo sounding
- ROV and other imaging surveys

4.6.3 Avoidance, mitigation, remediation

There are often ways of avoiding, remedying or mitigating the effects of activities that would otherwise put marine species or ecosystems at risk. Below we briefly discuss those relevant to phosphorite nodule mining.

Non-mandatory Department of Conservation guidelines (2006 and 2011) should be followed to avoid or mitigate acoustic impacts on marine mammals.

Avoidance or mitigation of seabird strikes is possible by limiting unnecessary use of vessel flood lights at night and ensuring that those that are required are directed approximately vertically onto work surfaces. Visual checks of the vessel super-structure at first light each day for the presence of dazed or injured birds and the provision of appropriate care may help to remedy this impact.

Avoidance or mitigation of vessels and underwater equipment acting as vectors for non-indigenous species is possible by appropriate checking, cleaning, and application of antifouling paints. We understand that Biosecurity New Zealand (MAF-BNZ) is developing an import health standard and legislation and relevant regulations may be put in place in next 2-3 years.

Pressure on fish stocks caused by a mining exclusion zone forcing fishing activities into the remainder of the quota management area can be reduced or eliminated by purchase and retirement of appropriate commercial fish quota for the duration of the production phase.

Actions that increase the rate of recovery of benthic fauna from the impacts of nodule mining will greatly reduce the risks associated with this industry. Recolonisation by larval settlement from adjacent populations may be increased by mining in a chequerboard or strip pattern or by leaving up current populations intact. Because so little is known about larval connectivity in these populations, the optimal size or distribution of mining is unknown.

Given that mining activity will remove most of the hard surfaces in this habitat, artificial hard surfaces could be placed on the sefloor to act as settlement and attachment surfaces for corals, sponges etc. Early trials of this approach should be encouraged.

Table 4-6: Expert Panel Assessment: Phosphorite nodule mining. Levels of consequence, likelihood, risk and confidence associated with this activity in the EEZ and ECS. Activities are listed (a, b, c, etc) after each threat to which they contribute. The maximum possible level of environmental risk is 30. Extreme environmental risks are highlighted in red, high in yellow, and moderate in green. Low risk activities are not highlighted. *Threats managed under the Maritime Transport Act (1994). NA = not applicable as species assessed are all protected.

Expert Panel Assessment: Phosphorite nodules		Recovery period				Key species				Protected species				Ecosystem functional impact				Proportion of habitat affected			
Activity	**Threat**	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence
Prospecting a) Surface flood lights and noise b) ROV and other imaging surveys c) Acoustic swath mapping d) Sub-bottom profiling using CHIRPS, boomers and sparkers e) Spot sampling using ROV, submersible, or rock dredge f) Survey ship activities	*Seabird attraction, disturbance, collision (a)	1	6	6	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	1	6	6	1b
	Acoustic impact from multi-beam echo sounders on marine mammals, reptiles, fish and invertebrates (c)	0	5	0	2a	0	6	0	2a	1	5	0	2a	0	6	0	2a	0	6	0	2a
	Acoustic impact of high resolution acoustics on marine mammals, reptiles, fish and invertebrates (d)	1	4	4	2a	0	2	0	1c	2	4	8	2a	0	6	0	2a	1	6	6	1b
	*Ship strikes on marine mammals, fish, and reptiles (f)	3	6	18	2a	2	2	4	2b	2	2	4	1c	0	6	0	2b	0	4	0	1b
	Underwater flood lights (b)	0	5	0	2a	0	6	0	2a	0	5	0	2a	0	5	0	2a	0	5	0	2a
	Impact on benthos (e)	2	5	10	1c	1	4	4	2a	1	4	4	2a	2	5	10	1c	0	6	0	1b
Exploration g) Surface flood lights and noise h) Test extraction methods i) Bulk sampling j) Sediment plume k) Underwater noise l) Sub-bottom profiling using CHIRPS,	*Seabird attraction, disturbance, collision (g)	0	6	0	2b	NA	NA	NA	NA	2	5	10	2b	0	6	0	2b	0	6	0	1b
	Impact on benthos (h, i, j)	4	5	20	1c	2	4	8	2a	1	4	4	2b	2	5	10	2a	0	4	0	1b
	Acoustic impact on marine mammals, reptiles, fish and invertebrates (l)	1	6	6	2a	2	6	12	1c	2	6	12	2a	0	6	0	2b	0	6	0	1b
	Entanglement of megafauna (h)	3	6	18	2a	1	3	3	2b	1	3	3	2b	0	6	0	2b	0	6	0	2b

boomers and sparkers m) Site surveys using swath mapping &/or boomer surveys n) Survey vessel activities	*Ship strikes on marine mammals, fish, and reptiles from support vessels (n)	3	6	18	2a	2	2	4	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b
Mining o) Surface flood lights and noise p) Sea floor cutting/fragmentation q) Extraction plume r) Slurry pipes s) Deposition of tailings in stock piles or pits t) Deposition plume u) Underwater lights and incidental noise v) Waste water return w) Ore carrier activities x) Mining exclusion zone	Impact on water column ecosystem from plume sediments (q, t,)	1	6	6	2b	1	4	4	1c	1	4	4	1c	2	4	8	1c	0	6	0	1c
	Acoustic impact on marine mammals, reptiles, fish and invertebrates (p, u)	0	6	0	2a	1	6	6	1c	2	6	12	2a	0	6	0	2b	0	6	0	2b
	Impact on fished species (q, r, s, t,)	4	4	16	1c	3	5	15	1c	NA	NA	NA	NA	3	5	15	1c	3	4	12	1c
	Vector for non-indigenous species (w)	3	4	12	2b	1	4	4	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b
	Effects of spatial displacement of fishing on commercial fish stocks (x)	4	4	16	1c	2	5	10	1c	NA	NA	NA	NA	2	4	8	1c	2	5	10	1c
	*Ship strikes on marine mammals, fish, and reptiles (w)	3	6	18	2a	1	2	2	1c	3	3	9	2a	0	4	0	2b	0	5	0	2b
	*Seabird attraction, disturbance, collision (o)	0	6	0	2b	NA	NA	NA	NA	2	5	10	2b	0	6	0	2b	0	6	0	2b
	Entanglement of megafauna (p, r)	3	6	18	2a	1	3	3	2b	1	3	3	2b	0	6	0	2b	0	4	0	1c
	Impact on benthos (p, q, s, t,)	5	5	25	1c	3	4	12	1b	3	4	12	1b	3	4	12	1b	3	4	12	1b

4.7 Massive sulphides

4.7.1 Background

Seafloor Massive Sulphide deposits (SMS) form in submarine volcanic regions where sulphur-rich magmatic and hydrothermal fluids precipitate sulphur and metals around hydrothermal vents. The hydrothermal fields typically occur on mounds that contain precipitates and both high temperature 'black smoker' vents and lower temperature diffusive venting seen as gentle shimmering on the ocean floor. Where mineralization is extensive SMS deposits can form, consisting of economically viable reserves of Fe, Cu, Pb and Zn, with some also rich in Au and Ag (de Ronde et al. 2007) (Figure 4-3).

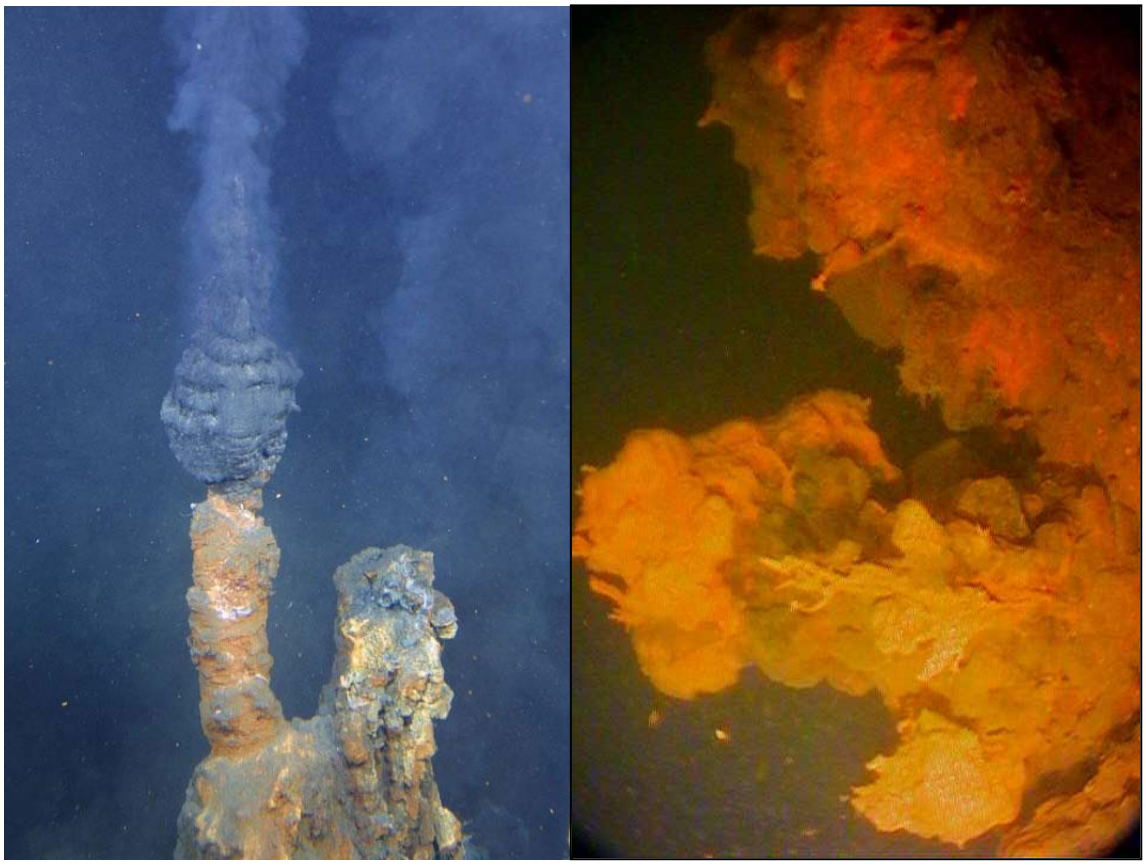


Figure 4-3: Black smoker chimney and massive sulphide deposit on the Kermadec Ridge.

Not all hydrothermal systems, however, are host to SMS deposits. In the New Zealand EEZ and ECS hydrothermal venting is known to occur on two-thirds of the ~30 Kermadec Arc volcanoes (de Ronde et al, 2007), but only two sites, Brothers and Rumble II West, are so far known to host SMS deposits. Deposits may also occur elsewhere in the Kermadec arc – Havre Trough volcanic system, although no hydrothermal activity has been found in the Havre Trough or on the Colville and Kermadec Ridges, which represent the proto-Kermadec arc (Wysoczanski and Clark, in press). However, the small number of known SMS deposits may simply be the result of limited exploration of these areas and other Kermadec arc volcanoes, as well as the Colville and Kermadec ridges, are likely to host active or old inactive deposits, respectively. All of these areas are currently of interest to mining companies and prospecting licences have been lodged for the entire area.

The technology to extract metals from SMS deposits from the ocean floor (at depths up to 4000 m) exists, but is as yet unproven. Different extraction methods are similar in that they require extraction mined material of the subsurface, transport to a large staffed mother ship, return of water and fine sediment to the ocean floor, and shipment of ore to land facilities. The most advanced proposal for exploration, by Nautilus Minerals in Papua New Guinea, involves remotely operated vehicles (ROVs), including the ocean bottom equivalent of bulldozers, and suction of ore to the mother ship (Nautilus website).

Active vent fields are home to some of the most highly specialised marine faunas known. Deep-sea vent ecosystems were first discovered in the late 1970s and are considered to be among the greatest scientific discoveries of the 20th century (van Dover et al. 2011). These ecosystems are fueled primarily by microbial primary production through a process known as chemosynthesis. Instead of using energy from sunlight to fix inorganic carbon into organic carbon (photosynthesis), microbes in vent ecosystems use chemical energy from the oxidation of reduced chemical compounds (van Dover et al. 2011). Hundreds of previously undescribed species have been discovered. Many are apparently endemic to the vent or seep environment, and may belong to higher-level taxa (genera and families) not previously known to science. Extractable resources at vents are fossil in nature and non-renewable. While mineral deposits can form quickly at vents, commercial ore deposits accumulate over millennia (van Dover et al. 2011).

4.7.2 Assessment

We assessed three probable phases of New Zealand's fledgling massive sulphide mining industry; prospecting, exploration, and production. Compared to the oil industry where the production facilities may be largely static for decades, decommissioning in this mining industry is likely to be a relatively routine part of on-going production as equipment is moved across a deposit. Thus we have not considered decommissioning as a separate phase in this industry. For each phase we identified and assessed the ecological impact of several distinct activities (Table 4-7). Below we present the main results for each phase.

Prospecting

Surveys using magnetometers coring devices, suspended camera systems, remotely operated vehicles (ROVs) and/or submersibles to quantify sulphide deposit distribution and chemical makeup are likely to occur over a wide area during this phase. This sampling is likely to be conducted from specially equipped vessels and affect a minor (<1-5%) proportion of deposits on a seamount. The risk to benthic habitats and organisms from this activity is likely to be minor to moderate but the recovery of directly impacted habitat patches of slower

growing non-vent fauna (deep-sea corals and other filter feeders) is likely to take years to decades (Samadi et al. 2007) (Table 4-7). Faster growing vent fauna (e.g. vent mussels, tubeworms and staked barnacles, including nationally critical species) will probably recover in months to years (e.g. Southward et al. 1994).

Acoustic swath mapping may be used to define the bathymetry of promising areas and high resolution seismics (e.g. Boomer, CHIRP) will probably be used to define seafloor and sub-seafloor geological features. Use of air guns to obtain deeper seismic information in these surveys is possible.

The acoustic impact of seismic surveys on marine mammals, in particular, is well documented (Gordon & Moscrop 1996, Cox et al. 2006, Brandon et al. 2008, Di lorio and Clark 2010) but may also affect a range of marine reptiles, fish and invertebrates. The consequences for marine mammals will vary from none, to behavioural (may leave area), to acute injury (ear drum damage), to serious (death) depending on noise level encountered, species and habitat. Beaked whales are thought to be particularly at risk. There may also be cumulative effects from repeated exposure.

Noise travels great distances underwater and so the footprint of this activity may be very broad though the greatest impacts will be much more restricted in area as sound intensity typically falls as the square of the distance from the source. Acoustic depth sounders and multibeam echo-sounders used for swath mapping pose little risk but high energy seismic devices such as air guns used for mapping sub seafloor geological structures pose a much greater risk. Using a precautionary approach our assessment assumed that air guns were used and the species affected was a nationally critical species such as southern right whales as these may occur throughout the EEZ though they occur in different areas at different times of the year. The risk from this activity was assessed to reach a score of 18 with a high level of confidence (Table 4-7) indicating the need for this to be a discretionary activity. .

Ship strikes on marine mammals may occur during transits among survey sites. These effects are covered under the Maritime Transport Act (1994) and the Marine Mammal Protection Act (1978).

Lights on ships at night typically attract and disturb seabirds and may cause them to collide with the coring vessel (Black 2005). These effects are covered under the Maritime Transport Act (1994) and the Wildlife Act (1953).

The magnetometer device is passive; merely recording variations in the local magnetic field so poses no threat to any part of the marine ecosystem.

Exploration

In this phase more intensive evaluation of potential mining sites will take place. The focus is likely to be on several deposits each approximately 0.01-1.0 km^2 perhaps on a single or several seamounts collectively capable of sustaining mining for a decade or more.

Within these areas multi-beam echo-sounders are likely to be used to further define the bathymetry and high resolution seismics (e.g. Boomer, CHIRP) will probably be used to define seafloor and immediate sub-seafloor geological features. Use of air guns to obtain deeper seismic information in these surveys is unlikely. The area affected is likely to be a minor proportion (<1-5%) of the crust habitat. The risk to marine mammals and other organisms from this activity was assessed to reach a score of 12 with a high level of

confidence (Table 4-7) indicating the need for this to be a discretionary activity. Use of air guns would considerably increase this risk.

Further surveys using coring devices, suspended camera systems, ROVs and/or submersibles to quantify fine scale deposit distribution, thickness and chemical content are likely to occur during this phase over a moderate proportion (5-20%) of the sulphide deposits but a smaller proportion (<1-5%) of the non-vent area on a seamount habitat. There will also be some trials of extraction methods and some bulk sampling of several hundred tonnes of deposits. The risk to benthic habitats and organisms from this activity is likely to be moderate for non-vent fauna and minor for vent fauna. Recovery of directly impacted benthic habitat patches is likely to take months to years for vent fauna and years to decades for non-vent fauna (Table 4-7).

Entanglement of megafauna in subsurface equipment including anchor lines, mooring lines, marker buoy lines, power cabling or hydraulic lines is a possibility during trials of extraction methods. Only a tiny fraction of the area (<<1%) is likely to have such hazards to fauna and these will probably be in place for only weeks to months. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to protected marine mammals from this activity was assessed as low (3) with a high level of confidence (Table 4-7).

Sediment plumes arising from the trials of mining equipment and processes may cause disruption to the water column ecosystem by increasing turbidity, thereby shading phytoplankton, or through the irritation of gills of fish and invertebrates. The deposits are poisonous. Anywhere from <1-5% of the pelagic habitat over a seamount may be affected at any one time and effects on key species, protected species and ecosystem functioning may be negligible to minor (Table 4-7). Recovery of the pelagic ecosystem is expected to be reasonably quick once sediment plumes stop.

Production

During mining a processing vessel is unlikely to moor to ‘permanent’ anchors blocks or anchor moorings. There is likely to be a sediment plume originating from the active mining face as well as from the slurry pipe depositing unwanted sediments.

The benthic ecosystem on the seafloor in and around the mining operations will be sequentially and severely impacted during the production phase as the sulphide deposits are mined and an area downstream of the mining operations is affected by smothering from sediments disturbed by mining operations. Course grains will settle quickly but finer particles may be carried some distance depending on current strength. In areas being actively mined probably close to 100% of the benthic organisms will be killed during the extraction process (ISA 2007, van Dover et al. 2011). Smothering from the sediment plume will decrease as the distance from the plume source increases. If vent areas are targeted, the total area affected is likely to be 20-50% of the non-vent fauna and a larger proportion (60-90%) of the vent habitat on a seamount. Consequently, the functional impact on the benthic ecosystem as a whole, as well impacts on key species, a nationally critical species and protected benthic species such as deepwater corals, are likely to be severe to catastrophic. Because the non-vent fauna includes slow-growing, long-lived species (Southward et al. 1994) their recovery is likely to be very long-term. Recovery of vent fauna is likely to take years. Overall, if vent areas are targeted the risks of mining massive sulphide deposits to the benthic ecosystems

on seamounts were judged to be high (Table 4-7), consistent with other studies (ISA 2007, van Dover et al. 2011).

Sediment plumes arising from the mining face or slurry pipe depositing sediments may also cause disruption to the water column ecosystem by increasing turbidity, thereby shading phytoplankton, or through the irritation of gills of fish and invertebrates. The crusts are known to contain poisonous/toxic substances (ISA 2004). Anywhere from 5-20% of the pelagic habitat over a seamount may be affected at any one time and effects on key species, protected species and ecosystem function may be minor to moderate (Table 4-7). Recovery of the pelagic ecosystem is expected to be reasonably quick once sediment plumes stop.

Mining activities on the seabed will produce some level of underwater noise from the suction head, and any submersed cutters, pumps or other machinery. This underwater noise may affect marine mammals, probably causing then to avoid the area, posing low risk (6) and recovering soon after the noise stopped.

Entanglement of megafauna in subsurface equipment including anchor lines, mooring lines, marker buoy lines, power cabling or hydraulic lines is a possibility. Only a tiny fraction of the area (<<1%) is likely to have such hazards to fauna. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to protected marine mammals from this activity was assessed as low (6) with a high level of confidence (Table 4-7). Recovery of affected populations should these entanglement hazards be removed is expected to take years as the species concerned are slow growing, late maturing with low fecundity.

Mining massive sulphide deposits may affect stocks of fished species in two ways. There may be some direct effects on fish during mining, and the seafloor may take years before the full range of prey species are available to benthic foraging fish. Additionally fish may move away from the area of active mining and plume influence. Mining areas will invariably have a zone of restricted access around them that prevents fishing access. Unless commercial fish quota is purposefully bought by the mining company and retired for the duration of the production phase then commercial fishing will be displaced into the remainder of the quota management area (QMA). The resulting increased fishing pressure has the potential to affect commercial fish stocks, though QMA 10 which includes many seamounts on the Kermadec Ridge has very low quota for most stocks. While the area of a QMA affected by direct effects on fish stocks is likely to be small, the effects of displaced fishing will be felt over a much greater area. We assessed there to be low (6) risks to key fish stocks and ecosystem functioning from direct effects on fish stocks, and lower risk from displaced fishing effort to key fish stocks (5) and ecosystem functioning (4). Recovery of affected fish stocks from direct and indirect effects may take months to years (Table 4-7).

Ships brought in to New Zealand from Australia or further afield to separate the sulphide deposits from other sediments may act as vectors for non-indigenous species but the likelihood is low for a vessel with fresh antifouling. New Zealand modified ships should pose little risk. The functional impact on the ecosystem surrounding the nodule separation vessel is probably negligible as vectored species are unlikely to survive independently of the ship in deep offshore waters. However, the ship may act as a stepping stone for non-indigenous species to invade shallow coastal habitats.

Mining activities on the seabed will produce some level of underwater noise from the suction head, and any submersed cutters, pumps or other machinery. This underwater noise may

affect marine mammals, mainly causing then to avoid the area, but we assessed this to pose low risk (6) and that recovery would be rapid after the noise stopped.

Entanglement of megafauna in subsurface equipment including anchor lines, mooring lines, marker buoy lines, power cabling or hydraulic lines is a possibility. Only a tiny fraction of the area (<<1%) is likely to have such hazards to fauna. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to protected marine mammals from this activity was assessed as low (6) with a high level of confidence (Table 4-7). Recovery of affected populations should these entanglement hazards be removed is expected to take months to years as the species concerned are slow growing, late maturing with low fecundity.

Risk summary for mining of massive sulphide deposits

Several activities associated with mining of massive sulphide deposits were considered to represent an extreme environmental risk and should be prohibited if no way can be found to avoid, mitigate or remedy their impact. These activities include:

- Creation of sediment plumes
- Use of slurry pipes
- Deposition of tailings in stock piles
- Toxic chemical release

The following activities were considered to be of high environmental risk (15-20) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Support vessel activity causing strikes on marine mammals, fish and reptiles
- Surface flood lights at night
- Testing and operation of undersea equipment with associated hydraulic lines, power cables and umbilical's creating an entanglement hazard
- Seafloor suction of deposits

The following activities were considered to be of moderate environmental risk (7-12) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Use of high resolution seismics e.g. Boomer, CHIRP
- Declaration of a mining area exclusion zone
- Spot sampling using ROV
- Bulk sampling of deposits
- Import and provision of biofouling surfaces
- ROV and other imaging surveys

The following activities were considered to be of low environmental risk (0-6) and should be categorised as permitted:

- Single and multibeam echo sounding
- Underwater imaging using ROV, AUV etc
- Incidental underwater noise
- Underwater flood lights

4.7.3 Avoidance, mitigation, remediation

There are often ways of avoiding, remedying or mitigating the effects of activities that would otherwise put marine species or ecosystems at risk. Below we briefly discuss those relevant to mining massive sulphide deposits.

Non-mandatory Department of Conservation guidelines (2006 and 2011) should be followed to avoid or mitigate acoustic impacts on marine mammals.

Avoidance or mitigation of seabird strikes is possible by limiting unnecessary use of vessel flood lights at night and ensuring that those that are required are directed approximately vertically onto work surfaces. Visual checks of the vessel super-structure at first light each day for the presence of dazed or injured birds and the provision of appropriate care may help to remedy this impact.

Avoidance or mitigation of vessels and underwater equipment acting as vectors for non-indigenous species is possible by appropriate checking, cleaning, and application of antifouling paints. We understand that Biosecurity New Zealand (MAF-BNZ) is developing an import health standard and legislation and relevant regulations may be put in place in next 2-3 years.

Pressure on fish stocks caused by a mining exclusion zone forcing fishing activities into the remainder of the quota management area can be reduced or eliminated by purchase and retirement of appropriate commercial fish quota for the duration of the production phase.

Actions that increase the rate of recovery of benthic fauna from the impacts of mining massive sulphide deposits will greatly reduce the risks associated with this industry. Recolonisation by larval settlement from adjacent populations may be increased by leaving adjacent vent communities intact to act as source populations. Because so little is known about larval connectivity in these populations, the minimum distances from source to impacted areas are unknown.

Many other potential mitigation methods are currently under development by mining companies (see http://www.nautilusminerals.com/s/Home.asp) but require testing and experimentation.

Table 4-7: Expert Panel Assessment: Massive sulphide deposit mining. Levels of consequence, likelihood, risk and confidence associated with this activity in the EEZ and ECS. Activities are listed (a, b, c, etc) after each threat to which they contribute. The maximum possible level of environmental risk is 30. Extreme environmental risks are highlighted in red, high in yellow, and moderate in green. Low risk activities are not highlighted. *Threats managed under the Maritime Transport Act (1994). NA = not applicable as species assessed are all protected.

Expert Panel Assessment: Massive sulphide deposits		Recovery period				Key species				Protected species				Ecosystem functional impact				Proportion of habitat affected			
Activity	**Threat**	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence
Prospecting a) Surface flood lights and noise b) ROV and other imaging surveys c) Acoustic swath mapping d) High resolution seismics e) Air gun seismic survey f) Spot sampling using ROV and AUV g) Survey vessel activities	*Seabird attraction, disturbance, collision (a)	1	6	6	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	3	6	18	2b
	Acoustic impact from multi-beam echo sounders on marine mammals, reptiles, fish and invertebrates (c)	0	5	0	2a	0	6	0	2a	1	5	0	2a	0	6	0	2a	0	6	0	2a
	Acoustic impact from high resolution seismics on marine mammals, reptiles, fish and invertebrates (d)	2	5	10	2a	0	5	0	2a	2	6	12	2a	0	6	0	2a	0	6	0	2a
	Acoustic impact of air guns on marine mammals, reptiles, fish and invertebrates (e)	3	6	18	2a	3	6	18	1c	3	6	18	2a	0	6	0	2a	3	6	18	2a
	*Ship strikes on marine mammals, fish, and reptiles (g)	3	6	18	2a	2	2	4	2b	2	2	4	1c	0	6	0	2b	0	6	0	2b
	Small scale physical disturbance of vent fauna (b, f)	2	6	12	1c	1	4	4	2a	NA	NA	NA	NA	2	5	10	1c	1	6	6	2a
	Small scale physical disturbance of non-vent fauna (b, f)	4	3	12	1c	1	4	4	2a	1	4	4	2a	2	5	10	1c	1	6	6	2a
Exploration h) Surface flood lights and noise i) Test drilling j) Bulk sampling k) Test extraction methods l) Sediment plume m) Underwater noise	*Seabird attraction, disturbance, collision (h)	0	6	0	2b	NA	NA	NA	NA	2	5	10	2b	0	6	0	2b	0	6	0	2b
	Impact on vent fauna (i, j, k, l)	2	4	8	1c	2	4	8	1c	NA	NA	NA	NA	2	5	10	1c	2	4	8	1c
	Impact on non-vent fauna (l, j, k, l)	3	4	12	1c	1	4	4	2a	1	4	4	2a	2	5	10	1c	1	4	4	2c

n) Site surveys using swath mapping and/or boomer surveys o) Survey vessel activities	Impact on water column ecosystem (l)	1	6	6	2b	1	4	4	1c	1	4	4	1c	0	4	0	1c	1	6	6	2b
	Acoustic impact on marine mammals, reptiles, fish and invertebrates (n)	2	6	12	2a	1	6	6	1c	2	6	12	2a	0	6	0	2a	1	6	6	2a
	Entanglement of megafauna (l, j, k)	1	1	1	1b	NA	NA	NA	NA	1	3	3	1c	0	1	0	1b	0	1	0	1b
	*Ship strikes on marine mammals, fish, and reptiles from support vessels (o)	3	6	18	2a	2	2	4	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b
Mining p) Surface flood lights and noise q) Sea floor suction r) Extraction plume s) Slurry pipes t) Deposition of tailings in stock piles of pits u) Deposition plume v) Underwater lights and noise w) Waste water return x) Toxic chemical release y) Mining vessel activities z) Mining area exclusion zone	*Seabird attraction, disturbance, collision (p)	0	6	0	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	0	6	0	2b
	Vector for non-indigenous species (y)	3	4	12	2b	1	4	4	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b
	Impact on water column ecosystem from plume sediments and toxins (r, u, w, x)	1	6	6	2b	1	4	4	1c	1	4	4	1c	2	4	8	1c	2	6	12	2b
	Acoustic impact from under-water noise from, suction heads, pumps, ROVs etc. (v)	0	6	0	2b	0	6	0	1c	1	6	6	1c	0	6	0	2b	1	6	6	2b
	Impact on fished species (q, r, s, t, u, w, x)	2	4	8	2a	2	3	6	1c	NA	NA	NA	NA	2	3	6	1c	2	4	8	2b
	Effects of spatial displacement of fishing on fish stocks (z)	2	4	8	1c	1	5	5	1c	NA	NA	NA	NA	1	4	4	1c	3	4	12	1c
	Impact on vent fauna (q, r, s, t, u, w, x)	3	4	12	1c	3	4	12	2b	NA	NA	NA	NA	5	4	20	1c	5	4	20	1c
	Impact on non-vent fauna (r, s, t, u, w, x)	4	6	24	1c	2	4	8	1c	2	4	8	2a	3	4	12	1c	2	4	8	1c
	Entanglement of megafauna (g, s)	2	1	2	1b	NA	NA	NA	NA	2	3	6	1c	2	1	2	1b	0	1	0	1b
	*Ship strikes on marine mammals, fish, and reptiles (y)	3	6	18	2a	2	2	4	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b

4.8 Polymetalic crusts

4.8.1 Background

Cobalt-rich ferromanganese crusts form on hard-rock substrates by the slow precipitation of minerals out of seawater, aided by the activities of micro-organisms, or associated with hydrothermal activity (ISA 2007, ISA 2008b). Such crusts are typically found in water depths of 1000-1500 m on the flanks and summits of seamounts in association with low rates of sedimentation, strong currents and a shallow and well-developed oxygen minimum layer (Hein et al., 1988 in Glasby and Wright, 1990). In the New Zealand EEZ, such crusts have been found previously on the Three Kings Ridge and SW Campbell Plateau (Glasby and Wright, 1990), while recently limonitic crusts have been discovered on the crest of the Challenger Plateau (Ocean Survey 20/20 voyage TAN0707, SD Nodder, pers. comm.). Hydrothermal-related crusts have also been found on Colville Ridge and on the western flanks of the Tonga-Kermadec Ridge (Glasby and Wright, 1990) (Figure 4-4).

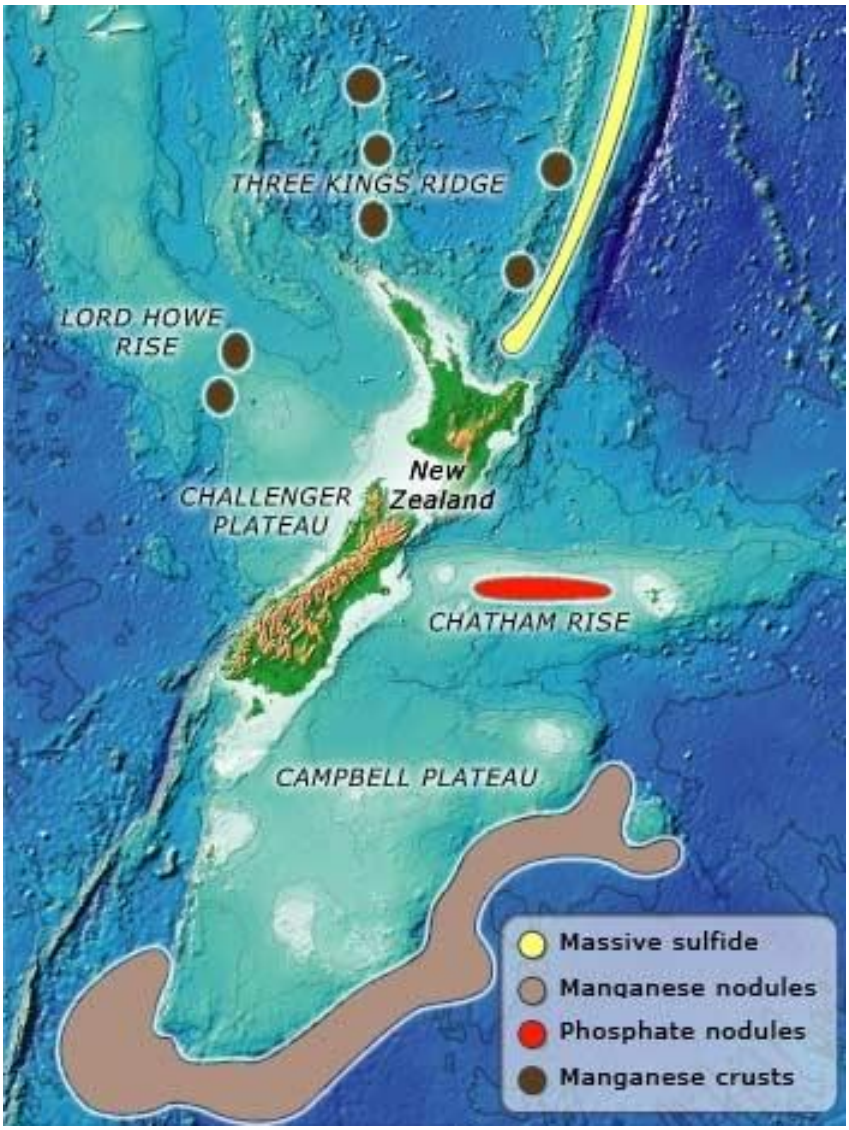


Figure 4-4: New Zealand EEZ distribution of mineral crusts and nodules.

The mining of Polymetalic crusts would be more difficult than for nodules because the crusts are attached to the underlying rock substrate (ISA, 2008). It is envisaged that articulated cutters on a mining dredge would fragment the crusts at the seafloor, which would then be

transported to the surface tender platform and/or vessels using hydraulic lifting methods (ISA, 2008a). Other techniques for removing crusts from the underlying substrate might include water-jet stripping, chemical leaching and/or sonic separation (ISA, 2008b).

4.8.2 Assessment

We assessed three phases of a possible future Polymetalic crust mining industry; prospecting, exploration, and production. Compared to the oil industry where the production facilities may be largely static for decades, decommissioning in the Polymetalic nodule mining industry would likely be a relatively routine part of on-going production as equipment was moved among mining sites once crust in one part have been exhausted. Thus we have not considered decommissioning as a separate phase. For each phase we identified and assessed the potential ecological impact of several distinct activities (Table 4-9). Below we present the main results for each phase.

Prospecting

Surveys using rock dredges, suspended camera systems, remotely operated vehicles (ROVs) and/or submersibles to quantify crust distribution and concentrations are likely to occur over a wide area during this phase. This sampling is likely to be conducted from specially equipped vessels and affect a small (<<1-5%) proportion of a crust field. The risk to benthic habitats and organisms from this activity is likely to be minor to moderate, but the recovery of directly impacted habitat patches is likely to take years to decades (Table 4-8).

Acoustic swath mapping may be used to define the bathymetry of promising areas and high resolution seismic reflection techniques (e.g., Boomer, CHIRP) may be used to define seafloor and sub-seafloor geological features. Use of air guns to obtain deeper seismic information in these surveys is highly unlikely. The acoustic impact of seismic surveys on marine mammals, in particular, is well documented (Gordon & Moscrop 1996, Cox et al. 2006, Brandon et al. 2008, Di lorio and Clark 2010), but may also affect a range of marine reptiles, fish and invertebrates. The consequences for marine mammals from the seismic gear likely to be used for these surveys will vary from none to behavioural (may leave area) perhaps to acute injury (ear drum damage) depending on noise level encountered, species and habitat. Beaked whales are thought to be particularly at risk. There may also be cumulative effects from repeated exposure.

Noise travels great distances underwater and so the footprint of this activity may be very broad though the greatest impacts will be much more restricted in area as sound intensity typically falls as the square of the distance from the source. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species, such as southern right whales, as these may occur throughout the EEZ though they occur in different areas at different times of the year. The risk from this activity was assessed to reach a score of 12 with a high level of confidence (Table 4-8) indicating the need for this to be a discretionary activity. Use of air guns, while inappropriate for defining these near seabed surface deposits, would considerably increase this risk.

Ship strikes on marine mammals may occur during transits among survey sites. These effects are covered under the Maritime Transport Act (1994) and the Marine Mammal Protection Act (1978).

Lights on ships at night typically attract and disturb seabirds and may cause them to collide with the coring vessel (Black 2005). These effects are covered under the Maritime Transport Act (1994) and the Wildlife Act (1953).

Exploration

In this phase more intensive evaluation of potential mining sites will take place. The focus is likely to be on areas of 30-50 km^2 capable of sustaining mining for a decade or more.

Within these areas multi-beam echo-sounders are likely to be used to define the bathymetry and high resolution seismic reflection techniques (e.g. Boomer, CHIRP) may be used to define seafloor and immediate sub-seafloor geological features. The area affected is likely to be a minor proportion (<1-5%) of the crust habitat. The risk to marine mammals and other organisms from this activity was assessed to reach a score of 12 with a high level of confidence (Table 4-8) indicating the need for this to be a discretionary activity. Use of air guns, though inappropriate for defining these near seabed surface deposits, would considerably increase this risk.

Further surveys using rock dredges, suspended camera systems, ROVs and/or submersibles to quantify crust distribution, thickness and chemical content are likely to occur during this phase, but are very likely to be concentrated over a small proportion (<1-5%) of the nodule habitat. There may also be some trials of extraction methods and bulk sampling of crusts. The risk to benthic habitats and organisms from this activity is likely to be minor to moderate, but the recovery of directly impacted benthic habitat patches is likely to take years to decades (Table 4-8).

Entanglement of megafauna in subsurface equipment, including anchor lines, mooring lines, marker buoy lines, power cabling or hydraulic lines, is a possibility during trials of extraction methods. Only a tiny fraction of the area (<<1%) is likely to have such hazards to fauna and these will probably be in place for only weeks to months. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to protected marine mammals from this activity was assessed as low (3) with a high level of confidence (Table 4-8). Recovery of affected populations should these entanglement hazards be removed is expected to take years as the species concerned are slow growing and late maturing with low fecundity.

Production

During submarine crust mining a processing vessel is unlikely to moor to ‘permanent’ anchors blocks or anchor moorings. There is likely to be a sediment plume originating from the active mining face as well as from the slurry pipe depositing unwanted sediments. To be profitable a large area of Polymetalic crust, perhaps 5km^2, will need to be mined each year, possibly for decades. Over the lifetime of the mining operation it is possible that a considerable proportion of a ridge or seamount (60-90%) could be affected.

The benthic ecosystem on the seafloor in and around the mining operations will be sequentially and severely impacted during the long production phase as the relatively thin crust (5-20cm) is mined and an area downstream of the mining operations is affected by smothering and toxic effects from sediments disturbed by mining operations. Coarse grains will settle quickly, but finer particles may be carried some distance depending on current strength. In areas being actively mined probably close to 100% of the benthic organisms will be killed during the crust removal process. Smothering from the sediment plume will decrease as the distance from the plume source increases. As the total area affected is likely to be a significant proportion of the total crust habitat on a seamount, the functional impact on the benthic ecosystem as a whole, as well impacts on key species and protected benthic species, such as deepwater corals, are likely to be major. Because the benthic fauna includes slow-growing, long-lived species recovery of affected areas is likely to be very long-

term. If species are dependent on the presence of the Polymetalic crust substrate then recovery may never occur in mined areas. Overall, the risks of this mining to the benthic ecosystems on ridges and seamounts were judged to be high (Table 4-8).

Sediment plumes arising from the mining face or slurry pipe depositing sediments may also cause disruption to the water column ecosystem by increasing turbidity, thereby restricting light availability for phytoplankton, or through the irritation of the gills of fish and invertebrates or through death from the toxic sediments. Anywhere from 5-20% of the pelagic habitat over a seamount may be affected at any one time and effects on key species, protected species and ecosystem function may be minor to moderate (Table 4-8). Recovery of the pelagic ecosystem is expected to be reasonably quick once sediment plumes stop.

Mining activities on the seabed will produce some level of underwater noise from the suction head, and any submersed cutters, pumps or other machinery. This underwater noise may affect marine mammals, mainly causing then to avoid the area, but we assessed this to pose moderate risk (12) and that recovery would be quick after the noise stopped.

Entanglement of megafauna in subsurface equipment including anchor lines, mooring lines, marker buoy lines, power cabling or hydraulic lines is a possibility. Only a tiny fraction of the area (<<1%) is likely to have such hazards to fauna. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to protected marine mammals from this activity was assessed as low (3) with a high level of confidence (Table 4-9). Recovery of affected populations should these tangling hazards be removed is expected to take years as the species concerned are slow growing and late maturing with low fecundity.

Mining Polymetalic crusts may affect stocks of fished species in two ways. There may be some direct effects on fish during mining, especially on benthic foraging fish, and the seafloor may take years before the full range of prey species are available for such fish populations. Additionally fish may move away from the area of active mining and plume influence. Mining areas will invariably have a zone of restricted access around them that prevents fishing access. Unless commercial fish quota is purposefully bought by the mining company and retired for the duration of the production phase then commercial fishing will be displaced into the remainder of the quota management area (QMA). The resulting fishing pressure has the potentail to affects some fish stocks, especially sedentary species with limited migrations. While the area of a QMA affected by direct effects on fish stocks is likely to be small, the effects of displaced fishing will be felt over a much greater area. We assessed there to be moderate (8) risks to key fish stocks and ecosystem functioning from direct effects on fish stocks, and lower risk from displaced fishing effort to key fish stocks (5) and ecosystem functioning (4). Recovery of affected fish stocks from direct and indirect effects may take months to years (Table 4-8).

Ships brought in to New Zealand from Australia or further afield to separate the crust from other sediments may act as vectors for non-indigenous species, but the likelihood is low for a vessel with fresh antifouling. New Zealand-modified ships should pose little risk. The functional impact on the ecosystem surrounding the crust separation vessel is probably minor as vectored species are unlikely to survive independently of the ship in deep offshore waters. However, the ship may act as a stepping stone for non-indigenous species to invade shallow coastal habitats.

Risk summary for mining of Polymetalic crusts

Several activities associated with mining of Polymetalic crusts were considered to represent an extreme environmental risk and should be prohibited if no way can be found to avoid, mitigate or remedy their impact. These activities include:

- Testing of extraction methods
- Bulk sampling of crusts
- Sea floor cutting/fragmentation / extraction
- Extraction plume
- Slurry pipelines
- Deposition of tailings in stock piles or pits
- Deposition plume
- Toxic chemical release

The following activities were considered to be of high environmental risk (15-20) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Support vessel activity causing strikes on marine mammals, fish and reptiles
- Surface flood lights at night
- Testing and operation of undersea equipment with associated hydraulic lines, power cables and umbilical's

The following activities were considered to be of moderate environmental risk (7-12) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Spot sampling and imaging using ROV, AUV
- Use of high resolution seismics e.g. Boomer, CHIRP
- Import and provision of biofouling surfaces
- Incidental underwater noise

The following activities were considered to be of low environmental risk (0-6) and should be categorised as permitted:

- Single and multibeam echo sounding
- Underwater flood lights
- Declaration of a mining area exclusion zone
- ROV and other imaging surveys

4.8.3 Avoidance, mitigation, remediation

There are often ways of avoiding, remedying or mitigating the effects of activities that would otherwise put marine species or ecosystems at risk. Below we briefly discuss those relevant to mining Polymetalic crusts.

Non-mandatory Department of Conservation guidelines (2006 and 2011) should be followed to avoid or mitigate acoustic impacts on marine mammals.

Avoidance or mitigation of seabird strikes is possible by limiting unnecessary use of vessel flood lights at night and ensuring that those that are required are directed approximately vertically onto work surfaces. Visual checks of the vessel super-structure at first light each day for the presence of dazed or injured birds and the provision of appropriate care may help to remedy this impact.

Avoidance or mitigation of vessels and underwater equipment acting as vectors for non-indigenous species is possible by appropriate checking, cleaning, and application of antifouling paints. We understand that Biosecurity New Zealand (MAF-BNZ) is developing an import health standard and legislation and relevant regulations may be put in place in next 2-3 years.

Pressure on fish stocks caused by the mining exclusion zone forcing fishing activities into the remainder of the quota management area can be reduced or eliminated by purchase and retirement of appropriate commercial fish quota for the duration of the production phase.

Actions that increase the rate of recovery of benthic fauna from the impacts of crust mining will greatly reduce the risks associated with this industry. Recolonisation by larval settlement from adjacent populations may be increased by leaving adjacent communities intact to act as source populations. Because so little is known about larval connectivity in these populations, the minimum required distances from source to impacted area is unknown.

Table 4-8: Expert Panel Assessment: Polymetalic crust mining. Levels of consequence, likelihood, risk and confidence associated with this activity in the EEZ and ECS. Activities are listed (a, b, c, etc) after each threat to which they contribute. The maximum possible level of environmental risk is 30. Extreme environmental risks are highlighted in red, high in yellow, and moderate in green. Low risk activities are not highlighted. *Threats managed under the Maritime Transport Act (1994). NA = not applicable as species assessed are all protected.

Expert Panel Assessment: Polymetalic crusts		Recovery period				Key species				Protected species				Ecosystem functional impact				Proportion of habitat affected			
Activity	**Threat**	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence
Prospecting a) Surface flood lights and noise b) ROV and other imaging surveys c) Acoustic swath mapping d) Sub-bottom profiling using CHIRPS, boomers and sparkers e) Spot sampling using ROV, submersible, or rock dredge f) Survey vessel activities	*Seabird attraction, disturbance, collision (a)	1	6	6	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	3	6	18	2b
	Acoustic impact from multi-beam echo sounders on marine mammals, reptiles, fish and invertebrates (c)	0	5	0	2a	0	6	0	2a	1	5	0	2a	0	6	0	2a	0	6	0	2a
	Acoustic impact of high resolution seismics on marine mammals, reptiles, fish and invertebrates (d)	1	6	6	2a	2	6	12	1c	2	6	12	2a	0	6	0	2b	2	6	12	2b
	*Ship strikes on marine mammals, fish, and reptiles (f)	3	6	18	2b	2	2	4	2b	2	2	4	1c	0	6	0	2b	0	6	0	2b
	Impact on benthos (b, e)	4	3	12	1c	1	4	4	2a	1	4	4	2a	2	5	10	1c	1	6	6	2a
Exploration g) Surface flood lights and noise h) Test extraction methods i) Bulk sampling j) Sediment plume k) Underwater noise l) Sub-bottom profiling using CHIRPS, boomers and sparkers m) Site surveys using swath	*Seabird attraction, disturbance, collision (g)	0	6	0	2b	NA	NA	NA	NA	2	5	10	2b	0	6	0	2b	0	6	0	2b
	Impact on benthos (h, i)	4	6	24	1c	2	4	8	2a	1	4	4	2a	2	5	10	2a	1	4	4	2b
	Acoustic impact on marine mammals, reptiles, fish and invertebrates (l, m)	1	6	6	2a	2	6	12	1c	2	6	12	2a	0	6	0	2b	2	6	12	2b
	Entanglement of megafauna (h, i)	3	5	15	2b	1	3	3	2b	1	3	3	2b	0	6	0	2b	0	6	0	2b
	*Ship strikes on marine mammals, fish, and reptiles from support vessels (n)	3	6	18	2a	2	2	4	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b

n) Mining vessel activities	mapping &/or boomer surveys																				
Mining o) Surface flood lights and noise p) Sea floor cutting/ fragmentation q) Extraction plume r) Sea floor slurry pipes s) Deposition of tailings in stock piles or pits t) Deposition plume u) Incidental underwater lights and noise v) Waste water return w) Toxic chemical release x) Mining vessel activities y) Mining area exclusion zone	Impact on water column ecosystem from plume sediments (g, t, w)	1	6	6	2b	1	4	4	1c	1	4	4	1c	2	4	8	1c	2	6	12	1c
	Acoustic impact on marine mammals, reptiles, fish and invertebrates (u)	1	6	6	2a	1	6	6	1c	2	6	12	2a	0	6	0	2b	1	6	6	2b
	Vector for non-indigenous species (x)	3	4	12	2b	1	4	4	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b
	Impact on fished species (p, q, r, s, t, v, w)	2	4	8	1c	2	4	8	1c	NA	NA	NA	NA	2	4	8	1c	2	4	8	2b
	Displacement of fishing activity (y)	1	5	5	2b	1	5	5	2b	1	4	4	2b	1	4	4	1c	1	4	4	2b
	*Ship strikes on marine mammals, fish and reptiles from support vessels (x)	3	6	18	2a	1	2	2	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b
	*Seabird attraction, disturbance, collision (o)	0	6	0	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	0	6	0	2b
	Entanglement of megafauna (p, r)	3	5	15	2b	1	3	3	2b	1	3	3	2b	0	6	0	2b	0	6	0	2b
	Underwater lights (u)	0	4	0	2a	0	4	0	2a	0	4	0	2a	0	4	0	2a	0	4	0	2a
	Impact on benthos (p, q, r, s, t, w)	5	6	30	2a	4	5	20	1c	4	5	20	1c	4	4	16	1c	4	4	16	1c

4.9 Polymetalic nodules

4.9.1 Background

Polymetalic nodules are also known as manganese nodules, and are formed by the slow deposition (cm/millions of years) of manganese and iron hydroxides, as well as elements such as nickel, cobalt and copper, directly from seawater (authigenic processes) or at the sediment-water interface (diagenetic processes) (ISA, 2008a). Typically, nodules are formed of concentric layering around a central core that might be as small as a foraminifera (calcareous protozoan) test or comprise rock or nodule fragments. Nodule formation generally requires slow rates of sedimentation and/or strong currents that restrict sediment deposition, planktonic sources of various elements (Cu, Ni, Co) and micro-organism activity. Accordingly, in the New Zealand EEZ and ECS, nodules occur in abundance over a very large area (~250,000 km^2) in deep water (4000-5000 m) immediately southeast of the Campbell Plateau, south of 56°S (Glasby and Wright, 1990) and in the vicinity of Bollon's Seamount at 50°S (Carter, 1989) where the Deep Western Boundary Current brings Antarctic Bottom Water into the New Zealand region (see Figure 4-4). The nodules have relatively low Cu, Ni and Co contents, and may have over 75% areal coverage in certain locations on the seafloor, although the entire area has only been sparsely surveyed (Glasby and Wright, 1990) (Figure 4-5).

Considerable research has been undertaken on the manganese nodule deposits elsewhere in the Pacific and Indian oceans, such that the most likely extraction techniques would involve hydraulic mining methods, comprising a seafloor hydraulic suction dredge connected to a mining platform via a flexible hose and rigid pipe string for transporting the nodules from the seafloor to the sea surface (ISA, 2008a). Other alternatives that have been considered include continuous line bucket dredging systems (ISA, 2008a).

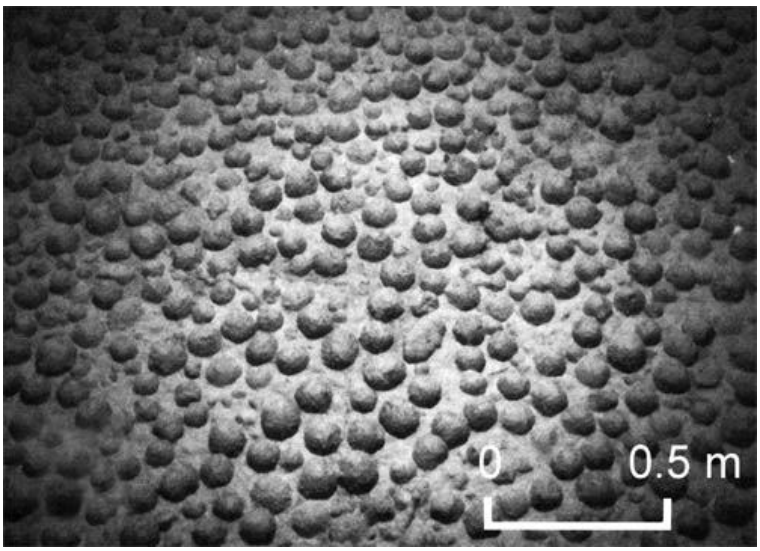


Figure 4-5: A dense field of Polymetalic (manganese) nodules from the Campbell plateau slope. Photograph courtesy Ashley Rowden.

4.9.2 Assessment

We assessed three phases of a possible future Polymetalic nodule mining industry; prospecting, exploration, and production. Compared to the oil industry where the production facilities may be largely static for decades, decommissioning in the Polymetalic nodule

mining industry would likely be a relatively routine part of on-going production as equipment was moved around the mining site once nodules in one part have been exhausted. Thus we have not considered decommissioning as a separate phase. For each phase we identified and assessed the potential ecological impact of several distinct activities (Table 4-9). Below we present the main results for each phase.

Prospecting

Surveys using rock dredges, suspended camera systems, remotely operated vehicles (ROVs) and/or submersibles to quantify nodule distribution and concentrations are likely to occur over a wide area during this phase. This sampling is likely to be conducted from specially equipped vessels and affect a very small proportion of the nodule field. The risk to benthic habitats and organisms from this activity is likely to be minor to moderate, but directly impacted habitat patches may never recover if the fauna is reliant on the presence of nodules as a settlement surface (Table 4-9).

Acoustic swath mapping may be used to define the bathymetry of promising areas and high resolution seismic reflection techniques (e.g., Boomer, CHIRP) may be used to define seafloor and sub-seafloor geological features. Use of air guns to obtain deeper seismic information in these surveys is unlikely. The acoustic impact of seismic surveys on marine mammals, in particular, is well documented (Gordon & Moscrop 1996, Cox et al. 2006, Brandon et al. 2008, Di Iorio and Clark 2010), but may also affect a range of marine reptiles, fish and invertebrates. The consequences for marine mammals from the seismic gear likely to be used for these surveys will vary from none to behavioural (may leave area) perhaps to acute injury (ear drum damage) depending on noise level encountered, species and habitat. Beaked whales are thought to be particularly at risk. There may also be cumulative effects from repeated exposure.

Noise travels great distances underwater and so the footprint of this activity may be very broad although the greatest impacts will be much more restricted in area as sound intensity typically falls as the square of the distance from the source. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species, such as southern right whales, as these may occur throughout the EEZ, although they occupy different areas at different times of the year. The risk from this activity was assessed to reach a score of 12 with a high level of confidence (Table 4-9) indicating the need for this to be a discretionary activity. Use of air guns, while inappropriate for defining these near seabed surface deposits, would considerably increase this risk. Recently established non-mandatory DoC guidelines should be followed to avoid or minimise effects.

Ship strikes on marine mammals may occur during transits among coring sites. These effects are covered under the Maritime Transport Act (1994) and the Marine Mammal Protection Act (1978).

Lights on ships at night typically attract and disturb seabirds and may cause them to collide with the coring vessel (Black 2005). These effects are covered under the Maritime Transport Act (1994) and the Wildlife Act (1953).

Exploration

In this phase more intensive evaluation of potential mining sites will take place. The focus is likely to be on areas of 100-200 km^2 capable of sustaining mining for a decade or more.

Within these areas multi-beam echo-sounders are likely to be used to define the bathymetry and high resolution seismic reflection techniques (e.g., Boomer, CHIRP) may be used to define the sub-seafloor geological strata. The area affected is likely to be a very small proportion (<<1%) of the nodule habitat. The risk to marine mammals and other organisms from this activity was assessed to reach a score of 12 with a high level of confidence (Table 4-9). Use of air guns, while inappropriate for defining these near seabed surface deposits, would considerably increase this risk. Recently established non-mandatory DoC guidelines should be followed to avoid or minimise effects.

Further surveys using rock dredges, suspended camera systems, ROVs and/or submersibles to quantify nodule distribution and concentrations are likely to occur during this phase, but are very likely to be concentrated over a small proportion (<<1%) of the nodule habitat. There may also be some trials of extraction methods that will involve bulk sampling. The risk to benthic habitats and organisms from this activity is likely to be minor to moderate, but directly impacted habitat patches may never recover if the fauna is reliant on the presence of nodules as a settlement surface (Table 4-9).

Entanglement of megafauna in subsurface equipment, including marker buoy lines, power cabling or hydraulic lines, is a possibility during trials of extraction methods. Only a tiny fraction of the area (<<1%) is likely to have such hazards to fauna and these will probably be in place for only weeks to months. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to protected marine mammals from this activity was assessed as moderate (9) with a high level of confidence (Table 4-9). Recovery of affected populations should these tangling hazards be removed is expected to take years as the species concerned are slow growing, and late maturing with low fecundity.

Production

During mining the processing vessel is unlikely to moor to ‘permanent’ anchors blocks or anchor moorings. There is likely to be a sediment plume originating from the active mining face as well as from the slurry pipe depositing unwanted sediments. To be profitable a large area, perhaps 10km^2, will need to be mined each year, possibly for decades. Over the lifetime of the mining operation it is possible that only a small proportion (<<1-5%) of the vast Polymetalic nodule habitat along the flanks of the Campbell Plateau would be affected.

The benthic ecosystem on the seafloor in and around the mining operations will be sequentially and severely impacted during the long production phase as areas are mined and backfilled with sediment and an area downstream of the mining operations will be affected by smothering from sediments from sediment plumes. Coarse grains will settle quickly, but finer silts, muds and clays may be carried some distance depending on current strength and resuspension. In areas being actively mined probably close to 100% of the benthic organisms will be killed during the mining or nodule concentration process. Smothering from sediment plumes will decrease as the distance from the plume source increases. As the total area affected is likely to be a small proportion of the total nodule habitat, the functional impact on the benthic ecosystem as a whole, as well impacts on key species and protected benthic species are likely to be moderate. Because the benthic fauna may include slow growing, long-lived species recovery of affected areas is likely to be very long-term. If species are dependent on the presence of Polymetalic nodules then recovery may never occur in mined areas. Overall, the risks of Polymetalic nodule mining to the benthic

ecosystems around the southern flank of the Southern Plateau were judged to be moderate (Table 4-9).

Sediment plumes arising from the mining face or slurry pipe depositing sediments may also cause disruption to the water column ecosystem by increasing turbidity, thereby restricting light availability for phytoplankton, or through irritation of the gills of fish and invertebrates. The area affected at any one time is likely to be very small and effects on key species, protected species and ecosystem function possibly will be minor to moderate (Table 4-9). Recovery of the pelagic ecosystem is expected to be reasonably quick once sediment plumes stop.

Mining activities on the seabed will produce some level of underwater noise from the suction head, and any submersed cutters, pumps or other machinery. This underwater noise may affect marine mammals, mainly causing then to avoid the area, but we assessed this to pose moderate risk (12) and that recovery would be quick after the noise stopped.

Entanglement of megafauna in subsurface equipment, including marker buoy lines, power cabling or hydraulic lines, is a possibility. Only a tiny fraction of the area (<<1%) is likely to have such hazards to fauna. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to protected marine mammals from this activity was assessed as moderate (9) with a high level of confidence (Table 4-9). Recovery of affected populations should these tangling hazards be removed is expected to take years as the species concerned are slow growing and late maturing with low fecundity.

Mining Polymetalic nodules will not affect commercial fish stocks as none are known to occur in these deep (4000-5000 m) waters.

Ships brought in to New Zealand from Australia or further afield to separate the nodules from other sediments may act as vectors for non-indigenous species, but the likelihood is low for a vessel with fresh antifouling. New Zealand modified ships should pose little risk. The functional impact on the ecosystem surrounding the nodule separation vessel is probably minor as vectored species are unlikely to survive independently of the ship in deep offshore waters. However, the ship may act as a stepping stone for non-indigenous species to invade shallow coastal habitats. We understand that Biosecurity New Zealand (MAF-BNZ) is developing an import health standard to cover the use of such ships and legislation and relevant regulations may be put in place in next 2-3 years.

Risk summary for mining of Polymetalic nodules

Several activities associated with mining of Polymetalic nodules were considered to represent an extreme environmental risk and should be prohibited if no way can be found to avoid, mitigate or remedy their impact. These activities include:

- Sea floor extraction / mining
- Creation of sediment plume
- Use of slurry pipes
- Deposition of tailings in stock piles
- Release of toxic chemicals

The following activities were considered to be of high environmental risk (15-20) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Support vessel activity causing strikes on marine mammals, fish and reptiles
- Surface flood lights at night
- Testing and operation of undersea mining equipment with associated hydraulic lines, power cables and umbilical's
- Bulk sampling of nodules

The following activities were considered to be of moderate environmental risk (7-12) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Spot sampling using ROV, AUV
- Use of high resolution seismics e.g. Boomer, CHIRP
- Import and provision of biofouling surfaces
- Incidental underwater noise

The following activities were considered to be of low environmental risk (0-6) and categorised as permitted:

- Multibeam echo sounding
- Underwater flood lights
- Imaging using ROV, AUV
- Declaration of exclusion zone

4.9.3 Avoidance, mitigation, remediation

There are often ways of avoiding, remedying or mitigating the effects of activities that would otherwise put marine species or ecosystems at risk. Below we briefly discuss those relevant to mining Polymetalic nodules.

Non-mandatory Department of Conservation guidelines (2006 and 2011) should be followed to avoid or mitigate acoustic impacts on marine mammals.

Avoidance or mitigation of seabird strikes is possible by limiting unnecessary use of vessel flood lights at night and ensuring that those that are required are directed approximately vertically onto work surfaces. Visual checks of the vessel super-structure at first light each day for the presence of dazed or injured birds and the provision of appropriate care may help to remedy this impact.

Avoidance or mitigation of vessels and underwater equipment acting as vectors for non-indigenous species is possible by appropriate checking, cleaning, and application of antifouling paints. We understand that Biosecurity New Zealand (MAF-BNZ) is developing

an import health standard and legislation and relevant regulations may be put in place in next 2-3 years.

Actions that increase the rate of recovery of benthic fauna from the impacts of nodule mining will greatly reduce the risks associated with this industry. Recolonisation by larval settlement from adjacent populations may be increased by leaving adjacent communities intact to act as source populations. Because so little is known about larval connectivity in these populations, the maximum distance from source to impacted areas is unknown.

Table 4-9: Expert Panel Assessment: Polymetalic nodule mining. Levels of consequence, likelihood, risk and confidence associated with this activity in the EEZ and ECS. Activities are listed (a, b, c, etc) after each threat to which they contribute. The maximum possible level of environmental risk is 30. Extreme environmental risks are highlighted in red, high in yellow, and moderate in green. Low risk activities are not highlighted. *Threats managed under the Maritime Transport Act (1994). NA = not applicable as species assessed are all protected.

Expert Panel Assessment: Polymetalic nodules		Recovery period				Key species				Protected species				Ecosystem functional impact				Proportion of habitat affected			
Activity	**Threat**	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence
Prospecting a) Surface flood lights and noise b) ROV and other imaging surveys c) Acoustic swath mapping d) Sub-bottom profiling using CHIRPS, boomers and sparkers e) Spot sampling using ROV, submersible, or rock dredge f) Survey vessel operations	*Seabird attraction, disturbance, collision (a)	1	6	6	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	1	6	6	1b
	Acoustic impact from multi-beam echo sounders on marine mammals, reptiles, fish and invertebrates (c)	0	5	0	2a	0	6	0	2a	1	5	0	2a	0	6	0	2a	0	6	0	2a
	Acoustic impact of high resolution seismics on marine mammals, reptiles, fish and invertebrates (d)	1	6	6	2a	2	6	12	1c	2	6	12	2a	0	6	0	2b	0	6	0	1b
	*Ship strikes on marine mammals, fish, and reptiles (f)	3	6	18	2a	2	2	4	2b	2	2	4	1c	0	6	0	2b	0	4	0	1b
	Impact on benthos (e)	4	3	12	1c	1	4	4	2a	1	4	4	2a	2	5	10	1c	0	6	0	1b
Exploration g) Surface flood lights and noise h) Test extraction methods i) Bulk sampling j) Sediment plume k) Underwater noise l) Site surveys using multi-beam echo sounding m) Sub-bottom profiling using CHIRPS, boomers and sparkers n) Support vessel	*Seabird attraction, disturbance, collision (g)	0	6	0	2b	NA	NA	NA	NA	2	5	10	2b	0	6	0	2b	0	6	0	1b
	Impact on benthos (h, i, j)	4	5	20	1c	2	4	8	2a	1	4	4	2a	2	5	10	2a	0	4	0	1b
	Acoustic impact from multi-beam echo sounders on marine mammals, reptiles, fish and invertebrates (l)	0	5	0	2a	0	6	0	2a	1	5	0	2a	0	6	0	2a	0	6	0	2a
	Acoustic impact on marine mammals, reptiles, fish and invertebrates (l, m)	1	6	6	2a	2	6	12	1c	2	6	12	2a	0	6	0	2b	0	6	0	1b
	Underwater flood lights	0	4	0	2a	0	4	0	2a	0	4	0	2a	0	4	0	2a	0	4	0	2a

activities	Entanglement of megafauna (h, i)	3	5	15	2b	1	3	3	2b	3	3	9	2b	0	6	0	2b	0	6	0	2b
	*Ship strikes on marine mammals, fish and reptiles (n)	3	6	18	2a	2	2	4	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b
Mining o) Surface flood lights and noise p) Sea floor mining q) Extraction plume r) Slurry pipes s) Deposition of tailings in stock piles or pits t) Deposition plume u) Incidental underwater lights and noise v) Waste water return w) Toxic chemical release x) Support vessel activity y) Declaration of exclusion zone	Impact on water column ecosystem from plume sediments (q, t, w)	1	6	6	2b	1	4	4	1c	1	4	4	1c	2	4	8	1c	0	6	0	1c
	Acoustic impact on marine mammals, reptiles, fish and invertebrates (u)	0	6	0	2a	1	6	6	1c	2	6	12	2a	0	6	0	2b	0	6	0	2b
	*Ship strikes on marine mammals, fish and reptiles from support vessels (x)	3	6	18	2a	1	2	2	1c	3	3	9	2a	0	4	0	2b	0	5	0	2b
	*Seabird attraction, disturbance, collision (o)	0	6	0	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	0	6	0	2b
	Vector for non-indigenous species (x)	3	4	12	2b	1	4	4	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b
	Entanglement of megafauna (r)	3	5	15	2b	1	3	3	2b	3	3	9	2b	0	6	0	2b	0	4	0	1c
	Underwater lights (u)	0	4	0	2a	0	4	0	2a	0	4	0	2a	0	4	0	2a	0	4	0	2a
	Impact on benthos (p, q, r, s, t, w)	5	5	25	1b	2	4	8	1b	1	2	2	1b	2	4	8	1b	1	4	4	1b

4.10 Ocean basin telecommunications cabling

4.10.1 Background

New Zealand has two existing telecommunications cables (Southern Cross & Tasman 2) that cross the EEZ and ECS. Another (Pacific Fibre) is proposed (Figure 4-6). The route of all three is broadly similar across the Tasman (from Sydney to Auckland) but only two (Pacific Fibre and Sothern Cross) are routed from New Zealand to the USA.

Both the Tasman Sea and the Pacific Ocean are challenging environments for laying cables. They reach great depths and have steep bathymetric features including numerous seamounts, ridges and troughs. The Pacific Ocean is tectonically active with the constant threat of volcanic activity, earthquakes and tsunamis that could damage or break cables. Routes are generally chosen to avoid hazard, such as areas of reef, steep bathymetry, active volcanoes, active faults and deep trenches.

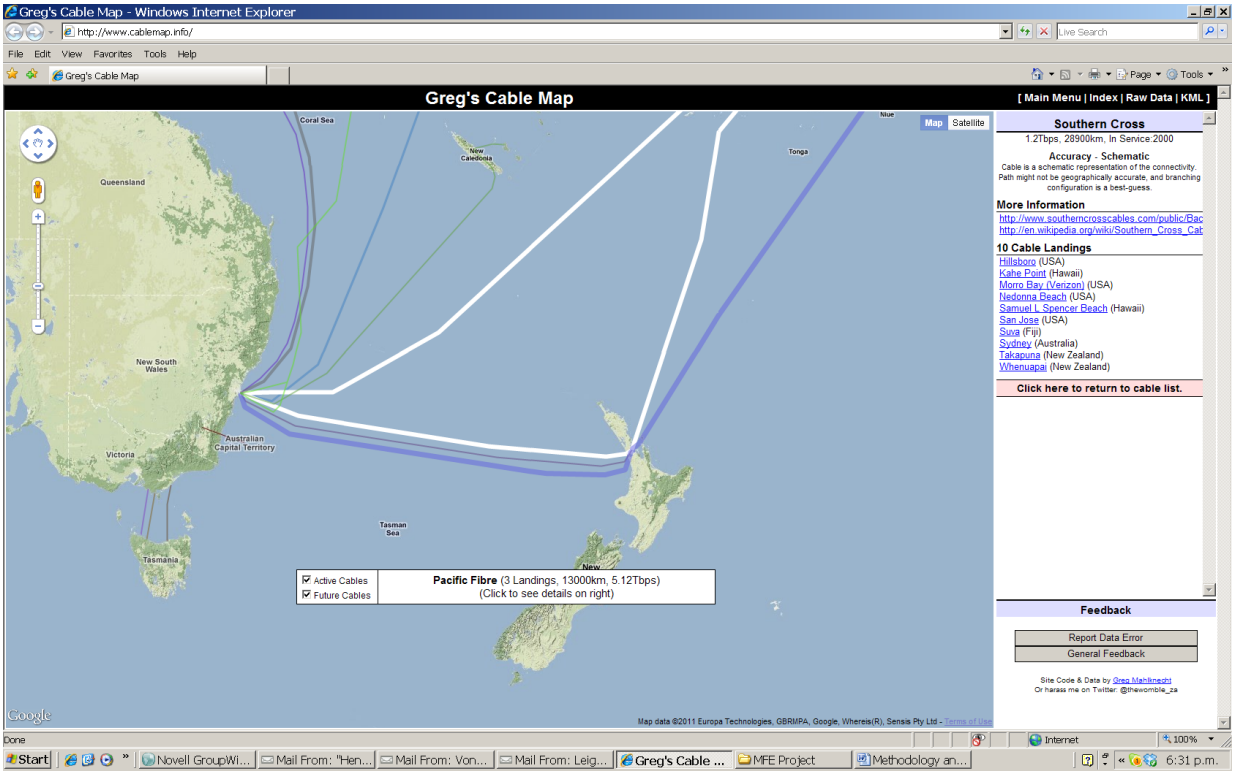


Figure 4-6: Telecommunication routes in the New Zealand region.

4.10.2 Assessment

Laying new subsea cables is a major undertaking and generally can be broken into four distinct phases: route exploration, cable laying and maintenance, cable operation and abandonment. For each phase we identified and assessed the potential ecological impact of several distinct activities (Table 4-10). Below we present the main results for each phase.

Route exploration

Surveys of potential routes across the Tasman Sea and Pacific Ocean will include multibeam echo-sounding to map bathymetry, and high resolution seismics (e.g. Boomer, CHIRP) for substrate characterisation, while seismic air guns may be used for fault mapping and identifying deeper geological hazards. Acquisition of seismic data is via a streamer comprising multiple hydrophones that may be up to 15km long. The streamer is typically

deployed at ~2 knots and acquisition of data occurs at 5 knots. A very large area, perhaps approaching 100% of the possible cable routes through the EEZ and ECS, may be surveyed during this phase though sequentially over a period of several weeks to a few months.

The acoustic impact of seismic surveys on marine mammals, in particular, is well documented (Gordon & Moscrop 1996, Cox et al. 2006, Brandon et al. 2008, Di lorio and Clark 2010) but may also affect a range of marine reptiles, fish and invertebrates. The consequences for marine mammals will vary from none to behavioural (may leave area) to acute injury (ear drum damage) to serious (death) depending on noise level encountered, species and habitat. Beaked whales are thought to be particularly at risk. There may also be cumulative effects from repeated exposure. Noise travels great distances underwater and so the footprint of this activity may be very broad though fatal impacts will be much more restricted in area as sound intensity typically falls as the square of the distance from the source. Acoustic depth sounders and multibeam echo-sounders used for swath mapping pose little risk but high energy seismic devices such as air guns used for mapping sub seafloor geological structures pose a much greater risk. Using a precautionary approach our assessment assumed that air guns were used and that the species affected was a nationally critical species such as southern right whales as these may occur throughout the EEZ though they occur in different areas at different times of the year. The risk from this activity was assessed to reach a score of 18 with a high level of confidence (Table 4-10) indicating the need for this to be a permitted activity.

Samples of surface sediments may be taken using coring devices to indicate the suitability of substrates for trenching and burial of the cable. However the area affected is expected to be very small and carry low risk for all aspects of the benthic environment (Table 4-10).

Ship strikes on marine mammals may occur during the route surveys. These effects are covered under the Maritime Transport Act (1994) and the Marine Mammal Protection Act (1978).

Lights on ships at night typically attract and disturb seabirds and may cause them to collide with the survey vessel (Black 2005). These effects are covered under the Maritime Transport Act (1994) and the Wildlife Act (1953).

Cable laying and maintenance

For the past decade or so trans-ocean fibre-optic telecommunications cables have been manufactured on board the cable ship and laid in one seamless run. It is also common practice to bury the cable in a shallow narrow trench using a trenching plough to help eliminate accidental damage from bottom trawl gear. These practices have greatly reduced twisting of the cable during laying and ongoing maintenance requirements. The area of benthic habitat affected by burial and any associated sediment plume is expected to be a very small proportion of similar habitats in the northern part of the EEZ and ECS and carry low risk for all aspects of the benthic environment but recovery will takes months to a few years (Table 4-10).

During cable laying and maintenance the arc of cable between the cable ship and the seafloor poses some risk of entanglement to megafauna such as the larger baleen whales and sperm whales. In deep water this arc of cable may be up to 7-10 km long. The area of hazard is likely to be very small. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species as these may occur throughout the EEZ. The risk to protected marine mammals from this activity was assessed as low (3) with a

low level of confidence as data about this hazard are few particularly in relation to modern cable designs and laying methods (Table 4-10). Recovery of affected populations once the cable is buried in the seafloor is expected to take years as the species concerned are slow growing, late maturing with low fecundity.

Cable laying is a slow speed operation and there is the potential for cable ships to act as a vector for non-indigenous species to enter New Zealand waters. However, the likelihood is low for a vessel with fresh antifouling. The functional impact on deepwater ecosystems in the EEZ and ECS is probably negligible as vectored species are highly unlikely to survive independently of the ship. However, as the cable laying operation nears shore the ship may act as a stepping stone for non-indigenous species to invade shallow coastal habitats.

Cable operation

Risks to the marine environment during this stage all arise from any part of the cable that is not buried in the sediment. Despite the best of plans cables may be suspended between high points or be undercut by strong currents. These cable suspensions pose ongoing but low (3) risks to deep-diving whales and the recovery of any affected population is expected to take years (Table 4-10).

Movement of suspended cable in currents may continuously damage small areas of benthic fauna but the ecological risks are negligible (Table 4-10).

Seafloor telecommunications cables may affect stocks of fished species. Cable routes invariably have a zone of restricted access around them that prevents fishing activity. Unless commercial fish quota is purposefully bought by the cable operator and retired for the duration of the cable operation then commercial fishing will be displaced into the remainder of the quota management area (QMA). The resulting fishing pressure has the potentail to affects some fish stocks, especially sedentary species with limited migrations. However, the area of a QMA affected is likely to be small (<1-5%) and we assessed there to be negligible risks to key fish stocks and ecosystem functioning (Table 4-10).

Abandonment

We have assumed that cables will be abandoned *in situ* at the end their working life rather than recovered. Recovery would be expensive and uncertain and removal of cables buried for decades has the potential to cause as much, if not more, ecological damage that when they were laid. Abandoned cables will slowly deteriorate and disintegrate over time but this may take decades or centuries. Steel reinforcing wires will eventually rust but glass fibres will remain. Exposed sections of cable have the potential to entangle deep-diving megafauna such as sperm whales and the risks are identical to those listed above during cable operation (Table 4-10).

Risks to benthic communities may be negligible, especially if most of the cable remains buried until it finally disintegrates (Table 4-10).

Risk summary for ocean basin telecommunications cabling

There were no activities associated with telecommunications cable installation or operation considered to represent an extreme environmental risk provisionally indicating prohibited status.

The following activities were considered to be of high environmental risk (15-20) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Surface flood lights at night causing bird strikes (regulated under the Maritime Transport Act (1994) and the Wildlife Act (1953)).
- Survey vessel activity causing strikes on marine mammals (regulated under the Maritime Transport Act (1994) and the Marine Mammal Protection Act (1978)).Use of high energy seismic devices such as airguns
- Cable lowering or raising activities

The following activities were considered to be of moderate environmental risk (7-12) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Provision of biofouling surfaces
- Use of high resolution seismics e.g. Boomer, CHIRP

The following activities were considered to be of low environmental risk (0-6) and should be categorised as permitted:

- Single and multibeam echo sounding
- Seabed sampling
- Cable trenching and installation
- Exposed cable movement
- Declaration of cable route exclusion zone
- Cable abandonment

4.10.3 Avoidance, mitigation, remediation

There are often ways of avoiding, remedying or mitigating the effects of activities that would otherwise put marine species or ecosystems at risk. Below we briefly discuss those relevant to ocean basin telecommunications cabling.

Non-mandatory Department of Conservation guidelines (2006 and 2011) should be followed to avoid or mitigate acoustic impacts on marine mammals.

Avoidance or mitigation of seabird strikes is possible by limiting unnecessary use of vessel flood lights at night and ensuring that those that are required are directed approximately vertically onto work surfaces. Visual checks of the vessel super-structure at first light each day for the presence of dazed or injured birds and the provision of appropriate care may help to remedy this impact.

Avoidance or mitigation of vessels and underwater equipment acting as vectors for non-indigenous species is possible by appropriate checking, cleaning, and application of antifouling paints. We understand that Biosecurity New Zealand (MAF-BNZ) is developing an import health standard and legislation and relevant regulations may be put in place in next 2-3 years.

Pressure on fish stocks caused by the cable exclusion zone forcing fishing activities into the remainder of the quota management area can be reduced or eliminated by purchase and retirement of appropriate commercial fish quota for the duration of the production phase.

Table 4-10: Expert Panel Assessment: Ocean basin telecommunications cabling. Levels of consequence, likelihood, risk and confidence associated with this activity in the EEZ and ECS. Activities are listed (a, b, c, etc) after each threat to which they contribute. The maximum possible level of environmental risk is 30. Extreme environmental risks are highlighted in red, high in yellow, and moderate in green. Low risk activities are not highlighted. *Threats managed under the Maritime Transport Act (1994). NA = not applicable as species assessed are all protected.

Expert Panel Assessment: Ocean basin telecommunications cabling		Recovery period				Key species				Protected species				Ecosystem functional impact				Proportion of habitat affected			
Activity	**Threat**	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence
Cable route exploration a) Acoustic multibeam for mapping bathymetry, b) High resolution seismics for substrate characterization c) Air guns for fault mapping and deeper geological hazards d) Surface flood lights and noise e) Cable route seabed sampling f) Survey ship activities	*Ship strikes on marine mammals, fish, and reptiles (f)	3	6	18	2b	1	2	2	2b	2	2	4	1c	0	6	0	2b	0	6	0	2b
	Acoustic impact from multi-beams echo sounders on marine mammals, reptiles, fish and invertebrates (a)	0	5	0	2a	0	6	0	2a	1	5	0	2a	0	6	0	2a	0	6	0	2a
	Acoustic impact from high resolution seismics on marine mammals, reptiles, fish and invertebrates (b)	2	5	10	2a	0	5	0	2a	2	6	12	2a	0	6	0	2a	0	6	0	2a
	Acoustic impact from air guns on marine mammals, reptiles, fish and invertebrates (c)	3	6	18	2a	2	4	8	1c	3	6	18	2a	0	6	0	2a	0	6	0	2a
	*Seabird attraction, disturbance, collision (d)	1	6	6	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	0	6	0	2b
	Benthic disturbance (e)	0	5	0	2b	0	4	0	2b	NA	NA	NA	NA	0	6	0	2a	0	6	0	2a
Cable laying and maintenance g) Surface flood lights and noise h) Cable lowering/	*Seabird attraction, disturbance, collision (g)	1	6	6	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	0	6	0	2b
	Entanglement of megafauna (h, i)	3	6	18	2a	NA	NA	NA	NA	3	1	3	1c	0	1	0	1c	0	6	0	2b

raising i) Cable trenching and installation j) Underwater lights & noise from ROVs and submersibles k) Cable ship activities	Vector for non-indigenous species (k)	3	4	12	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b
	Underwater flood lights (j)	0	4	0	2a	0	4	0	2a	0	4	0	2a	0	4	0	2a	0	4	0	2a
	Underwater noise (j)	0	4	0	2a	0	4	0	2a	0	4	0	2a	0	4	0	2a	0	4	0	2a
	Impact on benthos (i)	2	5	10	2b	0	6	0	2b	NA	NA	NA	NA	0	1	0	1c	0	6	0	2b
Cable operation l) Cable spanning and suspensions m) Biofouling n) Cable movement o) Cable route exclusion zone	Entanglement of megafauna (l)	3	6	18	2a	NA	NA	NA	NA	3	1	3	2a	0	4	0	1c	0	6	0	2b
	Impact on benthos (n)	0	5	0	2b	0	6	0	2b	NA	NA	NA	NA	0	1	0	2b	0	6	0	2b
	Effects of spatial displacement of fishing on fish stocks (o)	0	6	0	2b	0	6	0	2b	NA	NA	NA	NA	0	6	0	2b	1	6	6	2b
Abandonment p) Cable loss and degradation	Entanglement of megafauna (p)	3	6	18	2a	NA	NA	NA	NA	3	1	3	2a	0	4	0	1c	0	6	0	2b
	Impact on benthos (p)	0	5	0	2b	0	6	0	2b	NA	NA	NA	NA	0	1	0	2b	0	6	0	2b

4.11 Offshore renewable marine energy extraction

4.11.1 Background

Offshore "renewable" marine energy extraction involves capturing the kinetic and/or potential energy in the waves, tides, marine winds and ocean stratification. In all instances the technology is still very much under development and there are no clearly established dominant designs or approaches. This means there is a good deal of uncertainty. We can say, however, that any development will be in the form of arrays of devices linked in some way as with terrestrial wind farms in New Zealand. Remote human communities might use one or two devices. The present prohibitive cost of cabling and good territorial sea resources means that developments >12 NM offshore are unlikely any time in the next decade. However, there are a number of unique approaches around that are specifically designed to work well in far-offshore conditions and such locations are being considered elsewhere, serving to improve the economics of the cabling.

4.11.2 Assessment

There are likely to be three phases to any offshore energy extraction industry; trials and construction, operation and decommissioning. Below we present the main results for each phase.

Initial trials and construction

Because the technology is new and unproven initial trials of one or two energy extraction units will almost certainly take place before a larger 'energy farm' is established. Whatever the technology used to extract the energy there is likely to be some sort of surface and sub-surface structure, mooring lines and seafloor anchors as well as a cable to carry electricity to shore. The structures, mooring lines and cables may pose an entanglement hazard to marine megafauna. Although the area impacted is likely to be a small part of the broader marine habitat these hazards pose a moderate risk (9) to protected marine mammals and affected populations would take years to recover (Table 4-11).

Although the area likely to be impacted by mooring blocks and anchors is very small, if the trials occur over deepwater reefs, they pose some risk to protected species such as corals, which if damaged or destroyed may take decades to fully recover (Table 4-11).

Ship strikes on marine mammals may occur during the trial and construction phases. These effects are covered under the Maritime Transport Act (1994) and the Marine Mammal Protection Act (1978).

Lights on ships at night typically attract and disturb seabirds and may cause them to collide with support vessels (Black 2005). These effects are covered under the Maritime Transport Act (1994) and the Wildlife Act (1953).

Full operational phase

Although this phase is likely to comprise a number of replicate energy capture units the area occupied is likely to remain a very small proportion of the total area available. Thus the risks of entanglement to marine mammals remain identical to that during the trail phase (see above).

Depending on their design the energy capture devices may generate underwater noise and will also produce electro-magnetic frequencies. One or both of these may affect marine mammals, reptiles, fish and invertebrates. However, the area affected will be small and the risks to various aspects of the ecosystem are likely to be negligible to minor (Table 4-11).

Large arrays of offshore wave energy extraction devices have the potential to reduce the wave energy reaching the coast. It is possible that the area affected may be <1-5% of a particular coastline inshore of the energy farm and the risks to the near shore ecosystem may be minor to moderate (Table 4-11).

Large arrays of energy capture units will require substantial mooring or anchoring systems. A seabed cable may also be required to bring generated electricity onshore. Alternatively generated energy may be stored in the form of hydrogen and shipped onshore. Although the affected area of benthic habitat is likely to be small, if the energy farm is situated over deepwater reefs they pose some risk to protected species such as corals, which if damaged or destroyed may take decades to fully recover (Table 4-11).

If energy capture units are floated from overseas there is the potential them to act as a vector for non-indigenous species to enter New Zealand waters. However, the likelihood is low for newly constructed units with fresh antifouling. The functional impact on deepwater ecosystems in the EEZ and ECS is probably negligible as vectored species are highly unlikely to survive independently of the energy capture units (Table 4-11). However, energy farms may act as stepping stones for non-indigenous species to invade shallow coastal habitats. We understand that Biosecurity New Zealand (MAF-BNZ) is developing an import health standard to cover such situations and legislation and relevant regulations may be put in place in next 2-3 years.

Off-shore energy farms may affect stocks of fished species. The farms will invariably have a zone of restricted access around them that prevents fishing activity. Unless commercial fish quota is purposefully bought by the energy company and retired for the duration of the energy farm operation then commercial fishing will be displaced into the remainder of the quota management area (QMA). The resulting fishing pressure has the potentail to affects some fish stocks, especially sedentary species with limited migrations. However, the area of a QMA affected is likely to be small (<1-5%) and we assessed there to be negligible risks to key fish stocks and ecosystem functioning (Table 4-11).

Abandonment/ decommissioning

Recovery of electricity cables, mooring blocks, chains and anchors may disturb benthic habitats. However, the area affected is likely to be very small and ecological risks minor. It is likely that affected patches of benthic habitat may take years to recover (Table 4-11).

Underwater noise generated during this phase may disturb marine mammals but the effects are likely to be minor and risks low (Table 4-11).

Risk summary for offshore renewable energy extraction

There were no activities associated with offshore renewable energy extraction that were considered to represent an extreme environmental risk provisionally indicating prohibited status.

The following activities were considered to be of high environmental risk (15-20) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Survey vessel activity causing strikes on marine mammals (regulated under the Maritime Transport Act (1994) and the Marine Mammal Protection Act (1978)).
- Surface flood lights at night causing bird strikes (regulated under the Maritime Transport Act (1994) and the Wildlife Act (1953)).
- Installation of surface and subsurface floats and structures
- Installation of mooring blocks
- Installation of energy capture device

The following activities were considered to be of moderate environmental risk (7-12) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Cable trenching and installation
- Import and provision of biofouling surfaces

The following activities were considered to be of low environmental risk (0-6) and should be categorised as permitted:

- Production of an electromagnetic field
- Declaration of an exclusion zone
- Recovery of plant and equipment
- Power cable abandonment
- Under water flood lights
- Incidental underwater noise

4.11.3 Avoidance, mitigation, remediation

There are often ways of avoiding, remedying or mitigating the effects of activities that would otherwise put marine species or ecosystems at risk. Below we briefly discuss those relevant to offshore renewable energy extraction.

Non-mandatory Department of Conservation guidelines (2006 and 2011) should be followed to avoid or mitigate acoustic impacts on marine mammals.

Risks of marine mammal entanglement or injury could be minimised by locating marine energy devices away from whale migration routes.

Avoidance or mitigation of seabird strikes is possible by limiting unnecessary use of vessel flood lights at night and ensuring that those that are required are directed approximately vertically onto work surfaces. Visual checks of the vessel super-structure at first light each day for the presence of dazed or injured birds and the provision of appropriate care may help to remedy this impact.

Avoidance or mitigation of vessels and underwater equipment acting as vectors for non-indigenous species is possible by appropriate checking, cleaning, and application of antifouling paints.

Pressure on fish stocks caused by an exclusion zone forcing fishing activities into the remainder of the quota management area can be reduced or eliminated by purchase and retirement of appropriate commercial fish quota for the duration of the production phase.

Table 4-11: Expert Panel Assessment: Offshore renewable energy extraction. Levels of consequence, likelihood, risk and confidence associated with this activity in the EEZ and ECS. Activities are listed (a, b, c, etc) after each threat to which they contribute. The maximum possible level of environmental risk is 30. Extreme environmental risks are highlighted in red, high in yellow, and moderate in green. Low risk activities are not highlighted. *Threats managed under the Maritime Transport Act (1994). NA = not applicable as species assessed are all protected.

Expert Panel Assessment: Offshore renewable energy		Recovery period				Key species				Protected species				Ecosystem functional impact				Proportion of habitat affected			
Activity	**Threat**	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence
Initial trial and construction phase a) Surface flood lights and noise b) Surface floats and structures c) Subsurface structures d) Mooring blocks e) Support vessel activities	*Seabird attraction, disturbance, collision (a)	1	6	6	2b	NA	NA	NA	NA	2	5	10	2b	0	6	0	2b	0	6	0	2b
	Entanglement of megafauna (b, c)	3	6	18	2a	NA	NA	NA	NA	3	3	9	2b	0	6	0	2b	0	6	0	2b
	Impact on benthos (d)	3	6	18	2a	1	6	6	2a	1	6	6	2a	0	6	0	2a	0	6	0	2a
	*Ship strikes on marine mammals, fish, and reptiles (e)	3	6	18	2b	1	2	2	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b
Full operational phase f) Surface flood lights and noise g) Surface floats/structures h) Subsurface structures including energy capture devices i) Underwater lights and noise from ROV and energy plant j) Cable laying and maintenance k) Electromagnetic field l) Mooring blocks m) Maintenance n) Support vessel activity o) Declaration of exclusion zone	*Seabird attraction, disturbance, collision (f)	1	6	6	2b	NA	NA	NA	NA	4	5	20	2b	0	6	0	2b	0	6	0	2b
	Marine mammal entanglement or collision with energy capture device (g, h, j)	3	6	18	2a	NA	NA	NA	NA	3	3	9	2b	0	6	0	2b	0	6	0	2b
	Nearshore impact of altered wave climate (g, h)	2	4	8	2a	2	4	8	1c	1	2	2	1c	2	4	8	1c	1	4	4	2a
	Acoustic/EMF impact on marine mammals, reptiles, fish and invertebrates (j, k)	1	6	6	2a	0	6	0	1c	1	6	6	2a	0	6	0	2a	0	6	0	2a
	Disturbance of benthic fauna (j, l)	2	6	12	2a	1	6	6	2a	1	6	6	2a	0	6	0	2a	0	6	0	2a
	Vector for non-indigenous species (g, h)	3	4	12	2b	1	4	4	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b
	Displacement of fisheries affecting fish stocks (o)	1	4	4	2b	0	4	0	2b	NA	NA	NA	NA	0	4	0	2b	1	4	4	2b
	*Ship strikes on marine mammals, fish, and reptiles from support vessels (n)	3	6	18	2b	1	2	2	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b

Abandonment/ decommissioning p) Surface flood lights and noise q) Recovery of all equipment, plant & machinery r) Underwater lights and noise s) Mooring blocks t) Support vessel activity u) Abandonment of power cable	*Ship strikes on marine mammals, fish, and reptiles from support vessels (t)	3	6	18	2b	1	2	2	2b	3	3	9	2a	0	6	0	2b	0	6	0	2b
	*Seabird attraction, disturbance, collision (p)	1	6	6	2b	NA	NA	NA	NA	1	6	6	2b	0	6	0	2b	0	6	0	2b
	Marine mammal disturbance (q, r)	1	4	4	1c	NA	NA	NA	NA	1	6	6	2b	0	6	0	2b	0	6	0	2b
	Impact on benthos (s)	3	6	18	2a	1	6	6	2a	1	6	6	2a	0	6	0	2a	0	6	0	2a

4.12 Offshore Aquaculture

4.12.1 Background

In recent years the New Zealand aquaculture industry has expressed an interest in developing shellfish production units at more exposed offshore sites. Several offshore marine farm areas have been identified, mainly off the east coast of both the North and South Islands. Although these farms are within the 12 mile limit they represent a move to marine farming in more exposed locations. To date none of these farms have progressed beyond 'experimental' status and it looks unlikely that commercial operations will be established in the near future.

A number of countries are currently considering the potential for offshore production of both fish and shellfish (e.g. James and Slaski 2007). In most cases this represents a move to more exposed locations, rather than movement offshore by any significant distance. Almost universally the drive for offshore development is a result of limitations in the available inshore, or 'sheltered water' space available for the aquaculture industry to expand into (James and Slaski 2007).

Whilst legislative barriers to offshore developments may be lower than for inshore aquaculture, and the potential biological impacts are likely to be significantly diluted, there are technical and biological hurdles to overcome before the aquaculture industry can move to more exposed locations. These hurdles include the necessity for developing more robust systems to withstand exposed wave environments and developing systems that can remotely attend to feeding and veterinary care for the stock during periods of bad weather when farmers cannot access the site.

Designers of aquaculture systems for exposed areas tend to focus on submerged culture systems that are not therefore exposed to the high energy wave environments at the surface. For shellfish farms, the reduced density of planktonic feed offshore indicates that farms will be stocked at a lower density and therefore have a much larger footprint than inshore farms. Submerged systems that cover a large area are unlikely to represent a navigational hazard, but may interfere with fishing activities. From a biological standpoint such structures may act as artificial reefs offering potential benefits in terms of fish and invertebrate communities, but also potentially interrupting inshore migrations of some species.

Meeting the technological challenges associated with aquaculture in exposed areas inevitably increases the cost of production and risks associated with the development. Given the existing price structure for New Zealand shellfish products and the existing level of technical sophistication of the finfish farming industry, it currently looks unlikely that there will be significant development of the existing inshore exposed sites in the short to medium term and it therefore would appear unlikely that significant offshore aquaculture developments would occur in the next 20 to 30 years.

4.12.2 Assessment

There are likely to be three phases to any offshore energy extraction industry; trials and construction, full operation, and decommissioning. Below we present the main results for each phase.

Initial trials and construction

Because the technology is new and unproven initial trials of one or two production units will almost certainly take place before a larger farm is established. Farm structures and mooring lines may pose an entanglement hazard to marine megafauna. Although the area impacted is likely to be a small part of the broader marine habitat these hazards pose a moderate risk (9) to protected marine mammals and affected populations would take years to recover (Table 4-12). These risks could be minimised by locating offshore aquaculture farms away from whale migration routes or feeding grounds.

Although the area likely to be impacted by mooring blocks and anchors is very small, if the trials occur over deepwater reefs, they pose some risk to protected species such as corals, which if damaged or destroyed may take decades to fully recover (Table 4-12).

Ship strikes on marine mammals may occur during the trial and construction phases. These effects are covered under the Maritime Transport Act (1994) and the Marine Mammal Protection Act (1978).

Lights on ships at night typically attract and disturb seabirds and may cause them to collide with support vessels (Black 2005). These effects are covered under the Maritime Transport Act (1994) and the Wildlife Act (1953).

Full operational phase

Although this phase is likely to comprise a number of replicate production units on a single aquaculture enterprise the area occupied is likely to remain a very small proportion of the total area available. Thus the risks of entanglement to marine mammals remain identical to that during the trail phase (see above).

Large arrays of aquaculture production units will require substantial mooring or anchoring systems. Although the affected area of benthic habitat is likely to be a small proportion of the total available, if the energy farm is situated over deepwater reefs they pose some risk to protected species such as corals, which if damaged or destroyed may take decades to fully recover. The benthic fauna will also be affected by shell drop from cultured mussels and other shellfish and more severely by food waste, and faces particularly from farmed fish. (Table 4-12).

Aquaculture farms have the potential to affect water column productivity. Productivity may be enhanced downstream of fish farms because of nutrients from waste food and fish waste products. In contrast, productivity may be depleted downstream of shellfish farms because of filter feeding. As long as the area affected is a very small fraction of the total surface waters the ecological risks are likely to be negligible (Table 4-12).

If aquaculture production units are floated from overseas there is the potential them to act as a vector for non-indigenous species to enter New Zealand waters. However, it is more likely that units would be constructed in New Zealand. The functional impact on deepwater ecosystems in the EEZ and ECS is probably negligible as any vectored species are highly unlikely to survive independently of the aquaculture facilities (Table 4-12). However, offshore aquaculture farms may act as stepping stones for non-indigenous species to invade shallow coastal habitats. We understand that Biosecurity New Zealand (MAF-BNZ) is developing an import health standard to cover such situations and legislation and relevant regulations may be put in place in next 2-3 years.

Off-shore aquaculture has the potential to affect stocks of fished species. Farm structures may provide a new artificial reef-like surfaces and increase reef habitat in the area for reef associated fishes. The farms will invariably have a zone of restricted access around them that prevents fishing activity. Unless commercial fish quota is purposefully bought by the aquaculture company and retired for the duration of farming then commercial fishing will be displaced into the remainder of the quota management area (QMA). The resulting fishing pressure has the potentail to affects some fish stocks, especially sedentary species with limited migrations. However, the area of a QMA affected is likely to be small (<1-5%) and we assessed there to be negligible risks to key fish stocks and ecosystem functioning (Table 4-12).

Offshore aquaculture also has the potential to affect wild stocks of the same species by acting as a reservoir for disease and genetic pollution. Inshore farms of the same species pose the same potential problem. We assessed the risks to be minor if the species cultured was from the same stock area as the farm and therefore is unlikely to introduce new disease organisms or genes.

Abandonment/ decommissioning

Recovery of mooring blocks, chains and anchors may disturb benthic habitats. However, the area affected is likely to be very small and ecological risks minor. It is likely that affected patches of benthic habitat may take years to recover (Table 4-12).

Underwater noise generated during this phase may disturb marine mammals but the effects are likely to be minor and risks low (Table 4-12).

Risk summary for offshore aquaculture

There were no activities associated with offshore aquaculture that were considered to represent an extreme environmental risk provisionally indicating prohibited status.

The following activities were considered to be of high environmental risk (15-20) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Installation of surface and subsurface floats and structures

The following activities were considered to be of moderate environmental risk (7-12) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Surface flood lights at night causing bird strikes (regulated under the Maritime Transport Act (1994) and the Wildlife Act (1953))
- Installation of mooring blocks
- Seafloor deposition of organic waste

The following activities were considered to be of low environmental risk (0-6) and should be categorised as permitted:

- Multibeam echo-sounder survey of seabed

- Water column nutrient enrichment
- Water column production depletion
- High concentration of cultured species
- Recovery of all, equipment, plant and machinery
- Underwater lights and noise
- Declaration of exclusion zone

4.12.3 Avoidance, mitigation, remediation

There are often ways of avoiding, remedying or mitigating the effects of activities that would otherwise put marine species or ecosystems at risk. Below we briefly discuss those relevant to offshore aquaculture.

Avoidance or mitigation of seabird strikes is possible by limiting unnecessary use of vessel flood lights at night and ensuring that those that are required are directed approximately vertically onto work surfaces. Visual checks of the vessel super-structure at first light each day for the presence of dazed or injured birds and the provision of appropriate care may help to remedy this impact.

Avoidance or mitigation of vessels and underwater equipment acting as vectors for non-indigenous species is possible by appropriate checking, cleaning, and application of antifouling paints.

Pressure on fish stocks caused by the exclusion zone forcing fishing activities into the remainder of the quota management area can be reduced or eliminated by purchase and retirement of appropriate commercial fish quota for the duration of the production phase.

Table 4-12: Expert Panel Assessment: Offshore aquaculture. Levels of consequence, likelihood, risk and confidence associated with this activity in the EEZ and ECS. Activities are listed (a, b, c, etc) after each threat to which they contribute. The maximum possible level of environmental risk is 30. Extreme environmental risks are highlighted in red, high in yellow, and moderate in green. Low risk activities are not highlighted. *Threats managed under the Maritime Transport Act (1994). NA = not applicable as species assessed are all protected.

Expert Panel Assessment: Offshore aquaculture		Recovery period				Key species				Protected species				Ecosystem functional impact				Proportion of habitat affected			
Activity	**Threat**	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence
Construction and initial trial phase a) Surface flood lights and noise b) Surface floats & structures c) Subsurface structures d) Mooring blocks e) Lost or broken gear, nets, cages f) Multibeam acoustic survey of seabed	*Seabird attraction, disturbance, collision (a)	1	6	6	2b	NA	NA	NA	NA	2	5	10	2b	0	6	0	2b	0	6	0	2b
	Marine mammal entanglement (b, c, e)	3	5	15	2b	1	3	3	2b	3	3	9	2b	0	6	0	2b	0	6	0	2b
	Impact on benthos (d, e)	0	4	0	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b
	Acoustic impact from multibeam echo sounders on marine mammals, reptiles, fish and invertebrates (f)	1	4	4	2b	0	6	0	2b	1	5	5	2a	0	6	0	2a	0	6	0	2a
Full operational phase g) Surface flood lights and noise h) Surface floats/structures i) Subsurface structures j) Mooring blocks k) Harvesting operations l) Sea floor deposition of organic waste m) Biofouling n) Water column enrichment o) Maintenance p) Lost or broken gear, nets, cages q) Water column depletion by filter feeders (e.g. mussels) r) High concentration of	*Seabird attraction, disturbance, collision (g)	1	6	6	2b	NA	NA	NA	NA	2	5	10	2b	0	6	0	2b	0	6	0	2b
	Marine mammal entanglement (h, i, p)	3	5	15	2b	1	3	3	2b	3	3	9	2b	0	6	0	2b	0	6	0	2b
	Impact on benthos (j, l, p)	2	4	8	2b	1	4	4	2b	0	4	0	2b	1	4	4	2b	0	4	0	2b
	Impact on water column productivity (n, q)	0	4	0	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b
	Vector for non-indigenous species (h, i)	1	4	4	2b	1	4	4	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b
	Impact on fished species (l, n, p)	1	4	4	2b	0	4	0	2b	NA	NA	NA	NA	0	4	0	2b	0	4	0	2b
	Displacement of fisheries affecting fish stocks (s)	1	4	4	2b	0	4	0	2b	NA	NA	NA	NA	0	4	0	2b	1	4	4	2b

cultured species s) Declaration of exclusion zone	Effects on wild stocks due to disease and genetic pollution (r)	1	4	4	1c	1	4	4	1c	NA	NA	NA	NA	1	4	4	1c	0	4	0	2b
Abandonment/ decommissioning t) Surface flood lights and noise u) Recovery of all equipment, plant & machinery v) Underwater lights and noise w) Mooring blocks	Seabird attraction, disturbance, collision (t)	0	5	0	2b	1	3	3	2b	2	5	10	2b	0	6	0	2b	0	6	0	2b
	Marine mammal disturbance (u, v)	1	4	4	1c	NA	NA	NA	NA	1	6	6	2b	0	6	0	2b	0	6	0	2b
	Underwater flood lights	0	4	0	2a	0	4	0	2a	0	4	0	2a	0	4	0	2a	0	4	0	2a
	Impact on benthos (w)	0	4	0	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b	0	4	0	2b

4.13 Offshore ecotourism

4.13.1 Background

Ecotourism is a growing industry in the nearshore waters around New Zealand and is already starting to expand into the EEZ and ECS. Tourist ships regularly traverse offshore areas usually in transit to the sub-Antarctic Islands and the Ross Sea but surface wildlife (marine mammals and seabirds) fortuitously encountered on-route is part of the experience. More deliberate experiences are becoming more common as tourists seek close surface and underwater encounters with megafauna or densely shoaling smaller species. The line between charter fishing and tourism is now very blurred as 'chumming' is common to attract pelagic sharks and game-fish near the charter vessel, not for capture, but for the experience of viewing large pelagic predators either from the safety of the boat, an underwater cage or remotely via a towed camera. There is also a trend for charter boats to carry camera systems or remotely operated vehicles (ROVs) capable of encountering and viewing spectacular underwater scenery in the deep ocean. These trends are likely to increase over the next 20-30 years.

4.13.2 Assessment

We divided this growing industry into three components in order to assess their ecological impacts and risks; surface wildlife watching, underwater sea life watching via imaging systems or submersibles, and in situ sea-life encounters. Below we examine the main results of our assessment (Table 4-13).

Surface sea-life watching

Whale watching, dolphin watching and seabird spotting from a surface vessel are all part of this activity. The major impact is potentially on the modification of marine mammal behaviour, either by attracting mammals to the boat to bow wave for example, or by interfering with normal patterns of foraging, reproduction or resting. Numerous studies have indentified risks to inshore species (e.g. Constantine 2001, Constantine et al. 2004) but the risks to offshore deepwater species are less certain. In our assessment we assumed that the species affected was a nationally critical species as they occur throughout the EEZ. The area impacted will be small but tourist operators are likely to target areas with known concentrations at particular times of year. We assessed the risks to be low to moderate with recovery of normal behaviour likely to take months if the activity stopped (Table 4-13).

Ship strikes on marine mammals may occur during ecotourism activities. These effects are covered under the Maritime Transport Act (1994) and the Marine Mammal Protection Act (1978).

Lights on ecotourism ships at night typically attract and disturb seabirds and may cause them to collide with the vessel (Black 2005). These effects are covered under the Maritime Transport Act (1994) and the Wildlife Act (1953).

Remote underwater sea life watching

Underwater suspended or towed camera systems, ROVs and submersibles all have the capacity to disturb subsurface sea-life. This will particularly be the case if strong lights are used to illuminate the scene at night or in deeper water. The area of offshore waters likely to be affected at any one time is very small and the ecological risks negligible to minor (Table 4-

13). However, at particular localities if very regularly visited then risks will be increase correspondingly.

Seabed communities could be physically disturbed or impacted by camera systems, ROVs or submersibles through accidental collisions. The area of benthic habitat likely to be affected at any one time is very small and the ecological risks assessed as negligible to minor. However, at particular localities if very regularly visited then the risks will be increase correspondingly.. Recovery of impacted habitat patches may be slow, however, as many deepwater species grow slowly (Table 4-13).

In situ sea-life encounters

Dolphin swimming, whale swimming, shark encounters etc are all part of this group of activities and have the capacity to disturb surface and shallow subsurface species. For example, at Stewart Island the locals think the shark tourism is altering where the sharks are commonly found – this could have profound impacts if this area coincides with a conflicting mammal usage (Jenny Beaumont - personal comment). However, the area of habitat likely to be affected at any one time is very small and the risk to ecosystem functioning is probably negligible. However the risks to individual protected species and key species may be higher and affected individuals or populations may take months to recover (Table 4-13).

Risk summary for offshore ecotourism

There were no activities associated with offshore ecotourism that were considered to represent an extreme environmental risk and should be prohibited.

The following activities were considered to be of high environmental risk (15-20) and should be categorised as discretionary:

- Tourist vessel activity impacting marine mammals (regulated under the Maritime Transport Act (1994) and the Marine Mammal Protection Act (1978)).
- Surface flood lights at night causing bird strikes (regulated under the Maritime Transport Act (1994) and the Wildlife Act (1953)).

The following activities were considered to be of moderate environmental risk (7-12) and should be categorised as discretionary:

- Surface activity and noise
- Subsurface activity

The following activities were considered to be of low environmental risk (0-6) and should be categorised as permitted:

- Operations near the seafloor likely to result in collisions with benthic fauna
- Subsurface lights and noise generated by camera systems, ROVs and submersibles

4.13.3 Avoidance, mitigation, remediation

There are often ways of avoiding, remedying or mitigating the effects of activities that would otherwise put marine species or ecosystems at risk. Below we briefly discuss those relevant to offshore ecotourism.

Department of Conservation guidelines should be followed to avoid or mitigate the effects of tourist boat operations, *in situ* observation gear and human activity in the water on the behaviour of marine mammals and other protected species (e.g. great while sharks).

Avoidance or mitigation of seabird strikes is possible by limiting unnecessary use of vessel flood lights at night and ensuring that those that are required are directed approximately vertically onto work surfaces. Visual checks of the vessel super-structure at first light each day for the presence of dazed or injured birds and the provision of appropriate care may help to remedy this impact.

Impacts on vulnerable benthic species can be minimised by rotating visits around a number of sites. The appropriate rotation interval should be guided by the likely recovery time of the species concerned.

Table 4-13: Expert Panel Assessment: Offshore ecotourism. Levels of consequence, likelihood, risk and confidence associated with this activity in the EEZ and ECS. Activities are listed (a, b, c, etc) after each threat to which they contribute. The maximum possible level of environmental risk is 30. Extreme environmental risks are highlighted in red, high in yellow, and moderate in green. Low risk activities are not highlighted. *Threats managed under the Maritime Transport Act (1994). NA = not applicable as species assessed are all protected.

Expert Panel Assessment: Offshore Ecotourism		Recovery period				Key species				Protected species				Ecosystem functional impact				Proportion of habitat affected			
Activity	**Threat**	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence
Surface sea-life watching a) Surface flood lights and noise from ship activities b) Ship movements	*Seabird attraction, disturbance, collision (a)	1	6	6	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	0	6	0	2b
	Effects on behaviour of marine mammals (a, b)	1	4	4	2b	NA	NA	NA	NA	1	6	6	2a	0	4	0	2b	0	4	0	2b
	*Ship strikes on marine mammals, fish, and reptiles (b)	3	6	18	2a	1	2	2	2b	2	3	6	2a	0	6	0	2b	0	6	0	2b
Underwater sea-life watching via remote sensing c) Subsurface flood lights and noise at depths including benthic imaging and exploration using ROVs and submersibles d) Accidental collisions with sea floor	Sub-surface sea life disturbance (c)	1	4	4	2b	1	4	4	2b	0	4	0	2b	0	4	0	1c	0	4	0	2b
	Physical impact on benthos (d)	4	1	4	2a	1	6	6	2a	0	6	0	2a	0	6	0	2a	0	4	0	2b
In situ sea-life encounters e) Surface activity and noise f) Subsurface activity	Surface sea life disturbance (e)	1	4	4	2b	1	4	4	2b	2	6	12	2a	0	4	0	1c	0	4	0	2b
	Sub-surface sea life disturbance (f)	1	4	4	2b	1	4	4	2b	2	6	12	2a	0	4	0	1c	0	4	0	2b

4.14 Scientific Exploration and Sampling

4.14.1 Background

Over large parts of the EEZ and ECS science activities may be the only human activity. Commercial bottom trawling is largely restricted to depths less than 1500 m, fishing for pelagic species is centred on feeding areas or migration routes and seafloor mining of minerals will be on specific ore bearing areas. Oil exploration and production will be restricted to favourable sedimentary basins. This leaves vast areas of the EEZ likely to be largely unvisited except for research purposes. Note that captures or sampling of marine organisms for scientific purposes are covered by MFish Special Permit conditions and capture and tagging are covered by the Fisheries Acts (1993 and 1996), the Marine Mammal Protection Act (1978) or by the Wildlife Act (1953).

4.14.2 Assessment

Scientific exploration and sampling can be grouped into four distinct activities:

- underway sampling,
- water column sampling and instrumentation,
- seafloor exploration, sampling and instrumentation, and
- loss or abandonment of scientific equipment.

Below we assess the ecological consequences and risks of each group of activities (Table 4-14).

Underway sampling

This includes a variety of sampling methods made form a research vessel while underway (Table 4-14). Various threats arise from these activities.

Acoustic swath mapping may be used to define the bathymetry and high resolution seismic reflection techniques (e.g. Boomer, CHIRP) may be used to define the sub-seafloor geological strata. Use of air guns to obtain deeper seismic information may occur. The acoustic impact of seismic surveys on marine mammals, in particular, is well documented (Gordon & Moscrop 1996, Cox et al. 2006, Brandon et al. 2008, Di Iorio and Clark 2010), but may also affect a range of marine reptiles, fish and invertebrates. The consequences for marine mammals from the seismic gear likely to be used for these surveys will vary from none to behavioural (may leave area) perhaps to acute injury (ear drum damage), to death depending on noise level encountered, species and habitat. Beaked whales are thought to be particularly at risk. There may also be cumulative effects from repeated exposure.

Noise travels great distances underwater and so the footprint of this activity may be very broad although the greatest impacts will be much more restricted in area as sound intensity typically falls as the square of the distance from the source. Using a precautionary approach our assessment assumed that the species affected was a nationally critical species, such as southern right whales, as these may occur throughout the EEZ though they occupy different areas at different times of the year. The risk from this activity if seismic air guns were used was assessed to reach a score of 18 with a high level of confidence (Table 4-14) indicating the need for this to be a discretionary activity.

Fur seals and sea lions may be attracted to the seismic streamer during deployment and retrieval and could become entangled and injured or drown. The number of individuals affected is likely to be small given the one-off nature of a seismic survey and impacts will be largely restricted to locations where deployment and retrieval takes place at slow speeds. Using a precautionary approach our assessment assumed that the species affected was the New Zealand sea lion although few occur north of about 45^{o} S. The risk from this activity was assessed to reach a score of 3, but with a low level of confidence (Table 4-14) because few data exist about this effect. Populations are unlikely to be affected and ecosystem effects will be negligible.

It is possible that megafauna could become entangled in some of the other sampling gear towed behind research vessels. Although the area impacted is likely to be a small part of the broader marine habitat and these hazards pose only a low risk (3) to protected marine mammals, affected populations would take years to recover (Table 4-14).

Lights on survey ships at night typically attract and disturb seabirds and may cause them to collide with the ship (Black 2005). These effects are covered under the Maritime Transport Act (1994) and the Wildlife Act (1953).

Ship strikes on marine mammals, fish, and reptiles may occur during the survey and during transits to and from the survey area. These effects are covered under the Maritime Transport Act (1994) and the Marine Mammal Protection Act (1978).

Water column sampling and instrumentation

This includes a wide range of sampling methods giving rise to a number of potential threats (Table 4-14).

It is possible that megafauna could become entangled in the moorings used to suspend instruments in the water column. Although the area impacted is likely to be a very small part of the broader marine habitat and these hazards pose only a low risk (3) to protected marine mammals, affected populations would take years to recover (Table 4-14).

The location of moored arrays is always provided to fishermen and other mariners via Notices to Mariners warning that a navigational hazard is located at a certain point. In depths less than 1500 m this has the potential to displace fishing activity into the remainder of a quota management area (QMA). The resulting fishing pressure has the potentail to affects some fish stocks, especially sedentary species with limited migrations. However, the area of a QMA affected is likely to be small (<1-5%) and we assessed there to be negligible risks to key fish stocks and ecosystem functioning (Table 4-14).

Large scale experiments, such as iron fertilisation experiments, have the potential, indeed the purpose, of severely altering the abundance and composition of plankton communities in the upper ocean (de Baar et al. 2005). However, the area of the EEZ affected by such experiments is very small though measurable, perhaps <1-5%, and once the experiment is over (days to weeks) the pelagic ecosystem recovers to normal levels of productivity and species composition in a matter of weeks or months.

Chemical tracers, such as SF6, are used to track manipulated bodies of water and though these tracers have no known ecological impact there may be some social and cultural concerns with this practice.

Seafloor exploration, sampling and instrumentation

Physical disturbance of the benthos by commercial bottom trawling and dredging is well described (Dayton et al. 1995, Hall 1999, Kaiser et al. 2002, Millennium Ecosystem Assessment, 2005a & b, Dulvy et al. 2006, Myers et al. 2007, Donaldson et al. 2010, Williams et al. 2010) and research bottom trawling has similar effects though the spatial scale of impact is much less. However, over a 20-30 year horizon perhaps <<1% of the EEZ and ECS may be impacted in this way and there may be measurable ecosystem consequences, and some minor impacts on protected species, such as deep-sea corals, and on key species. It is important to note that the level of impact does depend upon the particular habitat and the size of the gear in proportion of these habitats. As some of the very deepwater species may be very slow growing, affected habitat patches may take decades to fully recover (Table 4-14). Effects of fishing in the EEZ are managed under the Fisheries Act (1996).

Small scale physical disturbance of the benthos is likely by a wide range of other scientific equipment including bottom sampling gear, by mooring blocks for instrument arrays, and by unintended impacts by ROVs, submersibles and towed camera systems. The areas affected are likely to be a small proportion of available habitats and the ecological consequences and risks minor (Table 4-14).

Other disturbance to deepwater seafloor habitats and species may occur because of underwater lights and noise from some of the instruments or sampling tools. The areas affected are likely to be a small proportion of available habitats and the ecological consequences and risks minor (Table 4-14).

Lost or abandoned scientific sampling equipment and instruments

Deepwater instrument moorings typically use steel (often old rail-wagon wheels) as the mooring block and typically these are left behind when the mooring instruments are acoustically released during the recovery process. Eventually these steel moorings rust and disintergrate but this may take decades. However each mooring block is comparatively small and the risks to the benthic community low.

Lost sampling gear may pose an ecological risk especially if it carries electronic equipment including batteries. Underwater housings, although routinely made of aluminium or stainless steel, will eventually corrode and leak contents into the surrounding ecosystem. However, such losses are infrequent, affecting only a tiny fraction of the EEZ and ECS and thus the overall ecological consequences and risks are low. However, affected patches of habitat may take years to decades to fully recover (Table 4-14).

Lost sampling gear may impact small areas of the benthos and associated benthic and bottom associated fauna. The ecological consequences negligible or minor and equipment losses are rare thus the risks are low (Table 4-14).

Risk summary for scientific exploration and sampling

No activities associated with scientific exploration and sampling were considered to represent an extreme environmental risk and provisionally indicating prohibited status.

The following activities were considered to be of high environmental risk (15-20) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Surface flood lights at night causing bird strikes (regulated under the Maritime Transport Act (1994) and the Wildlife Act (1953)).
- Use of air gun seismic devices
- Vessel activity impacting marine mammals (regulated under the Maritime Transport Act (1994) and the Marine Mammal Protection Act (1978)).
- Towed instrument arrays in core areas for nationally critical species
- Moored instrument arrays in core areas for nationally critical species
- Research bottom trawling and dredging.

The following activities were considered to be of moderate environmental risk (7-12) and may need to be categorised as discretionary unless conditions can be successfully applied to mitigate the risk:

- Use of high resolution seismics e.g. Boomer, CHIRP
- Large scale ocean productivity perturbation experiments

The following activities were considered to be of low environmental risk (0-6) and should be categorised as permitted:

- Single and multibeam echo sounding
- Displacement of fishing activities
- Use of small scale benthic sampling devices but as impact is habitat dependent standard regulations should be developed that prescribe the proportion of vulnerable habitats (e.g, vent and seep communities) that can be sampled within a period.
- Use of ROVs, submersibles, AUVs, Argo floats, underwater gliders and suspended imaging devices etc
- Use of electronic instrument systems

4.14.3 Avoidance, mitigation, remediation

There are often ways of avoiding, remedying or mitigating the effects of activities that would otherwise put marine species or ecosystems at risk. Below we briefly discuss those relevant to scientific exploration and sampling.

Non-mandatory Department of Conservation guidelines (2006 and 2011) should be followed to avoid or mitigate acoustic impacts on marine mammals.

Avoidance or mitigation of seabird strikes is possible by limiting unnecessary use of vessel flood lights at night and ensuring that those that are required are directed approximately vertically onto work surfaces. Visual checks of the vessel super-structure at first light each day for the presence of dazed or injured birds and the provision of appropriate care may help to remedy this impact.

Avoidance or mitigation of vessels and underwater equipment acting as vectors for non-indigenous species is possible by appropriate checking, cleaning, and application of antifouling paints.

Table 4-14: Expert Panel Assessment: Scientific exploration and sampling. Levels of consequence, likelihood, risk and confidence associated with this activity in the EEZ and ECS. Activities are listed (a, b, c, etc) after each threat to which they contribute. The maximum possible level of environmental risk is 30. Extreme environmental risks are highlighted in red, high in yellow, and moderate in green. Low risk activities are not highlighted. *Threats managed under the Maritime Transport Act (1994). NA = not applicable as species assessed are all protected.

Expert Panel Assessment: Scientific exploration and sampling		Recovery period				Key species				Protected species				Ecosystem functional impact				Proportion of habitat affected			
Activity	**Threat**	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence
Underway sampling a) Surface flood lights and noise b) Single and multi beam echo sounder operation c) High resolution seismics (e.g. CHIRP, boomer) for substrate characterization d) Air gun & streamers e) Sea floor explosives f) Towed instrumentation including magnetometers, gravity meters, CPRs, nets, CTDs, etc. g) Ship movements	*Seabird attraction, disturbance, collision (a)	1	6	6	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	1	6	6	2b
	Acoustic impact from multi-beam echo sounders on marine mammals, reptiles, fish and invertebrates (b)	0	5	0	2a	0	6	0	2a	1	5	0	2a	0	6	0	2a	0	6	0	2a
	Acoustic impact from high resolution seismics on marine mammals, reptiles, fish and invertebrates (c)	2	5	10	2a	0	5	0	2a	2	6	12	2a	0	6	0	2a	0	6	0	2a
	Acoustic impact of air guns and seafloor explosives on marine mammals, reptiles, fish and invertebrates (d)	3	6	18	2a	3	6	18	1c	3	6	18	2a	0	6	0	2a	3	6	18	2a
	Fur seal and sea lion attraction during streamer deployment and retrieval (d)	0	6	0	2b	0	2	0	1c	1	3	3	1c	0	6	0	2b	0	6	0	2b
	*Ship strikes on marine mammals, fish, and reptiles (g)	3	6	18	2a	2	2	4	2b	2	2	4	1c	0	6	0	2b	0	6	0	2b
	Entanglement of megafauna (f)	3	6	18	2a	1	3	3	2b	1	3	3	2b	0	6	0	2b	0	6	0	2b
Water column sampling and instrumentation h) Moored arrays, buoys i) Argo floats/gliders, AUV j) Ship based stationary sampling k) Perturbation	Entanglement of megafauna (h)	3	5	15	2a	1	3	3	2b	1	3	3	2b	0	6	0	2b	0	6	0	2b
	Displacement of fishing activity at depths less than 1500m (h, i, j, k)	0	6	0	2b	0	5	0	2b	0	5	0	2b	0	5	0	2b	0	5	0	2b

experiments e.g. ocean fertilization experiment l) Chemical tracers e.g. SF6	Potential change in species composition and abundance (k)	1	6	6	2a	2	5	10	2b	1	4	4	1c	3	5	15	2a	1	5	5	2a
Seafloor exploration, sampling and instrumentation m) Moored arrays/buoys n) Argo floats/gliders, AUV o) ROVs, submersibles, towed imaging systems, causing underwater lights and noise p) Research bottom trawling and dredging q) Sea floor sampling via sleds, box cores, multi-cores, piston cores or directed sampling from ROVs or submersibles and unanticipated benthic impact of other sampling gear r) Research drilling s) Cabled offshore observatory	Benthic impacts of research bottom trawling and dredging (p)	3	6	18	2a	1	6	6	2a	1	6	6	2a	2	6	12	2a	1	6	6	2a
	Benthic impacts of sampling via sleds, coring devices, drilling etc (n, o, q, r, s)	1	6	6	2a	0	5	0	2a	0	5	0	2a	0	5	0	2a	0	5	0	2a
	Disturbance to benthic and demersal fauna due to underwater lights and noise (o, q, r)	1	4	4	2b	1	4	4	2b	1	4	4	2b	1	4	4	1c	1	4	4	2b
Lost scientific equipment t) Lost electronic instruments, ROVs, AUVs, camera platforms etc u) Lost research nets and other sampling gear	Potential chemical pollution from electronics, sensors etc. (t)	3	2	6	1c	1	2	2	1c	0	2	0	2b	1	2	2	1c	0	5	0	2b
	Impacts on demersal and benthic fauna (u)	0	1	0	1b	1	1	1	1b	1	1	1	1b	0	1	0	2b	0	1	0	2a

5 Summary and Conclusions

In order to support the regulations being developed for the new Exclusive Economic Zone and Extended Continental Shelf (Environmental Effects) Bill, NIWA was engaged by MfE to undertake a study that makes recommendations as to how activities in the Exclusive Economic Zone (EEZ) and Extended Continental Shelf (ECS) might be classified, based on levels of environmental risk.

In this study we adopted an Ecological Risk Assessment Framework and carried out a "Level 1" assessment in line with accepted New Zealand and Australian risk assessment standards. For this an expert Ecological Risk Assessment (ERA) Panel was convened that assessed the environmental consequences and likelihoods of activities that comprise 1present or potential marine industries as well as scientific exploration and sampling.

Scores were given to the potential consequence (6 levels from negligible to catastrophic) and to the likelihood of that consequence (remote to likely) using a set of standard tables that described each level, for a range of activities. Risk was then calculated as the product of consequence and likelihood. This process was repeated for each identified activity likely to occur in the EEZ or ECS.

Using the exposure – consequence risk assessment framework adopted in this study, ecological risk is defined as the product of consequence and likelihood. Using the tables of defined levels and scores of environmental consequences (Table 2-2) and likelihoods (Table 2-3) ecological risk can range from a minimum of 0 to a maximum of 30.

We consider that activities with low risk levels of 6 or less could be categorised as permitted – these arise from the lowest two levels of consequence (0 -negligible and 1- minor) (see Table 3-1) at all levels of likelihood (including 6, likely), from moderate levels of consequence (2) at unlikely (3) or lower levels of likelihood, from severe levels of consequence (3) at rare (2) or remote (1) levels of likelihood, or from major and catastrophic levels of consequence at remote levels of likelihood (see Table 3-1 for a summary of risk scores, their derivation and categorisation).

From an ecological perspective we consider that activities with extreme risk levels of 24 or more should be provisionally classified as prohibited (Table 3-1) unless some means of avoiding or reducing the ecological consequences can be found. These levels of risk arise only from those activities judged to have major consequences (4) at the highest level of likelihood (6) and catastrophic consequences (5) at the two highest levels of likelihood (5 and 6).

Activities over a broad range of moderate (8-12) and high (15-20) risk values, we consider, should be provisionally categorised as discretionary (Table 3-1) and conditions applied that monitor and reduce the associated ecological risk.Our recommendations for classifications are based only on the level of environmental risk from activities. Risk scores were established using a precautionary approach, taking into account the worst case scenario for environmental risks. We have also not taken into account how any mitigation measures might reduce environmental risk when recommending classifications. These recommendations should not be taken as a comprehensive assessment of how activities should be finally regulated. They serve primarily as an indication of the activities that might require special conditions and close monitoring, regardless of how they are ultimately classified.

The detailed assessments by the expert panel are provided in Section 4 while a summary of the categorisation of activities by industry is provided in Table 5-1 below.

A total of 207 assessments were made of 42 identified activities across 13 industries and scientific exploration and sampling. Of these just 19 (9.2%) were assessed as having extreme risks to the environment, 48 (23.2%) were assessed as high risk, 75 (36.2%) were assessed as moderate risk, and 64 (30.1%) as low risk.

The number of activities assessed for an industry ranged from 7 for offshore ecotourism to 17 for mining of massive sulphide deposits, polymetalic crusts and polymetalic nodules and renewable marine energy. Four industries had between 3 and 7 activities we classified as posing an extreme risk to the environment. These industries were mining for phosphorite nodules, massive sulphides, polymetalic crusts, and polymetalic nodules. All industries had one or more activities that pose a high risk to the environment and 2-10 activities that pose a moderate risk. The industry with the highest percentage of activities in the low risk range was offshore aquaculture though there is a high risk in this industry to marine mammals from surface and sub-surface buoys, ropes and structures.

There are often ways of avoiding, remedying or mitigating the effects of activities that would otherwise put marine species or ecosystems at extreme, high or moderate risk. In each section we discuss some useful mitigation strategies and some common strategies include:

- Following non-mandatory Department of Conservation guidelines (2006 and 2011) to avoid or mitigate acoustic impacts on marine mammals.
- Limiting unnecessary use of platform and vessel flood lights at night and ensuring that those that are required are directed approximately vertically onto work surfaces to avoid or mitigate seabird strikes. Visual checks of the super-structure at first light each day for the presence of dazed or injured birds and the provision of appropriate care may help to remedy this impact.
- Avoidance or mitigation of vessels and underwater equipment acting as vectors for non-indigenous species is possible by appropriate checking, cleaning, and application of antifouling paints. We understand that Biosecurity New Zealand (MAF-BNZ) is developing an import health standard and legislation and relevant regulations may be put in place in next 2-3 years.
- Pressure on fish stocks caused by the declaration of an exclusion zone around a drilling or mining site, pipeline or cable route, and forcing fishing activities into the remainder of the quota management area can be reduced or eliminated by purchase and retirement of appropriate commercial fish quota for the duration of the production phase.
- Avoidance or mitigation of seals hauling out on platform structures is possible by reducing access to potential haul-out areas but modifications to exploitation platforms is unlikely given that they invariably come to NZ from overseas for a relatively short period of intense exploration activity.
- Efforts should be made to avoid areas of protected deepwater corals within the footprint of the drilling, mining, energy, or aquaculture operation. Pipelines and cables should also be routed to avoid reef habitat and any other benthic habitat of high biodiversity.

- Risks to seep communities during the exploratory drilling process or through methane extraction altering fluid flow at seep sites and/or direct damage from rig or production facilities can be avoided or minimised through careful selection of drilling sites.
- Assuming that iron sands and placer gold deposits occur to depths of 20-30m below the seafloor, impacts on benthic fauna will be minimised if fewer deeper pits are dug to extract a prescribed tonnage of ore. This is because most fauna is restricted to the upper 10-15 cm of sediment. A wide shallow pit will cause the maximum ecological damage for the least gain in ore extraction.
- Actions that increase the rate of recovery of benthic fauna from the impacts of mining will greatly reduce the risks associated with these industries. Recolonisation by larval settlement from adjacent populations may be increased by mining in a chequerboard or strip pattern or by leaving up-current populations intact. So little is known about larval connectivity in these populations that the optimal size or arrangement of these mining patterns is unknown.
- Impacts of tourism activities on vulnerable benthic species can be minimised by rotating visits around a number of sites. The appropriate rotation interval should be guided by the likely recovery time of the species concerned.

For many of the activities associated with new or yet to be established industries there are insufficient details available to determine the best conditions to apply to avoid, remedy or mitigate their effects. These need to be determined during the consenting process.

We conclude that the most effective way to manage ecological risk is to regulate the individual activities that together make up a marine industry taking place within defined marine habitats.

Table 5-1: Summary of categorisation of activities as having extreme, high, moderate or low environmental risk. At the bottom of the table we summarise the total number of risks of each category for each industry and for scientific exploration and sampling.

Activity	Oil and gas production	Carbon sequestration	Gas hydrates	Ironsand mining	Placer gold mining	Phosphorite nodule mining	Massive sulphides	Polymetalic crusts	Polymetalic nodules	Telecommunications cabling	Renewable marine energy	Offshore aquaculture	Offshore ecotourism	Scientific exploration and sampling
Surface flood lights at night	High	High	High	High	High	High	High	High	High	High	High	Moderate	High	High
Airgun seismic surveys	High	-	High	-	-	-	-	-	-	High	-	-	-	High
Vessel activity causing strikes on marine mammals	High	High	High	High	High	High	High	High	High	High	High	-	High	High
High resolution seismics (boomer, CHIRP)	Moderate	-	-	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	-	-	-	Moderate
Presence of seafloor structures, mooring blocks, chains or anchors	Moderate	Moderate	High	Moderate	Moderate	-	-	-	-	-	High	Moderate	-	Low
Import and provision of biofouling surfaces	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	-	Low

Activity	Oil and gas production	Carbon sequestration	Gas hydrates	Ironsand mining	Placer gold mining	Phosphorite nodule mining	Massive sulphides	Polymetalic crusts	Polymetalic nodules	Telecommunications cabling	Renewable marine energy	Offshore aquaculture	Offshore ecotourism	Scientific exploration and sampling
Deployment of platform structure	Moderate	Low	Moderate	-	-	--	-	-	-	-	-	-	-	-
Underwater pipeline laying and trenching	Moderate	Moderate	Moderate	-	-	-	-	-	-	-	-	-	-	-
Well capping	Moderate	Moderate	High	-	-	-	-	-	-	-	-	-	-	-
Recovery of underwater equipment, plant and machinery	Moderate	Moderate	Moderate	-	-	-	-	-	-	-	Low	Low	-	-
Underwater flood lights	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Low	Low
Incidental underwater noise	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Low	Low	Low	Low	-
Abandonment, sinking of structures and	Moderate	Moderate	High	-	-	-	-	-	-	-	-	-	-	-

Activity	Oil and gas production	Carbon sequestration	Gas hydrates	Ironsand mining	Placer gold mining	Phosphorite nodule mining	Massive sulphides	Polymetalic crusts	Polymetalic nodules	Telecommunications cabling	Renewable marine energy	Offshore aquaculture	Offshore ecotourism	Scientific exploration and sampling
equipment														
Single and multibeam echo sounding	Low	-	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	-	Low
Testing of undersea mining equipment, bulk sampling	-	-	-	High	High	High	High	Extreme	High	-	-	-	-	-
Seafloor drilling, suction / cutting, extraction	High	-	High	Moderate	Moderate	Extreme	High	Extreme	Extreme	-	-	-	-	-
Creation of seafloor pits and stock-piles	-	-	-	Moderate	Moderate	Extreme	Extreme	Extreme	Extreme	-	-	-	-	-
Discharge of sediment plumes	-	-	-	Moderate	Moderate	Extreme	Extreme	Extreme	Extreme	-	-	-	-	-
Slurry pipelines	-	-	-	Moderate	Moderate	High	Extreme	Extreme	Extreme	-		-	-	-
Declaration of exclusion zone	Low	Low	Low	Moderate	Moderate	High	Moderate	Low	Low	Low	Low	Low	-	Low

Activity	Oil and gas production	Carbon sequestration	Gas hydrates	Ironsand mining	Placer gold mining	Phosphorite nodule mining	Massive sulphides	Polymetalic crusts	Polymetalic nodules	Telecommunications cabling	Renewable marine energy	Offshore aquaculture	Offshore ecotourism	Scientific exploration and sampling
Magnetometer surveys	-	-	-	Low	-	-	-	-	-	-	-	-	-	Low
Small scale coring and seabed sampling	-	-	-	Low	Low	Moderate	Moderate	Moderate	Moderate	Low	-	-	-	Low
Toxic chemical release	-	-	-	-	-		Extreme	Extreme	Extreme	-	-	-	-	-
Bulk sampling of deposits	-	-	-			High	Moderate	Extreme	High	-	-	-	-	-
ROV and other imaging surveys						Low	Low	Low	Low	Low	Low	Low	High	Low
Cable lowering and raising	-	-	-	-	-	-	-	-	-	High	Low	-	-	-
Cable trenching & installation	-	-	-	-	-	-	-	-	-	Moderate	Moderate	-	-	-
Cable abandonment	-	-	-	-	-	-	-	-	-	Low	Low	-	-	-
Exposed cable movement	-	-	-	-	-	-	-	-	-	Low	Low	-	-	-
Installation of surface and	-	-	-	-	-	-	-	-	-	-	High	High	-	Low

Activity	Oil and gas production	Carbon sequestration	Gas hydrates	Ironsand mining	Placer gold mining	Phosphorite nodule mining	Massive sulphides	Polymetalic crusts	Polymetalic nodules	Telecommunications cabling	Renewable marine energy	Offshore aquaculture	Offshore ecotourism	Scientific exploration and sampling
subsurface floats & structures														
Installation of energy capture device	-	-	-	-	-	-	-	-	-	-	High	-	-	-
Production of electro-magnetic field	-	-	-	-	-	-	-	-	-	-	Low	-	-	-
Seafloor deposition of organic waste	-	-	-	-	-	-	-	-	-	-	-	Moderate	-	-
Water column nutrient enrichment	-	-	-	-	-	-	-	-	-	-	-	Low	-	-
Water column production depletion	-	-	-	-	-	-	-	-	-	-	-	Low	-	-
High concentration of cultured species	-	-	-	-	-	-	-	-	-	-	-	Low	-	-
Surface activity and noise	-	-	-	-	-	-	-	-	-	-	-	-	Moderate	-
Subsurface activity	-	-	-	-	-	-	-	-	-	-	-	-	Moderate	-

Activity	Oil and gas production	Carbon sequestration	Gas hydrates	Ironsand mining	Placer gold mining	Phosphorite nodule mining	Massive sulphides	Polymetalic crusts	Polymetalic nodules	Telecommunications cabling	Renewable marine energy	Offshore aquaculture	Offshore ecotourism	Scientific exploration and sampling
Towed instrument arrays in core areas for nationally critical species	-	-	-	-	-	-	-	-	-	-	-	-	-	High
Moored instrument arrays in core areas for nationally critical species	-	-	-	-	-	-	-	-	-	-	-	-	-	High
Research bottom trawling	-	-	-	-	-	-	-	-	-	-	-	-	-	High
Large scale ocean productivity perturbation	-	-	-	-	-	-	-	-	-	-	-	-	-	Moderate
Extreme	0	0	0	0	0	3	4	7	5	0	0	0	0	0
High	4	2	7	3	3	6	4	2	4	3	5	1	3	6
Moderate	10	6	6	10	10	5	5	4	4	3	2	3	2	2
Low	2	4	2	3	3	2	4	4	4	8	10	10	2	9
Total	**16**	**12**	**15**	**16**	**16**	**16**	**17**	**17**	**17**	**14**	**17**	**14**	**7**	**17**

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Environmental Protection Authority
Te Mana Rauhī Taiao

Application Ref:EEZ000006

DECISION ON MARINE CONSENT APPLICATION

Chatham Rock Phosphate Limited

To mine phosphorite nodules on the Chatham Rise



New Zealand Government

www.epa.govt.nz

EXCLUSIVE ECONOMIC ZONE AND CONTINENTAL SHELF (ENVIRONMENTAL EFFECTS) ACT 2012

Decision on marine consent application by Chatham Rock Phosphate Limited to mine phosphorite nodules on the Chatham Rise

Application	To mine phosphorite nodules on the Chatham Rise at depths from 250 m to 450 m in a 10,192 km^2 area located over 400 km east of Christchurch. For the first five years mining would be restricted to 820 km^2, with the operation extending to the wider marine consent area depending on the presence of other economic concentrations of phosphorite nodules and the securing of the requisite further mining permits. After the application was lodged, the proposed mining area was reduced by the applicant to 5,207 km^2, by removal of the eastern block from the marine consent application. The applicant proposed to mine 30 km^2 of seabed per year (ie three mining blocks approximately 2 km wide and 5 km long) to achieve an annual minimum production target of 1.5 million tonnes of phosphorite nodules. In the initial 15 years it was anticipated that an area of 450 km^2 would be mined. Over 35 years a total mined area of approximately 1,050 km^2 was envisaged. The phosphorite nodules would be mined using a conventional trailing suction hopper dredger or drag-head and separated from the other seabed material on board a vessel, with waste tailings being discharged using a sinker pipe with a diffuser 10 m above the seafloor. More specifically, the application sought approval for the following activities: • the construction, placement, alternation, extension, removal, or demolition of a structure on or under the seabed (Section 20(2)(a)); • the removal of non-living natural material from the seabed or subsoil (Section 20(2)(d)); • the disturbance of the seabed or subsoil in a manner that is likely to have an adverse effect on the seabed or subsoil (Section 20(2)(e)); • the deposit of any thing or organism in, on, or under the seabed (Section 20(2)(f)); • the destruction, damage, or disturbance of the seabed or subsoil in a manner that is likely to have an adverse effect on marine species or their habitat (Section 20(2)(g)); • specified activities in the waters of the EEZ, including activities related to structures, causing of vibrations and causing of explosions (Section 20(3) and (4)).

Decision Summary

i. Pursuant to Section 62(1)(b) of the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (the EEZ Act), the application by Chatham Rock Phosphate Ltd (CRP) for a marine consent is refused.

The application

ii. On 14 May 2014 CRP lodged an application with the Environment Protection Authority (EPA) for a marine consent to mine phosphorite nodules from the crest of the Chatham Rise.

iii. Initially consent was sought for a 35 year operation over an area of 10,192 km^2. On 1 August 2014 the area for which consent was sought was reduced to 5,207 km^2 by the withdrawal of the application's eastern mining block. CRP proposed to undertake the mining in stages, restricting the first five years of the operation to the 820 km^2 mining permit area (MPL 55549). Over the full 35 year period for which consent was sought, a total of some 1,050 km^2 was to be mined.

iv. Details of the specific activities for which a marine consent was sought are given in Chapter 2 of this decision.

v. The mining was to be carried out by a specially built or modified vessel using a mining system designed by Royal Boskalis Westminster nv (Boskalis). Phosphorite-bearing material was to be retrieved from the seabed by means of a trailing suction drag-head and mechanically processed on board the vessel. Phosphorite nodules greater than 2 mm would be separated from other material using sieves and logwashers and stored on the vessel. Waste material would then be released close to the seabed, using a discharge (sinker) pipe with a diffuser.

vi. CRP proposed to mine three of its 10 km^2 mining blocks each year, giving an estimated annual production of some 1.5 million tonnes. The mining would be at depths of up to 450 m.

vii. The applicant's outline mining plan included provision for establishing mining exclusion areas aimed at protecting areas of particular scientific or conservation sensitivity and values as identified through a marine spatial planning exercise. The applicant stated that it intended to undertake a range of monitoring and environmental surveys, including seabed sampling and habitat creation trials. It also

proposed to set up an Environmental Trust Fund, an Environmental Reference Group and a Chatham Islands Trust. It submitted in support of its application an Environmental Impact Plan, a draft Environmental Management and Monitoring Plan and a proposed set of conditions for the mining operation.

The Process

viii. The application was heard and determined by a Decision Making Committee (DMC) appointed by the EPA under Schedule 5 of the Crown Entities Act 2004. A detailed procedural history of the application is given in Appendix 1 to this report.

ix. Chapters 13, 14 and 15 explain how, in reaching its decision, the DMC applied the information principles of the EEZ Act and took into account the matters specified in Sections 59 and 60 of the EEZ Act.

Effects on the environment and existing interests

x. As required by the EEZ Act, the DMC took into account the effects of the proposal on the environment, including the significant and permanent adverse effects on the benthic environment of the Chatham Rise. The DMC also took into account the effects of the return of waste material to the seabed following processing aboard the vessel. Other risks to the environment considered by the DMC included: effects on the trophic web (including primary production, microbes and zooplankton), fish and other pelagic fauna, rock lobsters, paua, water quality and seabirds; the effects of mining-related noise, including on marine mammals; and the risks to biosecurity and human health.

xi. Existing interests considered by the DMC were: interests arising from Treaty of Waitangi settlements; commercial fishing; marine eco-tourism; customary fishing; and other vessels traversing the area. Consideration was also given to the effects of the proposal on other marine management regimes, including the Mid Chatham Rise Benthic Protection Area.

xii. Under Section 59(2)(m) of the EEZ Act, the DMC gave consideration to the interests of Chatham Islanders and to the effects of the proposal on Māori and Moriori cultural interests.

Decision

xiii. The destructive impact of the drag-head on the seabed and on the benthic fauna in and on the seabed was a major concern, given that:

(a) these effects could not be avoided, remedied or mitigated

(b) the mining would largely be occurring in an area where the seabed is currently protected from trawling and dredging by the Mid Chatham Rise Benthic Protection Area

(c) the effects would include the destruction of communities dominated by protected stony corals which are potentially unique to the Chatham Rise and which the DMC concluded are rare and vulnerable ecosystems

(d) the habitat would not return to its present form but rather would be transformed wholly into soft sediment habitat.

xiv. Moreover, the return of waste material to the seabed stood to have adverse effects on the benthic habitat in and around the mining blocks and across the wider marine environment.

xv. Notwithstanding the efforts of the applicant to research, document and substantiate its case, the DMC was left with a lack of certainty about both the receiving environment and the adverse effects of the project on that environment and existing interests. Partly this is explained by the current state of scientific knowledge about the Chatham Rise marine environment, albeit well researched in some dimensions. But there were other uncertainties stemming from the fact that this would be the first seabed mining project ever undertaken at such depths anywhere in the world, and from the heavy reliance placed on insufficiently validated modelling to predict the impacts of the project.

xvi. The DMC gave consideration to the likely economic benefit to New Zealand of the proposal. It was not persuaded that the proposal's economic benefit to New Zealand would be of the significance argued by the applicant, or that reliance could be placed on economic benefits as a potential offsetting factor.

xvii. The DMC gave careful consideration to whether an adaptive management approach would allow the activity to be undertaken. It also, as required by Section 59(2)(j) of the EEZ Act, considered the

extent to which imposing conditions under Section 63 of the EEZ Act might avoid, remedy or mitigate the adverse effects of the activity.

xviii. The DMC's finding is that the destructive effects of the extractive activity, coupled with the potentially significant impact of the deposition of sediment on the areas adjacent to the mining blocks and on the wider marine environment, could not be mitigated by any set of conditions or adaptive management regime that might reasonably be imposed. The conditions proposed by the applicant, although they went some way towards addressing some of the risks associated with the proposal, did not allay the DMC's basic concern about the adverse effects of the proposal on a distinctive and important marine environment. The various proposals made by the applicant for environmental compensation did not in the DMC's view amount to mitigation. After weighing all the information and evidence, and taking into account the matters listed in Section 59 of the EEZ Act, the DMC concluded that the application could not be approved either in part or in whole. The DMC's decision therefore is to refuse consent.

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1. Abbreviations and Acronyms

1. The abbreviations and acronyms are:

ANZECC	Australian and New Zealand Environment and Conservation Council Water Quality Guidelines 2000
AUV	Autonomous underwater vehicle
Boskalis	Royal Boskalis Westminster nv
BPA	Benthic Protection Area
CBD	United Nations Convention on Biological Diversity
CGE	Computable General Equilibrium
CRMS	Craft Risk Management Standard
CRP	Chatham Rock Phosphate Limited (also known as "*the applicant*")
DMC	Decision Making Committee
DOC	Department of Conservation
DSCC	Deep Sea Conservation Coalition
EDS	Environmental Defence Society
EEZ Act or the Act	Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMMP	Environmental Management and Monitoring Plan
EPA	Environmental Protection Authority
FAO	United Nations Food and Agriculture Organisation
FIR	Further information request
Greenpeace	Greenpeace New Zealand
HSE Act	Health and Safety in Employment Act 1992
IUCN	International Union for the Conservation of Nature
KASM	Kiwis Against Seabed Mining
London Convention	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 and its 1996 Protocol
MSC	Marine Stewardship Council
MarLin	Marine Life Network
MARPOL	International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978.
MEC	Marine Environmental Classification
MPL	Marine Prospecting Licence

MPUC	Maximum permissible uranium concentration
MTA	Maritime Transport Act 1994
NIWA	National Institute of Water and Atmospheric Research
Noumea Convention	Noumea Convention for the Protection of the Natural Resources and Environment of the South Pacific Region
NZAX	New Zealand's Alternative Share market
NZCPS	New Zealand Coastal Policy Statement
NZIER	New Zealand Institute of Economic Research
NZPAM	New Zealand Petroleum and Minerals
PP	Prospecting Permit
QMA	Quota management area
QMS	Quota management system
RMA	Resource Management Act 1991
SSC	Suspended sediment concentration
SST	Sea surface temperature
STF	Sub tropical front
TSS	Total suspended sediment concentration
The Regulations	The Fisheries (Benthic Protection Areas) Regulations 2007

2. Introduction and Background

2.1. EPA / DMC roles and responsibilities

2. One of the functions of the Environmental Protection Authority (EPA) pursuant to Section 13(1) of the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (the EEZ Act or the Act) is to decide marine consent applications.

3. The EPA has the ability to delegate its power to decide an application for marine consent to a committee appointed under clause 14 of Schedule 5 of the Crown Entities Act 2004 (Section 16(a) of the EEZ Act).

4. On 16 May 2014, the EPA Board appointed a Decision Making Committee (DMC) under clause 14 of Schedule 5 of the Crown Entities Act 2004 to hear Chatham Rock Phosphate Limited's (CRP) marine consent application, and delegated to it the powers and functions of the EPA relating to the processing, hearing and deciding of a marine consent application under the EEZ Act. The DMC comprised Mr Neil Walter (Chair), Dr Nicola Crauford (EPA Board Member), Mr David Hill, Mr Lennie Johns and Dr Greg Ryder.

5. In considering and deciding on this marine consent application, the DMC has acted independently from the EPA.

2.2. The applicant

6. CRP was incorporated in April 2004 as WPL (Newco) Limited, a wholly owned subsidiary of Widespread Portfolios. In May 2006 its name was changed to Widespread Energy Limited, and in April 2011 it became Chatham Rock Phosphate Limited.

7. CRP is listed on New Zealand's alternative share market (NZAX). As at March 2014 it had a market capitalisation of approximately NZ$ 41.8 million, assets of approximately NZ$ 22.4 million and some 665 shareholders in total.

8. In addition to being a CRP shareholder (through Boskalis Offshore nv), Royal Boskalis Westminster nv (Boskalis) was responsible for undertaking the design engineering, logistics studies and preliminary design work, including consideration of methods to minimise potential environmental impacts, for the mining proposal. CRP's expectation was that Boskalis would manage the mining vessel and related mining operations.[1]

[1] Section 3.3.2, Marine Consent Application and EIA, May 2014

2.3. The application

9. On 14 May 2014, the applicant lodged an application with the EPA for a marine consent to conduct a seabed mining operation on the Chatham Rise over a term of 35 years. The applicant proposed to mine phosphorite nodules at depths from 250 to 450 m in a 10,192 km^2 area located over 400km east of Christchurch (*Figure **1***).

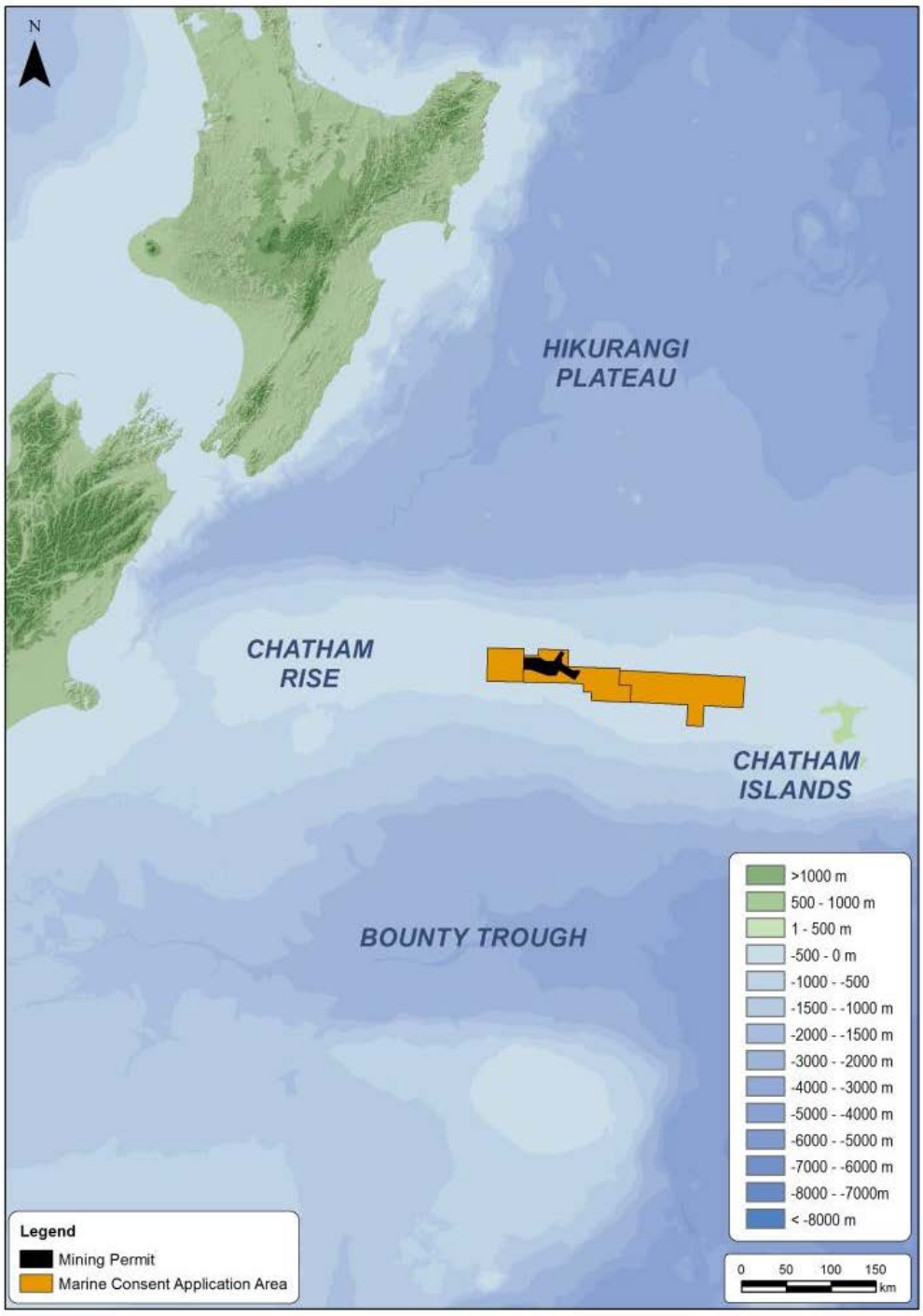


Figure 1. Chatham Rise and CRP's marine consent application area as at May 2014. (Source: Figure 1 of the EIA, May 2014)

10. For the first five years mining would be restricted to the 820 km^2 area for which a mining permit (MPL 55549) was already held by CRP. This area is located at the western end of the area covered by marine prospecting licence MPL 50270 granted to CRP in 2010 (*Figure **2***).

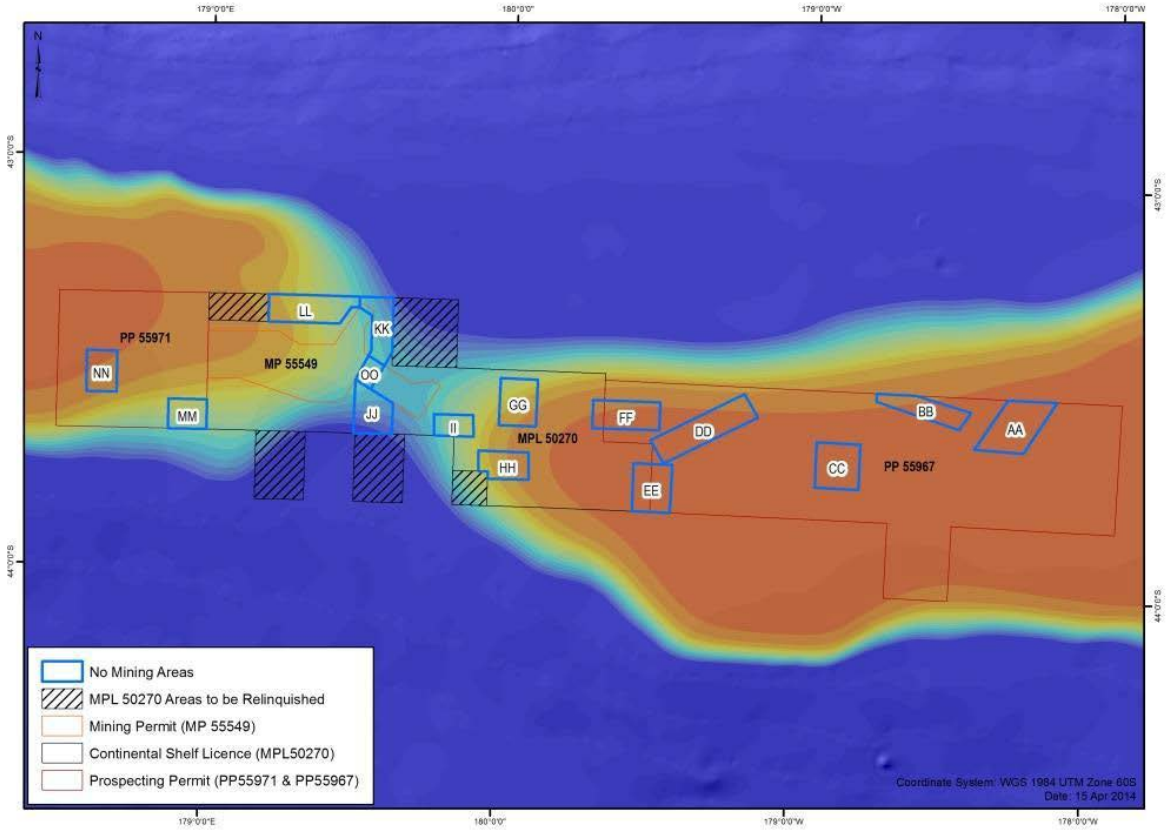


Figure 2. CRP's original proposed marine consent area (10,192 km^2), including mining permit area MP 55549, the revised continental shelf license area MPL 50270 for prospecting and the prospecting permit area PP 55971 for which it has recently applied. The original proposed mining exclusion areas are shown in blue. Prospecting permit area PP 55967 on the eastern end of this map is no longer a part of the marine consent area. (Source: Figure 18 of the EIA, May 2014)

11. Prospecting licence MPL 50270 covered an area of 5,207 km^2. In November 2013, CRP lodged applications with New Zealand Petroleum and Minerals (NZPAM) for two additional prospecting permit areas to the west and east of MPL 50270. CRP offered to relinquish 1,019 km^2 of MPL 50270 as part of this application. Those prospecting licence applications had not been determined by the completion of this decision.

12. Although initially the mining would take place within the area covered by mining permit MPL 55549, in the future the operation could extend to the wider marine consent area depending on the presence of other economic concentrations of phosphorite nodules and the securing of the requisite further mining permits.

13. On 1 August 2014, the applicant informed the EPA of its decision, in light of the work it had undertaken and in response to the issues raised by a number of parties, to remove the eastern mining block (PP 55967) from its marine consent application. This left a revised marine consent area of 5,207 km^2.

14. The Deepwater Group sought to have the application re-notified on the basis of the reduced marine consent application. The DMC considered this unnecessary, and its decision is recorded in Minute 7 of 22 August 2014.

15. The applicant proposed to mine 30 km^2 of seabed per year (ie three mining blocks approximately 2 km wide and 5 km long) to achieve an annual minimum production target of 1.5 million tonnes of phosphorite nodules. In the initial 15 years it was anticipated that an area of 450 km^2 would be mined. Over 35 years a total mined area of approximately 1,050 km^2 was envisaged.

16. The applicant's Environmental Impact Assessment (EIA) stated that, if mining did extend to new areas within the marine consent area, there would be no change to the mining operations in terms of the production target, the areas of seabed directly affected and the fundamentals of the mining operation.

17. The proposed mining operation is described in Chapter 5 of this report. It involved building or modifying a vessel to meet the specific requirements of this proposal, using a conventional trailing suction hopper dredger or drag-head. The mined material would be pumped through flexible hoses to the mining vessel, where phosphorite nodules would be separated from other seabed material using sieves and log-washers. The remaining material would be released back into the water just above the seabed through a sinker and diffuser hose. When the vessel's holds were full, the mining vessel would proceed to a port where the phosphorite would be unloaded, stored and distributed to the market.

18. The applicant proposed to undertake various surveying and monitoring activities, including seabed surveying and sampling. It also intended to undertake a hard substrate trial aimed at the re-establishment of benthic communities.

2.4. Activities requiring approval

19. The applicant sought marine consent for the following activities under the EEZ Act:

Section of the Act	EEZ Act Provision	Description of the Activity
20(2)(a)	The construction, placement, alternation, extension, removal, or demolition of a structure on or under the seabed.	Monitoring equipment consisting of no more than four mooring landers, would be placed, relocated on the seabed and eventually removed.
20(2)(d)	The removal of non-living natural material from the seabed or subsoil.	Phosphorite nodules, a non-living material, would be removed from the seabed and subsoil. In addition, as part of the environmental monitoring programme, seabed samples, including non-living material, would be collected and removed from the seabed and subsoil.
20(2)(e)	The disturbance of the seabed or subsoil in a manner that is likely to have an adverse effect on the seabed or subsoil.	Mining would disturb the seabed and subsoil. In addition, the collection of seabed samples would also disturb the seabed and subsoil.
20(2)(f)	The deposit of any thing or organism in, on, or under the seabed.	Non-phosphorite material, following processing on the mining vessel, would be returned / deposited on the seabed. Note: This material is also defined as a harmful substance, being a mining discharge from a ship. In addition, hard substrate is to be placed on the seabed initially as part of the proposed recolonisation trials, and if successful then possibly as part of subsequent habitat creation.

Section of the Act	EEZ Act Provision	Description of the Activity
20(2)(g)	The destruction, damage, or disturbance of the seabed or subsoil in a manner that is likely to have an adverse effect on marine species or their habitat.	The seabed and subsoil, and associated marine species and habitats, would be disturbed, if not damaged, as a result of the mining proposal. In addition, the collection of seabed samples would also disturb the seabed and subsoil and associated marine species and habitats, although the application considers impacts of this activity are minor.
20(3) and (4)	Specified activities in the waters of the EEZ, including activities related to structures, causing of vibrations and causing of explosions.	Section 20(4)(b) is potentially applicable in relation to noise. The applicant states that CRP's mining proposal is unlikely to cause vibrations that adversely affect marine life.

20. Under Section 36 of the EEZ Act, the applicant's proposed activities are discretionary activities because they are not classified in regulations made under the EEZ Act.

21. The applicant also described the proposed release of non-phosphorite material to the seabed (after processing) as a discharge to which Section 20C would apply when it comes into force. As Section 20C is not yet in force, a consent can neither be sought nor granted under that provision. The release of waste material is, however, an integral part of the proposal. To the extent that the material deposits on the seabed, that deposition is an activity regulated under Section 20(2)(f). To the extent that the material is released into, and may remain for some time within, the water column, that is plainly an inevitable effect of the proposal, and requires to be considered along with all other effects of the proposal, irrespective of whether 'discharges' are yet an activity expressly regulated by the Act.

22. Further, as Ms Taylor (planner for the applicant) acknowledged,[2] there were two activities forming part of the proposal that might require consents that the applicant had not yet sought. They were specifically:

[2] Line 32, page 2373 of the Transcript, 18 November 2014

a) CRP's application did not specify that consent was being sought for multibeam mapping, which may be an activity for which consent would be required under Sections 20(3) and (4)(b) due to its vibration effects

b) CRP's application was expressly limited to the placement of no more than four mooring landers on the seabed, which is a limit the applicant might have wished to exceed as part of its proposed monitoring activity.

23. The DMC has proceeded on the basis that the applicant could not enlarge the scope of its application and that if these elements of the proposal required marine consent then appropriate applications would need to be lodged.

2.5. Other activities

24. The EIA identified other components of CRP's proposed mining proposal as being:[3]

- operations at a port facility, namely the unloading, storage and dispatch of the mined material
- mining support activities including environmental monitoring and medical evacuation support facilities, potentially based on the Chatham Islands
- on-going research and investigations for both prospecting and mining components of the proposal, to assess resource distribution and benthic habitats for the purposes of future mine planning, survey work to identify optimal mining locations and review the areas that have been mined and environmental research and monitoring
- on-going consultation with interested parties to keep them informed about CRP's operations and as part of CRP's commitment to continue to listen to and resolve issues or ideas raised by these parties.

2.6. Process

25. A full procedural history of the application is contained in Appendix 1. The following is a brief summary.

26. The application was lodged on 14 May 2014 and assessed by the EPA for completeness under Sections 38 and 39 of the Act. It was not returned as incomplete by 28 May 2014.

27. The EPA and the DMC requested the applicant to provide a number of items of further information. Responses to all requests were given by the applicant by 2 September 2014.

[3] Section 3.3.4, Marine Consent Application and EIA, May 2014

28. The application was publicly notified on 12 June 2014, and the submission period ran from 12 June 2014 until 10 July 2014. In all, 294 submissions were received.

29. 35 statements or supplementary statements of evidence were filed by the applicant, and 39 by submitters. A pre-hearing meeting on existing interests and twelve expert conferencing meetings were held.

30. The hearing ran for 26 sitting days, starting on 25 September 2014 and adjourning on 19 November 2014. Sessions were held in Wellington, the Chatham Islands and Hamilton. The hearing formally closed on 12 December 2014.

31. The DMC completed its deliberations and issued this decision on 10 February 2015.

2.7. Acknowledgements

32. The EEZ Act sets a demanding timeframe for decision-making on marine consent applications. This was the view of a number of legal counsel, submitters and experts as well as the DMC. Given the scale and complexity of this particular application, the timeframe has been a constant source of challenge.

33. The DMC endeavoured at every point to ensure not only that all participants were treated fairly but that they were given every opportunity to prepare and present a considered view on the matters the DMC needed to determine. Much of the material presented in evidence was highly technical and complex in nature, and the task for participants in reading and responding to that material has been difficult.

34. The DMC is grateful for the considerable efforts made by the applicant, witnesses and submitters to respond constructively to the challenges presented by the process. It wishes particularly to record its appreciation of the work done by the experts who met in the various expert conferencing sessions. Their professionalism and constructive approach helped greatly in identifying and narrowing the issues.

35. The DMC held a one-day hearing in the Chatham Islands and a two-day hearing in Hamilton. The DMC wishes to acknowledge the warmth with which the Chatham Islanders received it, and the efforts made by individual and group submitters both there and in Hamilton to review the material relating to the application and present their views on it.

36. The DMC also wishes to record its appreciation to counsel representing the various parties for the positive way they went about the task of questioning experts and assisting it to clarify matters arising from the large amount of information and evidence placed before it.

37. Finally, the DMC wishes to record its appreciation of the excellent support received from staff involved in the management of the hearing. They showed commendable efficiency throughout a lengthy and challenging exercise.

3. The Legislative Framework

3.1. Introduction

38. This chapter outlines the legislative framework within which the application has been considered.

3.2. Purpose of the EEZ Act

39. The purpose of the EEZ Act is stated in Section 10(1) as *"to promote the sustainable management of the natural resources of the exclusive economic zone and continental shelf."*

40. The term "*natural resources*" means, "*in relation to the exclusive economic zone, includes seabed, subsoil, water, air, minerals, and energy, and all forms of organisms (whether native to New Zealand or introduced); and, in relation to the continental shelf, means the mineral and other non-living resources of the seabed and subsoil and sedentary species*." [4]

41. Many parties to the application referred the DMC to Section 10(2) of the EEZ Act which sets out the definition of "*sustainable management*"[5] as *"managing the use, development and protection of natural resources in a way, or at a rate, that enables people to provide for their economic wellbeing while—*

> *(a) sustaining the potential of natural resources (excluding minerals) to meet the reasonable needs of future generations; and*
>
> *(b) safeguarding the life-supporting capacity of the environment; and*
>
> *(c) avoiding, remedying or mitigating any adverse effects of activities on the environment.*

42. Section 10(3) provides that in order to achieve the purpose of the EEZ Act, decision-makers must take into account the decision-making criteria specified in relation to particular decisions (in this case, Section 59) and apply the information principles set out in Section 61 to the consideration of marine consent applications.

43. In the course of the hearing differences of opinion emerged as to precisely how the provisions of Section 10(2)(a), (b) and (c) of the EEZ Act should be interpreted in the context of this application.

[4] See definition of "natural resources", Section 4 of the EEZ Act
[5] For example, Paragraph 33, Opening Submissions for CRP, 25 September 2014; paragraph 20, Opening Representation of Te Rūnanga o Ngāi Tahu, 25 September 2014; paragraph 14, Legal Submissions on behalf of the Royal Forest and Bird Protection Society of New Zealand Incorporated, 26 September 2014 (document states 27 September 2014); paragraph 6, Opening Submissions of Counsel for EDS, 26 September 2014

44. Mr Enright (EDS) submitted that because the purpose of the EEZ Act was essentially the same as that of the RMA, RMA jurisprudence should be highly persuasive,[6] and particularly therefore the Supreme Court's decision in EDS *v* NZ King Salmon Ltd[7]. In that case, the Court had found that the word "*while*" means "*at the same time as*", and Mr Enright submitted that therefore the same 3 sub-paragraphs that are copied into the EEZ Act should be read as bottom lines that "*must be observed*" as the Court had determined.[8]

45. Mr Enright also urged the DMC to accept the Court's finding in that case that environmental protection was a core element of sustainable management.[9]

46. In reply, Mr Winchester disagreed with Mr Enright's analysis and repeated his opening argument that the sustainable management purpose envisaged a balancing exercise whereby provision for economic development is balanced against environmental considerations, rather than setting sub-paragraphs (a) – (c) as environmental bottom lines that must be met.[10] He submitted that a proper and more plausible reading of the Court's decision was that neither the sub-paragraphs nor the preceding part of the definition prevailed but that they should be read as an integrated whole — as should the purpose. He argued that fundamentally the EEZ Act was a *"resource and economic development statute"* rather than an environmental protection statute.[11] Furthermore, he suggested that while the decision-making criteria referred to in Section 10(3) must be taken into account and applied, they did not encapsulate the purpose.[12]

47. The DMC was referred to the then Minister for the Environment's third reading speech in which she said[13] "*... we saw merit in aligning the purpose of the exclusive economic zone bill more closely with that of the Resource Management Act by incorporating explicit reference to "sustainable management".*
In making this change, I reflected in particular on the use of the word "balance". Although balance is an easily understood expression conversationally, as a legislative provision of such import, however, I saw it as less than ideal. The use of "sustainable management" relating to the use and development of our resources, in conjunction with the detailed information principles within the bill, is designed to provide for fundamentally the same process but directed through better-understood legal mechanisms. Certainty of how the purpose will be interpreted was a key issue for industry and NGOs alike, which were concerned that the balancing purpose

[6] Lines 21-29, page 173 of the Transcript, 26 September 2014
[7] Environmental Defence Society Inc *v* New Zealand King Salmon Company Ltd (2014) NZSC 38
[8] Lines 28-32, page 174 of the Transcript, 26 September 2014
[9] Lines 39-40, page 174 of the Transcript, 26 September 2014
[10] Paragraphs 46-52, Closing Submission of CRP, 19 November 2014
[11] Paragraph 55, Closing Submission for CRP, 19 November 2014
[12] Paragraph 57, Closing Submission for CRP, 19 November 2014
[13] Adams, Amy: Exclusive Economic Zone and Continental Shelf (Environmental Effects) Bill — Third Reading [Sitting date: 28 August 2012. Volume:683;Page:4779.]

considered at the select committee could result in extensive litigation to clarify its interpretation. The concept of sustainable management, on the other hand is well defined in domestic legislation, through more than 20 years of resource management case law....
This bill will help us unlock the enormous economic potential that lies in our oceans in an environmentally responsible way that supports our clean, green reputation."

48. From the above, the DMC concludes that the Minister was reflecting a position somewhere between the approaches of Mr Winchester and Mr Enright. As the words of the Minister imply, the intention was that the EEZ's economic resource be unlocked "*in an environmentally responsible way that supports our clean, green reputation*".

3.3. Restricted activities

49. Section 20 of the EEZ Act lists the activities that may not be undertaken in the exclusive economic zone or in and on the continental shelf without a marine consent. There are some exceptions to Section 20, however, such as where regulations have been brought into force that prescribe one or more of those activities to be permitted or prohibited. In the absence of regulations classifying an activity that is listed in Section 20, the activity would be a "*discretionary activity*" and a person must have a marine consent before undertaking that activity. Activities listed in Section 20 include: the removal of non-living natural material from the seabed or subsoil; the disturbance of the seabed or subsoil in a manner likely to have an adverse effect on the seabed or subsoil; the deposit of any thing or organism in, on or under the seabed; and the destruction, damage or disturbance of the seabed or subsoil in a manner that is likely to have an adverse effect on marine species or their habitat.

3.4. Decision-making criteria

50. Section 59 of the EEZ Act spells out the criteria to be observed in considering an application for a marine consent. There are several matters to take into account, including *"any other matter that the EPA considers relevant and reasonably necessary to determine the application"*.[14]

51. For completeness, Section 59 is set out below:

> 59 *Environmental Protection Authority's consideration of application*
>
> *(1) This section and sections 60 and 61 apply when the Environmental Protection Authority is considering an application for a marine consent and submissions on the application.*
>
> *(2) The EPA must take into account—*

[14] Section 59(2)(m) of the EEZ Act

(a) any effects on the environment or existing interests of allowing the activity, including—

(i) cumulative effects; and

(ii) effects that may occur in New Zealand or in the waters above or beyond the continental shelf beyond the outer limits of the exclusive economic zone; and

(b) the effects on the environment or existing interests of other activities undertaken in the area covered by the application or in its vicinity, including—

(i) the effects of activities that are not regulated under this Act; and

(ii) effects that may occur in New Zealand or in the waters above or beyond the continental shelf beyond the outer limits of the exclusive economic zone; and

(c) the effects on human health that may arise from effects on the environment; and

(d) the importance of protecting the biological diversity and integrity of marine species, ecosystems, and processes; and

(e) the importance of protecting rare and vulnerable ecosystems and the habitats of threatened species; and

(f) the economic benefit to New Zealand of allowing the application; and

(g) the efficient use and development of natural resources; and

(h) the nature and effect of other marine management regimes; and

(i) best practice in relation to an industry or activity; and

(j) the extent to which imposing conditions under section 63 might avoid, remedy, or mitigate the adverse effects of the activity; and

(k) relevant regulations; and

(l) any other applicable law; and

(m) any other matter the EPA considers relevant and reasonably necessary to determine the application.

(3) The EPA must have regard to—

(a) any submissions made and evidence given in relation to the application; and

(b) any advice, reports, or information it has sought and received in relation to the application; and

(c) any advice received from the Māori Advisory Committee.

> *(4) When considering an application affected by section 74, the EPA must also have regard to the value of the investment in the activity of the existing consent holder.*
>
> *(5) Despite subsection (3), the EPA must not have regard to—*
>
> *(a) trade competition or the effects of trade competition; or*
>
> *(b) the effects on climate change of discharging greenhouse gases into the air; or*
>
> *(c) any effects on a person's existing interest if the person has given written approval to the proposed activity.*
>
> *(6) Subsection (5)(c) does not apply if the person has given written approval but the person withdraws the approval by giving written notice to the EPA—*
>
> *(a) before the date of the hearing, if there is one; or*
>
> *(b) if there is no hearing, before the EPA decides the application.*

52. With respect to the effects on the environment, the DMC refers to the definitions of 'environment' and 'effect' and notes that, while the activities for which CRP sought a marine consent were to take place in the exclusive economic zone, the scope of effects to be taken into account includes those that occur beyond the exclusive economic zone, such as effects that occur in New Zealand.[15]

53. In addition to effects on the environment, the DMC must also take into account the effects of the applicant's proposed activities on existing interests.

54. The EEZ Act's definition of existing interests covers an interest a person has in any lawfully established existing activity such as rights of access, navigation and fishing; the settlement of historical claims under the Treaty of Waitangi Act 1975; the settlement of a contemporary claim under the Treaty of Waitangi as provided for in an Act, including the Treaty of Waitangi (Fisheries Claim) Settlement Act 1992; and a protected customary right or customary marine title recognised under the Marine and Coastal Area (Takutai Moana) Act 2011.[16]

55. Section 60 of the EEZ Act provides guidance to the DMC about the manner in which the effects on existing interests of allowing the activity are to be taken into account.

[15] See definition of "environment" in Section 4 of the EEZ Act and the definition of "effect" in Section 6 of the EEZ Act
[16] See definition of existing interest, Section 4 of the EEZ Act

56. Section 59(2)(b) of the EEZ Act also requires the DMC to take into account the effects on the environment or existing interests of other activities undertaken in the area covered by the application or in its vicinity.

57. Another matter to be taken into account is the nature and effect of other marine management regimes.[17] Marine management regimes are regimes established under various Acts set out in Section 7(2) of the EEZ Act. The DMC cannot impose a condition to deal with an effect if the condition would conflict with a measure required in relation to the activity by another marine management regime.[18]

58. The implications for the activities for which consent was sought by the applicant of the legislation, regulations, conventions, regimes and Codes mentioned above are dealt with in the relevant chapters of this decision.

59. Section 59(2)(j) of the EEZ Act requires the DMC to take into account the extent to which imposing conditions might avoid, remedy, or mitigate the adverse effects of the activity. Section 63 of the EEZ Act then confers discretion to impose conditions that deal with the adverse effects of the activity.

60. Section 59(3) of the EEZ Act requires the DMC to have regard to submissions, evidence, advice, reports and information received in relation to the application and to have regard to advice received from the EPA's Māori Advisory Committee.

61. Finally, the relevance and significance of the matters in Section 59 of the EEZ Act depends on the facts and circumstances of the particular application before the DMC.[19]

3.5. Information principles

62. Section 61 of the EEZ Act sets out the information principles that the DMC must apply when considering an application for marine consent. Section 61 of the EEZ Act is directive and requires decision-makers to make full use of their powers by:

- requesting information from the applicant
- obtaining advice
- commissioning reviews or reports.

[17] Section 59(2)(h) of the EEZ Act
[18] Section 63(4) of the EEZ Act
[19] Paragraph 222, Opening Submissions for CRP, 25 September 2014

63. Furthermore, the DMC must base decisions on the best available information and take into account any uncertainty or inadequacy in the information available.

64. The term 'best available information' is defined as "*the best information that, in the particular circumstances, is available without unreasonable cost, effort or time*".[20]

65. The EEZ Act stipulates that when the information available in relation to an application is uncertain or inadequate, decision-makers must favour caution and environmental protection. If this means that an activity is likely to be refused, consideration must then be given to whether taking an adaptive management approach would allow the activity to be undertaken.[21]

66. Section 64 of the EEZ Act sets out examples of an adaptive management approach. It provides *inter alia* for conditions to be set requiring the activity to be undertaken in stages, with regular monitoring and reporting determining whether the next stage of the activity may be undertaken.

3.6. Decisions on marine consent applications

67. Applications for a marine consent may be granted either in whole or in part, or be refused. Section 62(2) of the EEZ Act states, for the avoidance of doubt, that the application may be refused if the decision-makers consider that they do not have adequate information to determine the application.

3.7. Treaty of Waitangi

68. Section 12 of the EEZ Act states:

> *In order to recognise and respect the Crown's responsibility to give effect to the principles of the Treaty of Waitangi for the purposes of this Act,—*
>
> *(a) section 18 (which relates to the function of the Māori Advisory Committee) provides for the Māori Advisory Committee to advise the Environmental Protection Authority so that decisions made under this Act may be informed by a Māori perspective; and*
>
> *(b) section 32 requires the Minister to establish and use a process that gives iwi adequate time and opportunity to comment on the subject matter of proposed regulations; and*

[20] Section 61(5) of the EEZ Act
[21] Section 61(2) and (3) of the EEZ Act

> *(c) sections 33 and 59, respectively, require the Minister and the EPA to take into account the effects of activities on existing interests; and*
>
> *(d) section 45 requires the Environmental Protection Authority to notify iwi authorities, customary marine title groups and protected customary rights groups directly of consent applications that may affect them.*

69. In other words, the Treaty of Waitangi is taken into account in terms of both the decision-making process and its outcome.

3.8. International obligations

70. Section 11 of the EEZ Act states:

> *This Act continues or enables the implementation of New Zealand's obligations under various international conventions relating to the marine environment, including—*
>
> *(a) the United Nations Convention on the Law of the Sea 1982;*
>
> *(b) the Convention on Biological Diversity 1992.*

71. Among the other international conventions to which New Zealand is a signatory, and which are relevant to CRP's application, are the International Convention for Prevention of Pollution from Ships 73/79 (MARPOL), the Convention on the Conservation of Migratory Species (Bonn Convention) and the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (London Convention) which deals with radiological risks in the marine environment. The International Marine Minerals Society's Code for Environmental Management of Marine Mining (commonly known as the Marine Mining Code) and the International Council on Mining and Metal's sustainable development principles are also relevant.

72. The applicability of international conventions and laws to marine consent applications was the subject of much discussion during the hearing. The applicant's stance, outlined in its opening legal submission, was that to apply conventions not specified in the Act would be incorrect in law.[22] In CRP's view, Section 11 applied to all New Zealand's international obligations under international conventions, not just those listed in (a) and (b). The applicant considered that, in making a decision in accordance with the EEZ Act, the DMC would have implemented all New Zealand's international obligations.

[22] Paragraphs 234 – 240, Opening Submissions for CRP, 25 September 2014

73. The DMC received legal advice from its counsel on this issue.[23] The legal advice considered in particular the relevance of New Zealand's obligations under the Noumea Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (the Noumea Convention), which some submitters argued put New Zealand under certain obligations in relation to the assessment of risks associated with release of uranium.[24]

74. DMC's counsel considered that the risks associated with the release of uranium fell within the assessment required under Section 59 due to the potential for such releases to affect the environment within the meaning of Section 59(2)(a) or to affect human health within the meaning of Section 59(2)(c). Section 59(2)(l) required the DMC to take into account any other applicable law such as the Maritime Transport Act 1994, which deals with the dumping and storage of radioactive waste and other radioactive matter. Radioactive waste or other radioactive matter is defined in the Radiation Protection Act 1965 and it was the DMC's counsel's conclusion that the statutory language in the Radiation Protection Act should prevail.[25]

75. Counsel for Kiwis Against Seabed Mining Incorporated (KASM), Greenpeace New Zealand Incorporated (Greenpeace) and the Deep Sea Conservation Coalition (DSCC) took an alternative view. In his closing submission, Mr Currie suggested that the words *"continues or enables the implementation of New Zealand's obligations"* should be seen as evincing an intent that decision-makers under the Act should comply with New Zealand's international obligations. He argued that the DMC should take into account New Zealand's international obligations and international best practice, and in the exercise of its statutory discretion, strive to reach a decision consistent with them.[26] Mr Currie concluded that there was reasonably common ground that international instruments were relevant.[27]

76. The applicant was in general agreement with the conclusions of the DMC's counsel and accepted that, while international conventions might have some relevance in terms of providing guidance on best practice in relation to an industry or activity, they were not relevant as "*any other applicable law"* because international agreements are not part of New Zealand law unless incorporated into domestic legislation.[28]

77. The DMC took the view that decision-makers on marine consent applications were not required to do anything more than apply the decision-making criteria in the EEZ Act in order to

[23] Memorandum of Counsel to assist the DMC 12 November 2014
[24] Paragraphs 35 and 37, Statement of Evidence of Tara Ross – Watt on behalf of Te Rūnanga o Ngāi Tahu, 11 September 2014; and Paragraph 88, Opening Representation on behalf of Te Rūnanga o Ngāi Tahu, 25 September 2014
[25] Paragraph 21, Memorandum of Counsel to assist the DMC 12 November 2014
[26] Paragraph 9, Closing Submissions by KASM, Greenpeace and Deep Sea Conservation Coalition, 17 November 2014
[27] Paragraph 10, Closing Submissions by KASM, Greenpeace and Deep Sea Conservation Coalition, 17 November, 2014
[28] Paragraphs 110 – 111, Closing Legal Submissions for CRP Limited, 19 November 2014

implement New Zealand's international obligations. That view is supported by the Supplementary Order Paper describing the final changes to the section.[29] Although the EEZ Act does not explicitly preclude decision-makers from having regard to international instruments, it seems to the DMC that the direction provided in the EEZ Act must take precedence over guidance contained in an international instrument to which New Zealand is a signatory.

3.9. The EEZ Act and the Resource Management Act

78. A number of parties to this application have referred to precedents and case law involving the Resource Management Act 1991 (the RMA). There are indeed many parallels that may be drawn between the RMA and the EEZ Act. However, as noted in the Trans-Tasman Resources Marine Consent decision, there are significant differences between the two pieces of legislation.[30] For example, the Acts have different stated purposes; the term "*natural resources*" is defined more narrowly in the EEZ Act; and the EEZ Act does not refer specifically to either communities or social and cultural wellbeing as factors in decision-making. On the other hand, the EEZ Act is more explicit than the RMA in spelling out the matters to be taken into account, and information principles to be observed by decision-makers. Given these differences, it is important to be mindful that, while the precedents and case law which have developed in light of the RMA may be relevant, they cannot automatically be applied in an EEZ Act context.

[29] Explanatory Note, House of Representatives, Supplementary Order Paper No. 100 of 14 August 2012
[30] Paragraph 78, Trans-Tasman Resources Ltd Marine Consent Decision, June 2014

4. Chatham Rise Description

79. The DMC received a good deal of information from the applicant and submitters describing the nature of the Chatham Rise. It has summarised this information here to provide a brief overview of the natural environment.

4.1. Geomorphology

80. The Chatham Rise is a broad submarine ridge, that extends from the shelf off Banks Peninsula to beyond the Chatham Islands, with steeply sloping flanks rising to less than 500 m from water depths of more than 3000 m (the Hikurangi and Bounty troughs) (Figure 3). The crest of the Rise, which is relatively flat and generally at 350 – 450 m below sea level, averages approximately 130 – 150 km in width and covers over 100,000 km^2, or roughly the equivalent of two-thirds the area of the South Island.[31]

81. Smoothly sloping flanks are prominent features along the northern and southern sides of the Rise. The northern slope extends down to 2,500 m and is much steeper than the slopes to the south, which deepen gradually to approximately 4,000 m below sea level.

82. Local features along the crest of the Rise include several raised bank areas (eg Mernoo Bank, Reserve Bank, Veryan Bank), isolated groups of volcanic peaks or seamounts, occasional kilometre-scale sea-valleys and depressions on the flanks and the Chatham Islands which rise above sea level near the eastern end of the Rise.[32] 'Pockmark' fields have been discovered in several locations, some approaching 1 to 5 km across and 50 to 150 m deep. They are assumed to be the remnants of seabed degassing.[33]

83. Iceberg furrows are another feature of the Chatham Rise seabed. These were caused by icebergs that carved off the decaying Antarctic ice-sheet at the end of the five extreme glacial periods in the Pleistocene age. Some of the furrows are large, up to 25 km long, 200 m across and 10 m deep.[34]

84. The surface sediments on the Chatham Rise crest are predominantly glauconitic sandy muds or muddy sands, typically <1 m thick. These sediments bear phosphorite nodules which are generally in the 0.5 to >1 mm size-fraction, up to maximum diameters of 50 mm to 200 mm. Carbonate sediments are also present which are derived largely from the deposition of residual

[31] EIA, Section 1.1 and Paragraph 23, Evidence of Mr Sandy Bartle for Royal Forest and Bird Protection Society of New Zealand Incorporated, 12 August 2014
[32] Paragraph 25, Statement of Evidence of Dr Scott Nodder for CRP, 25 August 2014
[33] Section 5.4.3 of Appendix 12 of the EIA, Natural Sedimentation on the Chatham Rise, August 2012 (updated April 2013)
[34] Section 5.4.2, Marine Consent Application and EIA, May 2014

biological material (eg fragments of plankton and benthic foraminifera, molluscs and echinoderm fragments) over thousands of years. Underlying these surficial sediments are softened chalky limestones (ooze).[35]

85. The proportion of sand on the seabed is greatest towards the Chatham Islands, and muds become more dominant towards New Zealand. Compared to sedimentation rates of previous eras, modern sedimentation rates are relatively slow[36] and expected to be substantially less than estimates of 1 to 6 cm per 1000 years for the sediments sampled on the flanks of the Rise.

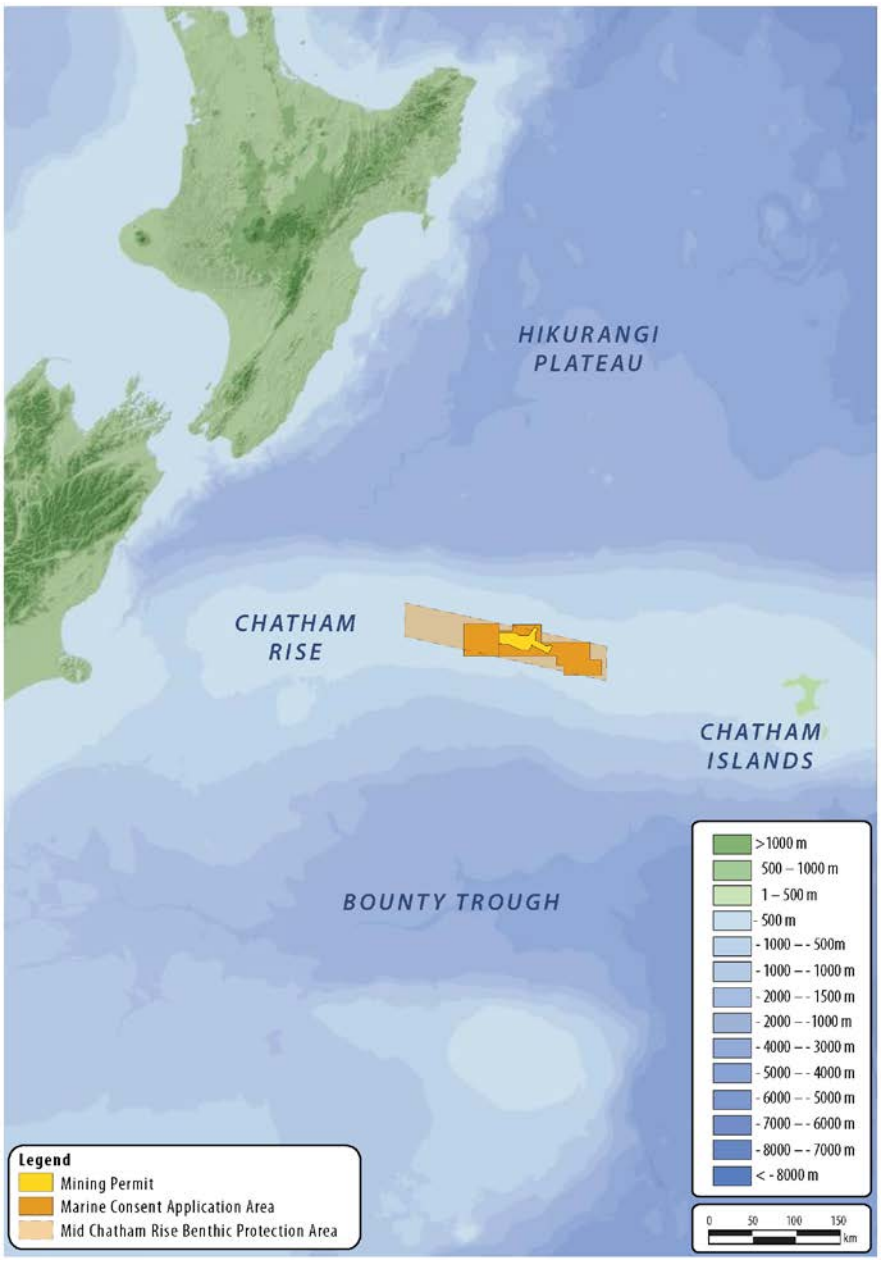


Figure 3. Map showing the location of the Chatham Rise in relation to other prominent ocean features and CRP's revised marine consent area.

[35] Section 5.6.3 of Appendix 12 to the EIA, Natural Sedimentation on the Chatham Rise (Nodder 2013).
[36] Section 4.1 of Appendix 11 to the EIA, Review of sediment chemistry and effects of mining (Golder 2014a)

4.2. Oceanography

86. The crest of the Chatham Rise lies beneath an area of the ocean where warm, saline subtropical water, flowing around northern New Zealand as the East Cape Current, mixes with cool and less saline, but nutrient-rich, sub-Antarctic water flowing around southern New Zealand as the Southland Current. The boundary between these currents is referred to as the Subtropical Convergence or Subtropical Front (STF), which flows in an easterly direction beyond the Chatham Islands before dipping to the southeast at the eastern end of the Rise.[37]

87. Typically, warmer water is found to the north of the STF and cooler water to the south, but eddies and intrusions of water from either side of the front into the other can occur at any time.

88. Over the Chatham Rise, the STF is relatively narrow (about 150 km wide) and limited vertically by the shallow bathymetry of the Rise relative to the ocean floor on either side. The STF featured heavily in the hearing and the DMC learned that it has a strong, possibly defining, influence on the ecology and productivity of the Rise.

89. Maximum ocean current velocities of up to 45 cm/s have been recorded near the seabed of the Rise, with the strongest flows associated with tides. Tides account for more than 70 % of the total variance of the flows measured at the applicant's mooring site within the consent application area. Tidal velocities at this site ranged from 10 cm/s near the bottom to 40 cm/s near the surface, and showed a fortnightly spring-neap cycle due to the difference in the lunar and solar semi-diurnal tidal period. Tidal currents changed direction every semi-diurnal tidal cycle (approximately twice a day). The direction of the flow moved anti-clockwise and changed in magnitude every tidal cycle.[38]

90. Internal (baroclinic) tides are associated with the vertical movement of density surfaces within the water column. Similar to surface (barotropic) tides, internal tides may be broken into higher modes (higher harmonics), each with a distinct vertical distribution of horizontal velocities that often extend to the seabed. Heath (1984) observed internal tides on the crest of the Chatham Rise with a M2 baroclinic signal accounting for about a quarter of the M2 tidal variance.[39]

91. Waters on the Chatham Rise and its flanks are vertically stratified, and both temperature and salinity display seasonal changes with water depth.

[37] Section 5.5.2, Marine Consent Application and EIA, May 2014
[38] Section 5.5.4.5, Marine Consent Application and EIA, May 2014
[39] Heath RA 1984. Summary of Current Observations from the Chatham Rise (SO-17 Cruise). Geologishces Jahrbuch 64: 25 – 26. Cited in Marine Consent Application and EIA, May 2014

4.3. Ecology and productivity

92. Water quality on the Chatham Rise is good, with low turbidity and relatively high dissolved oxygen levels. Water temperatures are coldest at depth (between about 3 and 4.5 °C) rising to between 11 and 14 °C at the surface. Temperatures are higher on the north side than the south by about 2 °C. Nutrient levels show the contrast between high nutrient sub-Antarctic waters over Campbell Plateau and Bounty Trough and low nutrient subtropical waters north of the Chatham Rise.[40]

93. The Chatham Rise is highly productive compared to the surrounding waters and, in general, other parts of New Zealand's EEZ. The subtropical front has a strong influence on this biological productivity. Elevated phytoplankton productivity is attributed to the presence of the STF, which is 'locked' to the Rise by its bathymetry. The mixing of nitrate-depleted subtropical water with nitrate rich sub-Antarctic water in the Chatham Rise region leads to this elevated phytoplankton productivity, which supports a complex ecosystem including deep-water fisheries, an unusually rich benthic environment and significant seabird and marine mammal populations.[41] Dr Pinkerton described the Chatham Rise food web as complicated, involving thousands of species interacting at a variety of spatial and temporal scales. Sizes of individuals and population biomasses on the Rise span more than four orders of magnitude (ie they vary by more than a factor of 10,000).[42]

94. Phytoplankton can be considered the engine of the Chatham Rise food chain. They are present in the upper-lit section of the water column and are preyed on by a diverse array of zooplankton species and represent food for a range of larger invertebrates (including squid and benthic dwelling organisms), fish and some species of whale. Mr Bartle told the DMC how all oceanic birds, fish and squid that live in the open ocean are totally dependent, firstly on phytoplankton production and, secondly on the efficient grazing of phytoplankton by zooplankton, leading to a consequential increase in abundance of the latter.[43]

95. Zooplankton animals are short-lived, with some living for only a few days and most for less than one year. If they are not consumed by other pelagic animals they fall to the seabed as detritus and provide a food resource for benthic organisms. The Chatham Rise benthic environment is regarded as one of the most studied in New Zealand's EEZ. While many benthic species from the Rise are yet to be identified, a number of benthic communities, some of which are not known outside of the Chatham Rise crest, have been identified through surveys. The sea surface temperature gradient (SST) is known to be particularly important in structuring benthic

[40] Section 5.7.5, Marine Consent Application and EIA, May 2014
[41] Section 2.1 of Appendix 22 to the EIA, Ecosystem Modelling of the Chatham Rise, April 2013
[42] Paragraph 33, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014
[43] Paragraph 48, Evidence of Mr JA (Sandy) Bartle for Royal Forest and Bird Protection Society of New Zealand Incorporated, 12 September 2014

communities across a wide area of the central Chatham Rise,[44] and there are different biological communities existing on the northern and southern slopes of the Rise. These differences have been attributed to the differing quantity and quality of benthic flux generated from the water masses on either side of the STF. There also appears to be a positive relationship between biodiversity in the benthic environment and the presence of phosphorite nodules, most likely reflecting the dependence of sessile (immobile) epifaunal organisms such as stony corals, brachiopods and bryozoans on hard substrate for attachment. The DMC discusses these relationships in more detail in Chapter 8.

96. The productive food chain of the Chatham Rise supports valuable deep water commercial fisheries, primarily for hoki, orange roughy, ling and oreo species. Other fish species are also caught on the Rise. Differences in the distributions of some deepwater fish species exist between the north and south sides of the Rise. Spawning grounds and nurseries for some commercial fish species (eg juvenile hoki) occur on the Rise, particularly the flanks. A scampi (a form of crustacean that build burrows in the seabed) fishery was established in the 1980s. The commercial importance of these fisheries is reflected in the level of fisheries and environmental research that has been undertaken in the area.

97. A number of fishing methods are employed on the Rise, including bottom and midwater trawling and bottom longlining. Most bottom trawling occurs along the flanks of the Rise.

98. The fisheries of the Chatham Rise are well known for their ecological importance. More than 200 species of fish have been identified.[45] Fish species of the Rise have been grouped by scientists into nine ‘guilds’ based on their method of feeding and target prey (eg jellyfish, squid, shrimps and other crustaceans or smaller fish species).

99. The Chatham Islands are renowned for their local inshore fisheries, particularly paua, rock lobster, and blue cod. These and a range of other species support commercial, traditional, recreational and tourism fisheries.[46]

100. Marine mammals (cetaceans) have been observed along the Chatham Rise, although there has been no systematic study of their distribution. The majority of the recorded sightings of cetacean are of sperm whales and pilot whales, which prefer the Chatham Rise slopes where they forage in steep slope habitat. Various other species of dolphins, baleen whales and beaked whales use and transit through the area, including killer whales and southern right whales.[47]

[44] Section 6.3.3.2, Marine Consent Application and EIA, May 2014
[45] Section 6.6.2, Marine Consent Application and EIA, May 2014
[46] Section 6, Marine Consent Application and EIA, May 2014
[47] Section 6, Marine Consent Application and EIA, May 2014

Recent habitat modelling has revealed that the southern edge of the Chatham Rise is an important foraging ground for southern right whales during summer and autumn. There is some evidence that several species of cetaceans have a strong regional linkage to the environment on the south flank of the Chatham Rise.[48] An abundant food supply appears to be one of the main attractants of cetaceans to the Rise.

101. Observations of whales off the South Island eastern coast near Kaikoura led to the establishment of a thriving eco-tourist industry in 1987, centred on sperm whales. This and other whale species that frequent the area are known to range across the Chatham Rise.

102. The Chatham Rise is widely regarded as one of New Zealand's most important seabird areas.[49] Fifty-two seabird species or sub-species have been observed on the Chatham Rise. This number of species represents 70 % of the seabirds that regularly breed in the New Zealand area. By comparison, only seventeen oceanic species live and breed in the much larger temperate North–east Atlantic area.

103. Most New Zealand albatross and petrel species are present on the Chatham Rise. The only New Zealand seabirds not seen there are tropical or subtropical. At least three species that nest on the Chatham Islands are considered rare or endangered. A number (such as albatrosses and petrels) travel large distances and breed on land well away from the Rise, in some cases many thousands of kilometres away.[50]

[48] Section 6, Marine Consent Application and EIA, May 2014
[49] Paragraph 207, Evidence of Mr JA (Sandy) Bartle for Royal Forest and Bird Protection Society of New Zealand Incorporated, 12 September 2014; Issue 2, Joint Statement of Experts in the Field of Seabirds, 23 September 2014.
[50] Section 6.9, Marine Consent Application and EIA, May 2014

5. The Mining Proposal

5.1. The mining proposal

5.1.1. The proposal

104. In order to understand the effects of the proposed activities on the environment and existing interests, the DMC considered it important to first understand the mining proposal itself. Detailed information on this was provided by the applicant and Boskalis in the initial application, in responses to the DMC's requests for further information and at the hearing. The following summary draws on the applicant's and Boskalis' statements and testimony**.**

105. The applicant envisaged a contract mining model whereby the dredge operator would be responsible for the capital costs of the dredging venture, manage the mining activities and be responsible for all mining costs, including maintenance. To cover the dredge operator's capital and operating costs and provide a profit margin, the dredge operator would charge CRP a tonnage-related fee. CRP's only significant assets would be the mining permit and the marine consent, and its funding responsibilities would be confined to head office expenses and costs such as licence fees.

106. The DMC was told that, although no contract had yet been finalised, Boskalis was CRP's preferred partner to build and operate the dredging vessel, having already undertaken significant work on the proposal with CRP. However, if Boskalis elected not to maintain its involvement, CRP had received expressions of interest from four other dredging specialists. For its part, Boskalis confirmed its commitment to working with CRP on this proposal. To reflect expected international interest in the proposal, CRP was planning a listing on the London Stock Exchange once marine consent was granted.[51]

107. Mr van Raalte, a Senior Expert at Boskalis / Hydronamic bv in the Netherlands, told the DMC that the proposed mining process would use existing state of the art techniques applied in a new context.[52] The mining concept was based on conventional trailing suction hopper dredger operations widely used around the world to dredge seabed materials.[53] Although this technology and equipment had been widely used at depths of up to 150 m, it was confirmed to the DMC by Mr van Raalte that it had not previously been used anywhere in the world at the depths envisaged on the Chatham Rise.[54]

[51] Edison Investment Research Report of 29 May 2014 https://www.nzx.com/markets/NZAX/securities/CRP/analysis and Paragraph 70, Statement of Evidence of Christopher David Castle for CRP, 28 August 2014
[52] Paragraph 149, Statement of Evidence of Gerard van Raalte for CRP, 28 August 2014
[53] Paragraph 2, Statement of Evidence of Gerard van Raalte for CRP, 28 August 2014
[54] Paragraph 114, Statement of Evidence of Gerard van Raalte for CRP, 28 August 2014

108. A trailing suction hopper dredger was to be employed, and the mined material would be pumped up to the vessel through a flexible hose or riser. The vessel, (a converted bulk material carrier or tanker built or modified specifically for deep seabed mining) would be equipped with an on-board separation system which separated the phosphorite nodules from the finer sediments. The phosphorite would be stored on board for transportation to shore and waste material returned to the seabed through a sinker with a diffuser.[55]

109. The mining system design required knowledge of the nature of the sediments and their physical properties as well as the shape of the sea floor. The phosphorite nodules are loosely distributed within a layer of glauconitic sand. The glauconitic sand is about 20 cm thick on average but ranges up to a maximum of 70 cm. The sand comprises 20 – 40 % silt and 30 – 60 % fine or very fine sand. The thickness of the glauconitic sand varies significantly over distances of tens of metres or less, and the concentration of nodules varies both vertically and laterally. Underneath the sediment layer is an ooze or chalk layer, which is usually stiffer than the sediment layer.[56]

110. The dredging unit would consist of a pumping unit and suction pipe (riser) with a drag-head. The pumping unit would be suspended above the seabed, with the drag-head being trailed over the seabed. One pump would suck up the seabed material and another push the mixture through the riser to the mining vessel. A third pump would provide the jet water for the drag-head. The total pump power was estimated to be 10 to 12 MW.[57]

111. The drag-head would be about 5 m wide and 1 m long. Jets would direct high-pressure water into the seabed to loosen and fluidise the sediments, which would be vacuumed up through the riser using pumps. The internal diameter of the riser would be approximately 750 mm. The jet water pressure and flow could be modified to account for differences in sediment properties and to reduce disturbance of the underlying ooze or chalk layer. The drag-head would not have cutting teeth to assist in breaking up the sea floor as this would risk cutting into the chalk–ooze layer. The number and size of the jets could be modified.[58]

112. The drag-head design was based on laboratory testing of the effectiveness of the jet size and power to fluidise the seabed material in order to collect phosphorite nodules from a layer that varied in thickness from 0 to 50 cm (35 cm on average) while avoiding dredging the underlying chalk-ooze layer. Where the sediment was thicker than 50 cm, the drag-head would not be able to mine the entire layer and would therefore leave some of the phosphorite behind.[59]

[55] Paragraph 28, Statement of Evidence of Gerard van Raalte for CRP, 28 August 2014
[56] Paragraphs 29 – 31, Statement of Evidence of Gerard van Raalte for CRP, 28 August 2014
[57] Paragraph 34, Statement of Evidence of Gerard van Raalte for CRP, 28 August 2014
[58] Paragraphs 36 and 38, Statement of Evidence of Gerard van Raalte for CRP, 28 August 2014
[59] Paragraph 44, Statement of Evidence of Gerard van Raalte for CRP, 28 August 2014

113. The pump-frame, riser and drag-head would be suspended from the ship on four steel wires: two connected to the pump-frame, one to the drag-head end of the riser and one to the forward end of the riser. The total weight of the pump-frame would be of the order of 300 tonnes and the expected force on the sea floor was 15 – 20 tonnes.

114. Pre-mining seabed surveys and core samples to be collected within the mining blocks would provide information about sediment depth and the stiffness of the underlying layer so that the mining operations could be adjusted in order to minimise contact with the chalk-ooze layer.[60]

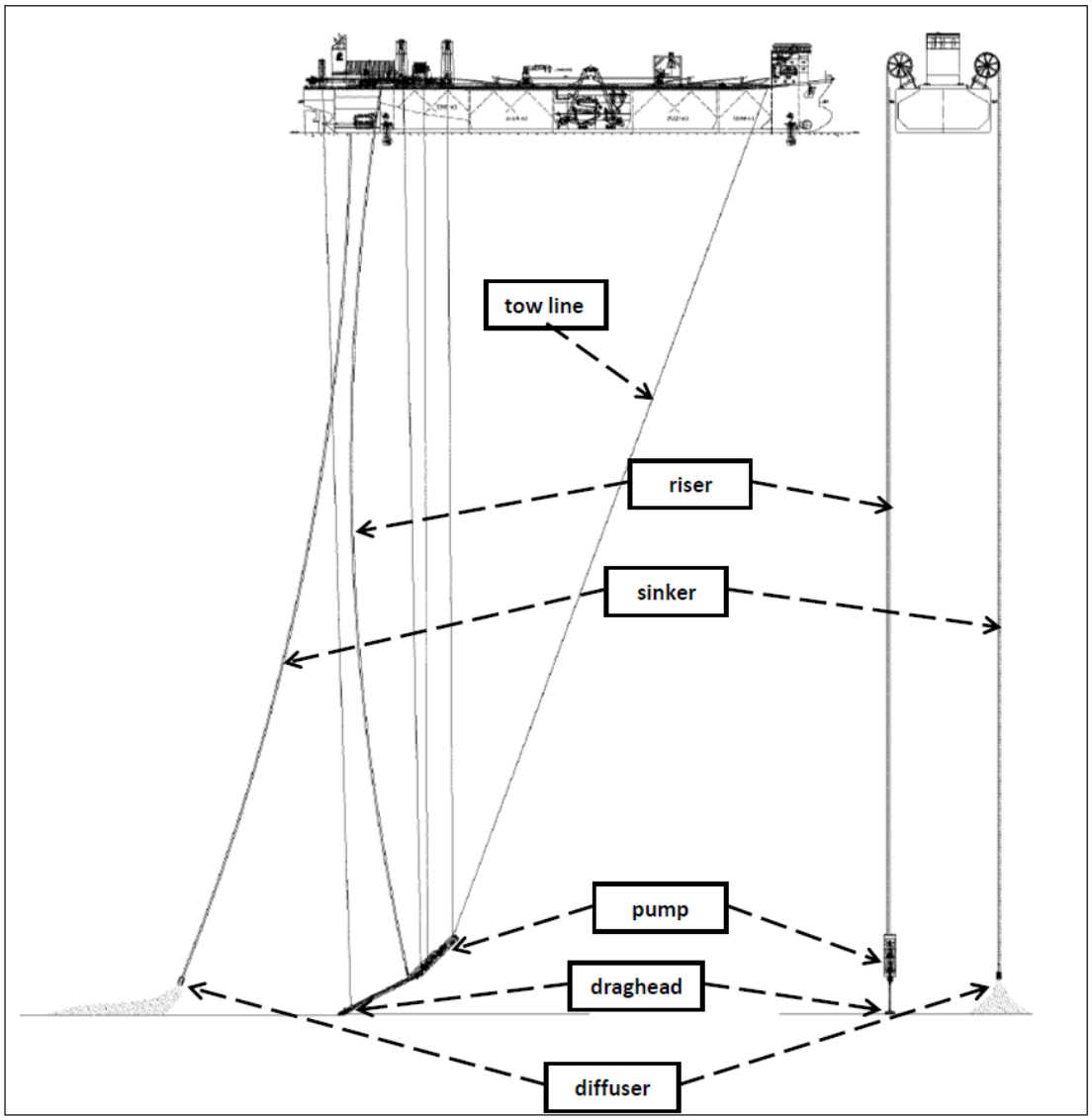


Figure 4. Diagram of the CRP mining proposal. (Source: Figure 5, Evidence from Gerard Van Raalte for CRP, 28 August 2014)

[60] Paragraphs 83 – 86, Statement of Evidence of Gerard van Raalte for CRP, 28 August 2014

115. After being pumped up to the mining vessel, all seabed material would be processed on board by a nodule separation plant. The plant would contain three or four parallel processing streams for coarse fraction separation, and a set of log-washers and two to four processing streams for finer fraction separation. The exact configuration of the processing streams would depend on the vessel design. No chemicals would be used in the processing system and no new or untested components would be used.[61] A screen on the drag-head would ensure that material greater than 150 mm would not be taken onto the vessel but would remain on the seabed. [62]

116. After extracting the phosphorite nodules, sediments less than 2 mm in size would be returned to the seabed via a sinker pipe positioned approximately 10 m above the seabed. The sinker pipe would be some 750 mm in diameter. A diffuser would limit turbidity and the spatial extent of the sediment plume. The release height of the discharge was expected to vary between 8 and 12 m from the bottom (10 m on average). A clump weight of some 50 tonnes would be attached to the sinker pipe to hold it in position.

117. Mining would take place in long parallel tracks with a 180 degree turn at each end, thereby forming a pattern of stretched ovals. In an optimised dredging process the drag-head would be kept on the seabed as long as possible, and so it would be preferable to dredge straight tracks with a section length as long as possible before turning. The central part of the oval and the curved ends would not be mined.[63] The mining pattern is shown in *Figure **5*** below.

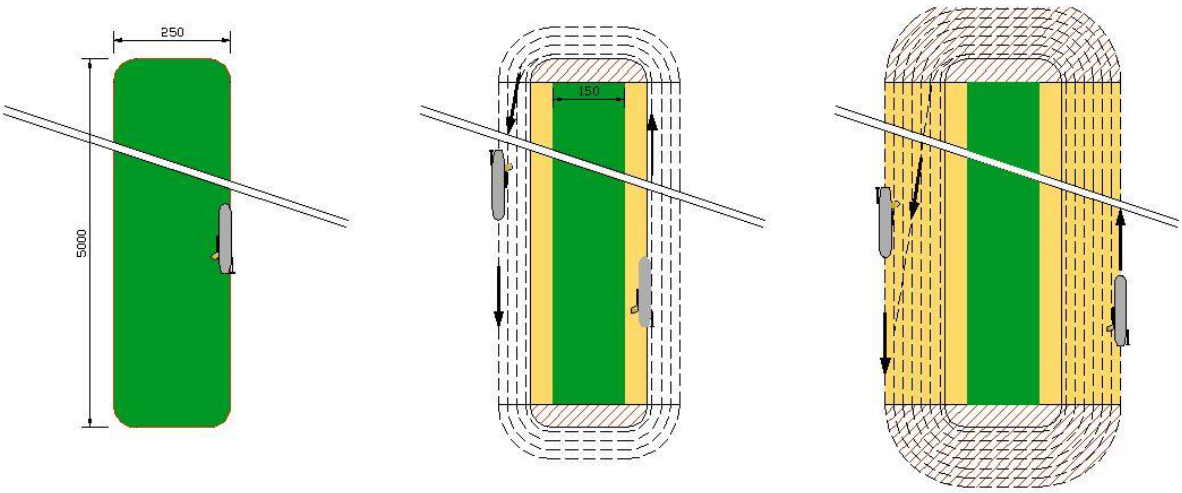


Figure 5. Mining pattern – "spiralling out". The green area is not mined and the yellow areas are mined or have sediment deposited directly on them. (Source: Statement of Evidence from Gerard Van Raalte for CRP, Figure 8)

[61] Paragraph 46, Statement of Evidence of Gerard van Raalte for CRP, 28 August 2014
[62] Section 4.4.3, Marine Consent Application and EIA, May 2014
[63] Paragraphs 58 – 59, Statement of Evidence of Gerard van Raalte for CRP, 28 August 2014

118. The mining vessel would operate on an approximately 10 day cycle, and would be expected to complete about 30 trips per year, allowing for unforeseen events and weather disturbance. Cycles would consist of:

- mining, onboard processing and hopper filling (4 to 5 days)
- transit to port (1.5 days)
- offloading and re-provisioning (3 days)
- transit to Chatham Rise to commence the next mining cycle (1.5 days).[64]

119. The port location had not yet been decided but several ports on New Zealand's east coast were being considered. A final decision would not be made until a vessel was chosen.[65]

5.1.2. Operational parameters

120. The proposed mining operation would require accurate positioning and movement of the drag-head and diffuser to follow the Mine Plan, avoid the chalk-ooze layer and maintain the discharge at the required height above the seabed. The position of the vessel and drag-head would primarily be controlled by a dynamic positioning and tracking system on the vessel, in conjunction with two electrically driven thrusters on the drag-head.[66]

121. The DMC asked the applicant for more information on the measures proposed to ensure that the mining operation remained within the agreed parameters, for example for the depth of cut of the drag-head (0.5 m) and non-disturbance of the chalk layer.[67]

122. In response, the applicant explained that there were a number of possible design solutions but they were constrained by geological and engineering factors such as limitations on the size of the pumps that could be installed and engineering and economic limits on the size of the riser and sinker pipes and on the processing plant on board the mining vessel. Ongoing monitoring and assessment of the performance of the systems would be required to minimise environmental impacts.[68]

[64] Paragraph 9, Statement of Evidence of Gerard van Raalte for CRP, 28 August 2014
[65] Paragraph 123, Statement of Evidence of Gerard van Raalte for CRP, 28 August 2014
[66] Paragraph 33, Statement of Evidence of Gerard van Raalte for CRP, 28 August 2014
[67] DMC Request for Further information, 25 July 2014
[68] Section 4.2.1, Response to the DMC's Request for Further Information (Part 1), August 2014 (date on EPA website – 8 August 2014)

5.2. Operational control

5.2.1. Monitoring and compliance with thresholds

123. One of the objectives of the proposed monitoring activities was to collect further information on background environmental conditions in the marine consent area in order to measure the effects of the mining activities. The applicant's plan for this monitoring was set out in the EIA, in the proposed conditions and in the evidence of Mr Wood.[69]

124. Monitoring would include:

- long-term oceanographic information (turbidity, current speed and direction, temperature, conductivity and pressure) and sedimentation data
- water turbidity (suspended solids) prior to, during and after mining
- benthic ecology monitoring to assess the impacts of mining outside the mining blocks
- benthic ecology monitoring to assess the nature and rate of recolonisation inside the mining blocks
- sound levels of the mining vessel and mining system.

125. Mr Steenbrink from Boskalis told the DMC that monitoring at this depth and distance from the shore would present difficulties.[70] Some oceanographic data (total suspended solids (TSS), turbidity, current speed and directions, temperature, conductivity, pressure, sedimentation) would be collected by mooring landings at various sites. Other data would be collected using an underwater survey vehicle or Autonomous Underwater Vehicle (AUV) equipped with sensors. Sediment traps would be used to collect sediment near the sea floor. Surveys would take place every six months for the initial two years, then annually.[71]

126. Monitoring impacts outside of the mining blocks to identify spatial changes in benthic habitats and the marine environment as a result of the mining activities would include targeted observations of the seafloor and seafloor sampling. These surveys would take place every three months for the initial 18 months of mining and once a year thereafter.[72]

127. Spatial changes in the marine environment would be monitored with photographs and data collected at monitoring sites. The applicant outlined in its proposed conditions the monitoring activities it intended to undertake. It proposed to forward a detailed plan to the Chief Executive of the EPA for certification prior to monitoring commencing.[73]

[69] Paragraphs 80 – 88, Statement of Evidence of Raymond Allen Wood for CRP, 28 August 2014
[70] Paragraph 33, Statement of Evidence of Sander Steenbrink for CRP, 28 August 2014
[71] Paragraphs 85 – 86, Statement of Evidence of Raymond Allen Wood for CRP, 28 August 2014
[72] Paragraph 87, Statement of Evidence of Raymond Allen Wood for CRP, 28 August 2014
[73] Paragraph 88, Statement of Evidence of Raymond Allen Wood for CRP, 28 August 2014

5.2.2. Best practice

128. Boskalis described its record in carrying out proposals requiring complex sediment processing and affirmed its commitment to research and development and environmental protection.[74] It also described its commitment to vessel safety and described a new programme introduced recently to improve its safety culture.[75]

129. Boskalis confirmed that the operation on board the vessel would adhere to international laws and standards (specifically MARPOL) as well as any additional requirements under New Zealand law. A detailed environment and management plan would be drafted and agreed before mining started. This would cover oily water, hazardous substances, wastewater, garbage (solid waste), emissions to air, ballasting and hull bio-fouling.[76]

130. Mr Ross-Watt for Te Runanga o Ngai Tahu (Ngāi Tahu) identified a number of good practice codes and guidelines that might be appropriate - for example, the International Marine Minerals Society's Code for Environmental Management of Marine Mining (IMMC), the Noumea Convention, the London Protocol and the Mining Code issued by the International Seabed Authority.[77] Some of these codes and guidelines had not been incorporated into New Zealand law. However Mr Ross-Watt considered that they would have some value as further guidance on international standards and good practice.[78]

5.3. Submitters' concerns

131. A number of submitters and participants in the hearing expressed concerns and reservations about the proposed mining operation. It was noted by several parties that no seabed mining operation had been undertaken anywhere in the world at such depths.

132. The question was raised whether the laboratory experiments and design work done by Boskalis accurately reflected the sea and weather conditions of the Chatham Rise. Wave heights for example would affect the movement of the ship and consequently the height of the discharge pipe above the seabed. Submitters also questioned if the speed that the sediment would enter the benthic environment could be accurately estimated, particularly as detailed design of the diffuser and other components had not yet been completed. Boskalis' ability to control the depth of mining to avoid the chalk-ooze layer was a concern shared by many submitters, particularly given the rugged terrain and varying depth of this layer. Mr Christensen noted that the level of

[74] Paragraphs 69 – 95, Statement of Evidence of Sander Steenbrink for CRP, 28 August 2014
[75] Paragraph 94, Statement of Evidence of Gerard van Raalte for CRP, 28 August 2014
[76] Paragraph 12, Statement of Evidence of Gerard van Raalte for CRP, 28 August 2014
[77] Paragraph 15, Statement of Evidence of Mr Tara Ross-Watt on behalf of Te Rūnanga o Ngāi Tahu, 11 September 2014
[78] Paragraph 111, Closing Submissions for CRP, 19 November 2014

sensitivity with a heavy drag-head, arm and clump weight at 400 m depth was astonishing[79]. Concerns were raised that all these issues associated with the physical mining process could have flow on implications for the accuracy of the modelling of sediment dispersion.

133. The noise associated with the seabed material passing through the riser and sinker pipes was a concern to some submitters, as was the overall noise level associated with the mining process.

134. Mr Currie, representing Greenpeace, the Deep Sea Conservation Coalition and Kiwis Against Seabed Mining raised concern over which flag the mining vessel would fly and the implications for adherence to which regulatory system[80], Mr van Raalte stated that normally Boskalis' larger vessels sailed under the Cyprus flag. Mr Currie suggested that Cyprus was known as a flag of convenience, making liability compensation potentially difficult to obtain in the event of unforeseen circumstances.[81]

135. Concern was also expressed by a number of parties to the application about the absence of a contractual arrangement between CRP and Boskalis with regard to the mining operation. Although Boskalis had been involved with CRP for a number of years, and through a subsidiary was a significant shareholder of CRP, there was no absolute assurance that Boskalis would be undertaking the mining.[82]

5.4. DMC findings

136. Although both the applicant and Boskalis had gone to considerable lengths to provide information about the mining operation, the DMC was left with a number of uncertainties. Many of these stemmed from the fact that this was the first proposal of its kind in the world to be undertaken at such depths and the heavy reliance placed on incompletely validated modelling.

137. Prominent among the DMC's concerns were the technical and practical uncertainties associated with the mining operation itself. For example, controlling the extent of sediment dispersion would depend largely on avoiding the chalk-ooze layer and maintaining the discharge diffuser at the required height above the seabed. Achieving this would require accurate positioning and movement of the drag-head. However the testimony given by Mr van Raalte provided the DMC with only qualified reassurance: *"As dredging or dredge-mining has not been attempted at depths of 400 m, a system has been designed on best available practices, supported by dedicated studies and expert assessments.*

[79] Page 2, "CRP's Mining Proposal – What will we Get?" from the Closing Submission of Mr Christensen on behalf of Te Rūnanga o Ngāi Tahu, 18 November 2014
[80] Lines 37 – 40, page 608 of the Transcript, 1 October 2014
[81] Lines 14 – 17, page 610 of the Transcript, 1 October 2014
[82] Lines 45 – 1, pages 205 – 6 of the Transcript, 26 September 2014

In my opinion, the system is able to cope with the variable seabed conditions, and will, whilst operating, provide adequate survey data for further optimisation and fine-tuning of the processes. The initial phase of mining will be used as a pilot / prototyping period to test and optimise the system in all conditions."[83]

138. The applicant also acknowledged that monitoring at this depth and distance from shore would present challenges. The monitoring programmes Boskalis had deployed on other proposals around the world would not be possible on the Chatham Rise.[84] The absence of a detailed and approved mining plan, monitoring programme and adaptive management until shortly before the commencement of mining, while understandable in terms of the process being followed, would leave a great deal to be resolved well after the conclusion of the consent process.

139. The DMC acknowledges that the outline mining plan and proposed conditions went some way towards addressing the risks and uncertainties of the mining operation. Proposed Condition 9, for example, would limit the number of vessels and the areas of the seabed to be mined. The applicant had decided to limit the drag-head to a single pass and to forego the use of cutter teeth in the drag-head. Other mitigations and safeguards were also proposed.

140. Proposed Condition 10 would restrict the mining area for the first five years of mining. The DMC agree with EPA staff that this proposed condition would have needed strengthening, for example by linking the five year period to the notification of the commencement of mining as required by Proposed Condition 5,[85] and by the inclusion of details of the location of the proposed exclusion zones prior to mining commencement.

141. Proposed Conditions 25 to 28 required a Mine Plan to be developed which contained details of the operation such as the mining method, the separation method for seabed material, the method used to return processed material from the mining vessel to the seabed, management and maintenance requirements for key components and the precise location of areas to be mined as well as those to be avoided.

142. As indicated above, it might have answered some of the questions raised by submitters and resolved some of the uncertainties if it had been possible to run a pilot mining proposal over a limited period in order to verify Boskalis' initial design work. Such a test pilot was not however deemed viable by the applicant because of the initial investment required.[86]

[83] Paragraphs 114 and 115, Statement of Evidence of Gerard van Raalte for CRP, 28 August 2014
[84] Paragraph 33, Statement of Evidence of Sander Steenbrink for CRP, 28 August 2014
[85] Page 4, EPA Comment on CRP Proposed Conditions, 14 November 2014
[86] Line 45, page 2594 of the Transcript, 19 November 2014

143. The DMC acknowledges that the conditions and adaptive management approach proposed by the applicant in respect of the mining operation covered many of the points that would have needed to be covered. At the same time, there were a number of gaps that would have needed to be filled and some proposed conditions that would have required significant modification and development in order for the DMC to be confident that it knew what kind of operation it was authorising, and with appropriate safeguards. Since the DMC concluded after reviewing all the evidence and testimony that the application could not be approved (on grounds largely independent of the mechanics of the mining operation), the DMC did not consider it necessary to either seek more information from the applicant or ask the applicant to undertake further work on the proposed conditions and adaptive management regime relating to the mining operation.

6. Reliance on Modelling and Monitoring

144. A significant feature of this application was the applicant's extensive reliance upon modelling and (largely) post-operational monitoring in the absence of, or additional to, what might be considered necessary empirical or observational evidence.

6.1. Modelling

145. There is no question that the use of modelling is appropriate both legally under the EEZ Act and technically in order to produce forecasts and predictions and to reduce levels of uncertainty. However, the extent to which reliance is placed upon modelling in this particular application is unusual. Moreover, there were questions about the reliability of some of the models used, particularly as much of the data was manifestly far from complete and in many cases the results of the modelling had not been field tested.

146. Modelling underpinned assessments of effects in the following key areas:

- oceanography / hydrodynamics
- sediment plume dynamics and sedimentation
- species' trophic relationships
- operational noise propagation and marine mammals
- benthic species' distribution
- commercial fish species distribution and population
- habitat prediction and spatial planning
- economic benefits
- ecotoxicology and human health
- the mining operation itself at depth.

147. Mr Winchester noted in opening that: "*Use of modelling in predictions is relatively common even in a terrestrial context. For many effects modelling and predictions based on existing data and observations are the best and only reasonable way to assess the nature or degree of impacts and frequently value judgments made by experts are imposed on top of the model outputs to reflect the context and environment*." [87]

148. The DMC agrees with that statement, as did most if not all of the technical experts who gave evidence. Certainly there was disagreement on particulars, scepticism expressed about aspects of the mechanics and dispute as to how far reliable conclusions could be drawn. What concerned many experts, including some of CRP's own witnesses, was the absence of "*ground-*

[87] Paragraph 42, Opening Submissions for CRP, 25 September 2014

truthing" of some of the more important models, which might have been internally verified but lacked empirical validation and more complete data collection.

149. For example, the Joint Statement of Experts in the Field of Sediment Modelling agreed that: "*at present the model has not been calibrated nor validated against a measured discharge sediment plume*" [88], and that "*Uncertainty pertaining to the model source terms and parameterization of the discharge sediments could be reduced by carrying out a model validation on the plume*." [89]

150. Those experts concluded, with respect to adaptive management, that "*it should also be required that any subsequent plume model, utilised to decide whether to extend the mining area, is validated and implemented to demonstrate the ability to meet the SSC and sedimentation thresholds ...*" [90]

151. Further, the Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning agreed that "*lack of ground-truth verification of the model predictions in locations where there is a lack of underlying data*" could be addressed "*with targeted sampling in areas informed by the model predictions*". [91]

152. The DMC discusses the particulars of the models, where those are especially important to its determination, under their individual topic areas.

153. Throughout the hearing, the extent of empirical verification was a common concern among expert and lay witnesses alike. A number of parties opposed to the application asserted that there was too much uncertainty about the modelling for the consent to be granted. The DMC does not agree with Mr Winchester that uncertainty was merely a convenient and overused "*buzz word*". [92] The DMC does however agree that beyond uncertainty lie risk and consequences that need to be assessed. A question the DMC sought to address was whether all the modelling, validated to the extent that it was internally or empirically, brought the DMC sufficiently close to closing the gaps between uncertainty, risk and consequence that the consent could be granted.

154. In that regard the DMC acknowledges that the applicant's final set of proposed conditions incorporated a number of field and *in situ* trials and surveys to ground-truth model predictions in

[88] Issue 6, Joint Statement of Experts in the Field of Sediment Modelling, 26 September 2014
[89] Issue 6, Joint Statement of Experts in the Field of Sediment Modelling, 26 September 2014
[90] Issue 6, Joint Statement of Experts in the Field of Sediment Modelling, 26 September 2014
[91] Issue 4, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014
[92] Paragraph 47, Opening Submissions for CRP, 25 September 2014

key areas. As was pointed out however, the results of this monitoring and these surveys would not be known until after the mining operation was underway.

155. The hearing produced two main schools of thought on the matter of field validation: those who thought that this could reasonably be accomplished as part of operational mining with the necessary review loops, and those who thought it must be done prior to operational mining so that the activity would avoid unanticipated adverse consequences and not have to resort to reactive management of those consequences.

6.2. Monitoring

156. The initial application included as Appendix 35(i) a draft Environmental Management and Monitoring Plan (EMMP) which indicated monitoring of:

- water quality and oceanographic information, including
- baseline and turbidity data collection
- water column turbidity associated with mining
- ecological impacts outside the mining area
- recolonisation, including
- recolonisation after mining
- hard substrate trials.

157. The proposed monitoring programme was further amended during the hearing to include such matters as:

- composition of mined phosphorite nodules
- mining block ground-truthing
- sediment chemistry in areas to be mined
- toxicity testing
- on-board coarse material screening organic content
- discharge water quality
- baseline seawater quality
- baseline oceanographic information, including currents, temperature and salinity
- water turbidity (suspended solids) prior to, during and after mining
- benthic communities
- recolonisation
- colonisation of new substrate
- fish trace element uptake
- subsurface noise.

158. This EMMP was then replaced by a proposed monitoring Schedule 2 to the conditions, which included the following areas:

2A — Prior to Commencement — Baseline:

- noise / sound
- water quality
- water quality and oceanographic (fixed moorings)
- bathymetry in MPA — completion
- mining exclusion area ground-truthing.

2B — During Mining Operations:

- elutriate testing
- toxicity testing
- noise / sound
- water quality and oceanographic (fixed moorings)
- plume water quality
- sediment composition
- discharge of processed material from the mining vessel
- ecological impacts outside of mining area
- trace elements in key commercial fish on the Chatham Rise
- hard substrate trials.

2C —To meet staged Adaptive Management Survey Requirements:

- bathymetry
- seabed composition
- benthic ecology
- oceanographic.

159. While this evolution in the sophistication of the monitoring proposed was a welcome and expected part of the hearing process, it served to emphasise that significant additional data, testing and refinement of the operation and its effects would be necessary and remained to be developed in detail.

7. Sediment Dispersion and Sedimentation

7.1. Background

160. One of the principal issues associated with the proposal was the acknowledged adverse effects on the benthic environment (discussed in Chapter 8.1) associated with the removal of seabed surface sediments and sediments immediately below the surface (ie the act of dredging). Equally contentious were potential adverse effects associated with the deposition of sediment tailings back on to the seabed following the removal of phosphorite nodules (ie sedimentation) and the production of suspended sediments within the water column (ie a sediment plume) associated with the discharge of sediment tailings from the sinker line via a diffuser positioned at a nominal height of 10 m above the seabed.

161. A number of submitters expressed concern about the dispersion of sediment tailings and what effect it might have on various aspects of the Chatham Rise ecosystem. For example, long-line fisherman Mr Summerton was concerned about the direction and distance of travel of the sediment plume.[93] Other submitters expressed concern about effects on plankton (eg Mr Bartle), benthic organisms (eg Dr Berkenbusch) and various other components of the Chatham Rise ecosystem. This was a critical issue for many submitters and there was considerable information presented in the applicant's EIA and at the hearing on the merits of the approach used and the findings of the applicant.

162. As there is no existing or previous comparable mining operation in place, or data on how discharges of sediment might behave on the Chatham Rise, the applicant commissioned a series of studies modelling the dispersion and sedimentation from the mining vessel's discharge. Such an approach required a number of assumptions associated with how the mining operation would proceed as well as information on the receiving environment such as current and tidal movements and sediment particle character associated with the discharge. Issues associated with model validation and sediment monitoring were addressed, and the DMC summarises that information below together with its findings.

7.1.1. Modelling approach

163. Preliminary modelling was undertaken by the National Institute of Water and Atmospheric Research (NIWA) and more detailed modelling was subsequently undertaken by Deltares using a variety of inter-dependent modelling tools. Different approaches were used to describe (i) the

[93] Paragraph 71, Evidence of Mr Greg Summerton, 9 September 2014

near-field transport of sediment released from the discharge (sinker) pipe via a diffuser and (ii) the transport of sediment away from the mine track and into the wider marine environment.[94]

164. The primary tool was a collection of software modules notably Delft3D flow and sediment transport models. Delft3D simulates three-dimensional flow, sediment transport and morphology.

165. Appendix 25 of the applicant's EIA described what the modelling was required to account for as:

- large-scale oceanic flows over the Chatham Rise, including seasonal variations
- sufficient model resolution in time and space on top of the Rise enabling
- a proper simulation of the far-field sediment mine tailing plume dispersion
- a proper schematisation of the mining track and cycle
- associated processed waste material (or mine tailings release characteristics
- an appropriate characterisation and schematisation of the mine tailings (ie particle grain size distribution and sediment characteristics)
- an appropriate schematisation of the mine tailings disposal during the mining process.

166. As described in Appendix 25 to the Marine Consent Application and the EIA, a 'Regional' Delft3D model was used to model large-scale oceanic flow effects and seasonal variations, and an optimised, higher resolution 'Local' model (using Local Delft3D models and Jet3D) was used to model the far-field plume dispersion and the mining process.[95]

167. The far-field modelling was initially set up to assess water movement and other oceanographic characteristics over three seasons; spring, summer and winter. Eventually, Delft3D was used to model water motion and large scale sediment plume motion over ten mining cycles in two seasons; winter and summer [96]. Ms Lescinski told the DMC that the ten mining cycles for the summer and winter periods had the largest variations in terms of ocean ambient conditions (ie (ie water temperature variations over depth, strength and direction of currents) and so it was considered that the expected ambient currents covered by these two 82 day periods covered the widest range of flow conditions, and thus the widest range in likely plume dispersion conditions. [97]

[94] CRP Marine Application and EIA: Appendix 23 Ocean model simulations of sediment plume behaviour (Hadfield 2013); Appendix 25 Modelling investigations on mine tailing plume dispersion on the Chatham Rise (Deltares 2014b)
[95] Appendix 25 to the Marine Application and EIA Modelling investigations on mine tailing plume dispersion on the Chatham Rise (Deltares 2014b)
[96] Paragraph 4, Statement of Evidence of Jamie Lescinski for CRP, 29 August 2014
[97] Paragraphs 116 and 181, Statement of Evidence of Jamie Lescinski for CRP, 29 August 2014

168. A wide range of assumptions were required for inputs to the modelling as described in the EIA and subsequently in the evidence of Ms Lescinski. Some of these are critical to the modelling outputs and included:

- a discharge rate of 2.15 m^3/s (0.31 m^3/s solids and 1.84 m^3/s water);
- sediment release rate of 827 kg/s;
- 44 % and 8 % of sediment mined has a particle size smaller than silt (60 µm) and clay (4 µm) size, respectively;
- a discharge release velocity of 0.75 m/s (the same as the sailing speed of the mine vessel but released in the opposite direction to provide a theoretical zero velocity);
- the time required to complete a mining cycle (ie it was estimated to mine one 5 by 2 km block would take 14 weeks and comprise of 10 mining cycles);
- mine tracks progressively shift outwards around the centre of each mining block;
- all far-field plume modelling excluded sand sized particles and larger as it was expected that sand would fall immediately to the seabed if the diffuser was at or near the seabed.

169. The results of preliminary modelling led the applicant to decide to return the processed non-phosphorite material at or near the seabed (ie no more than 10 m above the seabed). However, the EIA and further information requests presented the results of the modelling undertaken for disposal both at the seabed and at 10 m above the bed for comparison.

7.2. Model outputs

7.2.1. Water movement

170. Data from HYCOM and 2011 field measurements indicated that the long-term average seabed flows of water over the 2011 study period were most often directed towards the northwest. Tides accounted for about 70 % of the current speed and direction measured in the mining licence area by the 2011 field measurements. With respect to the three seasonal modelling periods, the summer, winter and spring periods were deemed reasonably representative with respect to the near-seabed currents.[98]

7.2.2. Sediment plume dispersion

171. The plume dispersion modelling by Deltares produced four types of output:

- snapshots of plumes of the suspended sediment concentration of silt and clay fractions nearest the bed

[98] Paragraphs 45, 62, 63, Statement of Evidence of Jamie Lescinski for CRP, 29 August 2014

- plots showing the total proportion of the simulation for which concentrations of silts and clay (at the bed) exceed different concentration thresholds
- time series showing the variation of concentration in the water column through time
- snapshots of the deposited fine sediment (silt and clay together).[99]

172. Modelling predicted sediment concentrations of several 100's to 1000's of mg/L near the seabed along the mine track, reducing to tens of mg/L as distance increased away from the mined area[100]. For the ten mining cycles required to mine a block, the predicted distribution and duration of TSS of 10 mg/L or more, lasting for more than about one day, were modelled to extend more than 15 km beyond the mining block, outside the boundary of the model.[101]

173. Suspended silt material close to the sediment disposal location was found to dissipate completely in between cycles. The clay fraction also tended to dissipate completely in between mining cycles, though transit periods were noted during which concentrations remain above 0.1 mg/L. Ms Lescinski considered these would not be discernible from the background TSS over the Chatham Rise[102]. She considered the modelling outputs indicated that settlement and / or dilution and flushing of the suspended sediments between mining cycles would bring the TSS concentrations back down to background levels.

174. The DMC notes that background TSS concentrations on the Chatham Rise crest are considered to be <1 mg/L[103], although this assessment is based on relatively few samples.

175. *Table **1*** below provides a useful summary of typical predicted sedimentation levels:

% time	>100 mg/L (km^2)	>50 mg/L (km^2)	>30 mg/L (km^2)	>10 mg/L (km^2)
>1 % (~ 1 day)	26	40	71	>304
>10 % (~ 1 week)	16	22	33	126
>30 % (~ 1 month)	3	12	15	47

Table 1 Predicted area (km^2) with TSS levels above the threshold as a function of time (summer model, discharge at the seabed). (Source: Table 5 of FIR #7)

[99] Appendix 25 of the Marine Consent Application and EIA, Modelling investigations on mine tailing plume dispersion on the Chatham Rise (Deltares 2014b)
[100] Section 2.5 of the HR Wallingford review, attached to the Revised Response to EPA Request for Further Information 3,4,5 and 7, August 2014 (date on EPA website – 5 August 2014)
[101] Page 23 of the Revised Response to EPA Request for Further Information 3,4,5 and 7, August 2014 (date on EPA website – 5 August 2014)
[102] Paragraph 126, Statement of Evidence of Jamie Lescinski for CRP, 29 August 2014
[103] Section 4 of Appendix 12 to the Marine Consent Application and EIA, Natural Sedimentation on the Chatham Rise, April 2013

176. For a discharge at 10 m above the seabed, the modelling predicted that the sediment plume would decrease rapidly with height above the seabed and remain within about 50 m of the seabed[104]. This section of the water column is well below the euphotic zone[105], which extends to a maximum depth of about 150 metres, where primary production takes place. The implication of this finding is that if no sediment was suspended into the euphotic zone, the sediment from mining would not affect primary productivity by light shading and therefore no direct impacts on phytoplankton within the euphotic zone could be expected. The applicant concluded that as such no significant and direct impacts on primary production were expected on the Chatham Rise as a result of the proposed mining activities.[106] The DMC discusses this issue further in Chapter 8.3.

7.2.3. Sedimentation

177. Ms Lescinski stated that, of the estimated total volume of discharged sediments after ten mining cycles of 2,640,000 tonnes (including the sand fraction), roughly 88 % was predicted to deposit within the model domain (2,330,000 tonnes). The other 12 %, consisting of two thirds clay (8 %) and one third silt (4 %), would leave the model domain over the model boundaries (310,000 tonnes). The concentration in the plume, when leaving the model domain at a distance of 20 km from the source, was estimated at about 5 mg/L (silt plus clay)[107]. Over the course of one mining cycle, the mean depositional height in the mining block (ie 5 km x 2 km mining region) was predicted to be around 10 cm, with small local peaks above 15 cm. This deposition was in addition to sand deposition, which was estimated to occur at a depth of approximately 5 cm per single track line.

178. Of the remaining 8 % of fines that settled to the seabed (mostly silt) for this 10-cycle winter scenario, half was predicted to settle on the seabed between 3 and 5 km from the centre of the mining tracks. Therefore, about 2 % of the discharged fines would be deposited further than 10 km from the centre of the mining tracks.[108]

179. The modelling work revealed that the spatial extent of sedimentation varied in relation to the character of the sediment (eg size of the particles and particle fall velocity), and sediment

[104] Section 8, Appendix 25 of the Marine Consent Application and EIA, Modelling investigations on mine tailing plume dispersion on the Chatham Rise (Deltares 2014b)
[105] Euphotic zone: The upper, sunlit part of the water column where the intensity of light is >1 % of that incident on the sea surface
[106] Paragraph 161, Statement of Evidence of Mr Paul Cameron Kennedy for CRP on Assessment of Environmental Impacts (Updated), 29 August 2014 (Amended, 14 November 2014); Paragraph 147, Opening Submissions for CRP, 25 September 2014
[107] Paragraph 135, Statement of Evidence of Jamie Lescinski for CRP, 29 August 2014
[108] Paragraph 141, Statement of Evidence of Jamie Lescinski for CRP, 29 August 2014

particles with larger fall velocities tended to be associated with a smaller but thicker total sedimentation footprint.[109]

180. For example, the modelling predicted that sedimentation of up to 1 cm thick would occur over a seabed area of 35 km^2 and up to 1 mm thick over an area of 103 km^2 (both for a single 10 km^2 block mined over three months, with a discharge 10 m above the seabed using a winter mining scenario). The area of sediment deposition was predicted to decrease markedly if the discharge was released at the seabed (ie 18 km^2 area for a 1 cm thick cover and 61 km^2 for a 1 mm thick cover). A review of the Deltares modelling by HR Wallingford (see Chapter 7.3) concluded that the model results with release of the discharge material into the model domain at the seabed were likely to represent a better approximation of the actual plume's behaviour than a discharge 10 m above the seabed.[110]

181. Figure 9 of the Further Information Request on the cumulative footprints (reproduced below as *Figure **6***) depicts the predicted sediment footprint after 15 years of mining, based on CRP's proposed Mine Plan.

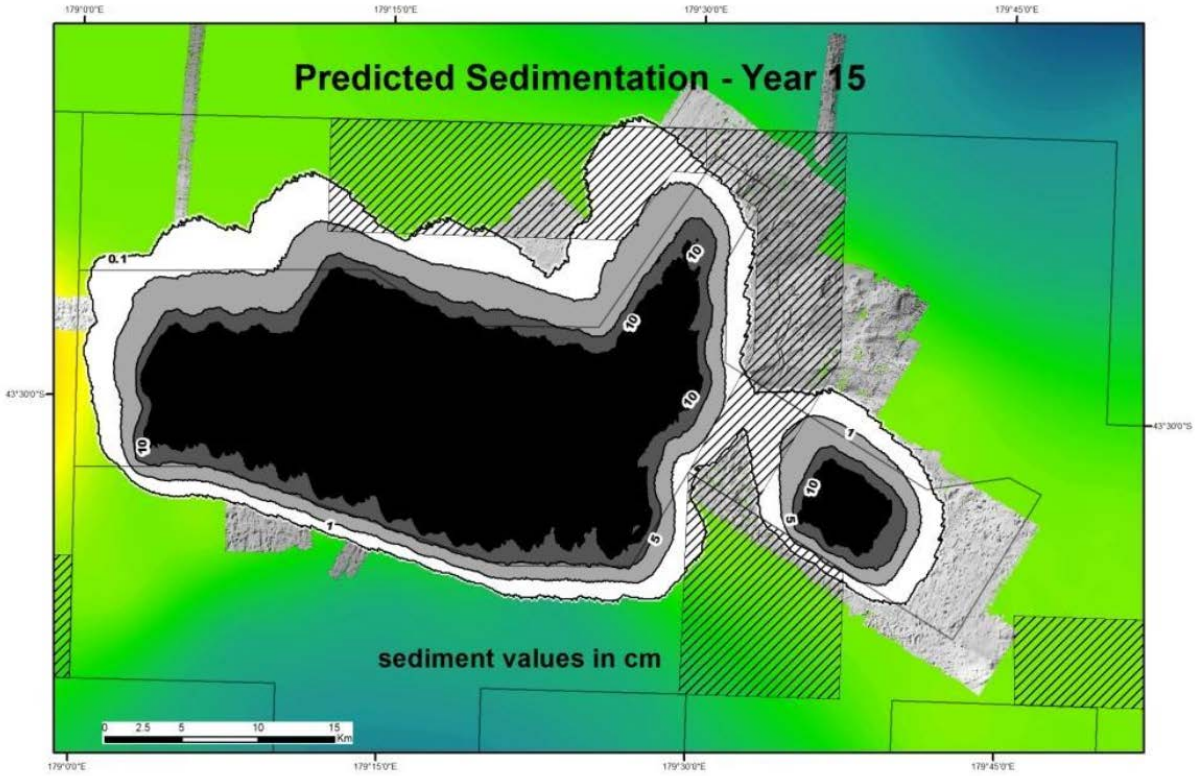


Figure 6. Predicted sediment footprint after 15 years of mining, based on release of tailings at 10 m above the seabed. (Source: FIR, Figure 9)

[109] Paragraph 110, Statement of Evidence of Jamie Lescinski for CRP, 29 August 2014; Section 3.2, Revised Response to Request for Further Information – Request Nos. 3, 4, 5 and 7.
[110] Section 5.2, in Revised Response to Request for Further Information — Request Nos. 3, 4, 5 and 7

182. The analysis shows that:

- cumulative sedimentation of 5 cm over 15 years is essentially contained within the mining permit area
- cumulative sedimentation of 1 cm over 15 years extends beyond the current mining permit area
- sedimentation of 1 mm over 15 years extends about 10 km north of the mining permit area from mining blocks located along the northern boundary of the area.

183. Mr Kennedy summarised these changes in his evidence in chief as a new soft sediment habitat comprising predominantly silt overlying sand over an area of 450 km^2 after 15 years of mining (or 1,050 km^2 if mining occurred for 35 years). He went on to note that this represented 0.6 % per year of the revised marine consent area, or 8.6 % over 15 years, and that in relation to the greater area of the Chatham Rise, this soft sediment habitat represented 0.6 % of the Chatham Rise shallower than 1,000 m.[111]

184. The implications of these changes to the benthic ecology are discussed in Chapter 8.1.

7.3. Peer review

185. The sediment plume and sedimentation modelling work of Deltares was reviewed by ERM and HR Wallingford. The ERM review concluded that overall the modelling approach, assumptions and model predictability were appropriate to the study objectives. The review went on to conclude that while some suggested improvements would provide additional details around the estimates, the model results provided were sufficient for impact assessment.[112]

186. The HR Wallingford review concluded that the Deltares plume assessment had over-estimated the dispersion of the plumes arising from mining activities due to (i) over-coarse resolution of the numerical model which then reduced plume concentration and prevented collapse as a density current onto the seabed, and (ii) conservatively low values of particle settling velocity that were used in the modelling and which did not allow for sediment flocculation[113] processes. As such, the review considered that the plume modelling presented a 'conservative' assessment of the dispersion of the plume. In other words, the plume modelling showed a wider dispersion of suspended sediment than was considered likely.[114]

[111] Paragraph 77, Statement of Evidence of Paul Cameron Kennedy for CRP on Assessment of Environmental Impacts (updated), 29 August 2014 (amended 14 November 2014)
[112] Letter from ERM / Fathom Consulting to the Deepwater Group dated 21 July 2013 (appended to the evidence of Mr Paul Starr and Dr David Middleton)
[113] Flocculation is a process through which fine organic and inorganic particles stick together, forming loose, fragile structures, which can easily break apart
[114] Attachment A: HR Wallingford review of Deltares plume assessment, July 2014. Appended to FIR # 3, 4, 5 and 7

187. The HR Wallingford review also concluded that the currents predicted by the Delft-3D flow model were adequate for the purposes of the study, and compared with measured currents, the Delft-3D model predicted broadly the right currents over the general area most of the time.[115]

7.4. Sediment re-suspension

188. Re-suspension of settled sediment can occur when the bottom currents are strong enough to dislodge a particle from the seabed, but can also depend on the geotechnical properties of the sediments.

189. Ms Lescinski described in her evidence the analyses that were undertaken to assess the risk of sediment re-suspension occurring. She noted that current speeds near the seabed were likely not strong enough to erode the natural, inorganic sediments on the surface of the seabed on a regular basis. It was considered that discharged sediments, which are simply the seabed sediments minus the fraction that is smaller than 2 mm, would consolidate quickly (ie over several hours to a few days) and were unlikely to easily re-suspend[116]. This assessment was somewhat at odds with the view of Professor Watling, who stated in his evidence "*In addition, the time for sediment de-watering, known as self-consolidation, seems to be very hard to predict, but could easily be of the order of decades. It is also likely that as the sediment is consolidating, it will be subject to shear forces generated by tidal currents, so may well tend to move around*".[117]

190. It was Mr Spearman's (HR Wallingford) opinion that any re-suspension would be 'tiny' compared to the discharge release rate that had been modelled.[118] The expert conferencing group on sediment agreed that once the re-deposited sediment had been on the bed for, *"on the order of 24 hours",* there was only very small potential for re-suspension.[119]

[115] Paragraph 9, Statement of Evidence of Jamie Lescinski for CRP, 29 August 2014
[116] Paragraph 34, Evidence of Professor Les Watling on behalf of Greenpeace, KASM and DSCC, 11 September 2014
[117] Paragraph 34, Evidence of Professor Les Watling on behalf of Greenpeace, KASM and DSCC, 11 September 2014
[118] Line 23, Page 494 of the Transcript
[119] Issue 12, Joint Statement of Experts in the Field of Sediment Modelling, 26 September 2014

7.5. Appropriateness of the modelling

7.5.1. Currents

191. A number of fishermen expressed concern about the applicant's information on Chatham Rise currents and how these were used in sediment plume modelling. For example, Mr Summerton stated in his evidence that currents at the seabed have a predominant north-easterly flow and were strong.[120] Mr Smith, a qualified deep-sea skipper, expressed similar concerns. [121]

192. The issue of Chatham Rise currents was discussed by the expert conferencing group on sediment, noting that while the plume modelling demonstrated plume transport to the north-west, fishermen reported extensive experience of water currents in a different direction (to the north-east). [122] The experts agreed that it is only the water currents in the bottom 50 m or so of the water column nearest the seabed which influence the sediment plume transport from the proposed mining operation, and that the plume was not anticipated to occur higher in the water column based on the modelling work. They also considered that while six months of current data was reasonable for model validation purposes, it would be of great benefit to have a longer measurement period than six months that also captured a summer season.[123]

193. Ms Lescinski considered that the current monitoring and modelling work showed that currents were faster in winter and so would transport the plume more quickly. She acknowledged the complexity of currents on the Chatham Rise, but considered this issue had been taken into account in the modelling work and subsequent environmental assessments.[124]

194. Mr Greer considered that the model performed well against measured currents.[125]

7.5.2. Plume dispersion

195. Appendix 25 of the marine consent application and the EIA notes that while Delft3D has been used and validated in several sediment plume dispersion studies, these have been mostly in shallower coastal waters, and in general little is known about the performance of models to predict plume dispersion in deep water due to a lack of observations[126]. The expert conferencing group on sediment modelling agreed that the proposed condition of releasing the sediment

[120] Paragraphs 78 and 79, Amended Statement of Evidence of Greg Summerton on behalf of Te Rūnanga o Ngāi Tahu, 29 September 2014
[121] Paragraph 20, Statement of Evidence of Andrew Peter Smith on behalf of the Deepwater Group Limited, 12 September 2014
[122] Issue 8, Joint Statement of Experts in the Field of Sediment Modelling, 26 September 2014
[123] Issue 8, Joint Statement of Experts in the Field of Sediment Modelling, 26 September 2014
[124] Paragraph 129, Statement of Evidence of Jamie Lescinski for CRP, 29 August 2014
[125] Line 20, page 622 of the Transcript, 1 October 2014
[126] Paragraph 71, Statement of Evidence of Jamie Lescinski for CRP, 29 August 2014

discharge on average no more than 10 m above the seabed over the mining block seemed reasonable.[127]

196. Mr Greer commented on evidence prepared by himself and Dr Mead at the request of the DMC. Their review of the plume modelling reports concluded that the best available information had been applied to the development of numerical models of plume dispersion and sedimentation in the modelling undertaken by Deltares on behalf of the applicant.[128] Industry recognised and respected models had been applied, and in general the model assumptions made in the use of parameters in the plume model were considered reasonable and appropriate for the environment and scenarios being modelled.[129]

197. The expert conferencing group on sediment agreed that the model had not been calibrated nor validated against a measured discharge sediment plume. The DMC finds its comments on this issue to be highly pertinent. It stated in the joint witness statement: "*There is value to both the consent holder and EPA in undertaking a plume model validation for the initial mine permit area once data is available for the plume generated due to mining. The value would be in demonstrating the conservativeness or otherwise of the model as it was used for the consent. It can be then used to guide confirmation of monitoring locations and inform decisions for expanding mining beyond the initial mine permit area.*"[130] In relation to the same issue and adaptive management, the group stated: "*It should also be required that any subsequent plume model, utilised to decide whether to extend the mining area, is validated and implemented to demonstrate the ability to meet the SSC* [suspended sediment concentration] *and sedimentation thresholds (as may be defined within the consent).*"

198. The expert conferencing group identified an information deficiency in the plume model relating to internal tides and how these may influence sediment transport. While the group concluded that their influence remained unquantified, it thought that they were unlikely to significantly influence the dispersion of the plume.[131]

7.5.3. Sediment character

199. A number of submissions expressed concern that the applicant's sediment modelling work was not based on analysis of seabed sediment character after it had been subject to on-board processing to remove phosphorite nodules. However, the expert conferencing group on

[127] Issue 4, Joint Statement of Experts in the Field of Sediment Modelling, 26 September 2014
[128] Paragraph 4, Executive Summary, Statement of Evidence of Mr Dougal Greer (Sediment Plume Models) (29 September 2014) – Annexure B: Assessment of the sediment plume models provided in the CRP marine consent application (9 September 2014)
[129] Assessment of the sediment plume models provided in the CRP marine consent application, 9 September 2014. Prepared by Dr Shaw Mead and Mr Dougal Greer, eCoast Marine Consulting and Research
[130] Issue 6, Joint statement of experts in the field of sediment modelling, 26 September 2014
[131] Issue 13, Joint statement of experts in the field of sediment modelling, 26 September 2014

sediment concluded that the particle size distribution applied to the sediment modelling adequately represented the initial mine permit area for the purpose of the mining assessment. While the group noted that it was possible that the particle size distribution would be altered slightly by way of transportation during the mining and processing procedures (eg by the potential effects of flocculation), it anticipated this not to be an issue due to the conservative nature of the modelling.[132]

7.5.4. Sediment plume generated by the drag-head

200. The EIA indicated that the drag-head could generate up to 25 % of the sediment mobilised by mining, with some of this material becoming suspended.[133] This level of suspended sediment material was considered by some submitters to be significant and they expressed concern that its fate had not been modelled or accounted for in assessments associated with sediment discharges and mobilisation. There remained some conjecture about the magnitude of this sediment source at the hearing. Mr Spearman (HR Wallingford), who peer reviewed the sediment modelling work undertaken by Deltares for the applicant, considered that the 25 % estimate was a gross over-estimate and thought it was likely to be much less. In response to questioning from the DMC, he stated he had provided evidence to the expert conferencing group regarding several studies that showed that the plumes from drag-head disturbance represented less than 1 % of the overflow, which he considered was a more reasonable estimate.[134]

201. Dr Longdill stated that in his experience drag-heads were capable of generating significant amounts of suspending sediment. However, he did not expect it to reach anywhere near 25 % and considered that 2 to 3 % was a more realistic estimate[135]. The expert conferencing group on sediment modelling agreed that 25 % was an extreme overestimate.[136]

202. Dr Longdill stated that ultimately the issue of sediment plume generation, regardless of whether it was caused by the discharge from mining vessel or the drag-head, or both, could be best managed by assessing the plume against consent conditions.[137]

7.6. Proposed conditions, adaptive management and monitoring

203. At the hearing, the applicant proposed a revised suite of conditions including several under the title of adaptive management and monitoring. Other proposed conditions stipulated operational

[132] Issue 1, Joint statement of experts in the field of sediment modelling, 26 September 2014
[133] Section 8.3.5, Marine Consent Application and EIA, May 2014
[134] Line 20, page 503 of the Transcript, 1 October 2014
[135] Line 40, page 652 of the Transcript, 2 October 2014
[136] Issue 5, Joint statement of experts in the field of sediment modelling, 26 September 2014
[137] Lines 6-10, page 653 of the Transcript, 2 October 2014

constraints that would affect the character of the sediment plume. For example, Proposed Condition 12 set out the requirements for the return of tailings. The sediment plume modelling (and therefore most of the effects as a result of the sediment plume) was based on a release of tailings 10 m above the seabed. Proposed Condition 12 specified the release height above the seabed as an average for each mining block. While the DMC acknowledges that the operator would not have the luxury of a static discharge point due to vessel movement caused by waves and tides, it considers that the height of discharge above the seabed would have been more appropriately expressed as an upper limit with sediment being required to be released a maximum of 10 m above the seabed. The sediment modelling experts group also recommended that limits be established for the height of tailings released above the seabed.[138]

204. The expert conferencing group on sediment modelling emphasised the need for validation of the plume model before mining expanded beyond the initial mine permit area.[139] The applicant proposed to confirm the suspended sediment concentrations predicted by the plume model through monitoring sediment (indirectly using turbidity as a surrogate for sediment concentration) as provided for in 1A of Schedule 1 of the proposed conditions. This schedule contained a concentration trigger of 50 mg/L (at a point 5 km or greater away from the edge of the mining block being mined, or at a point 50 m or greater above the seabed at any location). Mr Kennedy explained that the 50 mg/L threshold was an ideal concentration for the underwater turbidity monitoring vehicle (Autonomous Underwater Vehicle or AUV) to track and therefore provided a more accurate comparison with the sediment plume model for that particular threshold (ie if the model is verified at this point then, by implication and back-calculation, other distances and concentrations could be verified).[140]

205. Schedule 1 of the proposed conditions also contained a similar condition for sedimentation, based on a 1 mm sediment deposition threshold at a point no more than 7 km from the edge of mined mining blocks.

206. If any threshold level were exceeded under the criteria set out in Schedule 1, Proposed Condition 41 set out procedures including a requirement to complete an assessment of adaptive management approaches that could be implemented to "*avoid, remedy or minimise the exceedance of the environmental threshold identified in Schedule 1 or an unexpected adverse impact*". One of the difficulties the DMC identified with this proposed condition is that it would be left to the Chief Executive of the EPA to determine the significance of any exceedance of the environmental threshold or unexpected adverse effect, with any such determination subject to challenge by the consent holder.

[138] Issue 4, Joint statement of experts in the field of sediment modelling, 26 September 2014
[139] Issue 6, Joint statement of experts in the field of sediment modelling, 26 September 2014
[140] Lines 15 – 20, page 2226 of the Transcript, 17 November 2014

207. Proposed Schedule 2A outlined monitoring to be undertaken prior to mining, including total suspended solids and turbidity, measured by landers to measure turbidity at the seabed and AUVs. Similarly Proposed Schedule 2A(ix) required installing a sedimentation trap to measure the ambient sedimentation levels. The DMC understands that these were to enable a comparison to be made with measurements taken once mining began. Proposed Schedule 2B(iii) provided for the comparison of turbidity levels during mining.

208. Although the applicant's witnesses expressed confidence in the applicant's ability to implement a sediment monitoring programme, the DMC has some reservations over the ability to adequately monitor any sediment plume and associated sedimentation at the depths proposed and at the levels of accuracy the DMC considers would be necessary. Firstly, the type of equipment required is not easy to obtain, deploy and maintain. For example, the AUV referred to by Mr Woods was, according to him, booked up for 90 per cent of the year and so there was difficulty getting it to New Zealand. He also stated that to test this equipment on the Chatham Rise could cost in the order of $1.5 – 2 million or between $30,000 and $40,000 per day. [141] Consequently, cost might limit its application.

209. Secondly, it seemed uncertain whether the technique of monitoring of sedimentation by visual observations, as described by Mr Kennedy[142], would provide a sufficient level of accuracy. Mr Kennedy stated in response to questioning from the DMC that he had been assured that it was possible to get a general indication of the depth of sediment through photographs. He then went on to say however that it was extremely difficult to measure sedimentation depths when they are at the millimetre level. [143] The DMC heard from Dr Hewitt that sedimentation levels as low as 1 mm may be sufficient to adversely affect some benthic organisms. [144]

210. Mr Wood described the proposed monitoring of currents, turbidity (as a surrogate for suspended sediment) and sedimentation in the event that consent to mine was granted. He described the applicant's discussions with scientists at Woods Hole Oceanographic Institution regarding the provision of monitoring equipment. Measurements of turbidity before, during and after mining would be used to verify and calibrate the oceanographic and plume dispersion models. Proposed monitoring of sedimentation would be mainly by visual observation using an AUV taking photographic transects.[145] Mr Kennedy considered these and other proposed

[141] Lines 25 – 20, pages 247 – 248 of the Transcript, 26 September 2014
[142] Paragraph 183, Statement of Evidence of Paul Cameron Kennedy for CRP on Assessment of Environmental Impacts (Updated), 29 August 2014 (Amended, 14 November 2014)
[143] Lines 30 – 35, page 2236 of the Transcript, 17 November 2014
[144] Line 45, page 727 of the Transcript, 3 October 2014
[145] Paragraph 164, Statement of Evidence of Raymond Allen Wood for CRP, 28 August 2014

measurements associated with the sediment plume would provide a robust mechanism for ensuring that the environmental standards of the project were maintained.[146]

211. Reservations over the proposed approach to sediment monitoring were expressed by Mr Govier[147] and Dr Longdill. Dr Longdill implied that although turbidity and suspended sediment monitoring associated with shallow water dredging operations was fairly routine, he was not familiar with programmes in deep water or with robust methods that would get real time turbidity or suspended sediment measurements at the depths proposed.[148]

7.7. DMC findings

212. The DMC accepts that the sediment dispersion model can be regarded as being conservative with respect to the predicted dispersion of sediment from the diffuser. Arguably this is due to some inappropriate assumptions used by Deltares in the initial model set-up. Any dispersion of suspended sediment and sedimentation is however highly reliant on the nature of the mining operation, of which there are many possible operating and environmental variables that can affect the physical behaviour of the discharged sediment. If one or more of these variables was altered (or found to differ) relative to the assumptions and inputs used in the modelling to date (eg the design of the discharge diffuser, the speed of currents or the degree of sediment suspension created by the drag-head), it could potentially alter the behaviour and distribution of the sediment plume and subsequent sediment deposition on the seabed.

213. Limited empirical validation of the sediment model has been undertaken to date and substantially more *in situ* monitoring and validation would be required before the accuracy of the model, and its predictive capability, could be confirmed. While the DMC accepts that validation could be achieved through monitoring of the sediment plume and associated sediment deposition once mining commenced, it has reservations regarding the ability to accurately monitor these parameters at the depths and scale that mining would take place at, in order to protect the surrounding ecosystems. Provision would be needed for a rapid response when environmental thresholds were triggered. Questions also remain over the availability of specialised equipment.

214. The DMC finds that the proposed adaptive management conditions of the applicant surrounding the behaviour of suspended sediment and sediment deposition contain a good deal of residual uncertainty in terms of the likely environmental outcomes. The DMC also retains reservations

[146] Paragraph 181, Statement of Evidence of Paul Cameron Kennedy for CRP on Assessment of Environmental Impacts (Updated), 29 August 2014 (Amended, 14 November 2014)
[147] Line 25, page 340 – Line 40, page 341 of the Transcript, 29 September 2014
[148] Lines 27 – 43, page 655 of the Transcript, 2 October 2013

about suspended sediment threshold levels in the proposed conditions. While it accepts that they may be a convenient trigger for verification of the sediment plume model, the DMC notes that other thresholds were discussed through the hearing in terms of environmental impacts. For example, 3 mg/L suspended solids was agreed as a suitable threshold criterion for fish avoidance of the plume.[149] The DMC discusses these issues in more detail in Chapters 7 and 8.5.

[149] Issue 2, Joint statement of experts in the field of Impacts on Fish, 18 September 2014

8. Effects of the Proposal on the Environment

215. Section 59 of the EEZ Act sets out a number of matters which the DMC must take into account when considering an application for a marine consent and submissions on the application. This part of the decision identifies the main environmental effects in the context of Section 59 of the EEZ Act. It then discusses the applicant's proposed conditions and outlines the DMC's findings.

8.1. Benthic environment

8.1.1. Background

216. The seabed of the Chatham Rise where the proposed mining would take place is a benthic environment. The term benthic refers to anything associated with or occurring on the bottom of a body of water, and the animals and plants that live on or in the bottom are known as the benthos. Benthic macroinvertebrates are typically split into those organisms that live within the sediment (infauna) or on the seafloor surface (epifauna). Hyper-benthic organisms are mobile species associated with the seabed but predominantly living up to about one metre above it rather than on or in it.

8.1.2. Physical description

217. As described in Chapter 4, the crest of the Chatham Rise is generally flat, although punctuated in places with local typographical features such as banks, isolated volcanic peaks or seamounts and iceberg scours. The seabed sediments in the applicant's mining licence area are predominantly muddy sands, with localised areas containing variable amounts of gravel-sized phosphorite nodules[150]. In order to see what the benthic environment looked like, Mr Wood showed the DMC some of the footage taken in March 2012 by a remotely operated vehicle which conducted photographic transects of the seafloor within the proposed mining area. Examples of hard and soft bottom dominated sediments within the consent application area are shown in *Figure 7*. [151]

8.1.3. Seabed surveys and benthic communities

218. Benthic communities of the Chatham Rise were extensively reviewed in the applicant's EIA[152] and this information was summarised largely in the evidence of Dr Rowden. Video and still images taken of the seafloor by a remotely operated vehicle were used to determine the structure (composition and relative abundance) of epifaunal communities. Direct samples of the seabed were collected by a box-corer to determine the structure of infaunal communities.[153]

[150] Section 4.5 of Appendix 9 of the EIA, Seafloor morphology and substrate characterisation on Chatham Rise, May 2013
[151] Pages 220 – 226 of the Transcript, 26 September 2014
[152] Appendices 13, 14, 15 and 16 of the EIA
[153] Section 2.1.2, Benthic Epifauna Communities of the Central Chatham Rise Crest (NIWA, 2014)

219. Dr Rowden described how infaunal communities on the Chatham Rise are dominated numerically by polychaetes and peracarid crustaceans, with differences within these communities reflecting differences in the quantity and quality of the food supplied to the seabed as controlled by the spatial and temporal dynamics of the subtropical front.[154] He noted that eight distinct benthic epifaunal communities were found in an extensive survey in 2007 (Ocean Survey 20/20), three of which were found only on the Chatham Rise and the remaining five were also found on the Challenger Plateau. However this survey did not sample the central crest of the Chatham Rise.[155]

220. Subsequent surveys in 2012 and 2013 were used to identify and describe benthic communities on the central crest of the Rise, including sites within the applicant's marine consent application area. Five infaunal communities were identified in the consent area. One of these communities exhibited a positive relationship with phosphorite nodule density and was characterised mainly by amphipod and polychaete species.[156]

221. Up to thirteen epifaunal communities were identified in these later surveys and the overall structure of the epifaunal communities is related primarily to the presence of mud / sand and phosphorite nodules. Two of the epifaunal communities were dominated by the stony coral *Goniocorella dumosa* (*G. dumosa*) and showed a patchy distribution in the study area that was associated with the presence of phosphorite nodules (see *Figure 7*) that were concentrated in the marine consent area, particularly the mining permit area.[157]

222. The DMC was told that although the benthic macrofaunal communities of the Chatham Rise are one of the best sampled and studied deep-fauna of New Zealand's EEZ[158], the survey data varies spatially, with some areas surveyed more thoroughly than others. Not surprisingly, most of the information relating to this consent application concerned mining permit area MPL 55549. Geographical coverage of the surrounds, including the prospecting areas, was more limited[159]. The expert conferencing group on benthic ecology and spatial planning concluded that while there was sufficient knowledge to inform decision-making with regard to potential major impacts on the benthic resources within MPL 55549, there was inadequate geographical coverage of information in surrounding areas such that they could not predict with confidence the overall impacts of mining on organisms, communities and ecosystems at the broader Chatham Rise scale.[160] The DMC returns to this issue in subsequent chapters of this decision.

[154] Paragraph 27, Statement of Evidence of Dr Ashley Rowden for CRP, 25 August 2014
[155] Paragraph 29, Statement of Evidence of Dr Ashley Rowden for CRP, 25 August 2014
[156] Paragraph 38, Statement of Evidence of Dr Ashley Rowden for CRP, 25 August 2014
[157] Paragraph 39, Statement of Evidence of Dr Ashley Rowden for CRP, 25 August 2014
[158] Paragraph 25, Statement of Evidence of Dr Ashley Rowden for CRP, 25 August 2014
[159] Issue 1, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014
[160] Issue 1, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014

223. The expert group also agreed that there was uncertainty about the full degree of biodiversity due to restricted sampling effort and limited taxonomical resolution.[161]

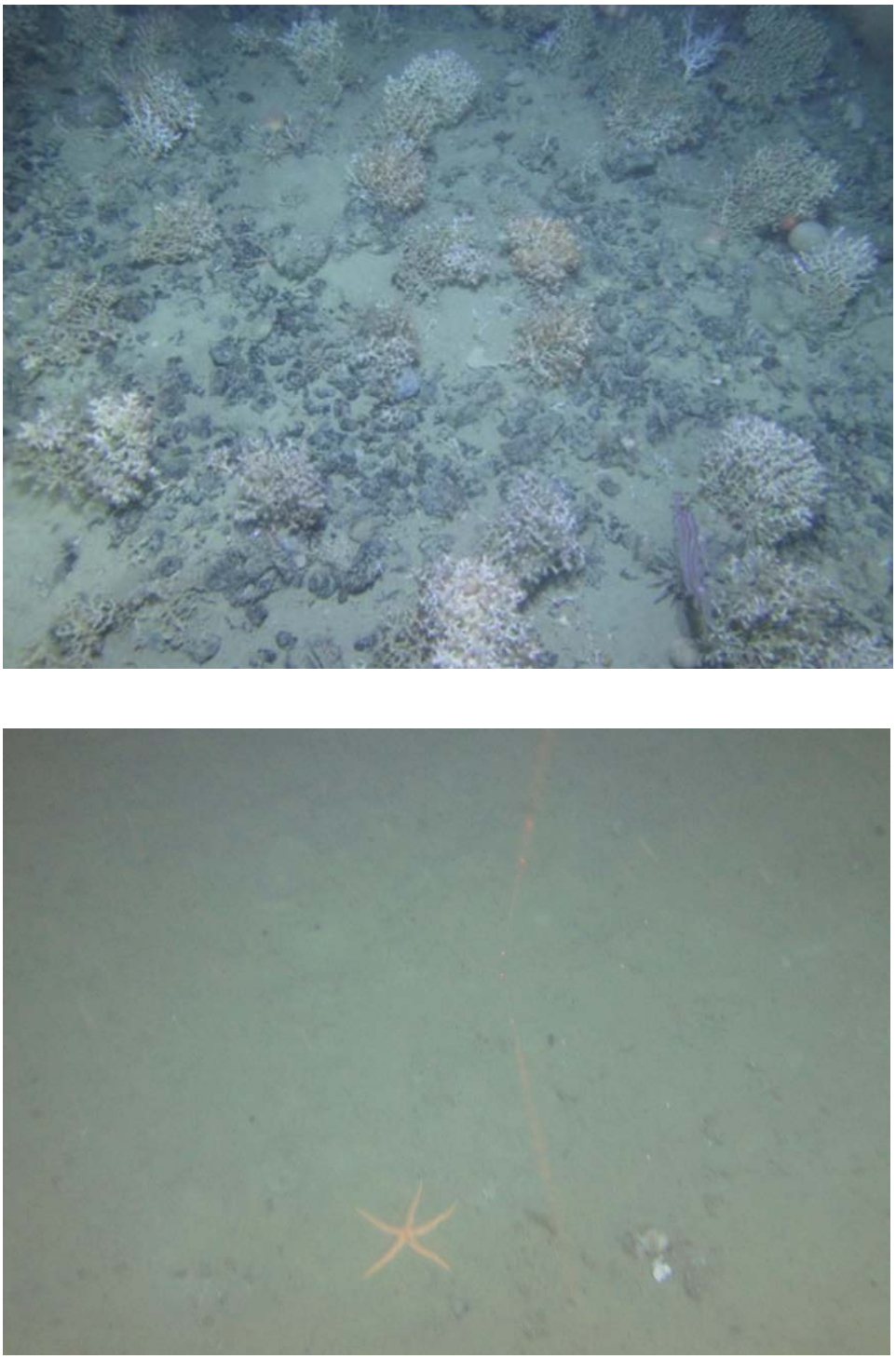


Figure 7. Top: Seafloor image of hard sediment showing an epifauna community characterised by the stony coral G. dumosa associated with haed sediments (phosphorite nodules). Bottom: Seabed surface dominated largely by fine sediments.[162]

[161] Issue 1, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014

8.1.4. Significance of the benthic communities

224. The DMC was interested to understand the distribution and uniqueness of benthic communities within the consent application area. Dr Rowden stated that of the five infaunal communities identified in the marine consent area, two are probably also represented elsewhere on the Rise. He opined there is less certainty around that assessment because of the difference in the level of taxonomic identification between the various studies. However, the nodule-associated amphipod-dominated infaunal community appears not to have been observed before on the Rise or elsewhere in New Zealand's EEZ. Dr Rowden speculated the phosphorite nodules may influence the particular type of infaunal community through their physical character such as internal structure of the sediment, the sediment sizes, and the spaces between the nodules.[163]

225. Dr Rowden also stated that the two epifaunal communities dominated by the stony coral *G. dumosa* within the marine consent area have not been found elsewhere on the Rise to date, or elsewhere in the New Zealand EEZ. The DMC was told that *G. dumosa* relies upon hard substrate, such as that provided by relatively large phosphorite nodules, for attachment. Similar corals, particularly when in high abundance, are known to provide habitat for a diverse community of other invertebrates, and potentially larval or juvenile fish[164]. Dr Rowden stated that these communities can be classed as coral reefs or thickets which are sensitive environments under the Exclusive Economic Zone and Continental Shelf (Environment Effects - Permitted Activities) Regulations 2013, and the stony coral on which they are based is a protected species in New Zealand waters (under the Wildlife Act 1953).[165]

226. Dr Berkenbusch stated that *G. dumosa* has been recorded as widespread throughout New Zealand's EEZ, but not as a dominant species that characterises benthic communities nor at such high densities and levels of abundance.[166] She explained that this coral species was determining the structure and distribution of the two unique epifaunal communities found within the marine consent area.

227. In response to questions from the DMC, Dr Rowden indicated that it was not possible to determine whether the stony coral communities could be classified as threatened because the level of identification for many of the organisms in these communities was not of sufficient resolution (ie not down to species level) to assess threat status as determined by the Department of Conservation.[167] Dr Rowden stated "… *species which are listed on the*

[162] Photos presented by Mr Ray Wood 26 September 2014
[163] Line 10, page 1997 of the Transcript, 6 November 2014
[164] Section 4.1.1 of Appendix 15 of the EIA, Benthic communities of MPL 50270 on the Chatham Rise, May 2013
[165] Paragraph 40, Statement of Evidence of Dr Ashley Rowden for CRP, 25 August 2014
[166] Lines 1 – 8, page 302 of the Transcript, 29 September 2014
[167] Lines 4 – 15, page 2013 of the Transcript, 6 November 2014

threatened list are always to the species level"[168]. He also noted that people often used the terms 'communities' and 'ecosystems' interchangeably.

228. When asked whether these communities might be considered rare and vulnerable[169], Dr Rowden said they may be considered 'Vulnerable Marine Ecosystems' as defined by the United Nations Food and Agriculture Organisation (FAO), which considers a number of criteria such as whether the community is fragile, whether or not it provides habitat and whether or not it has a restricted reproductive cycle.[170] In response to a question from Ms Hazaan (Greenpeace, KASM, DSCC), Dr Rowden acknowledged the coral-based communities would classify as 'vulnerable' under the FAO Deep Sea Guidelines to regulate bottom trawling.[171]

229. With respect to rarity, Dr Rowden was more circumspect. He made the point that while most deep sea organisms are considered rare "*you don't know if that's simply because generally the sampling in the deep sea is relatively poor and therefore rarity just means that that could simply be a sampling artefact*". He went on to conclude "*So most people in the deep sea try to keep away from the notion of rarity*".[172] However he did state "*there are a number of communities which look like they could be unique*".[173]

230. Dr Hourigan considered that the branching stony corals present in the mining application area may be of particular significance due to both the size of the colonies, their abundance and density in the area, and their likely contribution to structuring habitats for other species. He considered the coral-dominated communities would also appear to meet the criteria set out by the Convention on Biological Diversity 2009 for 'Ecologically or Biologically Significant Marine Areas' in the deep sea. They represented rare or distinct habitats with comparatively higher diversity, composed of fragile, slow-growing species.[174]

231. Dr Berkenbusch stated that the data that does exist indicates that benthic fauna on the Chatham Rise includes potentially unique and ecologically important communities in the marine consent application area. This included the epifaunal communities dominated by *G. dumosa* and one infaunal community that appear to be unique to the marine consent area. She explained the importance of coral in providing habitat for other species and fulfilling ecosystem functions.[175] The DMC also heard that while corals are important for forming habitats, sponges can fulfil this role as well.

[168] Line 15, page 2013 of the Transcript, 6 November 2014
[169] Under Section 59(2)(e) of the EEZ Act, the EPA must take into account the importance of protecting rare and vulnerable ecosystems and the habitats of threatened species
[170] Lines 37 – 43, page 2013 and lines 1 – 4, Page 2014 of the Transcript, 6 November 2014
[171] Lines 18 – 33, page 2029 of the Transcript, 6 November 2014
[172] Lines 5 – 11, page 2014 of the Transcript, 6 November 2014
[173] Lines 21 – 24, page 2014 of the Transcript, 6 November 2014
[174] Paragraph 27, Statement of Evidence of Thomas Francis Hourigan for the Crown, 12 September 2014
[175] Lines 22 – 26, page 338 of the Transcript, 29 September 2014

232. The impact of acidification was raised by the experts involved in ecosystem effects conferencing and Dr Fulton explained the significance of this. She explained that the pH of the ocean may in the future constrain the extent of species sensitive to ocean pH such as corals, and the Chatham Rise may become the only suitable habitat for them. This would make any losses potentially more significant.[176]

233. The experts who participated in conferencing on benthic ecology and spatial planning agreed that benthic communities on the crest of the Chatham Rise played an important role in ecosystem functions such as biodiversity, nutrient recycling and habitat provision, but noted that these specific aspects of ecosystem function had not been considered in the EIA.[177]

8.1.5. Effects

234. Given the apparent uniqueness of some of the benthic communities within the consent application area, and the seabed's protection from bottom trawling by a BPA (discussed in Chapter 10.1), the DMC was particularly interested in the potential effects of the mining proposal on the benthic environment. Section 59(d) and (e) of the EEZ Act requires the DMC to take into account the importance of protecting the biological diversity and integrity of marine species, ecosystems and processes and the importance of protecting rare and vulnerable ecosystems.

235. The DMC considers it likely that there would be four broad physical changes to the benthic environment as a result of the proposed mining operation:

i) the removal of large tracks of seabed and any associated benthic communities and probably hyper-benthic species

ii) the replacement of benthic habitat with a relatively thick layer of screened sands and silts of a more homogenous character minus the original hard substrate (ie phosphorite nodules) and living benthic biota

iii) the deposition of mainly clay and silt sediment particles over un-mined seabed in areas adjacent to the mine tracks

iv) the creation of a turbid sediment plume in the water column immediately above the seabed that would persist for a limited period of time determined largely by when active mining takes places.

[176] Lines 19 – 25, page 1000 of the Transcript, 15 October 2014
[177] Issue 2, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014

236. These four physical changes were broadly in line with the findings of the experts who participated in conferencing on benthic ecology and spatial planning. They agreed that the main potential effects on the benthic environment associated with the proposal would be:[178]

- removal and mortality of benthic organisms in the path of the drag-head
- permanent removal of phosphorite nodules reducing hard substrate habitat for epifauna and changing the landscape
- increased sedimentation for nearby organisms
- enhanced suspended sediment
- changing grain size of the sediment and sediment water content
- possible changes in organic content and food quality.

237. Potential chemical changes to the benthic environment were also possible due to sediment agitation and mixing with seawater associated with the mining process. Water quality is discussed in Chapter 8.8.

238. In general, the DMC found that changes to the benthic environment were undisputed by any party to this application, and these physical and biological changes would be inevitable as a result of the proposed mining and sediment disposal methods. All these changes are adverse in nature. A key consideration for the DMC was determining how significant these changes would be, and in particular, the likely short and long term effects on benthic communities, and how they may be avoided, remedied or mitigated.[179] These effects are discussed below.

239. Potential adverse effects to seafloor communities would be both within the proposed mining area and beyond the area that is physically mined. Dr Berkenbusch summarised the knowledge of potential effects: while there was a general understanding of the immediate direct impacts in the actively mined area, there was considerable uncertainty about potential indirect adverse effects, including in adjacent areas. The indirect effects were linked to increased sedimentation, elevated levels of suspended sediment, changes to sediment grain size and water content and potential changes to the organic content and food quality.[180]

240. Dr Hewitt provided further clarification by stating that the suspended sediment concentrations and the sediment deposition would decrease with distance from the area being mined and the impacts on the benthic organisms were also likely to form a gradient with distance. However this depended very heavily on the benthic species communities present at any point.[181]

[178] Issue 3, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014
[179] Lines 12 – 21, page 722 of the Transcript, 3 October 2014
[180] Lines 5 – 10, page 298 of the Transcript, 29 September 2014
[181] Lines 11 – 23, page 722 of the Transcript, 3 October 2014

Removal and mortality of benthic organisms due to the drag-head

241. The extraction of phosphorite nodules in the proposed mining area would remove both the phosphorite nodules and surrounding soft sediments, together with associated benthic faunal communities.[182] The DMC accepts that it is unavoidable that all benthic organisms (both flora and fauna) to the depth mined by the drag-head would be killed, or at the very least displaced. This is an inevitable consequence of the proposed mining technique.

242. The spatial extent of destruction of the seabed and associated benthic organisms was determined largely by the applicant's proposed Mine Plan (the sequential mining of areas referred to as mine blocks), which was described in the EIA, and in the evidence of Mr van Raalte and Mr Kennedy. Mr Kennedy stated that the extent of benthic habitat change associated with seabed directly affected by mining would be 10 km^2 per block or 30 km^2 per year (ie three 2 x 5 km blocks mined each year). This would equate to 450 km^2 over 15 years of mining (see *Figure **8*** below). Mr Kennedy went to state that this area represents 0.6 % per year of the revised marine consent application area, or 8.6 % over 15 years. Mr Winchester said that if mining occurred for 35 years, this would equate to about 1,050 km^2 of mined seabed or about 20 % of the revised marine consent application area.[183]

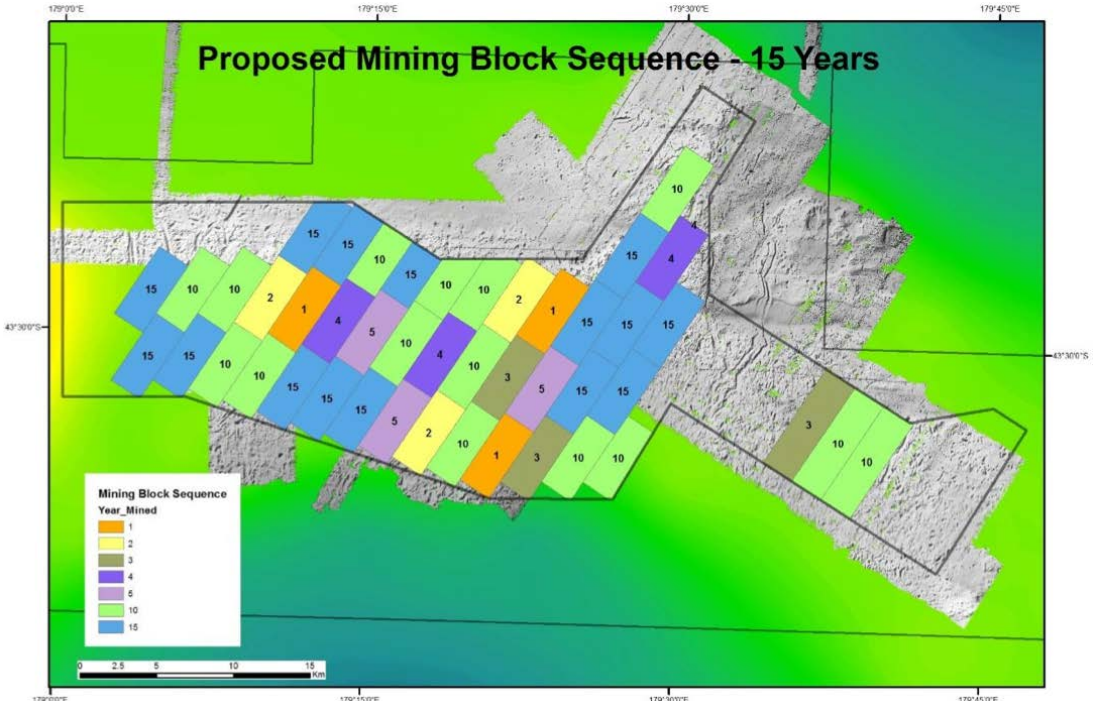


Figure 8. The current proposed sequence for 15 years mining blocks are shaded and labelled with the year they would be mined. Years 1 to 5 are indivually identified, years 6 to 10, and 11 to 15 are amalgamated and labelled as 10 and 15 respectively. (Source: FIR 6, 8 July 2014)

[182] Section 5 of Appendix 30 of the EIA, Potential for recolonisation and recovery by benthic communities following mining disturbance on the Chatham Rise. January 2013 (updated June 2013); and Issue 1, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014

[183] Paragraph 22, Opening submission for CRP, 25 September 2014

243. The DMC understands that this 1,050 km^2 mined area did not include proposed mining exclusion areas located within the consent application area as proposed by the applicant (as identified in Attachment B of Ms Taylor's evidence)[184]. Neither did it include potential additional mining exclusion areas identified through further proposed surveys undertaken after consent was granted, including further prospecting activities and areas of significant coral thickets, significant marine biodiversity and cultural significance. Some of these areas may be located outside of the consent application area and the BPA and so would require some form of regulation in order to provide effective protection from seabed disturbance activities (eg bottom trawling or future mining applications). The DMC discusses this issue later in the context of mitigation proposals.

244. Having accepted that mortality of benthic communities on a significant scale would be inevitable, the DMC turned its mind to the potential for recolonisation to understand the long term effects of the proposal. Recolonisation was explored during the hearing and is a complex matter. From the technical reports, evidence and joint witness statements, the DMC understands that the factors affecting recolonisation include the seabed sediment characteristics, a ready source of settling organisms and a suitable habitat. The DMC heard that resettlement of planktonic larvae is not well understood, with propagules demonstrating the ability to select surface characteristics that would enhance their chances of survival, for example biofilms, surface roughness / texture, colour and sediment particle size.[185]

245. Dr Berkenbusch advised that in general there is little known about recolonisation and recovery of benthic species and communities at the depth of the proposed mining. Colonisation and recovery of benthic communities in areas where the sediment would be returned would not be likely to occur until the sedimentary habitats consolidated and became suitable.[186]

246. Dr Rowden also noted that the lack of data available on recruitment and growth of benthic organisms in the deep sea made it difficult to estimate recovery time post-disturbance.[187] He went on to state that where fauna such as the stony coral *G. dumosa* depend upon the hard substrate provided by the nodules that have been removed, recolonisation would not be possible and significantly altered communities would result because of the loss of such key habitat-formers.[188]

[184] Appendix B of Attachment A to Statement of Evidence of Carmen Taylor for CRP, 29 August 2014
[185] Section 2.2.3 of Appendix 30 of the EIA. Potential for recolonisation and recovery by benthic communities following mining disturbance on the Chatham Rise, January 2013 (updated June 2013)
[186] Lines 14 – 18, page 298 of the Transcript, 29 September 2014
[187] Paragraph 48. Statement of Evidence of Dr Ashley Rowden for CRP, 25 August 2014
[188] Paragraph 7, Statement of Evidence of Dr Ashley Rowden for CRP, 25 August 2014

247. The DMC understands from the technical reports that there are two main pathways by which benthic invertebrates recolonise disturbed sediments: lateral migration of adults / juveniles of mobile taxa from nearby undisturbed habitats; and the dispersal of larvae from populations of reproductive adults. Larval dispersal was considered likely to be the main method for recolonisation of benthic communities following mining.[189] There was a risk that the wider effects of sedimentation and increased suspended sediment would affect the availability of larvae from surrounding areas for recolonisation.[190]

248. While the absence of data makes it difficult to estimate recovery time post-disturbance, there was a general consensus that recovery of benthic communities following disturbance in the deep sea was likely to be slower than in coastal or continental shelf communities.[191] It was also likely that as the size and frequency of disturbance increased, so would the length of time to recover to mature communities.[192]

249. The initial phases of recolonisation of disturbed hard substrate habitat in the proposed mining area were expected to take at least months or years, and complete recovery of the slow growing sessile fauna-dominated communities was likely to take decades or longer. Because recolonisation is dependent on the availability of larvae from neighbouring source populations, it was also possible that recovery to pre-mining community structure would not occur at all.[193]

250. Overall, the DMC agrees with Mr Kennedy that the benthic biota within the mining blocks would be removed and that this was a significant impact of the proposed mining operations that could not be avoided, remedied or entirely mitigated.[194]

Removal of hard substrate habitat

251. Dr Hourigan told the DMC that *G. dumosa* and other sessile invertebrates including sponges, ascidians and bryozoans appeared to be growing directly on the phosphorite nodules or in close association with them as they provided the hard substrate that these animals need for attachment.[195] The 2012 survey of the area indicated that Cnidaria (including anemones, the cold-water coral *G. dumosa* and the cup coral *Flabellum* sp.), Porifera, Bryozoa, Ascidia, some

[189] Executive summary of Appendix 30 of the EIA. Potential for recolonisation and recovery by benthic communities following mining disturbance on the Chatham Rise, January 2013 (updated June 2013)
[190] Section 4.2 of Appendix 30 of the EIA, Potential for recolonisation and recovery by benthic communities following mining disturbance on the Chatham Rise, January 2013 (updated June 2013)
[191] Page 23, of Appendix 30 of the EIA, Potential for recolonisation and recovery by benthic communities following mining disturbance on the Chatham Rise, January 2013 (updated June 2013)
[192] Section 5 of EIA of Appendix 30 of the EIA, Potential for recolonisation and recovery by benthic communities following mining disturbance on the Chatham Rise, January 2013 (updated June 2013)
[193] Section 4.2 of Appendix 30 of the EIA, Potential for recolonisation and recovery by benthic communities following mining disturbance on the Chatham Rise, January 2013 (updated June 2013)
[194] Paragraph 82, Statement of Evidence of Paul Kennedy for CRP on Assessment of Environmental Impacts (updated), 29 August 2014 (amended 14 November 2014)
[195] Lines 5 – 9, page 356 of the Transcript, 30 September 2014

Mollusca and some Annelida were the main benthic taxa associated with hard substrate habitat such as rocks, boulders and ledges in the proposed mining area.[196] Colonies of *G. dumosa* were frequently observed attached to nodules, and this species was the dominant epifaunal organism of the phosphorite nodule-soft sediment matrix habitat community.[197]

252. The benthic experts agreed that permanent removal of phosphorite nodules would reduce the available hard strata habitat for epifauna and change the landscape lived in by the infauna.[198] Where the fauna depended on the hard substrate provided by the nodules that were removed, recolonisation would not be possible and significantly altered communities would result.[199] The benthic experts agreed.[200]

253. The applicant proposed to assess artificial hard substrates with trials initially taking place in un-mined areas. There have been no recolonisation trials, and the benthic experts involved in conferencing agreed that there was a high level of uncertainty as to whether this would be successful. They agreed there was a need to clearly outline what "*successful"* trials would constitute.[201] The benthic experts considered the method needed to be proven successful before it can be proposed as a mitigation technique and the DMC agrees.

254. The benthic experts also agreed that even if an alternate substrate was provided, the recovery of communities and species populations to pre-mining state was uncertain. In addition, the benthic experts agreed that there was uncertainty about the degree of dependence of corals on phosphorite nodules and their ability to colonise other hard substrates.[202] Dr Berkenbusch further explained this statement: that it was unknown if the phosphorite nodules provide more to coral over and above just providing hard substrate.[203] The likely timeframes for potential colonisation of an alternate substrate were also unknown due a number of variables including sources of larvae, frequency of larvae production and vagaries of currents or temperature.[204]

255. Due to the dominance of *G. dumosa*, the recovery of the benthic community of the phosphorite nodule-soft sediment matrix habitat was very much tied to the recolonisation potential of this coral species.[205]

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[196] Section 4.2, Potential for recolonisation and recovery by benthic communities following mining disturbance on the Chatham Rise January 2013 (updated June 2013)
[197] Section 4.3, Potential for recolonisation and recovery by benthic communities following mining disturbance on the Chatham Rise January 2013 (updated June 2013)
[198] Issue 3, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014
[199] Section 5 of Appendix 30 of the EIA, Potential for recolonisation and recovery by benthic communities following mining disturbance on the Chatham Rise, January 2013 (updated June 2013)
[200] Issue 6, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014
[201] Issue 7, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014
[202] Issue 6, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014
[203] Lines 16 – 17, page 303 of the Transcript, 29 September 2014
[204] Lines 6 – 14, page 361 of the Transcript, 30 September 2014
[205] Section 4.3 of Appendix 30 of the EIA, Potential for recolonisation and recovery by benthic communities following mining disturbance on the Chatham Rise, January 2013 (updated June 2013)

256. Dr Hourigan advised that any decisions on mining should not be premised upon expectations of significant restoration. In his evidence he stated *"While the proposal to explore hard-substrate habitat creation that might encourage natural recolonisation is scientifically interesting, there is insufficient information on their potential for success. I am not aware of any examples of successful deep-sea coral restoration. The results of these experiments would not be seen for many years. Therefore, such untested experiments should not be relied upon as mitigation measures."*[206]

257. From the information provided and evidence heard, the DMC agrees with Dr Hourigan that recolonisation trials are unlikely to prove successful in a short time span, if at all. The DMC also agrees with Mr Kennedy that if indeed recolonisation of the mined areas occurred, it would be by the benthic fauna and communities that characterise soft sediment habitats and would result in a notably different habitat and benthic community to the existing phosphorite nodule communities.[207]

Smothering from the deposition of tailings (sedimentation)

258. The effects of the direct removal of the seabed as determined by the Mine Plan could be quantified as far as the proposal has been put before the DMC, with a number of caveats associated with exclusion areas and avoidance of other sensitive areas and areas not mined due to operational constraints or other such matters. Indirect effects on non-mined areas were however, less easily quantified in terms of impacts on benthic fauna associated with sediment deposition (ie fallout from the sediment plume). The distribution and scale of this sediment deposition away from mining blocks was the focus of considerable evidence and debate amongst experts and submitters concerned about protection of biodiversity and commercial fish species.

259. The DMC understands that the spatial extent and depth of sediment deposited from the tailings very much depends on factors such as sediment size, currents and height of release of tailings above the seafloor (as described in Chapter 7). In her evidence, Dr Hewitt stated that sediment smothering occurs when the depositional rate of sediment from the water column is more than the seafloor animals living in the area are adapted to.[208] The technical reports stated that sedimentation on organisms does not always directly result in death. Other potential effects included lower fertilisation, lower rates of larval survival and settlement, reduced juvenile

[206] Paragraph F, Statement of Evidence of Thomas Francis Hourigan for the Crown, 12 September 2014
[207] Paragraph 58, Statement of Evidence of Paul Cameron Kennedy for CRP on Assessment of Environmental Impacts (updated), 29 August 2014 (amended 14 November 2014)
[208] Paragraph 17, Statement of Evidence of Judith Elaine Hewitt for CRP, 28 August 2014

survival, increased fragility and decreased fitness resulting in decreased growth and ability to escape predation.[209]

260. Dr Hourigan stated in his evidence that deep sea coral buried by sediments would die after several days, and explained during questioning that this was because the sediment would interfere with their feeding and probably with their gas exchange. If they were buried, they would be unable to clean their mouth parts and clean their polyps in order to continue to ingest food and to breathe.[210]

261. The DMC heard from Dr Hewitt that the effect of sedimentation is determined by a large number of factors, for example mobility of the organism and the location, length and the mobility of the feeding apparatus.[211] Depth and duration of burial are also important predictors of impact.[212] Dr Hewitt informed the DMC that biological responses to stresses usually get worse with repeated events.[213] From this, the DMC considers that resuspension of sediment and consequential deposition could exacerbate the stress to organisms. Dr Hewitt informed the DMC that a series of lower level events were also likely to have more of an effect than a single event, if the animals could not recover condition between events.[214]

262. Dr Hewitt described the international information on sensitivity of benthic organisms to suspended sediment and sediment deposition. She noted that of the dominant communities and the taxa that comprise them found in recent benthic biological surveys conducted over the applicant's marine licence area (summarised in Appendix 15 of the EIA), there was no known New Zealand information on the sensitivities of these taxa to suspended solids or sediment deposition[215]. Dr Hewitt described how the MarLin (Marine Life Network) database was used to undertake an assessment of impacts of seafloor mining. This database lists sensitivities of 150 European benthic species. She described at least one of the dominant species in each epifaunal community as highly or very highly sensitive to smothering with the exception of Community H. Not surprisingly, the infaunal communities were comparatively less sensitive to smothering.[216] However Dr Hewitt acknowledged that the use of the MarLIN database for setting thresholds was questionable and that there was no information on the sensitivity of the benthic community to sedimentation in the application area.[217]

[209] Section 3.1 of Appendix 29 of the EIA, Impacts of sedimentation arising from mining on the Chatham Rise, August 2012 (updated July 2013)
[210] Lines 15 – 19, page 393 of the Transcript, 30 September 2014
[211] Lines 30 – 38, page 720 of the Transcript, 3 October 2014
[212] Section 3.1.2, Impacts of sedimentation arising from mining on the Chatham Rise, August 2012 (updated July 2013)
[213] Lines 38 – 40, page 720 of the Transcript, 3 October 2014
[214] Paragraph 49, Statement of Evidence of Judith Elaine Hewitt for CRP, 28 August 2014
[215] Paragraph 28, Statement of Evidence of Judith Elaine Hewitt for CRP, 28 August 2014
[216] Lines 9 – 15, page 720 of the Transcript, 3 October 2014
[217] Lines 42 – 44, page 722 of the Transcript, 3 October 2014

263. Dr Hewitt characterised all the epifaunal communities described from camera images from MPL 50270 on the Chatham Rise as being highly or very highly sensitive to smothering, and highly sensitive to suspended sediment. She thought that those damaged by sedimentation would take greater than 25 years to recover "*if at all*".[218]

264. The analysis of the MarLIN database led Dr Hewitt to conclude that epifaunal communities all had at least one defining taxon predicted to be destroyed or damaged, with recovery taking at least 10 years. The levels of sedimentation and suspended sediment concentrations expected to elicit this response were 5 cm sedimentation depth and 100 mg/L respectively, lasting for one month. However, on a cautionary note, Dr Hewitt went on to conclude that "*Also, while the depth of sedimentation is predicted to be <5 cm outside the actual mined area, the small size of some organisms and much experimental work within New Zealand on similar types of organisms, suggests that levels between 0.5 mm (height protruded by the small encrusting bryozoans found in the area) to 5 cm could have marked effects.*"[219]

265. The DMC clarified with Dr Berkenbusch that the experts were in agreement that the stony corals were *"highly sensitive"* to sedimentation and what this phrase meant. Dr Berkenbusch explained that this means that even small changes to the suspended sediment levels or to the sediment that is settling on to the coral are likely to have a dramatic adverse effect on the coral.[220]

266. From the evidence, the DMC understand that the effect of sediment deposition is greater than just the effects of smothering. The DMC heard from Dr Hourigan that if the hard substrate is covered by sediment, it can interfere with the settlement and attachment of larvae. Once they have settled, single polyps are barely a millimetre or two above the hard substrate on which they sit and are much more likely to get buried than would an adult coral colony which sits higher.[221] Dr Hourigan confirmed that in areas where there has been previous mining and polyps have settled then they are at risk again from sediment from subsequent mining.[222]

267. The experts for benthic ecology agreed that there was no information available on the sensitivity of organisms to increased sediment, and insufficient information to reliably assess the effects of changes to the sediment regime on benthic communities.[223] The benthic experts agreed that validation of the sediment plume model to determine the extent and depth of sediment would allow more accurate estimation of the effects of increased sediment.

[218] Paragraph 30, Statement of Evidence of Judith Elaine Hewitt for CRP, 28 August 2014
[219] Paragraph 50, Statement of Evidence of Judith Elaine Hewitt for CRP, 28 August 2014
[220] Lines 17 – 28, page 304 of the Transcript, 29 September 2014
[221] Lines 28 – 35, page 266 of the Transcript, 30 September 2014
[222] Lines 2 – 9, page 367 of the Transcript, 30 September 2014
[223] Issue 3, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014

Increased suspended sediment levels

268. The sediment plume was seen as a temporary effect as it was expected to last for a relatively short period of time, depending on when active mining of the bed was taking place. This was in contrast to any deposited fine sediment, which was expected to remain indefinitely on the seabed due to currents on the Chatham Rise crest not having sufficient shear stress to re-suspend fine sediments and disperse them further afield.

269. From the sediment modelling, the DMC understands that deposition of the tailings would create a sediment plume that would disperse outside of active mining areas. Increased levels of suspended sediment near the seabed can have an impact on organisms that feed on suspended organic particles such as filter feeders. Either the organisms consume additional energy sorting out the organic particles from the inorganic fraction or they must ingest both organic and inorganic particles together, thereby decreasing the average digestibility of their food. This can reduce the energy available for growth or reproduction, or even cause damage to feeding apparatus and gills.[224]

270. The DMC asked Dr Berkenbusch about the uncertainty around tolerance to suspended sediment and whether there is any practical way of addressing that information gap. Dr Berkenbusch considered that *in situ* experiments or even laboratory experiments could be undertaken.[225] However, questions remained about the practicality of undertaking such experiments given the remoteness of the consent application area and the depth at which local benthic communities live.

Changes to the benthic sediment characteristics

271. The recolonisation report in the EIA considered that environmental factors such as sediment particle size are known to be important factors for settlement and recolonisation of soft sediments. Thus, changes to the sediments within the disturbed area (including those resulting from back-filling of the excavated area with tailings) could further inhibit or delay recovery, or could lead to long-term changes in community structure.[226]

272. Both Dr Berkenbusch and Professor Watling considered that the sediment that is returned would not be as consolidated as it was before, and it is very likely that nothing can settle in that sediment until it consolidates from a "*soupy"* state.[227] Professor Watling opined that larvae that

[224] Section 3.1.1 of Appendix 29 of the EIA, Impacts of sedimentation arising from mining on the Chatham Rise, August 2012 (updated July 2013)
[225] Lines 11 – 17, page 305 of the Transcript, 29 October 2014
[226] Section 4.1 of Appendix 30, of the EIA, Potential for recolonisation and recovery by benthic communities following mining disturbance on the Chatham Rise, January 2013 (updated June 2013)
[227] Lines 1 – 4, page 316 of the Transcript, 29 September 2014

are only two-tenths of a millimetre in diameter would have difficulty settling in sediment with very high water content, even if the high water content is only in the top centimetre.[228] Fine sediment deposited over the top of coarser sediment may reduce sediment permeability by filling interstitial pore spaces, creating a cap on top of the coarser sediment through which pore water, nutrients and oxygen can no longer pass.[229] The DMC understands that under such under hypoxic conditions, suspension feeders may be replaced by deposit feeders, and macrobenthos by meiobenthos, ultimately resulting in a change in benthic community.[230]

273. Regardless of how quickly deposited fine sediments would consolidate, there was little doubt that the benthic community within mined areas of the seabed would change to one dominated almost exclusively by species that favour a soft sediment environment. As to changes in the benthic community away from the mined areas, the only evidence received from experts in this field indicated that adverse effects were likely for those species and communities that prefer hard surfaces. The extent of these effects would vary depending on individual species (for which there was very little information) and the degree of sediment dispersion and subsequent deposition.

Changes in food

274. From the research and evidence presented, the DMC understands that this effect could be both positive and negative. Deposited sediment may differ from ambient underlying sediments with increased organic matter from organisms crushed by the mining process. The effects of increased organic content in deposited sediment include provision of an extra food source for deposit feeders and scavengers, but also a reduction in the redox potential.[231] In general, the DMC understands that this would favour species that tolerate living within fine sediments with limited oxygen availability.

275. The DMC heard from Professor Watling that the particle concentration in the water may increase to the point where either the organism that is filtering particles out of the water for its food would get overwhelmed by sediment particles, or the actual food particles themselves would be diluted by the mineral grains from the plume. In either case the animal would not be getting enough food.[232]

[228] Lines 34 – 37, page 409 of the Transcript, 30 September 2014
[229] Paragraph 18, Statement of Evidence of Judith Elaine Hewitt for CRP, 28 August 2014
[230] Section 3.1.3 of Appendix 29 of the EIA, Impacts of sedimentation arising from mining on the Chatham Rise, August 2012 (updated July 2013)
[231] Section 3.1.4 of Appendix 29 of the EIA, Impacts of sedimentation arising from mining on the Chatham Rise, August 2012 (updated July 2013)
[232] Lines 27 – 34, page 414 of the Transcript, 30 September 2014

8.1.6. Mitigation and proposed conditions

276. Ms Taylor summarised in her evidence the applicant's range of proposed measures to avoid, remedy or mitigate the effects of mining.[233] Those specifically relating to the benthic environment included:

- not mining in large areas of rocky outcrops
- identification of mining exclusion areas, defined through the marine spatial planning exercise, in order to avoid or minimise impacts on areas of particular sensitivity or value (including areas with marine mammal fossil)
- ensuring the mining blocks in any year, during the first five years of mining, are sufficiently separated to avoid sedimentation impacts on other blocks and enable ecological monitoring of the actual impacts of sedimentation
- evaluation of the feasibility and viability of creating hard substrate habitat to enhance recolonisation, and, if viable, creating of such habitat.

277. The applicant proposed to set protected areas aside (referred also as no-mining areas or exclusion areas). These areas were arrived at by combining information on the known or predicted distribution of benthic communities / taxa with data on the known or predicted distribution of phosphorite nodules to identify areas that can be closed to protect biodiversity and areas where mining can continue.[234] This approach is a form of habitat modelling as described in the EIA and in the evidence and commentary of Dr Rowden.[235]

278. The Zonation modelling outcomes as described in the EIA and in evidence of the applicant's witnesses had a number of caveats. Dr Rowden noted that the Zonation analysis was undertaken to show how spatial planning can be used to develop management options for protecting biodiversity. He said that the initial selection of no-mining areas should be further evaluated and iterated by other stakeholders involved in the management process after predictive models have been verified.[236] Potentially, no-mining areas may need to be adjusted if surveys proved the model predictions were incorrect.

279. Dr Hourigan also cautioned that care must be taken with habitat modelling for the distribution of corals until it has been validated by actually going down and looking to see whether there are indeed corals in the areas where they are predicted to be.[237] The DMC's understanding of the validation was that while there were no independent *in situ* field validations of the model, there was validation using samples which were withheld from the original model. Rowden *et al*

[233] Paragraph 14, Statement of Evidence of Carmen Taylor for CRP, 29 August 2014
[234] Section 1.2 of Appendix 32 of the EIA, Developing spatial management options for the central crest of Chatham Rise, May 2014
[235] Paragraphs 61 – 71, Statement of Evidence of Dr Ashley Rowden for CRP, 25 August 2014
[236] Paragraph 9, Statement of Evidence of Dr Ashley Rowden for CRP, 25 August 2014
[237] Paragraph 32, Statement of Evidence of Dr Thomas Hourigan for the Crown, 12 September 2014

recommended further sampling and analysis in order to assess the potential uniqueness of some of the benthic communities in the licence area.[238] The benthic experts agreed.

280. Although Dr Leathwick supported the use of the Zonation modelling tool, the DMC heard from him that further analysis would be desirable, with an expanded set of biodiversity and environmental layers, along with information describing both fishing intensity and mining prospectivity.[239] He stated that fishing impacts need to be taken account of to avoid identifying or relying on sites for the protection of high biodiversity values that in fact are being compromised by fishing activity.[240] He considered that this approach would provide a more transparent and informed basis for decision-making.

281. Importantly, the DMC notes that the experts recommended that model predictions need ground-truth verification before spatial management decisions are made. They also agreed that consideration of anthropogenic disturbances should be incorporated into either the habitat suitability models or the Zonation analyses.[241] While the DMC accepts that the Zonation model approach employed by the applicant has some merit, there remains a good deal of uncertainty around the validation of the predictions on locations of benthic communities and the influence of existing lawful activities that may affect their ongoing protection.

282. Ms Taylor stated that the proposed mining exclusion areas would cover a total area of 1,024 km^2 or around 19.7 % of the revised marine consent area.[242] Ms Taylor noted that "*CRP has committed to use its best endeavours to try to ensure that the areas identified through this exercise are legally protected from all seabed disturbance activities as an alternative and enhanced protection mechanism to that provided by the BPA*."[243]

283. Dr Hourigan considered that the no-mining areas along with adequate buffer zones to reduce potential sediment impacts were probably the most effective way of to ensuring conservation of high value deep sea coral habitats should mining proceed. The mining exclusion areas proposed by the applicant, however, did not appear to include significant amounts of verified *G. dumosa* habitat nor did they seem to include large areas of the predicted habitat for the most dense community.[244] He opined that any no-mining areas established to protect corals should include a significant buffer zone to prevent secondary impacts from sedimentation.[245]

[238] Section 4 of Appendix 32 of the EIA, Developing spatial management options for the central crest of Chatham Rise, May 2014
[239] Paragraph D, Statement of Evidence of John Ralph Leathwick for the Crown, 12 September 2014
[240] Paragraph 23, Statement of Evidence of John Ralph Leathwick for the Crown, 12 September 2014
[241] Issue 4, Joint statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014
[242] Paragraph 118, Statement of Evidence of Carmen Taylor for CRP, 29 August 2014
[243] Paragraph 10, Statement of Evidence of Carmen Taylor for CRP, 29 August 2014
[244] Lines 35 – 41, page 357 of the Transcript, 30 September 2014
[245] Lines 4 – 6, page 358 of the Transcript, 30 September 2014

284. Ms Taylor acknowledged that the loss of benthic habitat and fauna within the mining blocks and sedimentation impacts on benthic habitat adjacent to the mining blocks remained a "*high or serious environmental risk, within the marine consent area, even after the adoption of proposed mitigation measures."*[246] The DMC presumes that her description of the impacts is consistent with the EIA's assessment criteria which included an environment risk matrix approach.[247] Ms Taylor summarised this approach in her evidence in chief.[248] This matrix considered 'consequence' and 'likelihood' categories for various potential effects (associated with mining) to produce a level of environmental risk ranging from low to serious. For example, a particular effect might be afforded a 'low' risk ranking because it is considered to have a rare likelihood of occurring and a minor consequence if it did. At the other end of the scale, a 'serious' risk ranking might be afforded to an effect that was almost certain to occur and would have a catastrophic consequence if it did.

285. In her evidence Ms Taylor's assessment of the loss of benthic habitat and fauna within the mining blocks was described as a 'serious environmental risk' in that the impacts were "*adverse, near-source confined, medium to long-term but ultimately reversible. Potential consequence is serious and the potential likelihood is almost certain*".[249] The DMC agrees with most of this description but does not accept that it is reversible. The DMC has seen no evidence to suggest that benthic communities that live on hard substrates would re-colonise mined areas. Mr Winchester in his opening submissions on behalf of the applicant stated there would be "*significant and irreversible effects*" on the benthic environment where mining occurs.[250] Indeed, he added that impact on corals in the areas where mining would occur would be "*permanent and significant*".[251]

286. Ms Taylor went on to conclude that in her opinion the applicant's proposed mitigation measures would achieve the purpose of the EEZ Act (Section 10), notwithstanding that the benthic environment within the mining area would be adversely affected, in some instances irreversibly.[252] Her reasoning was that the life-supporting capacity of the wider Chatham Rise environment would be safeguarded because potential impacts beyond the mining area would effectively be avoided, remedied or mitigated. Her rationale is understandable, but the DMC does not agree that the likely adverse effects to benthic communities within and adjacent to the mine permit area can be dismissed before their significance has been established.

[246] Paragraph 13, Statement of Evidence of Carmen Taylor for CRP, 29 August 2014
[247] Section 8.2, Marine Consent Application and EIA, May 2014
[248] Paragraphs 77 – 83, Statement of Evidence of Carmen Taylor for CRP, 29 August 2014
[249] Paragraph 84, Statement of Evidence of Carmen Taylor for CRP, 29 August 2014
[250] Paragraph 10(g), Opening Submissions for CRP, 25 September 2014
[251] Paragraph 11, Opening Submissions for CRP, 25 September 2014
[252] Paragraphs 18 – 20, Statement of Evidence of Carmen Taylor for CRP, 29 August 2014

287. The DMC agrees with Ms Rickard that it is unclear as to how meaningful proposed conditions could be drafted that address effects on benthic ecology when there was no agreed evidence regarding appropriate trigger levels.[253] It appeared from the joint witness conferencing in the area of benthic ecology and spatial planning that very few proposed conditions were developed and agreed.

288. While mining would permanently destroy the benthic environment and its associated hard substrate communities within the mined area and in areas alongside mining blocks, protection of mining exclusion areas was proposed by the applicant. Proposed Condition 14 required avoidance of identified and additional mining exclusion areas and rock outcrops. The wording of Proposed Condition 14(b) does not allow objective assessment of compliance with wording such as "*significant"* coral thickets. Moreover, there were no identified mechanisms for identifying Proposed Condition 14(c) or ensuring compliance with it.

289. The DMC understands that Proposed Condition 14(b) dovetails with Schedule 2A(iv) and was intended to verify the spatial modelling exercise that identified the areas for exclusion from mining. A report was to be provided to the Chief Executive at least three months before mining commences and may have amended the mining exclusion areas (or added additional areas). This reflected the recommendations of the experts in the field of benthic ecology and spatial planning.[254]

290. The experts in the field of benthic ecology agreed that it was important to identify the order in which mining blocks would to be chosen and that initial mining should not be adjacent to the most sensitive communities.[255] There was a requirement for monitoring in advance of mining in proposed Schedule 2A to confirm the Zonation model and a pre-mining report to be provided to the EPA. While this approach may allow the order of mining blocks to be altered depending on the results of the pre-mining monitoring, the proposed conditions as drafted appear to set the mining blocks for the first three years in Attachment B with little opportunity to change.

291. The requirement of Proposed Condition 14(b) regarding potential amendment of mining exclusion areas was consistent with the adaptive management approach recommended by the experts in the field of benthic ecology and spatial planning. They agreed that further surveys and spatial planning could identify further mining exclusion areas as part of an adaptive management process. They also agreed that, as a proposed condition, an EPA approved set of mining exclusion areas should be defined before operational mining commences.[256] However,

[253] Paragraph 25, Supplementary Statement of Evidence of Andrea Judith Rickard on behalf of Te Rūnanga o Ngāi Tahu and Deepwater Group Limited, 16 November 2014
[254] Issue 5, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014
[255] Issue 3, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014
[256] Issue 5, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014

reading Proposed Condition 11 and Proposed Condition 14, the DMC understands that any adjustment to the mining area to take into account verification of the modelling of benthic areas of particular interest would not be taken into account by the applicant until after the first three years of mining. The DMC considers this to be a significant limitation of the validation process.

292. Most of the exclusion areas were outside the initial 820 km^2 mining area. While most exclusion areas were within the BPA, those directly north of the mining blocks were outside the BPA and therefore would have no protection other than through this consent which protects the exclusion areas from the applicant's mining but not from other uses. Proposed Condition 60 acknowledged the need for a legal mechanism to provide protection for any mining exclusion areas from uses other than mining. The difficulty with this proposed condition was that any legal mechanisms could not be implemented by the applicant, and would rely upon the actions of third parties such as the Ministry for Primary Industries and the Department of Conservation. As stated in the opening legal submissions for KASM, Greenpeace and DSCC, this would involve an entirely different process with entirely different participants.[257] The DMC understands that this is the primary reason for the use of the "*best endeavours*" concept in the proposed condition; in that the applicant would not have any control over the establishment of protection over the mining exclusion areas other than refraining from mining them. The DMC agrees with EPA staff that this proposed condition may not be enforceable. [258] The DMC concludes in any event that this proposed condition could not realistically be relied upon to provide effective protection for mining exclusion areas.

293. Proposed Schedule 1C set out environmental thresholds for sedimentation of the benthic environment. The threshold was no observed adverse impacts on benthic organisms beyond the distance predicted for 1 mm sedimentation from the mining block, at a point no more than 7 km from the mining block. The reference to 1 mm was in accordance with the threshold for sensitive benthic organisms identified by Dr Hewitt in her evidence.[259]

294. Proposed Schedule 2B(vi) was a monitoring requirement to be undertaken during mining and has two purposes: firstly to confirm that the extent of sediment deposition was in accordance with the models; and secondly to ensure that the impacts on ecological values beyond the area of predicted adverse impact from sedimentation are no greater than predicted. The DMC notes the requirement to identify regional reference sites that would not be impacted by mining or any other activities. The DMC questions how realistic this is given that the BPA would potentially be affected by the sediment plume and that the areas outside the BPA may potentially be affected by other activities such as trawling and fishing.

[257] Paragraph 51, Opening Submissions by KASM, Greenpeace and DSCC, 26 September, 2014
[258] Page 16, EPA Comment on CRP Proposed Conditions, 14 November 2014
[259] Lines 40 – 41, page 728 of the Transcript, 3 October 2014

295. The need for hard substrate recolonisation trials is contained in Proposed Schedule 2B(ix) during mining operation, and reporting is required by Proposed Conditions 38 and 39. The experts in the field of benthic ecology and spatial planning were agreed that recolonisation trials need to be proven successful before recolonisation could be proposed as a mitigation technique.[260] Although there was a requirement for initial trials to be carried out in certain areas, there were no specifications for when, where, how many, surface area and so on. The proposed conditions as they were drafted did not contain enough detail for the DMC to actually understand what would be undertaken.

296. Proposed Schedule 2B(viii) was intended to monitor the recolonisation of mined blocks. The DMC understands that this would be an information gathering exercise and the proposed condition was to monitor rather than achieve any particular level of recolonisation.

297. Proposed Schedule 2C required representative seabed images and samples to confirm the nature and character of benthic habitats in accordance with Proposed Condition 40 in order to extend mining into additional areas.

298. The experts in the field of benthic ecology and spatial planning recommended the timing of mining to be adjusted to minimise effects on vulnerable life stages (eg presumed April to May reproduction period for *G. dumosa).*[261] This was not however reflected in the applicant's proposed conditions.

8.1.7. Adaptive management

As noted above, once consent had been granted, the applicant proposed to ground-truth its proposed mining exclusion areas, with possible adjustment or expansion to the exclusion areas. However our reading of the applicant's proposed conditions is that mining would be able to commence regardless of the ground-truthing outcomes. While Proposed Condition 14 requires research to be carried out verifying the Zonation modelling prior to mining commencing (Schedule 2), this related only to amendments to the mining exclusion areas and not to the mining blocks to be mined in the first three years. In accordance with Proposed Condition 11, mining would take place in the first three years in the areas identified in Attachment B of the proposed consent conditions. There was nothing in the proposed conditions that would prevent mining occurring, not even submitting the Mine Plan to the Chief Executive of the EPA, as he / she was only required to certify that the Mine Plan met the requirements of Proposed Conditions 25 and 26.

[260] Issue 7, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014
[261] Issue 3, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014

8.1.8. DMC findings

299. Section 59(2)(d) of the Act states that the DMC must take into account the importance of protecting the biological diversity and integrity of marine species, ecosystems, and processes, and the importance of protecting rare and vulnerable ecosystems and the habitats of threatened species. There was some uncertainty as to whether the DMC could describe the benthic community as an ecosystem in its own right or whether it formed just a component of the wider Chatham Rise ecosystem. Making such geographical distinctions is not always easy in the biological world, and the terms 'community' and 'ecosystem' can arguably be used interchangeably.

300. As discussed in Chapter 15, the DMC views any distinction between referring to the benthic environment and its associated biota as a community or group of communities, rather than as an ecosystem, as a rather arbitrary one. One of points agreed to by the expert group on ecosystem effects was that ecosystems do not have well defined boundaries[262]. One definition of ecosystem is *"A biological community of interacting organisms and their physical environment".*[263] The DMC sees no reason why parts of the benthic environment of the Chatham Rise should not be regarded as ecosystems in their own right. The two *G. dumosa*-dominated epifaunal communities and one infaunal community were found to have a direct correlation with the presence of high-density patches of phosphorite nodules. That to the DMC constitutes an ecosystem.

301. The experts who participated in conferencing on benthic ecology and spatial planning agreed that benthic communities of the crest of the Chatham Rise play an important role in ecosystem functions, such as biodiversity, nutrient recycling and habitat provision.[264]

302. The DMC finds that several potentially unique benthic communities within the consent application area were identified and they included at least one species protected under the Wildlife Act (the stony coral *G. dumosa*). While there is a general lack of detailed benthic survey work throughout the EEZ, the DMC is satisfied that these communities may be rare on the Chatham Rise and within New Zealand's EEZ. Given the communities are potentially unique to the Chatham Rise, it follows they are likely to be rare in that area. While habitat modelling predicts that they may be present outside the mine permit area, their presence outside the mine permit area has not been verified. Their predicted locations include substantial areas where bottom trawling is not prohibited. There are substantial gaps in the knowledge of benthic communities on Chatham Rise as well as considerable uncertainty about the full extent of

[262] Issue 2, Joint Statement of Experts in the Field of Ecosystem Effects, 17 September 2014.
[263] http://www.oxforddictionaries.com/definition/english/ecosystem
[264] Issue 2, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014

biodiversity and cryptic and rare species due to restricted sampling effort and limited taxonomic resolution.

303. Because this proposal was to mine the seabed to a depth of up to 0.5 m, benthic communities would be highly vulnerable to the effects of the proposed seabed mining. Those species that prefer hard substrates (or soft sediments for that matter) for habitat would be destroyed by the proposed mining operation. There is no dispute that this habitat and associated benthic communities would be destroyed over a large area if consent were to be granted. The DMC considers this is a significant matter. Compounding this effect, recolonisation of mined seabed by communities that prefer hard substrates (ie *G. dumosa* dominated communities) is unlikely to occur and the applicant has not committed to artificial recolonisation beyond a relatively small trial of unknown outcome. Given that recolonisation and recovery by other benthic communities are difficult to predict, the DMC finds that changes to the benthic environment through changes to substrate composition and sedimentation should be regarded as permanent at least in the timeframes relevant to re-colonisation by benthic organisms. In short, the DMC agrees with the applicant that the effects on the existing benthic communities within mining blocks would be significant and irreversible[265] and that no avoidance, remediation or mitigation measures can be applied.[266]

304. Furthermore, the DMC notes that in order to undertake recolonisation trials, a marine consent would be required under Section 20(2)(f) of the EEZ Act (the deposit of any thing or organism in, on, or under the seabed). Although the applicant sought consent under this section of the Act, it did not provide details of the proposed recolonisation trials for the DMC to consider.

305. Overall, the DMC considers there to be a large degree of uncertainty associated with recolonisation of the deep-water benthic environment following significant disturbance to the seabed.

306. There is also uncertainty about the hyperbenthos and how it might be affected by the mining operation and what role it might play in providing food for dermersal fish. The benthic experts involved in conferencing agreed that hyperbenthic communities on the Chatham Rise are an important component of the ecosystem and may be vulnerable to the proposed mining method.

307. Outside of the mining blocks there are likely to be additional impacts to benthic communities associated with suspended sediment and sediment deposition. The area affected by these processes would depend on the nature and behaviour of the sediment plume, as discussed in Chapter 7, and the nature of the benthic communities, in particular their sensitivity to fine

[265] Lines 20 – 22, page 9 of the Transcript, 25 September 2014
[266] Paragraph 88, Statement of Evidence of Paul Cameron Kennedy for CRP (Updated), 29 August 2014

sediment. As such, there is likely to be a gradient of effects away from the mining blocks. These matters carry a significant degree of uncertainty. While the movement of the sediment plume and associated sediment deposition has been modelled, the model outputs have not been verified. The sensitivities of the benthic communities and individual species are largely unknown and the applicant has had to rely on information on species that do not live on the Chatham Rise and in many cases are not found in New Zealand waters. Given these uncertainties, the DMC finds that it is not possible to quantify the scale of effects on benthic communities away from the mining blocks.

8.2. Trophic web

8.2.1. The importance of the trophic web

308. Section 59(2)(d) of the EEZ Act requires the DMC to take into account the importance of protecting the biological diversity and integrity of marine species, ecosystems, and processes. Trophic or food webs describe the flow of energy through ecosystems, typically by aggregating species into trophic levels, which are groups of species that have the same predators and prey in the food web. Dr Pinkerton developed a model of the structure of the trophic web of the whole of the Chatham Rise (*Figure **9***), using information from many different sources. He told the DMC that the model provided information about trophic connections (who eats whom) on the Chatham Rise, including all living biota from bacteria to whales, in 37 trophic groups.[267] He noted that the purpose of the model was to calculate an "*index of trophic importance*" for each group. This index measured the average interaction strength between a group and all others in the trophic web, which can be indicative of how central to the food web each group is.[268]

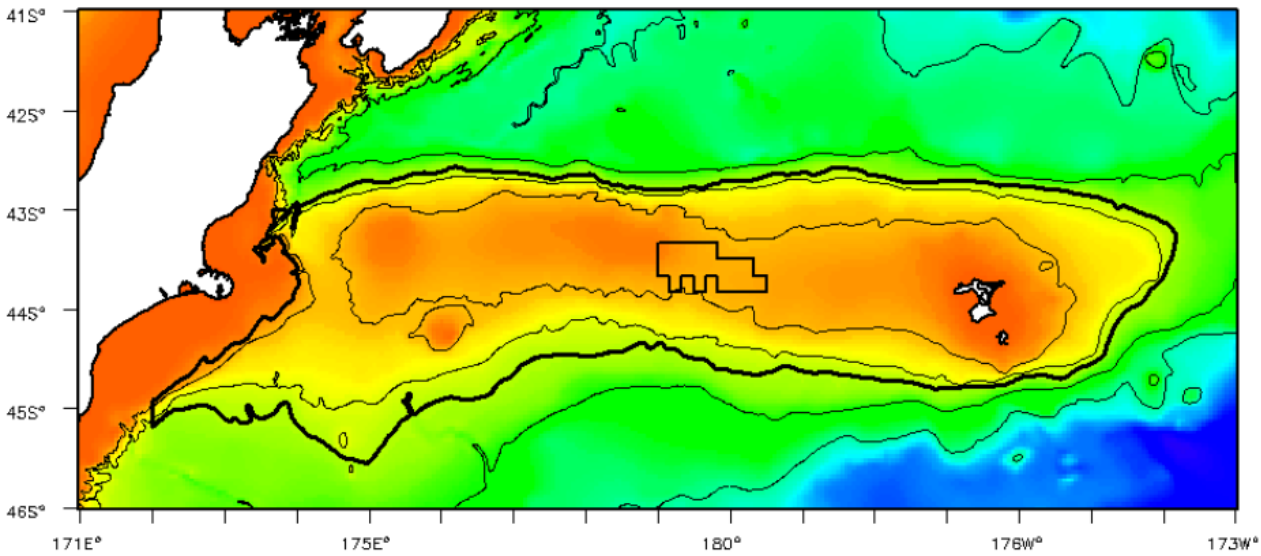


Figure 9. Spatial Extent of Trophic Model. The region of the Chatham Rise trophic model is the bold black line. The area proposed for mining by CRP is in the centre of the model area on the crest of the rise. The colours give the depth of water: deep waters are shown blue and shallow waters red (range 0 – 5100m). Depth contours (thin black lines) are plotted at 500, 1000, 2000 and 3000 m. (Source: EIA, Appendix 22, Figure 1)

309. Dr Pinkerton explained the variety of organisms that make up the trophic web on the Chatham Rise, from the phytoplankton at the surface of the water column where there is sunlight through to benthic organisms on the seabed.[269] His model included information on key species, their biomass, energetics (feeding and growth rates, assimilation efficiencies) and diets. The model

[267] Paragraph 1, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014
[268] Paragraph 2, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014
[269] Lines 43 – 35, pages 957 – 958 of the Transcript, 15 October 2014

had 37 groups: seabirds; toothed whales and dolphins; baleen whales; seals; nine demersal fish groups (hoki; orange roughy; oreos; warehou; pelagic foragers; benthopelagic and benthic invertebrate feeders; benthopelagic and benthic predators; small demersal fishes), four mesopelagic groups (mesopelagic fishes; squid; krill; salps), 10 groups of benthic invertebrates (corals; other encrusting invertebrates; seastars and brittlestars; echinoderms; sea cucumbers; prawns and shrimps; large benthic worms; bivalves and gastropods; macrobenthos; meiobenthos); three groups of small zooplankton (mesozooplankton; ciliates; flagellates); phytoplankton, bacteria and detritus.

8.2.2. Model findings

310. Despite quite a long list of caveats and reservations regarding the completeness of the model, Dr Pinkerton concluded that the trophic web modelling was able to suggest which groups of organisms are likely to be more or less important in terms of the energy flow through ecosystems and provide an ecosystem context to assessing ecological impact.

311. In this regard, the model determined phytoplankton had the highest trophic importance on the Chatham Rise, as the sole primary producer. Of the consumers, the highest trophic importance were demersal fishes (1st), mesozooplankton (2nd), hoki (3rd), microzooplankton (4th), benthic prawns and shrimps (5th), small midwater fishes (6th) and benthic meiofauna (7th).[270]

8.2.3. Model uncertainties

312. In terms of uncertainties associated with the model, the experts involved in the ecological effects conference agreed that there were many parameters in the model and the values are uncertain — some more than others. However, they concluded that the way the model deals with uncertainty is appropriate, although the levels of uncertainty may be reduced through additional sensitivity analysis.[271]

313. They agreed that the model was fundamentally sound in structure, comprehensive and met current standards,[272] but acknowledged its limitations such as seasonal dynamics and the fact that it represents a "*typical year*" only, focuses on major flows of energy, and has no recognition of the provision of habitat by one species for other.[273] Dr Fulton, for example explained the significance of the habitat dimension: habitat is critical for the survival or growth of a life history stage (eg juveniles) or for a process or behaviour (such as spawning).[274]

[270] Paragraph 36, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014
[271] Issue 3, Joint Statement of Experts in the Field of Ecosystem Effects, 17 September 2014
[272] Issue 1, Joint Statement of Experts in the Field of Ecosystem Effects, 17 September 2014
[273] Paragraph 26, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014 and Issue 1, Joint Statement of Experts in the Field of Ecosystem Effects, 17 September 2014
[274] Paragraph C, Statement of Evidence of Elizabeth Ann Fulton for the Crown, 12 September 2014

8.2.4. Ecosystem effects of mining

314. In his presentation at the hearing, Dr Pinkerton helpfully summarised the potential ecosystem effects of the mining application. They included:

- direct impacts such as the physical removal of organisms from the seabed, the effects of the sediment plume on organisms, noise and so on
- habitat mediated effects, where the mining changes the physical habitat of the seabed and that has an effect on some organisms or on some life stages of organisms
- ecosystem effects are those effects on the individual species moderated through the food web. For example, if there is a change in the abundance of one organism, its predators and prey can both be affected through feeding relationships (as described by the food web model).[275]

315. Dr Pinkerton considered that although phytoplankton and detritus had the most importance in the trophic model, the chances of impacts to these from seabed mining were relatively small as they would be spread throughout the Chatham Rise. Although there was potential for some mesozooplankton to be impacted by the sediment plume or by the mining, Dr Pinkerton regarded the potential for impacts as probably low overall when considered over the scale of the whole Chatham Rise.[276]

316. Dr Pinkerton concluded that out of the top eleven groups with the highest trophic importance, ten would have low likely impact from the proposed mining. He opined that there are four groups which cause concern as they have a relatively high trophic importance and unknown spawning patterns. He listed the groups as being small demersal fish, the hard-bodied macrozooplankton (eg krill), cephalopods (eg squid) and the rattails and ghost sharks. He stressed however that there was neither evidence nor lack of evidence as to whether those organisms do or do not form spawning aggregations near the mining site.[277]

317. As the proposal would kill or at the very least displace all benthic organisms (both flora and fauna) to the depth mined by the drag-head, the DMC was particularly interested in the importance of the benthic organisms. While the trophic web model determined that benthic macrofauna (12th) had above average trophic importance, all the benthic megafauna (such as corals, encrusting invertebrates, urchins, seastars and brittlestars) and large benthic worms had trophic importance in the lower half of groups in the model.[278] Dr Pinkerton concluded that, based on the model, even quite large changes to the abundances of corals and encrusting invertebrates are likely to have only a small effect on the pattern of energy flow through the

[275] Lines 10 – 30, page 957 of the Transcript, 15 October 2014
[276] Lines 31 – 40, page 964 of the Transcript, 15 October 2014
[277] Lines 35 – 46, page 966 of the Transcript, 15 October 2014
[278] Paragraph 36, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014

trophic web at the scale of the whole Chatham Rise.[279] Dr Pinkerton told the DMC that if there is a change in abundance to some of the benthic groups, it is unlikely to have a trophic effect on the food web of the Chatham Rise.[280]

318. Dr Pinkerton described how he undertook sensitivity analysis to determine the effect of changes to corals to propagate through the food web. This was undertaken to address the concern that poor information on the abundance of benthic invertebrate groups may have affected the estimate of their trophic importance. Dr Pinkerton told the DMC that this sensitivity analysis showed that 10-fold increases in the biomass of corals and encrusting invertebrates led to only small increases in their trophic importance. He concluded that the low trophic importance of corals and encrusting invertebrates to the Chatham Rise trophic web as a whole was robust despite the lack of good information on the biomasses of these two groups.[281]

319. The DMC takes it from this sensitivity analysis that if the abundance of coral on the Chatham Rise is reduced, there is not likely to be a significant effect on the trophic web. However as noted by Dr Pinkerton, there may be unforeseen effects that the model cannot demonstrate. For example, there may be effects on the trophic web because that coral provides habitat for something which has high trophic importance.[282] The DMC acknowledges that the model cannot consider the provision of habitat or the role of any particular species in the trophic web.[283]

320. The DMC asked Dr Pinkerton about the likely timeframes for an impact to be seen in the trophic web and its recovery. Dr Pinkerton opined that a big impact could be expected to be seen quite quickly because the organisms are quite short lived. As for recovery, it depended on whether their cycle of reproduction could pick up again after it has been affected.[284]

321. Dr Fulton drew to the DMC's attention that the trophic model also did not address other ecosystem processes such as nutrient cycling. She considered that disturbance of the seabed, direct removal or mortality of species in the mining path and potential smothering of benthic species under the plume have the potential to modify local scale nutrient cycling which could further exacerbate effects on bottom communities and detritus based food webs.[285]

[279] Paragraph 7, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014
[280] Lines 14 – 15, page 980 of the Transcript, 15 October 2014
[281] Paragraph 4, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014
[282] Lines 38 – 40, page 975 of the Transcript, 5 October 2014
[283] Paragraph 5, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014
[284] Lines 4 – 17, page 973 of the Transcript, 15 October 2014
[285] Paragraph E, Statement of Evidence of Elizabeth Ann Fulton for the Crown, 12 September 2014

322. Mr Bartle expressed concern there was a potentially significant risk of damaging ecosystem effects from the sediment plume; however the trophic model did not assist in addressing this concern.[286]

8.2.5. Proposed conditions

323. While the applicant's proposed conditions had a strong focus on the benthic ecology, the wider effects on the trophic web and ecology of the Chatham Rise were not addressed. There was some discussion at the hearing regarding monitoring of fish (eg for trace metal content), which raised the question as to whether monitoring of mobile species could be undertaken in a way that distinguished the effects of the applicant's activities from other activities taking place on the Chatham Rise (eg fishing) or from natural variation.[287]

8.2.6. DMC findings

324. From Dr Pinkerton's evidence, the DMC considers the value of the trophic model lies in its ability to show the predator-prey interactions between any two species, or groups of species with similar trophic status, and to indicate how important a particular organism might be to the structure of the Chatham Rise food web as a whole.[288] He explained that a large impact on organisms with a higher trophic importance means a high risk of large scale ecosystem effects. Conversely a large scale change on something lower down the list of trophic importance has less chance of propagating widely through the food web.[289]

325. Dr Pinkerton stressed that the model cannot be used to estimate the effects on the ecosystem caused by mining as the model is not dynamic and cannot represent changes to the food web over time.[290] Further, after considering the use of more sophisticated trophic models, FIR numbers 12 and 13 concluded "*Even with such a dynamic and spatially-resolved model, our ability to reliably forecast what will happen to the Chatham Rise ecosystem as a result of mining will be limited. The current state-of-the-art in this area of science is that the behaviour of complex and poorly-observed systems (such as the Chatham Rise ecosystem, even though it is the best known part of New Zealand's EEZ) cannot be reliably predicted.*"

326. Additionally, Dr Pinkerton acknowledged that only predator-prey connections are considered.[291] Provision of habitat was not considered[292] and the DMC sees that as a significant limitation to its

[286] Paragraph 166, Evidence of Mr J A (Sandy) Bartle for Royal Forest and Bird Protection Society of New Zealand Incorporated, 12 September 2014
[287] Lines 40 – 25, pages 827 – 828 of the Transcript, 14 October 2014
[288] Lines 34 – 46, page 961 of the Transcript,15 October 2014
[289] Line 41 page 963 – line 3, page 964 of the Transcript,15 October 2014
[290] Paragraph 6, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014
[291] Paragraph 5, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014
[292] Lines 37 – 41, page 970 of the Transcript, 15 October 2014

application to an assessment of the effects of seabed mining, which potentially would destroy a substantial area of benthic habitat on the Rise.

327. Despite the limitations, the DMC takes it from Dr Pinkerton's modelling approach, which included some sensitivity analyses, that even quite large changes to the abundances of corals and encrusting invertebrates are predicted to have only a small effect on the pattern of energy flow through the food web at the scale of the whole Chatham Rise. In other words, because benthic species on the Chatham Rise do not appear to feature significantly in the flow of energy through the food chain, the direct impacts of mining the seabed in the consent application area are unlikely to have trophic effects at the level of the wider Chatham Rise ecosystem.

328. The DMC notes that this is not an ecosystem model, and models only the trophic web. The model had some usefulness but as Dr Pinkerton told the DMC, it was not dynamic and therefore had limitations. As such the model cannot be used to estimate the scale of effects on the ecosystem caused by the proposed mining.

329. Notwithstanding Dr Pinkerton's caveats regarding the application of the model to assess the effects of the mining proposal, he made some general comments on the potential effects of mining on some aspects of the Chatham Rise food web, concluding that the chances of an impact of the mining proposal on important trophic groups would be relatively small [293]. His basis for reaching this conclusion essentially comes down to one of scale, whereby the size of the proposed mining area in relation to the size of the Chatham Rise is small, and that important trophic groups are spread out over the entire Chatham Rise and so a localised impact would not result in a widespread change.

330. The DMC notes that scale has been an issue throughout the process. Whether assessing the effect of the mining operation at the drag-head, at the mining block in the marine consent application area or on the Chatham Rise crest / flank / wider ecosystem, analyses and conclusions have been drawn at significantly different scales. It is self-evident that the more one zooms in or out, the more or less significance can be attributed to any particular effect. The DMC has in each case sought to apportion significance at an appropriate scale of effect.

331. In the DMC's view it is unlikely that a sediment plume due to dredging would have significant flow-on effects to the wider Chatham Rise food web.

[293] Pages 964 – 965 of the Transcript, 15 October 2014.

8.3. Primary production and marine microbes

332. Primary production is driven by phytoplankton (algae) that remain suspended in the lit part of the water column (known as the euphotic zone). Consequently, any change to the trophic web that could affect primary production could have potentially serious flow-on effects to the wider ecosystem.

333. Microbes, such as bacteria, are a fundamental component of food webs and are essential for ecosystem function. They consume detrital and dissolved organic material in the water column as well as on and in the seabed. In turn, they are fed on by other lower trophic level groups (eg ciliates, copepods, heterotrophic flagellates). Infaunal deep-sea communities, of which bacteria represent a significant component, are important in the processing and remineralisation of organic matter, in nutrient cycling and often providing the food upon which other benthic and pelagic organisms in the marine ecosystem rely.[294]

334. The relative importance of microbes in the Chatham Rise marine ecosystem was assessed by Dr Pinkerton via his trophic web model. Water column bacteria biomass and energetics were estimated based on published data while measurements of benthic bacterial biomass were made at ten stations across the Rise. These measurements of seabed sediment indicated that bacterial production decreases with depth into the seabed, and it was assumed that production below 9 cm depth is negligible.[295]

335. Mr Kennedy explained that bacteria were an important part of the Chatham Rise ecosystem.[296] Because of this importance, a marine bioluminescent bacteria (*Vibrio fisheri*) was used in assessments of toxicity associated with Chatham Rise sediment elutriate tests (see Chapter 8.8).

336. The trophic modelling work of Dr Pinkerton found that water column bacteria in the Chatham Rise have high trophic importance, ranking them 10th out of 19 trophic groups, due to their role in processing detritus. Detritus was of very high importance in the Chatham Rise food web as the flux of detrital material from the water column to the seabed essentially supported the entire benthic ecosystem.[297] He ranked bacteria in seabed sediment 18th.

337. The model determined that phytoplankton had the highest trophic importance on the Chatham Rise, as the sole primary producer.[298] These findings reinforced the importance of primary

[294] Section 1.2 of Appendix 13 of the EIA, Data on the Chatham Rise benthos: macro – faunal and infaunal communities, March 2011 (updated April 2013)
[295] Appendix H of Appendix 22 of the EIA, Ecosystem Modelling of the Chatham Rise, April 2013
[296] Lines 18 – 20, page 929 of the Transcript, 15 October 2014
[297] Paragraph 24 of the additional report appended to Executive Summary of Evidence of Dr Matt Pinkerton on behalf of CRP, 14 October 2014
[298] Paragraph 36, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014

production in the Chatham Rise ecosystem and that it underpinned the productivity of many other trophic groups including commercially important fisheries.

8.3.1. Effects on microbes

338. Hewitt and Lohrers' work on the effects of sedimentation on benthic organisms did not consider benthic bacteria or meiofauna (small infauna typically between 63 µm to 0.5 mm, mainly nematodes), however it was noted that these organisms can be affected by sedimentation and could play critical roles in determining whether effects are passed up trophic levels or affect ecosystem functioning, especially if reduced oxygen conditions in the sediment were affected.[299]

339. In terms of evaluating the direct effects of the mining on organisms (likely direct effects of mining and / or plume on productive capacity), Dr Pinkerton considered there would be "*negligible impact on bacteria at scale of Chatham Rise*" to both water column bacteria and benthic bacteria.[300]

340. One of the 30 minute sediment elutriates (PB1) used in toxicity tests induced a response in the bacterium tests at 90 % elutriate although no effects were reported for tests using the 24-hour elutriates. Mr Kennedy considered that these results suggest that the cause of toxicity in the 30 minute elutriate using the PB1 Sediment was transient with short-lived effects (ie less than 24 hours).[301] Mr Kennedy compared concentrations in undiluted elutriates to the Australian and New Zealand Environmental and Conservation Council (ANZECC) Water Quality Guidelines (2000) trigger values for marine species (assuming an undisturbed environment, 99 % species protection). Only copper and ammoniacal nitrogen exceeded the ANZECC (2000) trigger value. He opined that after 17.5 times dilution, no element for which there is guidance available would be elevated above the ANZECC (2000) 99 % trigger values for the protection of marine species. He noted that there is no toxicity data for uranium in the marine environment however.[302]

341. In terms of the effects of uranium on microbes, Dr Phillips cited previous research that suggested that marine cyanobacteria (variants of *Synechococcus* and *Anabena*) were effective absorbents of uranium and other metals and represent an important sink for metals in the marine environment. While the cyanobacteria were able to counter the toxic effects of the

[299] Section 3.3 of Appendix 29 of the EIA, Impacts of sedimentation arising from mining on the Chatham Rise, August 2012 (updated July 2013)
[300] Table 2 of additional report appended to Executive Summary of Evidence of Dr Matt Pinkerton on behalf of CRP, 14 October 2014
[301] Paragraph 57, Statement of Evidence of Paul Cameron Kennedy for CRP on Sediment and Chemistry, 29 August 2014
[302] Paragraph 62, Statement of Evidence of Paul Cameron Kennedy for CRP on Sediment and Chemistry, 29 August 2014

accumulated uranium, there was the potential for effects through consumption by other organisms.[303]

342. Dr Krause suggested that the change in temperature regime (bringing water from the very deep where it is cold up to what is essentially an industrial process and then depositing it back down) could change the amount and activity of bacterial action within the system. He considered that the pulverisation of organic material would lead to an increase in a demand for the dissolved oxygen that is in that water. The sediment and water ultimately returned down the pipe would likely be much lower oxygen. [304] Mr Kennedy thought it unlikely that depletion of dissolved oxygen would occur as a result of mining, and that mining would not produce anoxic conditions in the water column.

8.3.2. DMC findings

343. The DMC accept that both benthic and pelagic bacteria are fundamental components of the Chatham Rise trophic web as indicated by Dr Pinkerton's model. At the scale of the Chatham Rise, Dr Pinkerton considered the effects of mining on bacteria would be negligible. [305] While the DMC's understanding of the consequential effect of the proposal on the ecosystem within and immediately adjacent to the consent application area is limited, the DMC agrees with Dr Pinkerton's conclusion given the scale of the proposed activity relative to the size of the Chatham Rise.

344. Toxicity testing of sediment elutriate indicated some mild toxicity towards the bacterium test organism. However the DMC considers that the level of dilution of the discharge after leaving the diffuser would be sufficient to reduce the potential for toxicity effects. The same reasoning applies to the risk for significant oxygen depletion as raised by Dr Krause. The applicant did not propose conditions that address potential effects on microbial species or the changes to primary production. However, the DMC considers that monitoring of these potential issues could be required as a part of proposed consent conditions if a conservative approach was required.

[303] Paragraph 50, Amended Statement of Evidence of Ngaire Robyn Phillips on behalf of Te Rūnanga o Ngāi Tahu and Te Ohu Kai Moana Trustee Limited, 22 September 2014
[304] Lines 4 – 12, page 2075 of the Transcript, 6 November 2014
[305] Table 2, Summary of evidence of Dr Matt Pinkerton for CRP, 14 October 2014

8.4. Zooplankton

8.4.1. The issues

345. Zooplankton are organisms of varying size that primarily drift with currents, although some have locomotion that allows them to avoid predators. Zooplankton are grouped and referred to by their size. Microzooplankton are approximately 20 to 200 µm (0.02 to 0.2 mm) in size and include heterotrophic flagellates and ciliates and other organisms such as the early life stages of crustacea. They play a pivotal role in the transfer of microbial biomass to higher trophic levels as they are the primary grazers of bacteria and picophytoplankton. Mesozooplankton are larger (0.2 to 2 mm in size) and include crustacean such as copepods. Macrozooplankton (2 to 20 mm) include copepods, euphausiids, chaetognaths and larval crustaceans.[306] Dr Pinkerton told the DMC these organisms are mostly in the middle of the water column, and can be hard bodied animals like arthropods or they can be soft bodied animals like salps or jellyfish.[307]

346. The DMC understands that zooplankton are a fundamental component of the pelagic ecosystem and food web. Mr Bartle told the DMC how important they are as a food for higher organisms.[308] This was confirmed by Dr Pinkerton's trophic web model which indicated mesozooplankton and microzooplankton as being the second and fourth most important components respectively of the trophic web for the consumer groups.[309] Microzooplankton were a key link between the microbial food web and the higher trophic levels, having a pivotal role in energy transfer from the lower food web to middle trophic level predators.[310]

347. Mr Bartle explained that all oceanic birds, fish and squid etc that live in the open ocean are totally dependent firstly on phytoplankton production, and secondly on the efficient grazing of phytoplankton by zooplankton.[311] For example, Dr Pinkerton estimated that 44 % of the seabird diet comprised macro and mesozooplankton.[312]

348. As outlined by Dr Pinkerton, despite the relative importance of the zooplankton in the trophic model, not a lot was known about their vertical distribution and migration behaviour.[313] He considered that while there is some information on zooplankton over the Chatham Rise, there is not a huge amount.[314]

[306] Section 6.4.3.1, Marine Consent Application and EIA, May 2014
[307] Lines 11 – 15, page 958 of the Transcript, 15 October 2014
[308] Lines 9 – 10, page 744 of the Transcript, 3 October 2014
[309] Paragraph 3, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014
[310] Section 6.4.3.5, Marine Consent Application and EIA, May 2014
[311] Paragraph 48, Evidence of Mr J A (Sandy) Bartle for Royal Forest and Bird Protection Society of New Zealand Incorporated, 12 September 2014
[312] Appendix A of Appendix 22 of the EIA, Ecosystem Modelling of the Chatham Rise, April 2013
[313] Lines 37 – 45, page 988 of the Transcript, 15 October 2014
[314] Lines 7 – 11, page 994 of the Transcript, 15 October 2014

8.4.2. Effects

349. The effects on zooplankton were not extensively discussed in either the application, evidence or the hearing. The DMC deduce from the evidence presented by Dr Pinkerton and Mr Bartle that the sediment plume may be one effect. Dr Pinkerton suggested that in assessing the potential impacts of mining on zooplankton, their vertical distribution in the water column, including diel (daily) migration behaviour, and that of their prey and predators should be taken into account.[315]

Sediment Plume

350. The DMC heard from Mr Bartle that the most abundant euphausiid on the Chatham Rise (*Nematoscelis megalops*) reaches depths of 300 to 500 metres by day. At night they can be up on the surface or in mid water and available for food for fish and feeding themselves, but during the day they descend to depths of 300 to 500 metres. This means they may descend into the sediment plume.[316] Dr Pinkerton agreed that if zooplankton are migrating to depths where they may be affected by mining, then that could be a direct effect of mining.[317]

351. Dr Pinkerton outlined that microzooplankton occur predominantly in the upper water column, while mesozooplankton and macrozooplankton can occur throughout the whole water depth. His evidence supported Mr Bartle's that diel vertical migration would occur for many organisms, especially mesozooplankton and macrozooplankton.[318]

352. Dr Pinkerton opined that elevated concentrations of suspended sediment deep in the water column are likely to affect feeding (and productivity) of zooplankton, especially detrivores / herbivores.[319] However he considered it unlikely that zooplankton in the surface mixed layer (between the sea surface and shallower than ~150 m) would be negatively affected by the mining operation. This was due to the modelling of the sediment plume showing that the suspended sediment generated by the mining operation would remain close to the seabed.[320]

353. Dr Pinkerton considered that while there was potential for some mesozooplankton to be impacted by the sediment plume or by the mining, it was probably a low overall effect on the scale of that group over the whole Chatham Rise.[321]

354. Dr Pinkerton did express concern about krill which are crustacean zooplankton living in the water column and form an important diet of a lot of fish, and some of these have a dependence

[315] Paragraph 46, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014
[316] Lines 26 – 32, page 744 of the Transcript, 3 October 2014
[317] Lines 15 – 19, page 989 of the Transcript, 15 October 2014
[318] Paragraph 36, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014
[319] Paragraph 59, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014
[320] Paragraph 61, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014
[321] Lines 37 – 40, page 964 of the Transcript, 15 October 2014

on the benthos for reproduction that is not particularly well known. From the acoustic data, he considered krill might have a particular higher abundance in the area over the top of the mining site which led to his concerns.[322]

355. In terms of the significance and effects of zooplankton being in the sediment plume, Mr Bartle explained that copepods do not distinguish between the inorganic particulates and phytoplankton — they consume all particles in this size range, and their gut can become full of sediment and not food. Ingestion of sediment therefore causes reduced food uptake for copepods as a result of having full stomachs. Mr Bartle told the DMC that laboratory experiments on copepods with total suspended sediment concentrations from 1 to 100 mg/L in steps of 10mg/L had shown that the ingestion of suspended inorganic sediments reduced egg production rates and carbon turnover in the two zooplankton genera studied.[323]

356. Mr Bartle considered more work needed to be done to determine the effects.

Role in the trophic web

357. Dr Pinkerton's model suggested that changes to bentho-pelagic groups may have a relatively large effect on the pattern of energy flow through the food web at the scale of the whole Chatham Rise. Mesozooplankton is ranked second behind small demersal fish in terms of trophic importance and therefore is a critical component of the trophic web.[324] Because everything in the food web is interrelated, Dr Pinkerton opined that grazing by zooplankton on live phytoplankton cells in the mixed layer was likely to be reduced if abundances of these species of zooplankton were reduced elsewhere because of the effects of the mining.[325]

358. Mr Bartle expressed concern that if ingestion of suspended inorganic sediments reduced egg production rates and carbon turnover in zooplankton, this would have ecosystem effects.[326] Given that the mean turnover time of copepods on the Chatham Rise was 7.3 days, Mr Bartle opined that the effect for marine productivity on the Chatham Rise could be significant if zooplankton were ingesting sediment rather than food.[327] The DMC understands this could be particularly important if egg production of zooplankton is reduced due to ingestion of sediment, as is indicated by studies into the effects of suspended sediments on zooplankton.

[322] Lines 32 – 41, page 965 of the Transcript, 15 October 2014
[323] Paragraph 163, Evidence of Mr J A (Sandy) Bartle for Royal Forest and Bird Protection Society of New Zealand Incorporated, 12 September 2014
[324] Paragraph 8, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014
[325] Paragraph 44, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014
[326] Lines 32 – 35, page 748 of the Transcript, 3 October 2014
[327] Lines 7 – 11, page 743 of the Transcript, 3 October 2014

359. Similarly Mr Bartle considered ingestion of sediment from the sediment plume would affect other species that prey on the zooplankton and thus ingest the grit, for example seabirds.[328]

8.4.3. Proposed conditions

360. No conditions were proposed by the applicant that address potential effects on zooplankton, or would have provided further baseline information. The proposed conditions would not enable any potential effects on zooplankton to be assessed or verified.

8.4.4. DMC findings

361. Zooplankton appear to be a critical group in the Chatham Rise trophic web, for example microzooplankton are considered a key link between the microbial food web and the higher trophic levels, having a pivotal role in energy transfer from the lower food web to middle trophic level predators.[329] Trophic modelling suggests that significant changes to zooplankton could have a relatively large effect on the pattern of energy flow through the food web at the scale of the whole Chatham Rise. Such a level of change due to the effects of the mining proposal seems unlikely.

362. From both Dr Pinkerton's and Mr Bartle's evidence, it is apparent that zooplankton would be subjected to increased levels of suspended sediment from the plume. Microzooplankton occur predominantly in the upper water column, while mesozooplankton and macrozooplankton can occur throughout the whole water depth and daily vertical migration occurs for many organisms.

363. The DMC expects that the sediment plume would result in localised adverse effects to zooplankton through effects on the likes of health and reproduction, and the scale of these effects are likely to be proportionate to the size, intensity and duration of the sediment plume, characteristics which have a degree of uncertainty. Some zooplankton groups with a dependence on the benthos for reproduction (such as krill) may be more vulnerable than others. However, the risk to the wider Chatham Rise food web as a result of an adverse effect on zooplankton is probably low given their mobile nature, relatively short life cycles and the scale of the proposed activity relative to the size of the Chatham Rise.

[328] Lines 32 – 35, page 748 of the Transcript, 3 October 2014
[329] Section 6.4.3.1 of the Marine Consent Application and EIA, May 2014

8.5. Fish and pelagic fauna

364. The DMC is required to take into account the importance of protecting the biological diversity and integrity of marine species, ecosystems and processes (Section 59(2)(d) of the Act). Fish and pelagic fauna are clearly part of this. Although linked to the biological effects on fish addressed below, the effects on fisheries and fishing are addressed in Chapter 9.8 and are not discussed further in this chapter.

365. As effects on the benthic environment are addressed in Chapter 8.1, this chapter looks at the potential effects of the proposal on pelagic organisms rather than benthic.

366. The DMC understands from the Jacobs review of the application that fish communities and species of the Chatham Rise are relatively well understood, with annual research trawls being undertaken in the area since 1992. Over 250 fish species have been recorded on the Chatham Rise, with this diversity thought to be driven by high levels of production. The commercial fish species on the Chatham Rise includes hoki, hake, ling, and silver warehou as well as orange roughy and oreos in deep waters.[330]

367. The DMC heard and received evidence from many witnesses about fish and fishing — this included technical experts (Drs O'Driscoll, Helson, Huber, Krause, Middleton, Pinkerton, Tuck; Ms Baird; Messrs Page and Dunn; and Professor Popper), corporate fisheries managers and skippers (Messrs Clement, Connolly, Hollyman, Patrick, Paulin, Shaw, Smith, Summerton and Walls) and experienced local fishermen — particularly from the Chatham Islands (Messrs Christiansen, Karatea and Maxwell).

368. In order to understand the potential impacts on fish, the DMC needed to understand the variety of fish species present on the Chatham Rise and the importance of this area for habitat and spawning. The key sources of data for Chatham Rise fish species and pelagic fauna derived from commercial catch records and research trawls supplemented by fisher observations. Knowledge of demersal fish distribution and abundance, particularly in the mining permit area, was scant.

369. The principal evidence on fish species was given by Dr O'Driscoll. He noted that more than 250 species had been caught on the Chatham Rise in the period 1992 – 2010 (the survey area[331] referred to as the Chatham Rise being an area of 139,496 km^2, of which 3.7 % — ie 5,207 km^2 constitutes the revised marine consent area of the application).

[330] Paragraph 3 of Annexure B (Assessment of effects on plankton and fish from the Chatham Rise Phosphate Limited marine consent application) of the Statement of Evidence of Michael Edward Huber (Effects on Plankton, Fish and Cephalopods), 12 September 2014
[331] Figure 1, Statement of Evidence of Richard O'Driscoll for CRP, 28 August 2014

370. Sixty-three species were identified from the MPL 50270 prospecting licence area (the area within the application area from which most commercial information is available). Of those 63 species, 45 species (43 important commercial and non-commercial fish species, New Zealand southern arrow squid, and scampi) had statistically useful information. None of these had more than 10 %[332] of their Chatham Rise estimated biomass (averaged over the past 10 years) within the revised marine consent area.[333] On a year-on-year examination, 3 species (juvenile white warehou, adult silverside and adult red cod) demonstrated greater than 10 % biomass on 5 occasions (range 10.5 % – 14.7 %).[334]

371. However, Dr O'Driscoll acknowledged that there was very little commercial catch effort information from within the revised marine consent area since 2003, mainly because of the imposition of the BPA in 2007, a total 10 year catch of only 165.6 t (99 t by longline, 64 t by trawl), but which included 49 species (predominantly ling, hoki, spiny dogfish, javelinfish and sea perch). This catch represented less than 0.5 % of the catch of the respective species from its associated quota management area (QMA), and less than 0.1 % from New Zealand's overall EEZ.[335]

372. Dr O'Driscoll also noted[336] that species / maturity groupings with the greatest concentration within the revised consent area were juvenile and adult lookdown dory, adult silverside, banded bellowsfish, juvenile white warehou, juvenile spiny dogfish, scampi, and juvenile ling.

373. While hake, ling, spiny dogfish, lookdown dory, sea perch, Bollons's rattail, dark ghost shark, hapuku, long-nosed chimaera, pale ghost shark, ribaldo, silver warehou, giant stargazer, and white warehou may spawn in and / or around the revised consent area, Dr O'Driscoll noted no evidence that the revised marine consent area was a particularly important spawning ground for any of those species, acknowledging that data from this area was sparse (only one trawl tow in the MPL 55549 mining permit area over ten years).[337]

374. Mr Page noted[338] that 17 benthic and 46 demersal or pelagic fish species were known to occur in prospecting licence area MPL 50270. Of those, fifteen spawn on the Chatham Rise and five (ling, hake, giant stargazer, lemon sole and lookdown dory) occur in the area.

[332] Dr O'Driscoll confirmed that there was nothing magical about the 10 % — simply the highest number of 9.9 % rounded up
[333] Paragraphs 2 – 3, Statement of Evidence of Richard O'Driscoll for CRP, 28 August 2014
[334] Paragraph 30, Statement of Evidence of Richard O'Driscoll for CRP, 28 August 2014
[335] Paragraph 11, Statement of Evidence of Richard O'Driscoll for CRP, 28 August 2014
[336] Slide 5 of powerpoint presentation of Statement of evidence by Richard O'Driscoll, 16 October 2014
[337] Paragraph 26, Statement of Evidence of Richard O'Driscoll for CRP, 28 August 2014
[338] Paragraph 3, Statement of Evidence of Mike Page for CRP, 28 August 2014

375. During consultation, the potential impact on freshwater eels migrating to the Pacific to breed was raised as an issue. Longfinned eel (*Anguilla dieffenbachia*) and shortfinned eel (*Anguilla australis*) both occur on the Chatham Islands[339]. While longfinned eels are known to swim at depths typically 200 to 300 m at night and at depths of 600 to 900 m during the day, larvae of other eel species are known to be present at shallower water depths of between 80 to 250 m during the day and 30 to 100 m at night, which is above the depths at which mining would occur. The EIA concluded that there was nothing that suggests eels were likely to be present within or adjacent to the proposed mining area on the Chatham Rise. Their spawning grounds were north of New Zealand in the subtropical Pacific, and it was unlikely that significant numbers of spawning eels would cross to the Chatham Rise.[340]

376. Research undertaken by Dr Patrick concluded that adult eels from the Chatham Islands were unlikely to traverse over the proposed mining area and eel larvae were unlikely to descend to the depths at which mining would occur.[341]

377. Ms Page on behalf of Ngāti Mutunga expressed concern that few studies have been undertaken on Chatham Island eel migration.[342]

8.5.1. Effects

378. The experts on the impacts on fish who were involved in conferencing identified the following as potential effects of the proposal on fish[343]:

- habitat loss
- increased sediment in the water column
- exposure to bio-available and bio-accumulative toxic substances
- entrainment in the dredge and pump
- noise.

379. The DMC also heard that there may be an effect on spawning and fish nurseries from the deposition of sediment. Dr Krause opined that there may be effects on the trophic web and the DMC has addressed this in Chapter 8.2.

[339] McDowall RM 1978. New Zealand Freshwater Fishes: a Natural History and Guide. Auckland, New Zealand. Heinemann Reed.
[340] Section 8.6.7.3 Marine Consent Application and EIA, May 2014
[341] Attachment A (Chatham Island Long Finned Eels – Breeding, Migration and Return) of Response to the DMC's Request for Further Information (Part 1), August 2014 (date on EPA website — 8 August 2014)
[342] Lines 24 – 26, page 2171 of the Transcript, 12 November 2014
[343] Joint Statement of Experts in the Field of impacts on Fish 18 September 2014

Habitat loss

380. The proposed mining would result in a substantially modified benthic environment as discussed in Chapter 8.1.

381. The DMC understand that the benthic environment is a key part of the underwater habitat. The EIA identified these impacts as:[344]

- impacts resulting from species dependencies, ie a detrimental impact on one benthic species may affect a species dependent on the impacted species for food or shelter (eg living in or on a coral)
- trophic impacts affecting available food for other components of the ecosystem (eg demersal fish species)
- biogeochemical impacts related to changes in sediment physical and biogeochemical properties that influence trophic components such as microbiology.

382. Dr Krause opined that all of these expected impacts to the benthic community would result in a decrease in available habitat and food resources to fishes.[345]

383. While the experts agreed that the relationship between habitat and fish on the Chatham Rise was not well understood, the experts involved in the conference for impacts on fish agreed that the removal of benthic habitat was likely to be the most significant effect on demersal fish in the mined area. The effects of this would be primarily on benthic species rather than pelagic. The experts involved in conferencing agreed that as a result of the change in habitat in the mined area, fish would be displaced to other areas.[346]

384. There was acknowledgement by experts involved in conferencing that the details of the associations between fish and their habitat were not fully understood.[347]

Increased sediment in the water column

385. Increased sediment in the water has the potential to affect fish at all of their life stages, including larvae and fish eggs. Mr Page explained that suspended sediments may affect fish directly by reducing visibility of pelagic food and clogging gills with associated acute and chronic effects such as physiological stress, reduced growth and reproductive fitness.[348] Dr Krause also

[344] Section 8.6.3.1, Marine Consent Application and EIA, May 2014
[345] Paragraph 68, Statement of evidence of Dr Paul Richard Krause on behalf of Deepwater Group Limited and Te Rūnanga o Ngāi Tahu, 12 September 2014
[346] Issue 1, Joint Statement of Experts in the Field of impacts on Fish, 18 September 2014
[347] Issue 1, Joint Statement of Experts in the Field of impacts on Fish, 18 September 2014
[348] Paragraph 30, Statement of Evidence of Mike Page for CRP, 28 August 2014

considered that invertebrates may be affected by sedimentation, which in turn would affect those fish that prey on invertebrates.[349]

386. Mr Page considered that benthic species that live and breed on the seafloor on the Chatham Rise such as ling, giant stargazer, lemon sole, skates and rays are more likely to be affected by a sediment plume than demersal species such as hake and lookdown dory that spend a lower proportion of time close to the seafloor.[350] This was due to pelagic species being more likely to spend time above most of the plume.

387. The experts in the field of impacts on fish agreed that mesopelagic fish were only likely to encounter the upper extent of the plume at their very lowest extent of their diurnal migrations. This would only be over a relatively small area compared to their overall distribution.[351] Mr Page anticipated no adverse effect on mesopelagic fish species, which migrate vertically to within 50 m of the seabed, other than avoidance behaviour if they contact the plume during elevated total suspended sediment concentrations.[352] Pelagic fish were unlikely to be affected to any significant extent provided that the plume behaved as predicted in the lowest 50 m of the water column.[353]

388. In terms of adult fish, the experts involved in the conference for impacts on fish agreed that the most likely effect of increased TSS would be avoidance of the plume, with motile species expected to actively avoid the plume.[354]

389. Although Mr Page considered that 2 mg/L could be used as a conservative threshold beyond which no effects would be experienced by fish[355], the experts agreed that 3 mg/L TSS was an appropriate threshold criterion for fish avoidance of the plume. The predicted average of the maximum daily plume area coverage of TSS 3 mg/L is 49 km^2 based on modelling of the sediment plume.[356]

390. Mr Dunn estimated the long-term impact on future biomass and yields of the three key commercial species (hake, hoki and ling) known to be present in prospecting licence area MPL 50270. His analysis[357] was a worst-case outcome assuming 100 % mortality of all displaced fish, maximum destruction of benthic habitat, and no recolonisation of mined areas following

[349] Paragraph 32, Statement of evidence of Dr Paul Richard Krause on behalf of Deepwater Group Limited and Te Rūnanga o Ngāi Tahu, 12 September 2014
[350] Paragraph 7, Statement of Evidence of Mike Page for CRP, 28 August 2014
[351] Issue 2, Joint Statement of Experts in the Field of Impacts on Fish, 18 September 2014
[352] Paragraph 43, Statement of Evidence of Mike Page for CRP, 28 August 2014
[353] Issue 2, Joint Statement of Experts in the Field of Impacts on Fish, 18 September 2014
[354] Issue 2, Joint Statement of Experts in the Field of Impacts on Fish, 18 September 2014
[355] Paragraph 28, Statement of Evidence of Mike Page for CRP, 28 August 2014
[356] Issue 2, Joint Statement of Experts in the Field of Impacts on Fish, 18 September 2014
[357] Paragraph 3, Statement of Evidence of Alistair Dunn for CRP, 29 August 2014

initial impact. The detailed model assumptions and predictions were presented in his evidence, but in summary Mr Dunn concluded[358] that for the avoidance scenarios the adverse effect was below the calculation accuracy of the model and was therefore negligible; and that for recruitment loss the adverse effect was small. As this represented a worst-case scenario he concluded that the actual effect was negligible.[359]

391. Dr Tuck's evidence related to a comparative analysis of sediment suspension arising from demersal trawling versus mining and its effect on benthic species. That has been discussed elsewhere in this decision in the context of the sediment plume and is not further discussed in this chapter.

8.5.2. Increased sediment on eggs and larvae

392. Mr Page explained that sediment adhesion to the egg chorion (the outermost membrane around the egg) and the gills of larvae could affect their dispersal and survival.[360] Mr Page explained that increased suspended sediment can change buoyancy of eggs due to adhesion, but also can smother eggs and lower developmental rates and hatching success.[361] The experts considered that fish larvae are more susceptible to sediment than eggs and adults.[362]

393. The experts in the area of impacts on fish considered that ling are likely to be particularly vulnerable. Other species, including female hake in spawning condition, spawning and spent spiny dogfish, spent hoki, spent lookdown dory and spent sea perch occur in the consent area. There is also possible spawning of Bollon's rattail, dark ghost shark, hapuku, ling, long-nosed chimaera, pale ghost shark, ribaldo, silver warehou, stargazer, and white warehou. Hoki and hake are not expected to be affected by the sediment plume due to their migration and spawning patterns.[363]

394. While many of the expert witnesses expressed concern about the vulnerability of ling larvae and juveniles to increased sediment levels, Ms Baird noted that ling larvae are pelagic, at least 24 mm long before settling and may live in the water column for several months.[364] However she did not consider plume total suspended sediment or sedimentation a larval threat. She also stated that there is little overlap between the bottom longline ling fishery and the three permit / licence areas.[365] Dr Krause considered it unlikely that the early life-stages of hoki or hake would be adversely impacted by sedimentation given their general distribution, however

[358] Paragraphs 32 and 33, Statement of Evidence of Alistair Dunn for CRP, 29 August 2014
[359] Hearing Transcript, Page 1255
[360] Paragraph 5, Statement of Evidence of Mike Page for CRP, 28 August 2014
[361] Paragraph 25, Statement of Evidence of Mike Page for CRP, 28 August 2014
[362] Issue 2, Joint Statement of Experts in the Field of Impacts on Fish, 18 September 2014
[363] Issue 2, Joint Statement of Experts in the Field of Impacts on Fish, 18 September 2014
[364] Paragraph 59, Statement of Evidence of Susan Jane Baird for CRP, 25 August 2014
[365] Slide 4 of powerpoint presentation of Summary of Evidence of Susan Jane Baird, 16 October 2014

there was a high likelihood of the mining activity producing an effect on the early life stages of ling.[366] Drs Starr and Middleton gave their opinion that ling eggs and larvae are vulnerable to sediment effects because ling produce a sticky egg mass that adheres to the seabed and hard structures in similar depths to that of the proposed mining.[367]

395. The DMC notes the absence of information on the distribution of fish eggs or larvae in the vicinity of the proposed mining operation and the area predicted to be influenced by the plume as modelled.[368] Dr O'Driscoll considered that hake and ling may spawn within or in the vicinity of the revised consent area, with the area east of the revised mining area being a very important ling spawning location.[369]

396. Mr Page noted that eggs and larvae sensitivity to sediment adhesion is species and life-history specific, and that there were no egg or larval studies on species that occur within the revised marine consent area. [370] Mr Page therefore imported and adopted (with appropriate caution regarding comparability) a TSS concentration threshold tolerance of 2 mg/L, determined for eggs and larvae for the demersal Atlantic cod and pelagic herring and flounder. This is the value level at which no effects are likely to occur[371], noting that Atlantic cod and mackerel were found to avoid total suspended sediment concentrations of 3 to 5 mg/L.

397. The DMC understands from the experts in the field of impacts on fish that there were limitations to the data available: the Chatham Rock trawl survey research data only related to one time of the year, and there is limited knowledge of non-commercial species in terms of biodiversity.[372] Based on the available information, the experts in the field of impacts on fish agreed on a 2 mg/L total suspended sediment level as a suitable threshold criterion for effects on eggs and larvae.[373]

Exposure to toxic substances

398. Dr Krause told the DMC that the vigorous mixing associated with the mining process and disposal of tailings on the sea floor has the potential to release nutrients and contaminants.

[366] Paragraphs 24 – 25, Statement of Evidence of Dr Paul Richard Krause on behalf of Deepwater Group Limited and Te Rūnanga o Ngāi Tahu, 12 September 2014
[367] Paragraph 38, Statement of Evidence of Paul Joseph Starr and David Alexander Jon Middleton on behalf of Deepwater Group Limited and Te Rūnanga o Ngāi Tahu, 12 September 2014
[368] Paragraph 22, Statement of Evidence of Mike Page for CRP, 28 August 2014
[369] Figures 6 – 7, Statement of Evidence of Richard O'Driscoll for CRP, 28 August 2014
[370] Paragraph 6, Statement of Evidence of Mike Page for CRP, 28 August 2014
[371] Paragraph 28, Statement of Evidence of Mike Page for CRP, 28 August 2014
[372] Issue 2, Joint Statement of Experts in the Field of impacts on Fish, 18 September 2014
[373] Issue 2, Joint Statement of Experts in the Field of impacts on Fish, 18 September 2014

These can cause a variety of health issues for marine animals, including adversely impacting reproduction or egg development.[374]

399. Dr Krause expressed concern that conditions may be anoxic and there is the potential for the mining and tailings disposal process to release toxic and bioaccumulatable concentrations of metals that would impact fishes within the consent area.[375] Despite these concerns, the experts in the field of effects on fish agreed that release of toxic substances in the water column itself was not a toxicological issue for fish because the contaminants were at a low concentration and fish would not remain in close proximity to the discharge due to other factors such as noise and the sediment plume.[376]

400. The experts did not expect there to be any significant toxicological effects but recommended further information on organic carbon concentrations in the deposited material to confirm that anoxic conditions would be unlikely to arise.[377] This potential effect is explored in more detail in Chapter 8.8.

Entrainment in the dredge and pump

401. The experts in the field of impacts on fish agreed that a certain number of fish were going to be sucked up the riser and suffer mortality. However the experts considered this would not be a critical issue for any pelagic organisms across the Chatham Rise because it would impact on a negligible proportion of the population.[378]

402. The experts recommended screening the pump in-takes and designing to a maximum in-take velocity of 0.5 m/s to minimise fish entrainment.[379]

Noise

403. Noise was identified as a potential effect by the experts in the field of impacts on fish. Noise can cause physiological effects and behavioural effects. The experts in the field of impacts on fish considered that the intensity of sound from the dredging would not produce any physical trauma to fish but there would be potential for behavioural changes. The effects of sound emissions on

[374] Paragraphs 34 – 35, Statement of Evidence of Dr Paul Richard Krause on behalf of Deepwater Group Limited and Te Rūnanga o Ngāi Tahu, 12 September 2014
[375] Paragraphs 42 – 45, Statement of Evidence of Dr Paul Richard Krause on behalf of Deepwater Group Limited and Te Rūnanga o Ngāi Tahu, 12 September 2014
[376] Issue 3, Joint Statement of Experts in the Field of Impacts on Fish, 18 September 2014
[377] Issue 3, Joint Statement of Experts in the Field of impacts on Fish, 18 September 2014
[378] Issue 4, Joint Statement of Experts in the Field of Impacts on Fish, 18 September 2014
[379] Issue 4, Joint Statement of Experts in the Field of Impacts on Fish, 18 September 2014

fish were likely to be limited to species-specific behavioural effects. These may include attraction, avoidance, and / or not responding.[380]

404. The experts in the field of impacts on fish agreed that very little is known about behavioural responses of fish to sound. Although the lack of data on particle motion component of sound was acknowledged, the experts considered the uncertainty was acceptable as particle motion attenuates rapidly with distance from the source.[381] The most significant uncertainty was that it was unclear what behavioural responses the operational sounds may cause. Some species may be attracted while others may avoid or show no response at all.

405. Professor Popper gave evidence related to fish acoustics, noting that all fish species on the Chatham Rise hear by means of particle motion rather than sound pressure, and would not therefore be affected by the noise of the mining operation beyond a very limited distance from the source.

406. Mr Smith however noted[382] that skippers use noise (both mechanical and concussive) and water colour change in pelagic fishing to their advantage to keep mackerel, kahawhai and tuna species in the net when purse seining. He added "*Any deep-water fisherman will tell you that vessels and acoustic noise can have a drastic effect on orange roughy fishing, as the fish simply do not like the disturbance and will not aggregate."*

407. The DMC understands that sound data for the proposed operation was not available and thus Dr Jones modelled sound source levels.

408. The experts in the field of impacts on fish agreed that 15 km from the sound source was a key distance for effects. The likelihood of effects on pressure-detecting species declined beyond 15 km, and for those fishes that do not primarily use sound pressure for hearing, the maximum distance at which they may detect sound was much less than 15 km.[383]

409. The experts in the field of impacts on fish agreed there would be no deleterious physical / physiological / mortality effects on fishes and invertebrates as a result of operation-generated sound from the dredging. Professor Popper opined that based on extensive experimental data, fish would not be physically harmed or killed by the sounds from the dredging operations.[384]

[380] Issue 5, Joint Statement of Experts in the Field of Impacts on Fish, 18 September 2014
[381] Issue 5, Joint Statement of Experts in the Field of Impacts on Fish, 18 September 2014
[382] Paragraphs 24 – 25, Statement of Evidence of Andrew Peter Smith on behalf of Deepwater Group Limited, 12 September 2014
[383] Issue 5, Joint Statement of Experts in the Field of impacts on Fish, 18 September 2014
[384] Paragraph 22, Statement of Evidence of Professor Emeritus Arthur Popper for CRP, 28 August 2014

410. The experts in the field of impacts on fish also concluded that sound generated by the operation was unlikely to cause significant effects at the level of fish populations, with effects more likely to be on individuals. A very precautionary estimate of the maximum distance was 1 km for fish and invertebrates that primarily detect particle motion. They also concluded that significant ecological consequences as a result of noise effects were unlikely, as any effects would only be localised to the mining area, and not impact a large proportion of a population.[385]

8.5.3. Proposed conditions

411. Although the experts in the field of impacts on fish recommended conditions requiring monitoring of benthic and demersal fish both within the mining footprint and within the area of highest sedimentation, this was not reflected in the proposed conditions.[386]

412. Proposed Condition 15 required the avoidance of the ling spawning period and area and was in accordance with the recommendations of the experts in the field of impacts on fish.[387] While the wording of the proposed condition could be improved, the concept of avoiding mining during August and September and areas east of longitude 180^{o} would assist in reducing any impact on ling.

413. The DMC agrees with Ms Rickard that it is not clear whether any fish abundance or presence monitoring is proposed.[388] The DMC acknowledges the difficulty in establishing a meaningful trigger level appropriate for such a proposed condition, particularly in the absence of baseline information on the abundance of fish species in the proposed mining site.

414. The DMC's understanding from the experts in the field of impacts on fish is that 3 mg/L TSS is an appropriately conservative threshold criterion for fish avoidance of the plume. The experts also agreed that 2 mg/L TSS was an appropriate threshold criterion for adverse effects on eggs and larvae. However the DMC notes that neither of these levels appears in the proposed conditions. Instead, a level of 50 mg/L monitoring level was given in proposed Schedule 1A as a trigger. Mr Kennedy explained that the 50 mg/L threshold was an ideal concentration for the underwater turbidity monitoring vehicle to track and therefore provided a more accurate comparison with the sediment plume model for that particular threshold.[389]

[385] Issue 5, Joint Statement of Experts in the Field of Impacts on Fish, 18 September 2014
[386] Issue 1, Joint Statement of Experts in the Field of Impacts on Fish, 18 September 2014
[387] Issue 2, Joint Statement of Experts in the Field of Impacts on Fish, 18 September 2014
[388] Paragraph 18a, Supplementary Statement of Evidence of Andrea Judith Rickard on behalf of Te Rūnanga o Ngāi Tahu and Deepwater Group Limited, 16 November 2014
[389] Lines 15 – 20, page 2226 of the Transcript, 17 November 2014

8.5.4. DMC findings

415. Of all the potential effects on fish, the DMC concludes that the effect of increased sediment is the most significant. From the evidence and information provided to the DMC, the DMC finds that the most likely effect of increased total suspended sediment on mature fish and pelagic fauna would be avoidance of the sediment plume. The DMC accepts that fish are highly mobile and those not tolerant of high suspended sediment concentrations would likely move to more suitable habitats. However the DMC remains concerned that larvae and eggs are likely to be more affected by increased levels of sediment and do not have the same level of mobility as adults. The early life stages of ling in particular appear to be particularly susceptible to the effects of sediment, and the DMC heard from Dr O'Driscoll that the proposed mining area is an important ling spawning location. The DMC understands that there are limitations to the data available, not only the year-round distribution and numbers of fish species in the proposal area but also the sensitivity of those species to increased sediment levels.

416. The proposed conditions did not adopt the TSS thresholds as recommended by the experts in the field of impacts on fish[390]. In terms of the effect of sediment on fish and pelagic fauna, the DMC is left uncertain as to the importance of this area to fish and spawning and the effect of increased sediment, particularly as the proposed conditions did not reflect the sediment concentration recommendations of the experts in the field of impacts on fish.

417. While the DMC accepts the use of 50 mg/L as a threshold in the conditions may be a convenient number with which to measure and empirically calibrate the model, it has some difficulty accepting that this would provide a reliable spatial boundary for the expert recommended trigger levels of 3 mg/L and 2 mg/L. The DMC agrees with Ms Rickard that as the potential impacts could be felt at 2 mg/L, the trigger monitoring level should relate to that.[391]

418. Dr Pinkerton's trophic model, based on the Chatham Rise as a whole, showed that of the 37 trophic groups, based solely on predator-prey relationships, small demersal fish were 1st in trophic importance of the consumers (ie as opposed to phytoplankton being the 1st and sole primary producer), followed by hoki (3rd) and small mesopelagic (ie mid-water) fish (6th). [392] This indicated the importance of fish in the trophic web. He concluded that while there were unlikely to be species-wide (population) effects because of the wide distribution of all fish species over the Chatham Rise, impacts due to mining on small demersal fish, cephalopods, and rattails and ghost sharks could lead to indirect (trophically-mediated) effects on other organisms at the scale of the Chatham Rise food web, although there is no evidence one way or the other. [393]

[390] Joint Statement of Experts in the Field of Impacts on Fish 18 September 2014
[391] Paragraph 23(d), Supplementary Statement of Evidence of Andrea Judith Rickard on behalf of Te Rūnanga o Ngāi Tahu and Deepwater Group Limited, 16 November 2014
[392] Paragraph 3, Statement of Evidence of Dr Matt Pinkerton of CRP, 29 August 2014
[393] Paragraph 10, Executive Summary of Evidence of Dr Matt Pinkerton on behalf of CRP, 14 October 2014

419. Given the importance of fish commercially as well as their role in the trophic web, the DMC find that the levels of knowledge and scale of impacts are uncertain and that the proposed conditions do not appropriately alleviate this concern. While it may have been possible to address the DMC's concerns about effects on fish through a more appropriate suite of monitoring and response / trigger conditions, the DMC did not go down this path for the reasons outlined in later chapters.

420. Other potential effects on fish raised at the hearing appeared to be relatively minor. Noise from the mining operation appears at best to have localised effects on fish and populations would not be threatened. Similarly, entrainment in the dredge and pump system would impact only a negligible proportion of the population.

421. Some submitters were concerned about effects on eels. Due to the absence of detailed information on eels presented in the application, submissions or the hearing, the DMC was not able to draw any conclusions on the potential adverse effects on eels. The evidence the DMC did receive suggests however that these are highly unlikely at the population level.

8.6. Marine mammals

8.6.1. The issues

422. The potential effects of the proposal on marine mammals, particularly whales, were raised in a number of submissions.

423. The Cultural Impact Assessment identified marine mammals as taonga species and the Ngāi Tahu Claims Settlement Act 1998 recognises six marine mammals as taonga species: southern elephant seal, New Zealand fur seals, humpback whales, sperm whales, New Zealand sea lion / Hooker's sea lion and southern right whale. The DMC understands that taonga species schedules in the Ngāi Tahu Claims Settlement Act 1998 are not exhaustive and that not all culturally important species were included. The DMC further understands from the Cultural Impact Assessment that Ngāi Tahu consider all whales taonga.[394] In addition to marine mammals being an important aspect of Ngāi Tahu culture, the DMC heard from Mr Ngapora they are also source of economic wellbeing.[395]

[394] Section 4, Cultural Impact Assessment Report, Dyanna Jolly on behalf of Te Runanga o Ngāi Tahu, 2014
[395] Statement of Evidence of Kauahi Koroneho Ngapora on behalf of Te Rūnanga o Ngāi Tahu, 11 September 2014

424. The main issues for the DMC related firstly to marine mammal presence and abundance in and around the proposed mining area, and secondly to the effects of the proposed activity on them.

Significance of the proposed consent area to marine mammals

425. The 2013 NIWA report Distribution Patterns of Cetaceans on the Chatham Rise (commonly referred to as the Torres *et al* report during the course of the hearing) provided the basis of information on marine mammals in and around the proposed mining site. This report collated data from two datasets of opportunistic sightings of cetacean species: the Department of Conservation's cetacean sightings data, and a dataset provided by Mr Cawthorn of incidental cetacean sightings by transiting ships. These two datasets provided 137 records of 12 different cetacean species and one species group (beaked whales) sighted between July 1981 and November 2007 within the Chatham Rise study area as seen in *Figure **10***.[396]

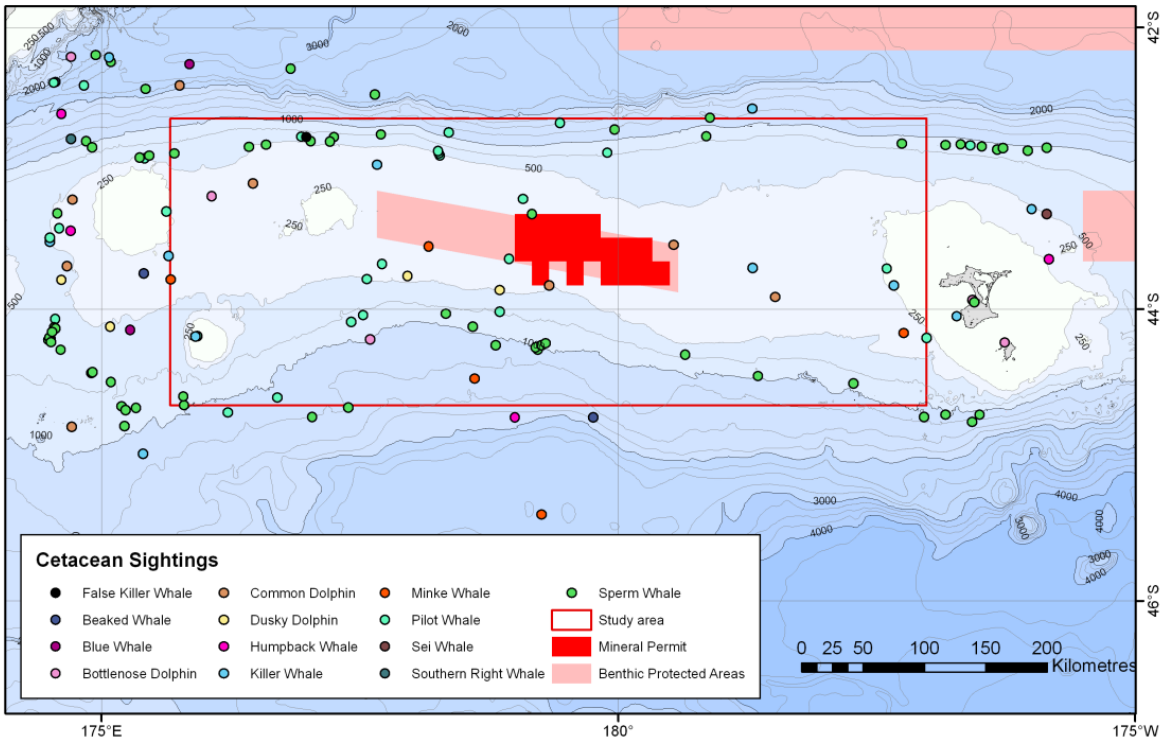


Figure 10. Distribution of all cetacean sighting locations from DOC and Cawthron datasets within the Chatham Rise study area. (Source: Figure 1-1, Appendix 20 of the EIA, November 2012 (updated April 2013))

426. Although not expressed in the Joint Witness Statement of Experts in the Field of Marine Mammals, there was a consensus amongst experts giving evidence on marine mammals that

[396] Section 1 of Appendix 20 of the EIA, Distribution patterns of cetaceans on the Chatham Rise, November 2012 (updated April 2013)

the data was deficient.[397] The data available were opportunistic sightings rather than a systematic survey. Dr Childerhouse stated that without systematic survey data on the application area, as well as the wider Chatham Rise, it was difficult to clearly identify which species were likely to be present in the area and, more importantly, the specific significance of the proposed mining area to marine mammals.[398] Dr Torres herself acknowledged in her report that the sighting rates were biased due to observational effort and could not be considered representative of actual temporal distribution of cetaceans over the Chatham Rise. The report advised that cautious interpretation of these sightings data was warranted due to a lack of standardized observational effort and the absence of data.[399]

427. From the data available, the twelve species and one species group recorded near the application area were: beaked whales, blue whale, bottlenose dolphin, common dolphin, dusky dolphin, false killer whale, humpback whale, killer whale, minke whale, pilot whale, sei whale, southern right whale and sperm whale.

428. The Crown, in its submission, added Ministry for Primary Industries Fisheries Observer Whale Sightings and Chatham Islands Whale Strandings data collected since 1872 to the information known about marine mammals on the Chatham Rise. This data identified twelve additional species to the marine mammals likely to be in and around the application area.[400] Even so, Dr Childerhouse opined that this data was subject to significant limitations, being:

- that the sightings were mainly collected by observers on fishing and seismic vessels and, therefore, were biased towards areas where these operations are occurring
- that the sightings were opportunistic and unlikely to be representative of actual marine mammals present
- observations from fishing and seismic vessels would be influenced by the nature of their operations and therefore could not be considered representative of the normal situation
- these records only provided information about where marine mammals have been seen and not about where they had not been seen, as the data set contained no effort data.[401]

[397] Eg Paragraph B, Statement of Evidence of Simon John Childerhouse for the Crown, 17 September 2014; Paragraphs 12 – 13, Evidence of Associate Professor Elisabeth Slooten for Greenpeace New Zealand, KASM, DSCC, 12 September 2014; Paragraph 3, Review by Dr Michael Huber, Mr Miles Yeates and Dr Gareth Taylor (Jacobs) appended to the Statement of Evidence of Michael Edward Huber for the DMC, 12 September 2014
[398] Paragraph D, Statement of Evidence of Simon John Childerhouse for the Crown, 17 September 2014
[399] Section1 of Appendix 20 of the EIA, Distribution patterns of cetaceans on the Chatham Rise, November 2012 (updated April 2013)
[400] Paragraph 18, Statement of Evidence of Simon John Childerhouse for the Crown, 17 September 2014
[401] Paragraph 19, Statement of Evidence of Simon John Childerhouse for the Crown, 17 September 2014

429. Having acknowledged the limitations of the data, Dr Childerhouse and Mr Cawthorn were agreed that the data sets represented the most comprehensive records currently available.[402]

430. Many of the experts considered that the Chatham Rise supported a high diversity and abundance of marine mammal species due to the relatively high productivity of the Chatham Rise ecosystem and the significant fish stocks it supported.[403]

431. Habitat modelling conducted predicted the Chatham Rise to be an important foraging habitat for southern right whales, particularly along the southern slope, during the summer and autumn months.[404] The Chatham Rise is also a migration corridor for several species of whales migrating between the northern breeding grounds and feeding grounds in the Southern Ocean.[405]

432. As pointed out by Associate Professor Slooten, marine mammal surveys rather than habitat modelling were needed to determine which species of marine mammals use the Chatham Rise area and how much time they spend there.[406]

433. The DMC heard from various marine mammal experts that dedicated systematic marine mammal surveys are possible using passive acoustic monitoring, aerial surveys and observers on marine vessels. Mr Cawthorn outlined in his evidence the various limitations to each of the data source techniques.[407]

[402] Paragraph 20, Statement of Evidence of Simon John Childerhouse for the Crown, 17 September 2014 and Paragraph 74, Statement of Evidence of Martin William Cawthorn for CRP, 25 August 2014
[403] Paragraph 10, Statement of Evidence of Simon John Childerhouse for the Crown, 17 September 2014 and Paragraph 23, Statement of Evidence of Martin William Cawthorn for CRP, 25 August 2014
[404] Section 1 of Appendix 20 of the EIA, Distribution patterns of cetaceans on the Chatham Rise, November 2012 (updated April 2013)
[405] Section 2. 2 of Appendix 20 of the EIA, Distribution patterns of cetaceans on the Chatham Rise, November 2012 (updated April 2013)
[406] Paragraph 26, Evidence of Associate Professor Elisabeth Slooten on behalf of Greenpeace, KASM and DSCC, 12 September 2014
[407] Paragraph 73, Statement of Evidence of Martin William Cawthorn for CRP, 25 August 2014

Conservation status

434. Section 59(d) of the EEZ Act requires the DMC to take into account the importance of protecting the biological diversity and integrity of marine species, ecosystems and processes. Section 59(e) also requires the DMC to take into account the importance of protecting rare and vulnerable ecosystems and the habitats of threatened species.

435. Of the recorded marine mammals sighted or stranded relevant to the application area, the DMC understand that a number have a national or international threat classification:[408]

- southern elephant seal — Nationally Critical (NZ status)
- killer whale — Nationally Critical (NZ status)
- southern right whale — Nationally endangered (NZ status)
- bottlenose dolphin — Nationally endangered (NZ status)
- humpback whale — Endangered (IUCN Red List)
- sei whale — Endangered (IUCN Red List)
- pygmy blue whale — Endangered (IUCN Red List)
- Antarctic blue whale — Endangered (IUCN Red List)
- fin whale — Endangered (IUCN Red List)
- sperm whale — Vulnerable (IUCN Red List).

8.6.2. Effects

436. Torres et al. (2014) identified the potential impacts on marine mammals from the proposed mining operation as:[409]

- noise
- ship strike
- habitat degradation
- entanglement
- pollution.

[408] Table 1, Statement of Evidence of Simon John Childerhouse for the Crown, 17 September 2014
[409] Section 3 of Appendix 20 of the EIA, Distribution patterns of cetaceans on the Chatham Rise, November 2012 (updated April 2013)

Effects of noise

437. The experts agreed that the most significant potential impact on marine mammals was operational noise, and the DMC heard a large amount of evidence on this issue.[410] There were two main questions in order to determine the effects of noise on marine mammals: (i) what is the predicted noise generation by the proposed operation? (ii) at what noise thresholds would there be an adverse effect on marine mammals?

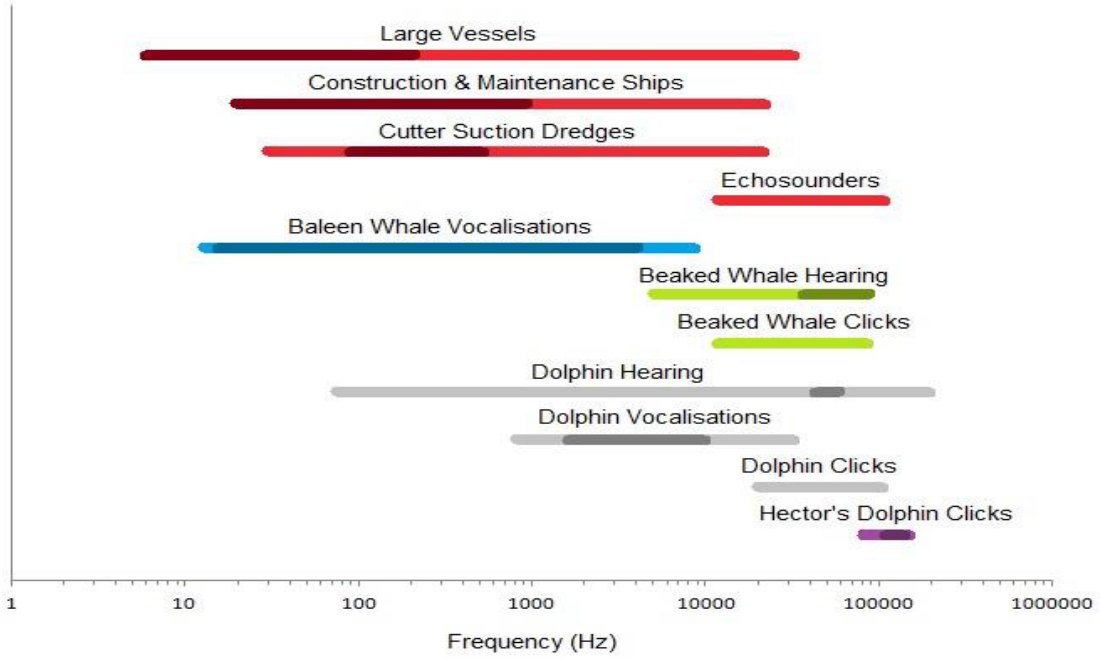


Figure 12. Comparison of marine megafauna hearing ranges with anthropogenic sources. Darker sections of marine mammal hearing ranges indicate peak hearing ranges, range of vocalisations (Johnson 1967, Kastelein et al. 2003, Mellinger et al. 2007, Popov et al. 2007, Houser et al. 2008, Nachtigall et al. 2008, Dawson 1990). Darker sections of anthropogenic sources of noise (red bars) indicate main energy ranges, echo sounders are variable (Götz et al. 2009, Thomsen et al. 2009, CEDA 2011, Robinson et al. 2011). (Source: Figure 1, Statement of Evidence of Simon John Childerhouse for the Crown, 17 September 2014)

[410] Issue 1, Joint Statement of Experts in the Field of Marine Mammals, 15 October 2014

438. The basis for the noise discussion amongst the experts on marine mammals was the JASCO report which modelled sound levels under a fully operational mining scenario. This scenario modelled three individual sources of noise:

- the dredge under dynamic positioning (point source location at approximate thruster depth for the surrogate vessel *Amundsen Spirit*)
- an on-board mining plant (a point source at fully loaded hull depth of *Amundsen Spirit)*
- a point source 25 m above the seafloor representing the dredge pump (scaled using *Sand Falcon* as a proxy).[411]

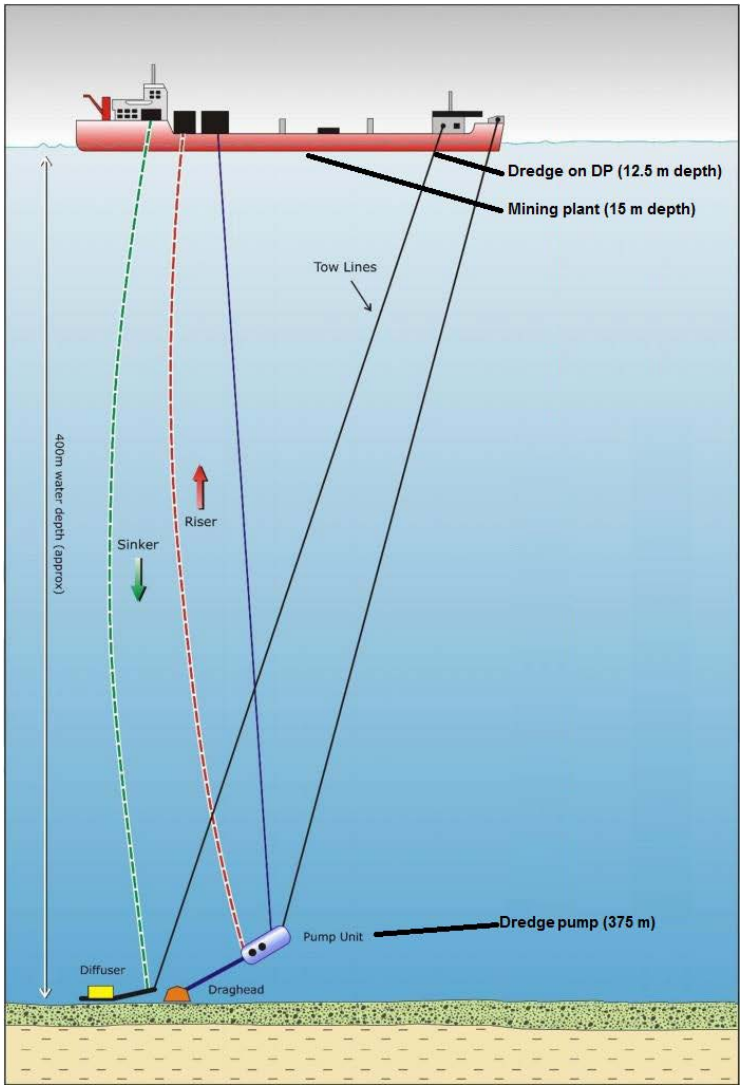


Figure 13. Image of dredge concept with location (depth) of sources used in modelled scenarios. (Source: Figure 3 of JASCO report attached to Statement of Evidence of Dr Darlene Ketten for CRP, 7 October 2014)

[411] Section 2.1 of the JASCO Chatham Rock Phosphate Underwater Acoustic Modelling report appended to the Statement of Evidence of Dr Darlene Ketten for CRP, 7 October 2014

439. The experts in the field of marine mammals agreed that the JASCO model, based on data supplied by Boskalis, provided the best available information regarding sound source characteristics and spread of acoustic pressure levels from proposed operations.[412]

440. The outcome of the JASCO model was that the proposed operation would generate RMS[413] source level of 195.8 dB re 1µPa at 1 m (the DMC notes that all experts accepted this underwater sound metric as appropriate). When fully operational, the 120 dB received level radii (R95 %) was 29 km and the ensonified area was 2,100 km^2.[414]

441. There were however some uncertainties and lack of information with the JASCO modelling. The acoustic model did not include riser pipe noise, although noise from the riser pipes was approximated and included in the dredge and subsea pumps' maximum-over-depth planar sound map. The JASCO report considered that the individual contribution of the pipes as a sound source would be less than those of the sources already included in the modelling, and therefore that the inclusion of the pipes would not increase the maximum-over-depth planar sound field of the operation.[415] This was acknowledged by the experts for marine mammals as introducing an element of uncertainty.[416] Mr Humpheson opined it would have been helpful to consider whether the movement of sediment and nodules within the pipe would generate high frequency sound along its entire length of approximately 375 m. He acknowledged that the high frequency sound was only likely to affect the area immediately surrounding the dredge due to rapid attenuation of the high frequencies.[417]

442. The experts in marine mammals agreed that there was uncertainty about the dredge pump as source levels above 40 kHz were not included in the modelling.[418] The DMC understands from Mr Humpheson that this was due to the unavailability of source data above this frequency range.[419]

443. The experts in the field of marine mammals agreed that not having data on the ambient noise (including other vessel and animal sound within the predicted ensonified area) introduced another uncertainty regarding the model's application.[420] The memorandum prepared by Mr Humpheson explains the importance of this, for example should there be concurrent shipping activity on the Chatham Rise then there would be additional noise. This would likely have the

[412] Issue 1A, Joint Statement of Experts in the Field of Marine Mammals, 15 October 2014
[413] RMS = root mean square; or the mean sound pressure over a defined duration, (Ketten EiC, Report, page 8)
[414] Table 7 of the JASCO Chatham Rock Phosphate Underwater Acoustic Modelling report appended to the Statement of Evidence of Dr Darlene Ketten for CRP, 7 October 2014
[415] Section 2.1 of the JASCO Chatham Rock Phosphate Underwater Acoustic Modelling report appended to the Statement of Evidence of Dr Darlene Ketten for CRP, 7 October 2014
[416] Issue 1A, Joint Statement of Experts in the Field of Marine Mammals, 15 October 2014
[417] Paragraph 10, Summary of Evidence of Darran Humpheson for the Crown, 20 October 2014
[418] Issue 1A, Joint Statement of Experts in the Field of Marine Mammals, 15 October 2014
[419] Paragraph 9, Summary of Evidence of Darran Humpheson for the Crown, 20 October 2014
[420] Issue 1B, Joint Statement of Experts in the Field of Marine Mammals, 15 October 2014

effect of increasing the overall dB.[421] From his analysis, Mr Humpheson concluded that the applicant's proposed dredging operations would be dominant compared to the noise of shipping activity, including fishing vessels.[422]

444. The DMC understands that the effect of noise on marine mammals is complex and can be demonstrated in a range of ways. Dr Childerhouse summarised the potential effects of noise as involving both behavioural changes (eg such as avoiding or leaving an area, affecting communication and / or echolocation or altering behavioural state such as feeding or breeding), and physiological (both temporary and permanent threshold shifts in hearing) for marine mammals at varying distances from the sound source.[423]

445. Dr Ketten informed the DMC that not only do all sounds not have the same impact across all species, but there can be significant individual variability within species. It is species-specific and is dependent upon both the animal's physiological ability to hear the signal and behavioural dispositions.[424]

446. The experts on marine mammals concluded that the threshold for behavioural responses is likely to occur at received levels between 120 dB and 135 dB re 1 µPa rms. As a level of 120 dB re 1 µPa rms is at or below the sensitivity of toothed whales, the principal concern identified is for baleen whales, which are able to hear those frequencies.[425]

447. It was Dr Ketten's opinion that as Mysticeti (baleen whales) are thought to be migrants and infrequently dive below 200 metres, there was little probability of sufficient numbers of individuals encountering the sound field frequently, at sufficient received levels and for sufficient durations to produce a population level temporary or permanent threshold shift.

448. Dr Ketten acknowledged some concern, but to a far lesser degree, for sperm whales because they are a more common resident species and capable of protracted dives at deeper depths. However she noted that they have moderate to poor auditory sensitivity at the relevant operational frequencies. Cumulative effects cannot be ruled out for either sperm whales or mysticetes that are more sensitive to these frequencies, but they were unlikely given that the marine mammals that are most sensitive are migrants, and sperm whales do not typically forage in the vicinity of the proposed operations. All other reported marine mammal species for the Chatham Rise areas either have sufficiently poor or no hearing abilities at the predicted operational frequencies even with repeated exposures, or are rare in the mining application

[421] Section 3.2, Memorandum from Darran Humpheson: Consideration of Future and Existing Noise Environment on the Chatham Rise, 15 October 2014
[422] Paragraph 13, Summary of Evidence of Darran Humpheson for the Crown, 20 October 2014
[423] Paragraph F, Statement of Evidence of Simon John Childerhouse for the Crown, 17 September 2014
[424] Lines 27 – 29, page 1509 of the Transcript, 21 October 2014
[425] Issue 1D, Joint Statement of Experts in the Field of Marine Mammals, 15 October 2014

area. Furthermore, given their highly mobile behaviour it was unlikely they would sustain any significant direct, physiological impacts even with frequent encounters.[426]

449. The experts on marine mammals agreed that it was likely that there would be some behavioural effect on some species. Behavioural changes could include altered diving, foraging, pod cohesion, masking of significant acoustic cues (eg communication, echolocation from prey), reproduction, spatial distribution and habitat use.[427]

450. The experts also discussed engine start up. The experts agreed that sudden onset sounds were more likely to cause behavioural change than continuous noise.[428] Dr Childerhouse explained that one way to allay that is to undertake 'soft starts', which essentially involved starting noise-generating machinery slowly at a very low sound level before progressively winding them up to full production and maximum noise.[429]

Loss of habitat and food resources

451. The joint conferencing experts on marine mammals agreed that ecological impacts through benthic destruction and impact on prey species was a potential impact, and ranked this second in significance to noise effects. While the Torres *et al* report considered the magnitude of these impacts would be small scale, short-term or unlikely,[430] the experts generally agreed that there was insufficient information to confirm the level of significance of this effect.[431]

452. Associate Professor Slooten noted that habitat degradation includes direct damage to benthic communities from mining, and indirect impacts caused by the sediment plume.[432] Dr Huber noted that sediment plumes associated with discharged wastewater have the potential to disrupt some marine mammal behaviours, including feeding and migration. However, as modelling predicted that sediment plumes would generally be confined to the deepest 50 m of the water column, the primary consideration would be for deep-diving whale species such as sperm whales, pilot whales and beaked whales. Dr Huber concluded that suspended sediment plumes of the concentrations predicted are unlikely to cause impacts on whales and that in any case the

[426] Page 4 of Appendix A (Assessment of Operational Acoustics and Potential Marine Mammal Impacts for Chatham Rise) of the Statement of Evidence of Dr Darlene Ketten for CRP, 7 October 2014
[427] Issue 1D, Joint Statement of Experts in the Field of Marine Mammals, 15 October 2014
[428] Issue 1D, Joint Statement of Experts in the Field of Marine Mammals, 15 October 2014
[429] Lines 26 – 30, page 1579 of the Transcript, 21 October 2014
[430] Section 4.3 of Appendix 20 of the EIA, Distribution patterns of cetaceans on the Chatham Rise, November 2012 (updated April 2013)
[431] Lines 14 – 17, page 1489 of the Transcript, 21 October 2014
[432] Paragraphs 37 and 38, Evidence of Associate Professor Elisabeth Slooten on behalf of Greenpeace, KASM, and DSCC, 12 September 2014

plumes could be easily avoided. Accordingly such impacts, if they occurred, would be of a small scale.[433]

Pollution

453. Torres *et al* identified the main environmental toxins that are currently of concern for populations of marine mammals as persistent organic pollutants (POPs), including PCBs, PBDE's, dioxins and furans. Other pollutants include oil-pollution derived substances, marine debris, metals, sewage-related pathogens, excessive amounts of nutrients causing environmental changes, and radionuclides.[434] That report concluded that the impact of pollution on cetaceans was likely to be negligible given their large range, the small-scale nature of this mining proposal, and the probability of an event coinciding with the presence of any animal. The report acknowledged the potential for toxins to bioaccumulate in cetaceans if there was an oil spill or chemical release.[435]

Ship strike and entanglement

454. The Torres *et al* report considered that based on the slow travel speed of the dredging vessel while operating (1 m/s), it was unlikely that a collision or harmful interaction with a cetacean would occur, especially with agile species including all odontocetes. While baleen whales are less agile, the report concluded that collision or harmful interaction is again unlikely due to the slow travel speed of the dredging vessel while operating. The report recommended transiting vessels to and from the mining area should take precautions not to strike whales, particularly around the southern edge of the Chatham Rise during summer and autumn when this habitat is important for foraging southern right whales.[436]

455. The Torres *et al* report also concluded that entanglement of a cetacean in the lines between vessel and dredge / riser / sinker was unlikely due to (i) the thickness of the lines, and (ii) the lines remaining under tension in order to move the dredge head along the seafloor. Cetaceans would likely be able to perceive the lines visually and if physical contact were made, it was unlikely that an entanglement would occur.[437]

[433] Paragraph 7 of Annexure B (Assessment of Effects on Marine Mammals from the Chatham Rise Phosphate Limited Marine Consent Application) of the Statement of Evidence of Michael Edward Huber (Marine Mammals), 12 September 2014
[434] Section 3.5 of Appendix 20 of the EIA, Distribution patterns of cetaceans on the Chatham Rise, November 2012 (updated April 2013)
[435] Section 4.5 of Appendix 20 of the EIA, Distribution patterns of cetaceans on the Chatham Rise, November 2012 (updated April 2013)
[436] Section 4.1 of Appendix 20 of the EIA, Distribution patterns of cetaceans on the Chatham Rise, November 2012 (updated April 2013)
[437] Section 4.4 of Appendix 20 of the EIA, Distribution patterns of cetaceans on the Chatham Rise, November 2012 (updated April 2013)

456. The experts in the field of marine mammals agreed that ship strike and entanglement were sufficiently unlikely that they did not represent a significant concern.[438] The DMC heard no evidence to the contrary so accept that ship strike or entanglement of marine mammals is an unlikely effect of the proposal. The DMC also accepts Mr Cawthorn's evidence that the risk of marine mammal strike while the mining vessel is transiting to or from port is little different to the risk posed by fishing vessels operating on the Chatham Rise.[439]

8.6.3. Proposed conditions

457. Proposed Condition 17 required reduction of operating speeds when within 300 m of any observed whales and the reporting of any contact with whales to the Department of Conservation. The DMC supports the intent of this proposed condition and understands it to be at the discretion of the master of the vessel to avoid any whales.

458. Proposed Condition 18 required that a mitigation zone be visually checked for mammals and that mining commence only after no marine mammals had been observed for at least two hours. The experts in the area of marine mammals agreed on a number of proposed conditions relating to mammals including the distance of a mitigation zone being greater than 200 m (as originally proposed in the conditions) and the period of time for observations. The DMC notes that Proposed Condition 18 reflected the recommendations of the experts in the area of marine mammals in terms of the 1.5 km distance, two hour observation time and the reassessment of the mitigation zone on the basis of measurement of actual sound produced by the mining operation.[440]

459. The experts in the area of marine mammals also recommended the use of passive acoustic monitoring to provide range and direction to the vocalising animals. The DMC notes this did not appear in the proposed conditions.[441] Similarly, the suggested requirement for a soft start was not reflected in the proposed conditions.

460. The DMC also notes that Proposed Condition 20(a) required that independent and appropriately trained marine mammal observers be placed on-board the vessel in accordance with the draft conditions recommended by the experts in the area of marine mammals.[442] However, while the experts did not set a minimum duration for the observer on-board the vessel, the DMC notes that Proposed Condition 20(a) limited the need for the trained observer to between one and two years. Thereafter, Proposed Condition 21 required that relevant personnel on the mining vessel undertake appropriate training.

[438] Issue 2, Joint Statement of Experts in the Field of Marine Mammals, 15 October 2014
[439] Paragraph 45, Statement of Evidence of Martin William Cawthorn for CRP, 25 August 2014
[440] Issue 1C, Joint Statement of Experts in the Field of Marine Mammals, 15 October 2014
[441] Issue 1C, Joint Statement of Experts in the Field of Marine Mammals, 15 October 2014
[442] Issue 1C, Joint Statement of Experts in the Field of Marine Mammals, 15 October 2014

461. The effect of noise on marine mammals was a significant issue during the hearing but the DMC notes that the proposed conditions did not set any noise limits, and instead referred to verification of the JASCO modelling. Proposed Schedule 2B(i) requires measuring the near field and far field of the mining vessel and mining equipment to verify the acoustic modelling results. Monitoring was required no later than one month after mining commences and was to be collected for up to two months while mining was occurring. However the experts in the field of mammals sought more certainty and greater specificity in their agreed recommended conditions. They sought empirical measurements within three months at specified distances of 100 m, 500 m, 1000 m and 2000 m from the planned dredging lane to be measured for at least three dredging passes. The experts specified certain recorded bandwidths, although not all agreed on 200 kHz.[443] The proposed conditions did not contain this level of specificity and instead just required verification of the JASCO acoustic model.

8.6.4. DMC findings

462. The DMC accepts that the information and evidence about marine mammals was based on reported sightings and strandings rather than systematic and specific surveys. Based on the limited information available, the DMC cannot be certain as to the significance of the proposed marine consent area as habitat for marine mammals.

463. None of the marine mammal experts concluded that the mining operation would have significant adverse effects at a population level, albeit they differed on individual measures.

464. The DMC found operational noise from the proposed mining operation to have the greatest potential impact to marine mammals, but was satisfied that general knowledge about the marine mammal species observed in the wider area of the Chatham Rise, and knowledge about the species-specific behavioural and physiological characteristics and responses (including their auditory ranges), provided sufficient confidence that any effects on individual marine mammals could be managed by a range of conditions, a suite of which were suggested in the final set of proposed conditions tabled by the applicant, including mechanical noise limits, monitoring arrays, vessel speed controls, observers, stop-work separation distances, and reduction of operating speeds.

465. The DMC agrees that there is a lack of information regarding the potential effect of the proposal on marine mammals in terms of loss of habitat and food resources, but agrees with Dr Huber that marine mammals should be able to avoid the sediment plume. The DMC also notes that

[443] Issue 1A, Joint Statement of Experts in the Field of Marine Mammals, 15 October 2014

such is the range and mobility of marine mammals that it is unlikely that the proposal would have a significant effect in terms of food sources.

466. The DMC agrees with Dr Childerhouse that the risk is not dissimilar to that from other vessel operating in the area.[444] As such, the DMC does not consider pollution from the proposal to be a significant risk to marine mammals.

467. The DMC finds other potential adverse effects such as loss of habitat and food resources, pollution, ship strike and entanglement to be relatively minor, with likely minimal risk to individuals and little or no effect at the population level. Overall, the DMC considers that the suite of conditions based on the applicant's proposals and including marine mammal observers would have addressed the concerns raised by the experts.

8.7. Seabirds

8.7.1. The issues

468. The DMC understands from the application and evidence presented that the Chatham Rise is the most important zone for seabirds within the New Zealand region, and has the largest assemblage of seabirds in the world because of the abundance of sea bird prey species on the Chatham Rise. The majority of New Zealand's seabirds could be encountered here at some point over the course of the year, with the possible exception of those species breeding at the Kermadec Islands to the north.[445] While a very large proportion of New Zealand's seabird species may be found over the Chatham Rise, a smaller proportion of species are known to, or are likely to, use the Chatham Rise area more extensively. This is because they breed close to the Chatham Rise at the Chatham Islands or because they forage over the Chatham Rise from breeding sites further afield.[446]

469. Section 59(2)(d) and (e) of the EEZ Act requires the EPA to take into account "*the importance of protecting the biological diversity and integrity of marine species, ecosystems, and processes and the importance of protecting rare and vulnerable ecosystems and the habitats of threatened species.*"

470. Dr Thompson stated that four taxa of seabirds likely to be found in the marine consent application area are classified as 'threatened' under New Zealand's threat classification system. Antipodean albatross, Salvin's albatross and magenta petrel (also known as the Chatham Island taiko) have a conservation status of 'nationally critical', and the Chatham petrel has a

[444] Paragraph 80, Statement of Evidence of Simon John Childerhouse for the Crown, 17 September 2014
[445] Section 1 of Appendix 21 of the EIA, Seabirds of the Chatham Rise, November 2012 (updated April 2013)
[446] Section 1 of Appendix 21 of the EIA, Seabirds of the Chatham Rise, November 2012 (updated April 2013)

conservation status of 'nationally vulnerable'.[447] Mr Taylor also advised that the Chatham Island taiko is critically endangered, with just 20 known breeding pairs, and that recent DOC tracking studies have shown that they forage occasionally over the proposed mining application area.[448] It is one of the rarest seabirds in the world and is listed in the IUCN Red List Threat Classification as critically endangered.[449] Mr Bartle and Dr Leigh Bull agreed in their opinion that even low level additional mortality of adults or fledglings of either Chatham Island taiko or Chatham petrel could lead to their early extinction.[450]

471. The DMC understood from Dr Bull that the means through which formal protection is provided for seabirds is via the Wildlife Act 1953.[451]

8.7.2. Current situation

472. The DMC was told that the applicant's knowledge of seabird occurrence on the Chatham Rise derives mostly from observational data (often collected on an *ad hoc* basis), seabird mortality data from commercial fisheries operations, and data acquired from electronic tracking of individual seabirds. It was common ground that there have been no systematic and quantitative surveys of spatio-temporal seabird occurrence and abundance on the Chatham Rise.[452]

473. It was agreed by the experts involved in the conferencing regarding seabirds, that regardless of gaps in information, the Chatham Rise is an important area for seabirds.[453]

8.7.3. Effects

474. The experts all agreed that the main potential effects on seabirds associated with the proposal were:[454]

- light attraction resulting in increased probability of collision with wires, cables and vessel structure
- discharge attraction resulting in increased probability of collision with wires, cables and vessel structure
- oil pollution
- sound attraction resulting in increased probability of collision with wires, cables and vessel structure

[447] Paragraph 21 – 22, Statement of Evidence of Dr David Thompson for CRP, 25 August 2014
[448] Paragraph C, Statement of Evidence of Graeme Andrew Sydney Taylor for the Crown, 12 September 2014
[449] Paragraph 19, Statement of Evidence of Graeme Andrew Sydney Taylor for the Crown, 12 September 2014
[450] Paragraph 144, Evidence of Mr J A (Sandy) Bartle, Royal Forest and Bird Protection Society of New Zealand Incorporated, 12 September 2014
[451] Line 6, page 775 of the Transcript, 3 October 2014
[452] Paragraph 1, Statement of Evidence of Dr David Thompson for CRP, 25 August 2014
[453] Issue 1, Joint Statement of Experts in the Field of Seabirds, 23 September 2014
[454] Issue 3, Joint Statement of Experts in the Field of Seabirds, 23 September 2014

- effect of the sediment plume on abundance of vertically migrating prey species of seabirds.

475. It was Dr Thompson's opinion that increased sediment in the water column would not affect seabirds through a reduction in foraging efficiency for visual foragers. He concluded this because the sediment modelling indicated that any increase in turbidity would occur at depths in excess of 300 m, which is beyond the foraging range of diving seabirds.[455] That conclusion was not challenged by any seabird expert. Accordingly the DMC accepts that conclusion and does not consider this effect further. The DMC addresses each of the other identified effects below.

476. Dr Thompson gave evidence about the number of birds that were reported killed by commercial fishing activity and returned for autopsy in the seven years up to 2013.[456] He considered that of current activities occurring on the Chatham Rise, commercial fishing longline and trawl operations have the most effect on seabirds, primarily through direct mortality of birds due to incidental capture by fishing gear.[457] While the DMC accepts this to be the case, the DMC turned its mind to the question as to whether the proposed mining activity increased the level of risk to seabirds, in terms of both the activity itself and any potential cumulative effect (Section 59(2)(a)(i) of the EEZ Act).

Increased risk of collision

477. In terms of increasing the risk of seabird collision with the mining vessel, all the experts involved in conferencing agreed that lighting posed the greatest potential risk.[458] Nocturnal bird strikes on vessels tend to occur when bright, artificial light sources are used at times of poor visibility, typically during bad weather, often angled outwards or upwards from the vessel, and when the vessel is relatively close to large breeding aggregations of seabirds.[459]

478. It was Dr Thompson's opinion that the likelihood of bird strike of taiko and Chatham petrels was low, based on an absence of any strikes being reported.[460] However Mr Taylor gave evidence as to how DOC uses lights to attract the taiko in order to capture and tag the birds, indicating how attracted to light they are. Storm petrels, prions and other birds are also attracted to the DOC lights, which shine upwards.[461]

[455] Paragraph 28, Statement of Evidence of Dr David Thompson for CRP, 25 August 2014
[456] Paragraph 24, Statement of Evidence of Dr David Thompson for CRP, 25 August 2014
[457] Paragraph 24, Statement of Evidence of Dr David Thompson for CRP, 25 August 2014
[458] Issue 4, Joint Statement of Experts in the Field of Seabirds, 23 September 2014
[459] Paragraph 7, Statement of Evidence of Dr David Thompson for CRP, 25 August 2014
[460] Lines 41 – 46, page 436 of the Transcript, 30 September 2014
[461] Lines 21 – 43 page 469 and lines 36 – 39 page 474 of the Transcript, 30 September 2014

479. The applicant proposed the use of green lights on board the mining vessel as a possible mitigation measure. Although none of the bird experts was categorical that green lighting would make a difference, it was noted that they had been effective in the North Sea, although that trial did not include seabirds. The experts agreed that green lights were worth testing to determine whether, and to what extent, this might be an effective approach to reducing the attraction of seabirds to light. The DMC asked whether DOC's capture and tag programme would present an opportunity to trial the green lights and Mr Taylor agreed that this was an option.[462] However the DMC notes that there was some reservation about the efficacy of a land-based trial. Mr Bartle agreed that a trial was required in advance, which could involve a vessel with green lights, possibly even close to the seabird colonies, to see whether any sea birds fly on board or not[463] (although the DMC understood this not to refer to taiko colonies). Dr Bull clarified that, in her opinion, success would be no birds reacting to green lights on land or sea.[464] The DMC gained the impression from other experts however, that a relative reduction in attractiveness rather than an absolute reduction was more probable.

480. Mr Prebble on behalf of the Crown drew the DMC's attention to the lighting requirements for navigational safety under the Maritime Transport Act (Maritime Rules Part 22: Collision Prevention).[465] The DMC understands that these rules set the minimum night-time lighting profile for vessels (including the distance requirement for visible white lights) and therefore assist in the evaluation of risk of collision by seabirds, although, as noted elsewhere, the DMC was left uncertain as to the applicability of these rules beyond territorial waters. The lighting requirements for workplace safety may also constrain the use of alternative lighting mitigation measures.

481. The seabird experts agreed that if green light was not effective or not used, then no mining should occur on nights when birds are most at risk (ie foggy / cloudy nights with no moon present). The experts also agreed that during the known fledging dates for seabirds which breed on the Chatham Islands, night suspension of mining for a 14 day period a week either side of the new moon in May should be required (to protect fledglings of Chatham taiko and Chatham petrel in the critical period when they first depart to sea). The experts supported reducing all unnecessary deck and cabin lighting, covering portholes and windows at night, orientating the deck lights downwards, avoiding upward or horizontal lighting as much as possible and using light intensity reducing technology such as dimmers or timers. [466]

[462] Lines 41 – 42, page 474 of the Transcript, 30 September 2014
[463] Lines 17 – 19, page 755 of the Transcript, 3 October 2014
[464] Lines 7 – 8, page 772 of the Transcript, 3 October 2014
[465] Lines 17 – 46, page 453 of the Transcript, 30 September 2014
[466] Issue 4, Joint Statement of Experts in the Field of Seabirds, 23 September 2014

482. The seabird experts also agreed that discharge from the applicant's vessel (both organic waste from the vessel and benthic material) would increase its attractiveness to seabirds. The experts concluded that this potential effect should be overcome through appropriate design of the vessel, by ensuring that no waste is discharged into the sea and by returning benthic material successfully to the sea floor.[467]

483. One other potential attractant considered by the seabird experts was noise. While the experts agreed that noise could be an attractant, they could not agree on whether low revving diesel engines were less attractive to birds, and therefore whether any measures were required to reduce the risk. Mr Bartle considered that the sort of pumps and generators likely to be used in the dredging operation would pose a potential hazard if they were on deck.[468] Overall, however, this was considered to be a low risk by the majority of the seabird experts.[469]

484. Mr Taylor expressed concern about the size of the vessel potentially increasing the risk of collision by seabirds, compared to typical fishing vessels, due to its greater overall bulk and profile, including wires.[470] The seabird experts concluded that the risk could be reduced by the vessel design being assessed by a seabird expert to identify design hazards and ways to mitigate the risks.[471]

Effect on food sources

485. The effect of the sediment plume on the abundance of vertically migrating prey species of seabirds was identified by the seabird experts as a potential effect; but one where there is a high degree of uncertainty due to lack of information.[472] The DMC understands that vertically migrating marine organisms include a range of small fish, krill and plankton that descend into very deep dark water during the daytime and then at night ascend to feed in the plankton rich waters nearer the surface.[473] It follows that if these organisms are significantly affected by the sediment plume, there could be consequential effects on the food source for seabirds. However, there was no agreement between the experts as to how significant that risk is, due to the absence of available and uncontroverted information. The DMC addresses the effects on zooplankton in Chapter 8.4 of this report.

[467] Issue 5, Joint Statement of Experts in the Field of Seabirds, 23 September 2014
[468] Paragraph 197, Evidence of Mr J A (Sandy) Bartle, Royal Forest and Bird Protection Society of New Zealand Incorporated, 12 September 2014
[469] Issue 6, Joint Statement of Experts in the Field of Seabirds, 23 September 2014
[470] Lines 1 – 3, page 476 of the Transcript, 30 September 2014
[471] Issue 7, Joint Statement of Experts in the Field of Seabirds, 23 September 2014
[472] Issue 9, Joint Statement of Experts in the Field of Seabirds, 23 September 2014
[473] Lines 21 – 44, page 471 of the Transcript , 30 September 2014

Oil

486. It was common ground that oil spill represented a low risk to seabirds although known to clog and damage feathers or be ingested. Mr Taylor considered the risk no different to any other fishing vessel or other boats operating on the Rise, apart from the fact that this would be a larger vessel and therefore likely to have more oil on board.[474] The DMC agrees.

8.7.4. Proposed conditions

487. Seabirds were acknowledged in Proposed Schedule 1 as an environmental threshold. If this were exceeded, it would be classed as an "*unexpected adverse impact*" and an adaptive management approach would need to be followed in terms of Proposed Condition 41. Two seabird environmental thresholds were identified in proposed Schedule 1B as:

- injury or killing of any Chatham Island taiko (*Pterodroma magenta*) or Chatham petrel (*Pterodroma axillaris*)
- in any calendar month, injury or killing of more than two other seabirds.

488. The experts in the field of seabirds identified a number of species that were most at risk, including Chatham Island taiko (Magenta petrel) as critically endangered and Chatham Island petrel as endangered.[475] Although the seabirds experts identified Chatham Albatross, Southern Buller's albatross (not agreed by all experts), Salvin's albatross and Gibson's albatross as declining populations, these species are considered less at risk. The DMC considers the singling out of the Chatham Island taiko and Chatham petrel as being an environment threshold appropriate given their endangered status. The DMC notes that the Crown expert agreed with the thresholds set out in Proposed Schedule 1 for seabirds.[476]

489. Proposed Condition 7 would ensure no food wastes are discharged from the vessel either during mining or transiting to and from the mining site. This proposed condition reflected the recommendations of the experts in the field of seabirds.[477] The DMC considers this proposed condition appropriate to avoid attracting seabirds to the vessel and therefore reducing the potential for seabird strike or entanglement.

490. Proposed Condition 19 outlines all the avoidance measures to reduce the potential impact on seabirds. The DMC notes that most of the proposed conditions recommended by the experts in the area of seabirds were reflected in the proposed conditions, for example minimising lighting on the vessel, covering portholes, and orienting lights downwards.[478] The experts'

[474] Lines 20 – 23, page 478 of the Transcript, 30 September 2014
[475] Issue 10, Joint Statement of Experts in the Field of Seabirds, 23 September 2014
[476] Paragraph 11.6, Crown's Closing Submissions, 18 November 2014 (note the submission states 18 October 2014)
[477] Issue 5, Joint Statement of Experts in the Field of Seabirds, 23 September 2014
[478] Issue 4, Joint Statement of Experts in the Field of Seabirds, 23 September 2014

recommendation regarding the use of dimmers and timers and other light intensity reducing technology was not specified in the proposed conditions, although it could arguably be a component of Proposed Condition 19(a)(i). Proposed Condition 19(a)(vi) required minimising the use of vertical wires and objects on the deck, reflecting the recommendations of the experts.[479] Proposed Condition 19(a)(viii) reducing oil on the deck was also in accordance with the experts' recommendations.[480]

491. The DMC notes that the experts recommended that a trial investigating the effectiveness of using green light on a vessel in the Chatham Rise should be undertaken prior to the final build / fitting out of the mining vessel. The experts considered that if the trial was not possible for some reason, green lights should still be installed wherever practical. Although the proposed conditions did not require a trial of green lights, Proposed Condition 19(2)(ii) required maximising the use of green lights.[481]

492. The experts in the field of seabirds agreed on the need for night suspension of mining for a 14 day period for a week either side of any new moon in May (to protect fledglings of Chatham taiko and Chatham petrel in the critical period when they first depart to sea). This recommended condition was not adopted by the applicant.

493. The DMC notes also that the recommended condition regarding the encasing of deck-mounted engines or generators in a housing to reduce noise did not appear in the proposed conditions (although the DMC acknowledges that not all of the experts in the field of seabirds could agree on this proposed condition).[482] Dr Thompson noted that there was insufficient scientific knowledge in this area and Mr van Raalte indicated that it was most unlikely that above-deck generators would be incorporated in the vessel design.[483]

494. The DMC notes that many of the clauses in Proposed Condition 19 were qualitative rather than quantitative and could be difficult to enforce. The DMC agrees with the EPA's assessment that many of the clauses in Proposed Condition 19(a) would be appropriately addressed in the Lighting Management Plan required by Proposed Condition 19(b).[484]

495. The DMC notes that Proposed Condition 20(a) required independent and appropriately trained seabird observers on-board the vessel in accordance with the draft conditions recommended by the experts in the area of seabirds.[485] The experts considered that a trained seabird observer

[479] Issue 7, Joint Statement of Experts in the Field of Seabirds, 23 September 2014
[480] Issue 8, Joint Statement of Experts in the Field of Seabirds, 23 September 2014
[481] Issue 4, Joint Statement of Experts in the Field of Seabirds, 23 September 2014
[482] Issue 6, Joint Statement of Experts in the Field of Seabirds, 23 September 2014
[483] Issue 6, Joint Statement of Experts in the Field of Seabirds, 23 September 2014
[484] EPA Comment of CRP Conditions, 14 November 2014
[485] Issue 1, Joint Statement of Experts in the Field of Seabirds, 23 September 2014

was required on board for the first year of operation and seasonally dependent thereafter depending on the monitoring results of seabird mortality. The DMC notes that Proposed Condition 20(a) limited the need for the trained observer to between one and two years. Thereafter Proposed Condition 21 required that relevant personnel on the mining vessel undertake appropriate training. The seabird experts considered information gathered from seabird observers was essential for incorporation into any adaptive management response if seabird mortality and / or vessel strike issues arose.[486] The DMC considers the suite of proposed conditions associated with seabird observers to be generally appropriate.

496. There was some disagreement between the seabird experts regarding the value of undertaking baseline seabird surveys. Drs Bull and Thompson did not consider baseline surveys to be necessary, but thought that the independent observers could collect data on birds around the boat in a systematic way.[487] The DMC agrees that such surveys, being methodologically quite complex, would require considerable time and effort to be useful and, on the basis of the evidence, did not appear to be warranted.

8.7.5. DMC findings

497. The Chatham Rise is a nationally and internationally significant marine region for birds because of the diversity and abundance of seabirds using the area. This significance is highlighted by the presence of a number of endemic species that are considered threatened or at risk. The experts on seabirds and the DMC accepted this overall assessment of the importance of the Chatham Rise for seabird populations. The DMC found no compelling evidence that significant direct adverse effects on the seabird population of the Chatham Rise would arise from the proposed mining operation provided that it adhered to an appropriately structured set of conditions.

498. With respect to the critically endangered Chatham Island taiko population, it was common ground that any fatality could be a significant issue given their low breeding numbers and especially if, for example, the one male that is responsible apparently for a high proportion of the living offspring was that casualty. However the DMC notes that the probability of such an event is extremely small.

499. Overall the DMC considers that most of the conditions proposed by the applicant are consistent with those recommended by the experts in the field of seabirds and would have minimised the potential effect on seabirds despite the qualitative nature of many of the conditions.

[486] Issue 1 and 7, Joint Statement of Experts in the Field of Seabirds, 23 September 2014
[487] Lines 35 – 39, page 788 of the Transcript, 3 October 2014

8.8. Water quality

8.8.1. Issues

500. The disturbance of seabed sediments by the drag-head and the re-introduction of processed sediments back to the bed via the sinker and diffuser structure were assessed in terms of the potential to alter local water quality and mobilisation of potential contaminants. It was proposed that sediment would be excavated from the seabed using water jets and suction. As Mr Kennedy described in his evidence, the excavation of seabed sediment results in the mixing of seawater in the drag-head with pore water contained in the excavated sediment. It also causes the release of some constituents that were associated with the surfaces of sediment particles, resulting in potential changes in water quality.[488]

501. The application of Chatham Rise phosphorite to New Zealand land was also raised by the applicant as having potential benefits to freshwater quality through a reduction in the loss of phosphorus to water.[489] Submitters however raised potential adverse effects to land and freshwater through the phosphorite application due to its elevated uranium levels relative to other fertilisers currently used in New Zealand. Some submitters[490] from the Chatham Islands also expressed concerns about effects on surrounding water quality and local fisheries if phosphorite fertiliser was applied to farm land on the islands.[491]

502. Potential changes in water quality immediately above and at the seabed associated with the release or mobilisation of organic material and trace elements originally associated with seabed sediments was a key water issue at the hearing. In particular:

- potential for an increase in oxygen demand associated with the discharge of processed sediment and associated organic matter back to the seabed
- heavy metals, their ability to be taken up and accumulated through the marine food chain (ie biouptake and bioaccumulation) and their toxicity to aquatic life in both the marine and freshwater environment.

503. The release of radioactive substances into the marine environment was the focus of considerable attention by a number of parties particularly given the presence of uranium in phosphorite. The human effects of radioactivity are addressed separately in Chapter 8.9.

504. Changes in light penetration through the water column due to the presence of a sediment plume were another water quality issue raised by some submitters. While the effects of suspended sediment on water clarity was potentially a water quality issue, the main effect in this instance,

[488] Paragraph 37, Statement of Evidence of Paul Kennedy for CRP on Sediment and Water Chemistry, 29 August 2014
[489] Paragraph 13, Opening Submissions for CRP, 25 September 2014
[490] Eg Mr Cameron
[491] Lines18 – 19, page 198 of the Transcript, 26 September 2014

given the depth at which the discharge would take place, appeared to be the potential for physical effects on marine organisms through the likes of displacement and interference by smothering surfaces and clogging feeding structures. These effects are discussed elsewhere.

505. The chemistry of the Chatham Rise sediments and sediment pore water in the vicinity of the mining permit area was assessed from samples collected during surveys. Pore water chemistry was assessed indirectly using an elutriate process. The elutriate process was described to the DMC by Dr Phillips who said the tests are designed to simulate the release of contaminants from a sediment during dredged material disposal and involve the mixing of dredged material with dredging site water and then allowing the mixture to settle. The resulting liquid or elutriate that remained after the sediment has settled was considered to contain the metals and other contaminants that are most bioavailable to organisms [492]. The applicant's experts used the results of this testing to provide information on the changes in water quality associated with the mixing of sediments and seawater.[493]

506. The elutriate testing undertaken on behalf of the applicant was criticised by several witnesses at the hearing.[494] The primary criticisms of the technique used were: that the sediment samples used for the elutriate for toxicity testing were three years old and had been frozen, which introduced some uncertainty into the results; and that the water used in the elutriate test was not sourced from the Chatham Rise but rather from the Raglan coast (east coast of the North Island) and at a site *en route* to the Chatham Islands. Further, the elutriate tests were performed on seabed material that most closely resembles the dredged sediment, rather than the sediment after it had been processed on board and returned to the seabed. The experts involved in the conferencing on toxicology and water quality echoed these concerns. They could not agree on whether the sediment as used in the elutriate test represented the material after it had been processed and returned.[495] Dr Phillips expressed concern in her evidence that as the elutriate tests were undertaken on seabed material rather than the processed or returned sediment, the results did not represent the bioavailability associated with the processed or returned material. She considered that the 30 minute elutriate tests did not adequately represent the effects on sediment chemical and physical properties that may arise from mining activity or return of the material to above the seabed.[496]

507. Dr Phillips was also concerned that toxicity was determined only for elutriates derived from surface sediments, whereas the sediment to be mined may consist of any combination of a mix of three layers, namely surface, subsurface and chalk.[497] From this the DMC understands that

[492] Line 5 page 794 of the Transcript, 14 October 2014
[493] Paragraph 40, Statement of Evidence of Paul Kennedy for CRP on Sediment and Water Chemistry, 29 August 2014
[494] Eg Dr Ngaire Philips, Dr Louis Tremblay, Associate Professor Peake
[495] Issue 2, Joint Statement of Experts in the Field of Toxicology and Water Quality, 19 September 2014
[496] Lines 11 – 25, page 794 of the Transcript, 14 October 2014
[497] Lines 45 – 2, pages 794 – 5 of the Transcript, 14 October 2014

the samples and results may not be representative of the sediment disturbed and processed by the mining operation. Dr Tremblay expressed similar concern that most of the metals are in the deeper suboxic layers which would be mined.[498]

508. The experts agreed that, on balance, the appropriateness of the elutriate testing was not a major issue, although there would be value in following this up.[499] They recommended that the applicant should be required to validate the toxicity tests with fresh sediment samples as a part of a pre-mining sampling programme.

509. Associate Professor Peake expressed concern at the lack of baseline data on the quality of the elemental composition of the water column through the proposed mining area. He proposed that in order to measure and assess the effect of a mining activity, the quality of the water must be known before mining commences. He did not consider that the applicant had provided adequate evidence for what that quality was.[500]

8.8.2. Release of organic matter and oxygen demand

510. Mr Kennedy explained that due to the crushing of organic material by the mining operation and the resulting increase in organic carbon concentrations in the water as a result of the discharge, there may be a corresponding increase in oxygen demand as the material is converted into carbon dioxide.[501]

511. Mr Kennedy noted that oxygen depletion predicted in the dispersion model was dependent on how much organic carbon was in the sediments. Assessments on behalf of the applicant concluded that if all benthic organisms in the target areas were included in the processed sediment and discharged back to the seabed in the return sediment discharge, carbon accumulation rates on the Rise may temporarily increase by as much as 80 %, but on average much less. However Mr Kennedy thought this scenario was unlikely and concluded that the proposed mining would not produce anoxic conditions in the water column.[502] He considered that the models were inherently conservative and indicative of worst-case scenarios. In particular, he noted the dilution of the plume outside the immediate mining area was not considered (ie effects would be much less outside the modelled 1.2 km^2), and that it was likely that some carbon would be removed from the water column (ie settle out) before it could oxidise.

[498] Lines 30 – 32, page 837 of the Transcript, 14 October 2014
[499] Issue 2, Joint Statement of Experts in the Field of Toxicology and Water Quality, 19 September 2014
[500] Lines 17 – 22, page 822 of the Transcript, 14 October 2014
[501] Paragraph 63, Statement of Evidence of Paul Cameron Kennedy for CRP on sediment and Chemistry, 29 August 2014
[502] Section 7.4 of Appendix 11 of the EIA, Review of Sediment Chemistry and Effects of Mining , May 2014

512. Dr Krause challenged these conclusions. He considered it likely that the tailings being deposited would be anoxic and sulphide rich owing to the physical and chemical processes associated with the dredging, transport, processing and return of sediments to the sea floor during the mining operation.[503]

8.8.3. Trace elements including heavy metals and their toxicity

Source of heavy metals

513. The DMC heard that both the phosphorite nodules and other seabed sediments of the Chatham Rise contain trace elements including heavy metals, with distributions that differ between sediment types. For example, phosphorite nodules contain elevated phosphorous and uranium levels, while surrounding chalk material contains elevated calcium and barium.[504] Heavy metals are of particular concern as many are known to exert toxic effects on aquatic organisms when they become soluble and can be available for uptake by organisms either directly through exposure to surrounding water or indirectly through the food chain.

514. Due to the separation of the phosphorite nodules from the seabed sediment, and their different eventual receiving environments, the DMC was interested in the trace elements of each and therefore the effects of those trace elements. The nodules would ultimately end up in the terrestrial environment through application of fertiliser, while the rest of the sediment and associated trace elements would be deposited back on the seabed with some remaining in suspension for an extended period of time depending on their particle size and solubility. The DMC addresses each of these in turn.

8.8.4. Effects of tailings

515. The DMC heard that during the process of mining, seawater would be mixed with tailings sediment which would cause a release of trace elements and nutrients into the water column.[505] A number of submissions expressed concern in regard to trace elements and heavy metals including the effect on the quality and health of organisms and fish, exceedance of ANZECC guidelines and impacts on the food web.[506]

Major and trace elements

516. The key to understanding the toxicology effects of the tailings from the proposed mining is the element composition of the seabed sediment. Analysis of sediment showed that the different

[503] Paragraph 42, Statement of Evidence of Dr Paul Richard Krause for Deepwater Group Limited and Te Rūnanga o Ngāi Tahu, 12 September 2014
[504] Paragraph 2, Statement of Evidence of Paul Cameron Kennedy for CRP on Sediment and Chemistry, 29 August 2014
[505] Paragraph 3, Statement of Evidence of Paul Cameron Kennedy for CRP on Sediment and Chemistry, 29 August 2014
[506] Eg submissions from Ngāi Tahu Submission, Hokotehi Moriori Trust, Deep Water Group and KASM.

seabed sediments have different chemical compositions. Elements like chromium and vanadium are enriched in the sand fraction, while elements such as strontium and barium are associated with the silty siliceous and carbonaceous materials in the sediment.[507]

517. Elutriate samples were examined for the following constituents:

- dissolved ammoniacal-N, nitrate and nitrite-N (and soluble inorganic nitrogen (SIN) as the sum)
- dissolved iron and manganese
- dissolved arsenic, copper, cadmium, chromium, lead, mercury, nickel, uranium and zinc.[508]

518. The DMC heard that abundances of all elements were lower than sediment quality guidelines provided by ANZECC, except cadmium in the elutriate test.[509]

519. Elutriate testing confirmed that there would be a release of some elements into the water column. The most environmentally significant releases would be inorganic nitrogen, arsenic, cadmium and copper.[510] The experts involved in toxicology and water quality conferencing all agreed that the concentration of metals released or mobilised from the sediments would be critical in assessing the impacts as a result of the mining operation.[511]

Toxicity effects

520. The DMC heard that toxicity testing was undertaken using three species: the amphipod *Chaetocorophium c.f. lucasi*, the early life stages of the blue mussel (*Mytilus galloprovincialis*) and a marine bioluminescent bacteria. Mr Kennedy outlined in his evidence the varying responses to the elutriates.[512]

521. Experts such as Dr Phillips and Associate Professor Peake felt that the three species used were not representative of species found at depth in full salinity on the Chatham Rise.[513] However, the DMC understood that the three species used are fairly standard and allow any toxicity they exhibit to be assessed on a relative basis. The experts agreed that a proposed condition of

[507] Section 5.6.2, Review of Sediment Chemistry and Effects of Mining, May 2014
[508] Section 2.2.3, Review of Sediment Chemistry and Effects of Mining, May 2014
[509] Paragraphs 34 and 44, Statement of Evidence of Paul Cameron Kennedy for CRP on Sediment and Chemistry, 29 August 2014
[510] Paragraph 3, Statement of Evidence of Paul Cameron Kennedy for CRP on Sediment and Chemistry, 29 August 2014
[511] Issue 1, Joint Statement of Experts in the Field of Toxicology and Water Quality, 19 September 2014
[512] Paragraphs 55 – 58. Statement of Evidence of Paul Cameron Kennedy for CRP on Sediment and Chemistry, 29 August 2014
[513] Lines 18 – 20, page 795 and Lines 2 – 4, page 823 of the Transcript, 14 October 2014

consent should be a requirement to undertake research that would help to establish toxicity values based on species that are relevant to the consent area.[514]

522. Only copper and ammoniacal nitrogen exceeded the conservative ANZECC 99 % protection guidelines, with vanadium maximally 64 % of the guideline value. Together, these data were considered to indicate that only minimal reasonable mixing in the near-field region of the mining discharge outlet would be required to satisfy these toxicity-related thresholds.[515]

523. The DMC heard from Mr Kennedy that the use of the 99 % protection guideline values was adopted for the Chatham Rise assessment as the Rise can be considered a high value ecosystem.[516] Mr Kennedy considered that based on the toxicity test results, a minimum dilution of 17.5 times would be required to prevent any chronic effects in the biota tested.[517] Mr Kennedy concluded that after 17.5 times dilution, no element for which there is guidance available would be elevated above the ANZECC (2000) 99 % trigger values for the protection of marine species.[518]

524. Given that the mined benthic area would be devoid of life, it is our understanding that toxicity would be more of an issue for species in the pelagic zone and nearby areas of unmined seabed affected by sedimentation. Dr Phillips confirmed that the level of toxicity would depend on how long the sediment plume remained suspended.[519] Associate Professor Peake concurred that the key parameter was the time the sediment plume takes to disperse, which would determine the extent of exposure of fish that were swimming in that area and therefore exposed to elevated levels.[520]

525. Based on these results, Mr Kennedy considered that a dilution factor of 17.5 would be required to ensure no adverse effects occur as a result of mining. Dilution within the plume close to the discharge would be about 700 times, and towards the outer parts of the plume, dilution would be about 5,000 times or higher within 10 m of the seafloor (350 – 450 m deep) and greater at shallower depths away from the seabed. Consequently he predicted no toxicological effects would occur as a result of the mining process.[521]

526. Dr Phillips expressed concern that toxicity effects and increases in some contaminants were observed with the 24 hour elutriates, which warranted further examination of the potential long

[514] Issue 3, Joint Statement of Experts in the Field of Toxicology and Water Quality, 19 September 2014
[515] Executive Summary of Appendix A (Chatham Rise sediment elutriates: toxicity and chemistry) of the Statement of Evidence of Paul Cameron Kennedy for CRP on Sediment and Chemistry, 29 August 2014
[516] Paragraph 46, Statement of Evidence of Paul Cameron Kennedy for CRP on Sediment and Chemistry, 29 August 2014
[517] Paragraph 58, Statement of Evidence of Paul Cameron Kennedy for CRP on Sediment and Chemistry, 29 August 2014
[518] Paragraph 62, Statement of Evidence of Paul Cameron Kennedy for CRP on Sediment and Chemistry, 29 August 2014
[519] Lines 17 – 19, page 798 of the Transcript, 14 October 2014
[520] Lines 15 – 16, page 827 of the Transcript, 14 October 2014
[521] Paragraph 4, Statement of Evidence of Paul Cameron Kennedy for CRP on Sediment and Chemistry, 29 August 2014

term accumulation of metals in fish in particular given the importance of the Chatham Rise as a commercial and customary fishery.[522]

527. Mr Kennedy cautioned the DMC that exceedance of an ANZECC (2000) trigger value did not imply an adverse effect. Instead, an exceedance should be a trigger for investigation in relation to the possibility of effects (ie monitor and assess the condition of ecological communities).[523] This caused the DMC some difficulty as it suggested that ANZECC values were therefore not appropriate levels to use as proposed conditions of marine consent. As pointed out by Dr Phillips, exceedance of the ANZECC levels required more investigation. Dr Phillips posed the question: if there was continued exceedance, then what?[524]

528. Associate Professor Peake suggested further research should be undertaken before mining started by measuring the toxicity for the four major commercial species, hoki, ling, orange roughy and warehou, and comparing it with the total possible uranium content in the water at the point of discharge from the discharge pipe.[525] He opined that toxicity may be different for the different stages of the lifecycles of these pelagic species and that it could be that the larval stage is more sensitive to uptake than the adult, which would be an added complication.[526]

529. Dr Tremblay acknowledged the challenge of assessing long term potential impacts, particularly as they relate to multigenerational impacts or ecosystem services. He opined that there were significant knowledge gaps particularly in the deep sea environment.[527] Although the toxicology tests indicated whether there was an acute effect which is short term ("*basically the organisms going belly-up*"), they would not indicate longer term abilities to reproduce.[528]

530. The experts in this field agreed that there was a lack of information about the sensitivity of site-specific organisms to dissolved metals in the water column.[529] However, they considered that this could be addressed through proposed conditions requiring the applicant to collect baseline information prior to the commencement of mining and to undertake research to establish toxicity thresholds based on species relevant to the proposed marine consent area.

[522] Lines 12 – 17, page 796 of the Transcript, 14 October 2014
[523] Paragraph 48, Statement of Evidence of Paul Cameron Kennedy for CRP on Sediment and Chemistry, 29 August 2014
[524] Lines 5 – 9, page 808 of the Transcript, 14 October 2014
[525] Lines 31 – 35, page 823 of the Transcript, 14 October 2014
[526] Lines 21 – 23, page 825 of the Transcript, 14 October 2014
[527] Lines 10 – 16, page 837 of the Transcript, 14 October 2014
[528] Lines 38 – 41, page 842 of the Transcript, 14 October 2014
[529] Issue 17, Joint Statement of Experts in the Field of Toxicology and Water Quality, 19 September 2014

Uranium

531. The issue of uranium was raised in submissions and was discussed at length in the hearing. The DMC heard from Dr Phillips and Associate Professor Peake that there were two effects in the case of uranium: the ecotoxic effect from the chemical perspective, and the effect of the radiation of the uranium and its breakdown products. The two were interrelated.[530]

532. The DMC heard that one of the areas where there is a distinct lack of information is toxicity data for uranium in the marine environment. Dr Phillips outlined the difficulty of making a decision about whether uranium levels are acceptable or not in the absence of guidelines.[531]

533. Compared to the Canadian water quality guidelines for the protection of aquatic life: Uranium (2011), at least 50 % of the uranium concentrations measured in elutriate samples were found to be lower than the short-term exposure guidance. The EIA concluded that following a ten-fold dilution, the elutriate concentrations would have been diluted to concentrations at or below the Canadian water quality guidelines for the protection of aquatic life (uranium chronic guidance).[532] The DMC notes that this guidance is for freshwater biota and questions its relevance. The applicant's EIA report concluded that as the uranium in the diluted elutriate is likely to be present as carbonate complexes, the risk of chronic toxicity to marine biota was considered remote. The report considered it unlikely that any significant change in the concentration of uranium in fish muscle tissue would occur, due to the dilution of uranium with distance from the discharge, released uranium being present as carbonate complexes, and uptake in fish occurring mainly in bony tissues.[533]

534. Evolving information was presented to the DMC with regard to uranium concentrations. In the application documents, the plume dispersion model showed that close to the discharge point, increases in seawater uranium concentrations were predicted to be about 10 % of the naturally occurring seawater concentrations. By about 15 km (the edge of the dispersed plume) the relative elevation above the natural concentration was estimated to be about 1 %.[534] After revised sediment plume modelling was undertaken, the experts in the field of radioactivity agreed that dilution of uranium (dilution factor 750) to background levels would occur within the near field within 250 m of discharge.[535]

[530] Lines 41 – 44, page 834 of the Transcript, 14 October 2014
[531] Lines 23 – 24, page 801 of the Transcript, 14 October 2014
[532] Section 8 of Appendix E (Review of Uranium in Seawater and its Release from Chatham Rise Sediment) of Appendix 11 of the EIA, Review of Sediment Chemistry and Effects of Mining, May 2014
[533] Section 8 of Appendix E (Review of Uranium in Seawater and its Release from Chatham Rise Sediment) of Appendix 11 of the EIA, Review of Sediment Chemistry and Effects of Mining, May 2014
[534] Section 7 of Appendix E (Review of Uranium in Seawater and its Release from Chatham Rise Sediment) of Appendix 11 of the EIA, Review of Sediment Chemistry and Effects of Mining, May 2014
[535] Issue 1, Joint Statement of Experts in the Field of Radioactivity, 18 September 2014

535. While Dr Hermanspahn acknowledged an increased risk factor for the near field (50 m from the point of discharge), he concluded overall that it constituted a low risk due to the exposure is being of only limited duration (being around one day of mining). While uranium was quite soluble in seawater, polonium tended to attach to particulates and would be removed from the plume faster than uranium and settle down into the sediment again. He concluded that the radiological risks to marine biota were small.[536]

536. Although uranium and its potential effects were discussed during the hearing, the DMC understands from Dr Jeffree that Uranium-238 is a 'primordial' radionuclide which decays to produce a series of daughter radionuclides. Among these radioactive elements, there are several which have greater significance for adverse radiological effects on aquatic biota than Uranium-238, being Polonium-210 (Po-210), Radium-226 (Ra-226) and Lead-210 (Pb-210).[537] Dr Jeffree considered Thorium-232 (Th-232) and Uranium-235 (U-235) need further consideration and quantitative assessment with regard to their potential for radiological detriment to benthic biota at Chatham Rise.[538] The experts in the field of radioactivity all agreed that it would be advisable to establish that levels of radionuclides especially Polonium 210 in the four pelagic fish species of the Chatham Rise would not pose a radiological risk.[539]

537. As identified by Dr Jeffree, there are a number of uncertainties. He suggested that the unconsolidated nature of tailings sediment may result in radionuclides being more easily liberated into the benthic water layer than when they were contained within nodules. Their enhanced water concentrations could then lead to increased radiological exposure of benthic biota through their bioaccumulation. He suggested that it is also possible that very particle-reactive radionuclides would be retained in the suspension layer directly above the benthic sediment, in the very fine colloidal or clay fraction which is not likely to settle between mining cycles, therefore providing an enhanced exposure pathway for benthic filter feeders ingesting such contaminated particles.[540]

[536] Lines 23 – 33, page 877 of the Transcript, 14 October 2014
[537] Paragraph 13 of Annexure A (Assessment of Effects of Radioactive Elements on the Marine Environment from the CRP Marine Consent Application) of the Statement of Evidence of Dr Ross Anthony Jeffree, 12 September 2014
[538] Paragraph 16 of Annexure A (Assessment of Effects of Radioactive Elements on the Marine Environment from the CRP Marine Consent Application) of the Statement of Evidence of Dr Ross Anthony Jeffree, 12 September 2014
[539] Issue 1, Joint Statement of Experts in the Field of Radioactivity, 18 September 2014
[540] Paragraph 53 of Annexure A (Assessment of Effects of Radioactive Elements on the Marine Environment from the CRP Marine Consent Application) of the Statement of Evidence of Dr Ross Anthony Jeffree, 12 September 2014

538. The experts in the field of radioactivity agreed that Polonium 210 and other radionuclides have a high affinity for fine sediment. They considered the potential for the increase of radionuclides at the sediment water interface to be of secondary importance as the bulk of the radionuclides reside in the phosphorite and would be removed through the mining process.[541] They recommended that the applicant undertake research to establish a recognised toxicity threshold for uranium in the marine environment.

539. Dr Santillo brought to the attention of the DMC the International Atomic Energy Agency as being recognised by Parties to the London Convention and London Protocol as the appropriate body to provide technical advice. He considered that International Atomic Energy Agency Guidelines, including the step-wise approach to consider criteria for *de minimis* exemption and the specific assessment for potential impacts on human health and marine flora and fauna had not so far been applied to the case of the phosphorite deposits on the Chatham Rise.[542]

Biouptake and bioaccumulation

540. The DMC understands that the potential toxicity to the aquatic environment depends on the bioavailability. Mr Kennedy considered the potential for biouptake of arsenic, cadmium and copper and concluded that bioaccumulation of trace elements by fish would be regulated by biological processes. He opined that no biomagnification of any trace element was predicted.[543]

541. As already noted, the experts in the field of toxicology and water quality agreed that there was an absence of baseline data on the bioaccumulation of metals in important customary and commercial fisheries on the Chatham Rise, and that this must be collected before mining is undertaken.[544]

542. The applicant's report on uranium stated that uptake of uranium had been demonstrated in both fresh and marine environments. Maximum uptake occurs through feeding and exposure under conditions of lower pH. When higher carbonate conditions occur (and at near neutral pH as occurs in seawater), lower uptake is observed. Uranium does not biomagnify.[545]

543. The experts in the field of radioactivity agreed that although radionuclides have the potential to bioaccumulate, the radionuclides of interest do not biomagnify.[546]

[541] Issue 2, Joint Statement of Experts in the Field of Radioactivity, 18 September 2014
[542] Paragraph 22, Evidence of Dr David Santillo on behalf of Greenpeace, KASM, and DSCC, 11 September 20
[543] Paragraph 88, Statement of Evidence of Paul Cameron Kennedy for CRP on Sediment and Chemistry, 29 August 2014
[544] Issue 5, Joint Statement of Experts in the Field of Toxicology and Water Quality, 19 September 2014
[545] Section 8 of Appendix E (Review of Uranium in Seawater and its Release from Chatham Rise Sediment) of Appendix 11 of the EIA, Review of Sediment Chemistry and Effects of Mining, May 2014
[546] Issue 1, Joint Statement of Experts in the Field of Radioactivity, 18 September 2014

Cumulative effects

544. Mr Kennedy compared the disturbance of the seabed and consequential release of suspended sediment between mining and bottom trawling. He considered that trawling carried out over large areas of the Chatham Rise also results in the release of trace elements and other constituents (nitrogen) to the water column. On a daily basis the releases to the water column are smaller from trawling than mining.[547] The DMC notes here that Dr Tuck on behalf of the applicant provided the DMC with an estimate of the annual amount of sediment suspended by bottom trawling on the Chatham Rise and compared this figure to that predicted through CRP's mining operation.[548] However, he did not assess the effects on Chatham Rise water quality.

545. Associate Professor Peake refuted the findings of Mr Kennedy, noting that the extent to which the trawling would release sediment would be different from the proposed mining operation. He suggested that the proposed mining operation would disturb a much greater depth of sediment and in the process of filtering it and processing it on board there was the potential for release of more elements from a bound state than it would be from trawling which leaves sediment on the bottom. He stated that with trawling there is only an immediate perturbation just above the seabed with nothing like the same degree of potential mobilisation of the proposed mining operation.[549]

546. Dr Tremblay considered that trawling activities would probably be much more at the oxic level where it is more unlikely that to have remobilisation of metals, whereas mining goes deeper to 50 cm and so the suboxic layers would be suspended, and this is where most of the metals were.[550]

Freshwater quality

547. The application of Chatham Rise phosphorite to New Zealand land was also raised by the applicant as having potential benefits to freshwater quality through a reduction in the loss of phosphorus to water.

548. The DMC heard that moving from a water soluble phosphate product such as superphosphate to a sparingly soluble phosphorous fertiliser like Chatham rock phosphate would lead to reductions in total phosphorous losses of 0 to 20 %.[551] Based on research, Mr Mackay considered that because the application of a reactive phosphate rock does not result in a sudden short-term rise in readily available phosphorous in the soil or plant, there is a reduction

[547] Paragraph 90, Statement of Evidence of Paul Cameron Kennedy for CRP on Sediment and Chemistry, 29 August 2014
[548] Paragraphs 6 and 10, Statement of Evidence of Dr Ian Tuck for CRP, 28 August 2014.
[549] Lines 10 – 26, page 833 of the Transcript, 14 October 2014
[550] Lines 28 – 32, page 837 of the Transcript, 14 October 2014
[551] Paragraph 33, Statement of Evidence of Dr Alec Donald Mackay for CRP 28 August 2014

in the potential risk of phosphorous losses in runoff in the weeks following application to receiving environments.[552] However submitters such as Mr Sandle questioned how the level of runoff for the direct application phosphate compared to superphosphate in the medium and longer term.[553]

549. In its closing statement, the applicant suggested that its product would assist farmers in meeting the requirements of the New Zealand National Policy Statement for Freshwater Management 2014, (which regional councils must give effect to through their regional plans and policy statements under Sections 62(3) and 67(3) of the RMA). The applicant considered that New Zealand National Policy Statement for Freshwater Management 2014 would provide a regulatory 'push' in terms of managing freshwater quality and nutrient runoff in particular that was likely to have some impact on the market's preferences for fertiliser products.[554]

550. However, the DMC also noted Dr MacKay's recommendation that a reactive phosphate rock is only used in soil with a pH <6.0 and where there is at least 800 mm annual rainfall.[555] Mr Sandle estimated the locations within New Zealand that meet the criterion for annual rainfall and suggested that on this basis, the use of direct application fertiliser may be limited.[556]

551. The DMC understands that the applicant intended to market the product for direct application for a premium price, but that a proportion would be converted into superphosphate. As the DMC's mandate does not extend to over the use of the end product, the DMC did not consider in detail the differences in the product used for direct application as opposed to being blended for superphosphate, or the potential effects on freshwater quality.

8.8.5. Proposed conditions

552. Schedule 2 of the proposed conditions required the collection of water samples to determine near seabed water quality prior to the commencement of any mining operations. Parameters to be tested in these samples include organic carbon, nutrients and heavy metals including Polonium 210. It was proposed that elutriate testing of sediments and toxicity testing with the same organisms previously used be repeated, as well as, and if practical, appropriate organisms representative of Chatham Rise species. Testing of trace metal content in key commercial fish on the Chatham Rise was also proposed.

553. The DMC considers the applicant's proposed monitoring conditions a step in the right direction regarding the need to characterise the existing water quality character of the consent

[552] Paragraph 39, Statement of Evidence of Dr Alec Donald Mackay for CRP 28 August 2014
[553] Lines 11 – 14, page 1950 of the Transcript, 5 November 2014
[554] Paragraphs 321 – 323, Closing Legal Submissions for CRP, 19 November 2014
[555] Paragraph 36, Statement of Evidence of Dr Alec Donald Mackay for CRP 28 August 2014
[556] Lines 4 – 9, page 1947 of the Transcript, 5 November 2014

application area prior to mining commencing. What they appear to lack however, is any clear feedback into the consequences for mining procedures should the results indicate a water quality or toxicity state of concern.

554. The applicant's proposed adaptive management conditions included unexpected adverse impacts (Proposed Condition 41). This is where the DMC thought that an unexpected water quality result or toxicity test result might potentially result in an alteration to, or at least reconsideration of, the mining operation.

8.8.6. DMC findings

555. The DMC finds that there are potential adverse water effects associated with the applicant's proposed mining operation. These effects are associated with the mobilisation of trace elements (heavy metals including some with radioactivity) and organic enrichment. While there is some uncertainty around the magnitude of these effects, in general they appear to be localised and relatively minor. The DMC expects an increase in oxygen demand as a result of the tailings discharge, but accepts that this would be localised and short-term in nature given the amount of dilution available.

556. While the mobilisation of heavy metals is possible, testing suggests that the concentration levels would not be sufficient to exert toxic effects on marine organisms, particularly after mixing with the surrounding seawater.

557. Biomagnification of heavy metals including radioactive elements appears unlikely. The experts in the field of radioactivity all agreed that although radionuclides have the potential to bioaccumulate, the radionuclides of interest do not biomagnify through the food chain.[557] Monitoring of fish prior to the commencement of mining would in our view benchmark background contamination levels in fish (and other local organisms if necessary) and the DMC considers that conditions could be developed to achieve the necessary level of information.

558. The DMC acknowledges that there is some concern surrounding some of the testing procedures used to characterise existing water quality and assess the effects of mining discharges on Chatham Rise water quality, and also the toxicity of tailings discharges on local marine species. It considers however that these concerns could be addressed by additional monitoring and testing prior to mining, as proposed by the experts.

559. The DMC did not reach any firm conclusion on the impact on freshwater quality of the application of Chatham Rise phosphorite. There was insufficient information as to the quantities

[557] Issue 1, Joint Statement of Experts in the Field of Radioactivity, 18 September 2014

of phosphorite fertiliser that would be applied to New Zealand agricultural land, or in what form. In any event, the DMC considers this issue is sufficiently distant from the marine consent, and ultimately not material to our determination. The marine consent process does not provide for controls to be placed on the use made of this kind of end product.

8.9. Human health

8.9.1. The issues

560. Section 59(2)(c) requires the DMC to take into account the effects on human health that may arise from effects on the environment. This is a complex topic as there are many components to it. Due to the separation of the phosphorite nodules from the seabed sediment and their different eventual receiving environments, there are a number of pathways by which human health may be affected. While the phosphorite nodules were intended for use in a terrestrial environment as fertiliser, the discharge of the rest of the sediment would result in a sediment plume and the deposition of waste material on the seabed.

8.9.2. Effects

561. The various ways in which the DMC considered the effects on human health are:

- marine environment - through the consumption of seafood
- terrestrial environment - through the use of fertiliser and the consumption of plants and animals
- health and safety for workers involved with the processing and handling the end product
- air discharges from the combustion of heavy fuel oil in the engines on the vessels.

Consumption of seafood

562. The chemical makeup and toxicology of the sediment tailings is detailed in Chapter 8.8. There were two main areas of concern in terms of human consumption of seafood, trace elements (including heavy metals) and radioactive substances. During the hearing, not a lot of attention was given to the potential effects on humans through consumption of seafood *per se*; attention was given more to levels of trace elements within the sediment and potential toxicity to marine animals.

563. Mr Kennedy opined that in terms of muscle tissue and the possible effects on human health, the only element that is of any significance in fish muscle tissue is mercury.[558] There was no evidence for the release of mercury during elutriation experiments.[559]

564. Mr Kennedy considered no biomagnification of any trace element was predicted and the suitability of fish caught from the Chatham Rise for human consumption would be unaffected by the mining process.[560] Overall, Mr Kennedy concluded that because the biological uptake of any trace elements released into the water during mining was likely to be insignificant, there would be no risks to human health (from the consumption of fish from the Chatham Rise).[561]

565. Dr Jeffree considered the most important radionuclide in terms of human exposure for marine organisms is polonium, but opined that there would not be biomagnification through the food chain. While it may transfer from one trophic level to the next, it tends not to get to higher concentrations up the food chain.[562] As summarised by Dr Jeffree, a plausible transfer pathway from benthos to humans for elevated Po-210 levels is as follows; benthic water / particulates to benthic filter feeders to small javeline fish guild (bentho-pelagic invertebrate feeders) to hake guild (bentho-pelagic predators) + ling guild (benthic predators) to humans.[563]

Consumption of plants and animals

566. Analyses of a sample of phosphorite nodules shows that they are predominantly a mix of carbonate-bearing apatites derived from fluorapatite ($Ca_5(PO_4)_3F$) and hydroxyapatite ($Ca_5(PO_4)_3OH$), meaning that the nodules are particularly elevated in phosphorous (P up to 20 % wt.), calcium and fluoride.[564] However the DMC heard that the phosphorite nodules from the Chatham Rise have other trace elements. They are notable for low cadmium and lead abundances, and somewhat elevated arsenic (only in finer nodules) and uranium abundances.[565]

567. The DMC heard from a number of experts and submitters alike that the Chatham Rise phosphorite nodules have much lower cadmium concentrations than those typically associated with phosphate rock deposits. The DMC heard that the reduced level of cadmium was likely to be a significant selling point for Chatham rock fertiliser.[566]

[558] Lines 31 – 35, page 944 of the Transcript, 15 October 2014
[559] Paragraph 76, Statement of Evidence of Paul Cameron Kennedy for CRP on Sediment and Chemistry, 29 August 2014
[560] Paragraph 88, Statement of Evidence of Paul Cameron Kennedy for CRP on Sediment and Chemistry, 29 August 2014
[561] Paragraph 121, Statement of Evidence of Paul Cameron Kennedy for CRP on Sediment and Chemistry, 29 August 2014
[562] Lines 24 – 28, page 898 of the Transcript, 14 October 2014
[563] Paragraph 43, Annexure A (Assessment of Effects of Radioactive Elements on the Marine Environment from the CRP Marine Consent Application) of the Statement of Evidence of Dr Ross Anthony Jeffree, 12 September 2014
[564] Section 3.3 of Appendix 11 of the EIA, Review of Sediment Chemistry and Effects of Mining, May 2014
[565] Section 5.6.1 of Appendix 11 of the EIA, Review of Sediment Chemistry and Effects of Mining, May 2014
[566] Paragraph 31, Statement of Evidence of Christopher David Castle for CRP, 28 August 2014

568. Dr Mackay summarised the difference between Chatham rock and other sources of phosphate. He considered that it has a very low cadmium levels compared to most other rocks, two versus 20 to 30 milligrams per kilogram, but it also has above average levels of uranium so probably twice what you might expect in other rocks.[567] Other differences include a lower total phosphorus percentage, significant amounts of calcite and lower initial solubility in chemical extracts.[568]

569. Previous analyses noted uranium enrichment was limited to phosphorite nodules: in comparison the glauconitic material on the Rise did not have elevated uranium content. In a recent assessment of the radioactivity of the resource, it was found that the maximum radioactivity is nodules samples was 91 kBq/kg.[569] Consequently none of the material qualified as radioactive under the New Zealand Radiation Protection Act 1965.[570]

570. The DMC heard that Chatham Rise phosphorite was found to contain 3 % fluorine in the study of Syers *et al*., (1987) whereas single superphosphate in comparison contains 1.0 to 1.8 %. The fluorine to phosphorus ratio in superphosphate is between 0.11 and 0.19 whereas direct application of Chatham Rise phosphorite has a ratio of 0.32. This was similar to other phosphate rocks but higher than superphosphate and if used instead of superphosphate would result in higher rates of accumulation of fluorine in soils.[571]

571. Dr Mackay opined that any unwanted material or element accumulated in the soils did potentially limit future land use opportunities and future potentially market opportunities.[572] He also considered that as phosphorous fertiliser is essential to the on-going viability of New Zealand pastoral systems and economy, trace amounts of cadmium, uranium and fluorine would continue to accumulate in soils.[573]

572. The DMC heard that this product would offer a low cadmium phosphorous fertiliser option for producers with soils that already have elevated soil cadmium levels and would slow soil cadmium accumulation rates.[574] Dr Mackay explained that animals to some degree remove cadmium and accumulated it in the kidneys and livers in a pastoral system, but it becomes an issue when farmers swap out of livestock agriculture into say cropping where something is grown for direct human consumption.[575]

[567] Lines 4 – 9, page 849 of the Transcript, 14 October 2014
[568] Paragraph 2, Statement of Evidence of Dr Alec Donald Mackay for CRP 28 August 2014
[569] Kilobecquerel is a unit of measurement for radioactivity
[570] Section 5.6.1 of Appendix 11 of the EIA, Review of Sediment Chemistry and Effects of Mining, May 2014
[571] Paragraph 51, Statement of Evidence of Dr Alec Donald Mackay for CRP, 28 August 2014
[572] Lines 44 – 46, page 852 of the Transcript, 14 October 2014
[573] Paragraph 3, Statement of Evidence of Dr Alec Donald Mackay for CRP, 28 August 2014
[574] Paragraph 71, Statement of Evidence of Dr Alec Donald Mackay for CRP, 28 August 2014
[575] Lines 7 – 11, page 853 of the Transcript, 14 October 2014

573. Uranium was discussed by a number of experts during the hearing. Samples of Chatham Rise phosphorite analysed indicated levels of uranium ranging between 27 to 524 mg/kg with a mean of 155 mg/kg.[576] The DMC heard that currently there are no soil guideline values for uranium in New Zealand.[577]

574. The experts in the field of radioactivity agreed that while all phosphorites contain uranium and its decay products, it can accumulate in soils.[578]

575. The Crown submission attached the Institute for Environmental Science and Research (ESR) study on the implications of uranium concentrations in Chatham Rise phosphorite. These findings were however challenged by Dr Mackay. The ESR report concludes that the use of Chatham Rise phosphorite as a direct application fertiliser would increase uranium inputs by a factor of eight, while Dr Mackay considered a four-fold increase uranium inputs more realistic based on the levels in current superphosphate produced in New Zealand of around 60 ppm of uranium.[579] The ESR report concluded that continuous use of Chatham Rise phosphorite as a direct application fertiliser would exceed the Canadian soil uranium guideline of 23 ppm within 40 to 50 years. Dr Mackay considers that this ignores the effect of actions such as treading by livestock, earthworm feeding, mixing and burrowing (eg pedoturbation) which mixes the materials into the upper 7.5 cm root zone of a pasture soil.[580]

576. Dr Mackay calculated that it would take 689 years of applying 110 kg per year of Chatham rock phosphate to reach the Canadian soil uranium guideline limit (maximum permissible uranium concentration (MPUC) of 23 mgU/kg from an initial 1 mg U/kg.[581] Furthermore, decreasing the application rates to 40 kg P/ha would take 172 years to reach the MPUC limit, and if 20 % per annum of added uranium in the top soil layer is lost or removed (eg moves beyond 7.5 cm depth in the soil), then it would take 860 and 215 years to reach the MPUC limit for an annual application of 10 and 40 kg P/ha as Chatham rock phosphate, respectively.[582]

577. Dr Bull concluded that as uranium is immobile in soil and not readily removed from soil by plants or animals, uranium accumulation in soils is likely. [583] Based on current application rates, he calculated that the uranium accumulation rates in areas with extensive farming would be around 0.03 mg/kg per year, and up to 0.07 mg/kg per year with intensive farming.[584]

[576] Table 3 of Appendix 2 (Uranium in Phosphorite) of the Statement of Evidence of Dr David Bull for CRP, 28 August 2014
[577] Paragraph 50, Statement of Evidence of Dr Alec Donald Mackay for CRP, 28 August 2014
[578] Issue 3, Joint Statement of Experts in the Field of Radioactivity, 18 September 2014
[579] Paragraph 75, Statement of Evidence of Dr Alec Donald Mackay for CRP, 28 August 2014
[580] Paragraph 76, Statement of Evidence of Dr Alec Donald Mackay for CRP, 28 August 2014
[581] Paragraph 78, Statement of Evidence of Dr Alec Donald Mackay for CRP, 28 August 2014
[582] Paragraph 79, Statement of Evidence of Dr Alec Donald Mackay for CRP, 28 August 2014
[583] Paragraph 47, Statement of Evidence of Dr David Bull for CRP, 28 August 2014
[584] Paragraph 58, Statement of Evidence of Dr David Bull for CRP, 28 August 2014

578. As there are no guidelines for uranium levels in soil, Dr Bull proposed an indicative threshold of 10 mg/kg which includes an uncertainty factor of 50 %.[585] On this basis, he calculated more than 100 years to move from a background of 2 mg/kg to exceed a threshold of 10 mg/kg where Chatham rock phosphate was applied in intensively farmed soils. If uranium accumulated at 0.03 mg/kg per year then the soils would not exceed a threshold of 10 mg/kg for approximately 300 years.[586] The DMC notes that Dr Bull's proposed threshold is significantly less than Canadian limits of 23 mg/kg for soil ingestion, inhalation and dermal exposure (toddler), 33 mg/kg to protect the health of grazing mammals, and 500 mg/kg for protection of soil biota.[587]

579. Dr Bull made the point that if Chatham rock phosphate was blended with higher grade material to make superphosphate, that product would have a lower uranium level than Chatham Rise phosphorised lime.[588]

580. From his analyses, Dr Bull opined that uranium in fertilisers derived from Chatham rock phosphate posed little chemical risk to rural residents, people who live on fertilised land. He did however consider that accumulation of uranium in soils should be limited, firstly in order to protect food quality.[589]

581. The DMC heard from Dr Hermanspahn that in determining the radioactive effect of Chatham rock phosphate application to land, he had used the conservative scenario of subsistence farmers living on site and assumed that the person spend 100 % of their time on the land and sources 100 % of their water and food locally.[590] Dose calculations were performed for age groups of one year olds, ten year olds and adults. The group with the largest risk factor was one year olds living permanently on the converted farmland on a diet sourced completely from the site due to the higher rates of ingestion.[591] On the basis of a guideline level for uranium in soil of 20 mg/kg being adopted, he concluded it would take 275 years in the high application scenario (fertiliser application at 40 kgP/ha per year) and 675 years in the low application scenario (fertiliser application at 10 kgP/ha per year) to reach this limit.[592] The DMC heard that doses to general public would be restricted to dose from ingestion and equate to about 50 % of the total dose rate for the one year old age group, 25 % of total dose for the ten year old age group and 10 % for adults.[593]

[585] Paragraph 77, Statement of Evidence of Dr David Bull for CRP, 28 August 2014
[586] Paragraph 78, Statement of Evidence of Dr David Bull for CRP, 28 August 2014
[587] Paragraphs 81 – 82, Statement of Evidence of Dr David Bull for CRP, 28 August 2014
[588] Lines 27 – 34, page 865 of the Transcript, 14 October 2014
[589] Lines 14 – 19, page 866 of the Transcript, 14 October 2014
[590] Paragraph 37, Statement of Evidence of Dr Nikolaus Hermanspahn for CRP, 29 August 2014
[591] Paragraph 54, Statement of Evidence of Dr Nikolaus Hermanspahn for CRP, 29 August 2014
[592] Paragraph 56, Statement of Evidence of Dr Nikolaus Hermanspahn for CRP, 29 August 2014
[593] Paragraph 53, Statement of Evidence of Dr Nikolaus Hermanspahn for CRP, 29 August 2014

582. On this basis, Dr Hermanspahn concluded that uranium was expected to accumulate in agricultural soils, but that the radiological impact would be within acceptable dose limit of 1 mSv per year[594] for all members of public for more than 250 years of intensive fertiliser application.[595]

Effects on human health through handling

583. The initial EPA staff report raised the concern of potential generation of dust from phosphate nodules and exposure of phosphorous pentoxide (P_2O_5) to air and humans during the sorting and packing process onboard and possible effects on human health. Dr Bull pointed out that Materials Safety Data Sheets for phosphorite are readily available from major fertiliser companies (eg Ravensdown 2005). These sheets do not class phosphorite as a hazardous chemical; they may be handled, stored and transported by any person, are not corrosive, have low toxicity and low irritant tendencies. The sheets advise that ventilation and / or personal protection are recommended in conditions where dusts may form.

584. Given that phosphorite nodules would not be dried on board the vessel and therefore there would be no dust formation, Dr Bull concluded that the phosphate component of Chatham Rise phosphorite posed a low to negligible occupational health and safety hazard and is controlled through existing health and safety legislation and regulations.[596] He pointed out that under the Hazardous Substances and New Organisms Act 1996, rock phosphates used as fertilisers are not given a hazardous substance classification.[597]

585. Similarly the DMC heard from Dr Hermanspahn that the Radiation Protection Act 1965 and the Radiation Protection Regulations 1982 do not apply to the mining or use of Chatham Rise phosphorite as fertiliser, as Chatham Rise phosphorite is not classed as radioactive material.[598]

586. The Environment and Conservation Organisations of New Zealand Inc submitted that the risk of a radiological and toxic threat to workers might be "*further complicated*" if the vessel were flagged to another country.[599] The DMC requested advice on this matter.

587. Maritime New Zealand's response to the EPA stated that Maritime New Zealand was responsible for administering the HSE Act for work on board ships and for ships as a place of work.[600] Maritime New Zealand referred to Section 3B of the HSE Act. Their opinion concluded that the applicability of the HSE Act would depend on a number of facts such as whether the

[594] Radiation levels are generally measured in millisieverts (mSv)
[595] Paragraph 60, Statement of Evidence of Dr Nikolaus Hermanspahn for CRP, 29 August 2014
[596] Paragraphs 88 – 89, Statement of Evidence of Dr David Bull for CRP, 28 August 2014
[597] Lines 34 – 36 page 867 of the Transcript, 14 October 2014
[598] Paragraph 27, Statement of Evidence of Dr Nikolaus Hermanspahn for CRP, 29 August 2014
[599] Paragraph 5.7.5, Submissions by Environment and Conservation Organisations of NZ Inc, 6 November, 2014
[600] Maritime New Zealand report provided in accordance with Section 44 of the EEZ Act, 18 July 2014

contractual arrangements are governed by New Zealand law and whether the vessel could be required to be registered in New Zealand. The DMC was advised that if the provisions in the Health and Safety and Reform Bill were enacted in their current form (and assuming no change in the mining company's proposed structure) CRP's mining operation with respect to the mining vessel would be regulated.[601] The DMC notes that the Bill is expected to come into force in 2015.

588. Health and safety for workers is also addressed in Chapter 9.10.

Air discharges from the vessel

589. As set out in the EIA, MARPOL sets limits on sulphur oxide and nitrogen oxide emissions from ship exhausts and prohibits deliberate emissions of ozone depleting substances through MARPOL Appendix 1 Annex VI (Prevention of Air Pollution from Ships). The DMC understands that although New Zealand has not yet ratified the more stringent emission control standards for sulphur oxide, nitrogen oxide and particulate matter, the applicant has undertaken to ensure that its vessel meets all of the requirements of this Annex.[602]

590. The DMC agrees that the sulphur oxide emissions are fuel dependent and the fuel type used by the mining vessel would depend on what fuel is available in New Zealand ports.[603]

8.9.3. Proposed conditions

591. Human health is addressed indirectly by the proposed conditions in two different ways; flesh testing of fish and sampling of the chemical composition of phosphorite nodules.

592. Proposed Schedule 2A(viii) required muscle testing of hoki and ling prior to mining to determine the concentrations of trace elements and key radionuclides. Proposed Schedule 2B(vii) required a similar exercise to be undertaken after mining commenced after the first, second and fourth year that mining occurred.

593. While the reporting was to include a comparison of the data obtained prior to mining commencing, there are no standards or measureable limits outlined in the proposed conditions, not even an indication of what might be an acceptable or unacceptable change in levels of trace metals or radionuclides in commercial fish species. While it might be an interesting exercise and does reflect the recommendations of the experts in the field of toxicology and water quality,[604]

[601] Clauses 8 and 9, Health and Safety Reform Bill 2014 (192 – 1)
[602] Section 4.7.4.6, Marine Consent Application and EIA, May 2014
[603] Section 4.7.4.6, Marine Consent Application and EIA, May 2014
[604] Issue 5, Joint Statement of Experts in the Field of Toxicology and Water Quality, 19 September 2014

the DMC considers this is not a meaningful condition against which a proposal could be assessed for compliance, other than the requirement to provide a comparative report.

594. Proposed Schedule 2B(xii) required statistically representative samples to be collected from each shipload of phosphorite nodules to test for levels of major oxides and trace elements. Again, the DMC finds that while this information would be interesting, there are no measureable limits against which the results could be assessed. The DMC finds there is no correlation in the proposed conditions between the results of these samples and the potential effects on human health such as maximum acceptable levels.

595. The DMC also notes that cadmium, fluorine and radionuclides (other than uranium and vanadium) are not included in the list of tests to be undertaken.

8.9.4. DMC findings

596. The DMC was persuaded by Mr Kennedy's evidence that the proposed mining operation posed little risk to humans consuming seafood.

597. While Chatham Rise phosphorite generally contains more uranium than current phosphate fertilisers used in New Zealand, it is not classed as a radioactive material.

598. The joint statement of experts in the field of radioactivity agreed that radionuclides of interest do not biomagnify (increase in concentration) through the food chain according to reported studies from elsewhere.[605] Consequently, the DMC finds that the consumption of seafood from the Chatham Rise would pose no greater risk to human health than is currently the case, if mining were to occur.

599. Although the issue of uranium content and radioactivity of the eventual product (ie fertiliser) was raised in submissions and the hearing, the issue is significantly distant from the application for marine consent. Furthermore there are no guidelines, and the DMC agrees with the experts in the field of radioactivity that neither the EPA nor the applicant has any control over farm level decisions on the choice of fertiliser, or the amount to apply.[606]

600. The DMC notes that the experts in the field of radioactivity all agreed that several decades would elapse based on current rates of application of phosphate fertiliser use, before concentrations of uranium in soil would reach a point triggering the need to develop soil guideline values.[607]

[605] Issue 1, Joint Statement of Experts in the Field of Radioactivity, 18 September 2014
[606] Issue 3, Joint Statement of Experts in the Field of Radioactivity, 18 September 2014
[607] Issue 3, Joint Statement of Experts in the Field of Radioactivity, 18 September 2014

601. With respect to proposed conditions controlling levels of uranium content, the DMC agrees with Dr Bull that while levels of uranium and levels of phosphorous would be useful information, it would be far more useful to know the uranium and phosphorous content of all New Zealand's phosphate fertilisers.[608] The DMC agrees that a marine consent is not an appropriate mechanism to achieve this.

602. With regard to air emissions from the vessel, the DMC considers that these are no different from any other vessel and are most appropriately controlled by the MARPOL standards.

[608] Lines 8 – 22, page 867 of the Transcript, 14 October 2014

9. Effects of Proposal on Existing Interests

9.1. Definition of existing interests

603. In addition to considering the effects of the proposal on the environment, the DMC is required by the EEZ Act to take into account any effects on existing interests of allowing the activity.

604. Under Section 4 of the EEZ Act, existing interest means:

> *In relation to New Zealand, the exclusive economic zone, or the continental shelf (as applicable), the interest a person has in—*
>
> *(a) any lawfully established existing activity, whether or not authorised by or under any Act or regulations, including rights of access, navigation and fishing:*
>
> *(b) any activity that may be undertaken under the authority of an existing marine consent granted under section 62:*
>
> *(c) any activity that may be undertaken under the authority of an existing resource consent granted under the Resource Management Act 1991:*
>
> *(d) the settlement of a historical claim under the Treaty of Waitangi Act 1975:*
>
> *(e) the settlement of a contemporary claim under the Treaty of Waitangi as provided for in an Act, including the Treaty of Waitangi (Fisheries Claim) Settlement Act 1992:*
>
> *(f) a protected customary right or customary marine title recognised under the Marine and Coastal (Takutai Moana) Act 2011.*

605. Section 12 of the EEZ Act states:

> *In order to recognise and respect the Crowns responsibility to give effect to the principles of the Treaty of Waitangi for the purposes of this Act,—*
>
> *(a) section 18 (which relates to the function of the Māori Advisory Committee to advise the Environmental Protection Authority so that decisions made under this Act may be informed by a Māori perspective; and*
>
> *(b) section 32 requires the Minister to establish and use a process that gives iwi adequate time and opportunity to comment on the subject matter of proposed regulations; and*
>
> *(c) sections 33 and 59, respectively, require the Minister and the EPA to take into account the effects of activities on existing interests; and*

(d) section 45 requires the EPA to notify iwi authorities, customary marine title groups, and protected customary rights groups directly of consent applications that may affect them.

606. Under Section 39(1) of the EEZ Act, an applicant's impact assessment must —

(c) identify the effects of the activity on the environment and existing interests (including cumulative effects and effects that may occur in New Zealand or in the sea above or beyond the continental shelf beyond the outer limits of the exclusive economic zone; and

(d) identify persons whose existing interests are likely to be adversely affected by the activity;

607. Under Section 39(2) of the EEZ Act, an impact assessment must contain the information required by subsection (1) in —

(a) such detail as corresponds to the scale and significance of the effects that the activity may have on the environment and existing interests; and

(b) sufficient detail to enable the EPA and persons whose existing interests are or may be affected to understand the nature of the activity and its effects on the environment and existing interests.

608. Under Section 59(2) of the EEZ Act, the EPA must take into account:

(a) any effects on the environment or existing interests of allowing the activity, including —

(i) cumulative effects; and

(ii) effects that may occur in New Zealand or in the waters above or beyond the continental shelf beyond the limits of the exclusive economic zone

(b) the effects on the environment or existing interests of other activities undertaken in the area covered by the application or in its vicinity, including —

(i) the effects of activities that are not regulated under the Act; and

(ii) effects that may occur in New Zealand or in the waters above or beyond the continental shelf beyond the outer limits of the exclusive economic zone;

609. Under Section 60 of the EEZ Act:

> *In considering the effects of an activity on existing interests under section 59(2)(a), the Environmental Protection Authority must have regard to —*
>
> *(a) the area that the activity would have in common with the existing interest; and*
>
> *(b) the degree to which both the activity and the existing interest must be carried out to the exclusion of other activities; and*
>
> *(c) whether the existing interest can be exercised only in the area to which the application relates; and*
>
> *(d) any other relevant matter.*

9.2. Identification of existing interests

610. The DMC identified the following persons holding existing interests on the basis of the criteria laid down in Section 4 of the Act:

- Iwi and imi holding fishing quota rights under the Treaty of Waitangi (Fisheries Claim) Act 1992 or customary fishing rights which overlap with the marine consent area, including the Chatham Rise Rohe Moana
- Te Runanga o Ngāi Tahu (through the Ngāi Tahu Claims Settlement Act)
- Kaikoura Whale Watch Ltd (as a marine eco-tourism activity)
- Commercial fishers
- Persons involved in lawful shipping, navigation and maritime activities.

611. The DMC was satisfied that no existing interests arose from the provisions of the EEZ Act relating to an existing marine consent (Section 4(b)); an existing resource consent (Section 4(c)); or a protected customary right or customary marine title recognised under the Marine and Coastal Area (Takutai Moana) Act 2011 (Section 4(f)).

9.3. Pre-hearing meeting of existing interest groups

612. A pre-hearing meeting was arranged on 22 September 2014 in order to ascertain the views of existing interest groups representing commercial fishing and various iwi and imi concerns. Of particular interest to the DMC was whether agreement could be reached among all the various groups on the likely effects of the proposal.

613. Participants in the meeting agreed on the following statement defining the areas they had in common with the area that would be affected by the proposal (Report of the Pre-Hearing

Meeting, dated 22 September 2014): *"The Chatham Rise and its connectivity to the whole marine environment. The marine environment is complex and interconnected and includes the air, the water column and the seabed, and the life within. This will be affected by the whole process of extraction (mining, processing, return of sediment, transport, further processing and end use). This includes an acknowledgement that the effects will be both immediate and will continue to have an effect over time. In some cases the effects will be permanent. Effects will occur outside the marine environment."*

614. The report on the meeting[609] contained an extensive list of matters that existing interest groups wanted the DMC to consider, but noted that it had not been possible in the time available to define those who agreed or disagreed with each issue. It also contained responses to some, but not all, of the questions posed by the DMC. However, many of these matters were covered during the course of the hearing.

9.4. Existing Interests of iwi and imi

9.4.1. Iwi and imi as quota holders

615. The DMC was given comprehensive information by Te Ohu Kaimoana Trust in relation to the Treaty of Waitangi (Fisheries Claim) Settlement Act 1992 and its importance to Māori commercial fishing interests.[610]

616. Commercial and non-commercial fishing rights secured under the Settlement were summed up as follows by Te Ohu Kaimoana Trust Ltd in *Figure **14*** and *Figure **15***.

[609] Pages 4 – 7, Report of Pre Hearing Meeting Existing Interests – Commercial Fishing and Cultural Impacts, 22 September 2014
[610] Paragraphs 8 – 10, Opening Statement of Kirstin Woods on behalf of Te Ohu Kai Moana Trustee Ltd, 25 September 2014

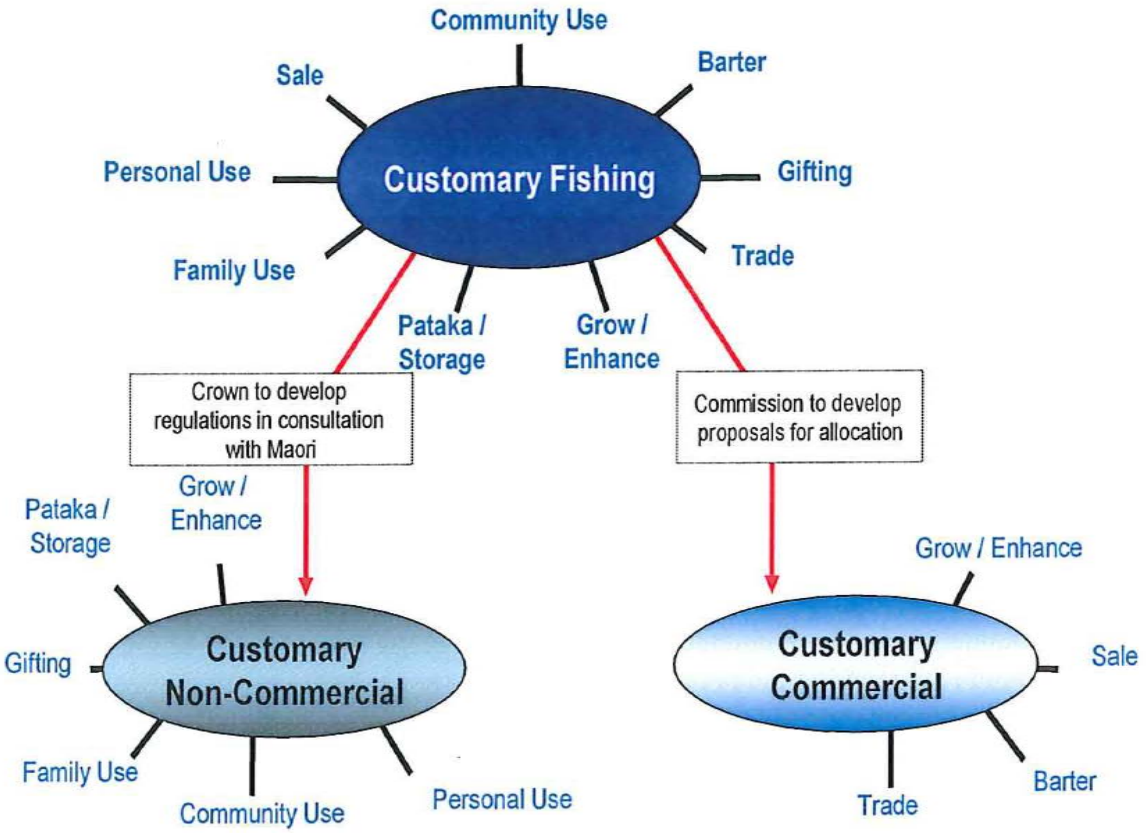


Figure 14. Commercial and non-commercial fishing rights under Fisheries Settlements (Source: Figure 1, Statement of Evidence of Kirstin Woods on behalf of Te Ohu Kai Moana Ltd, 12 September 2014)

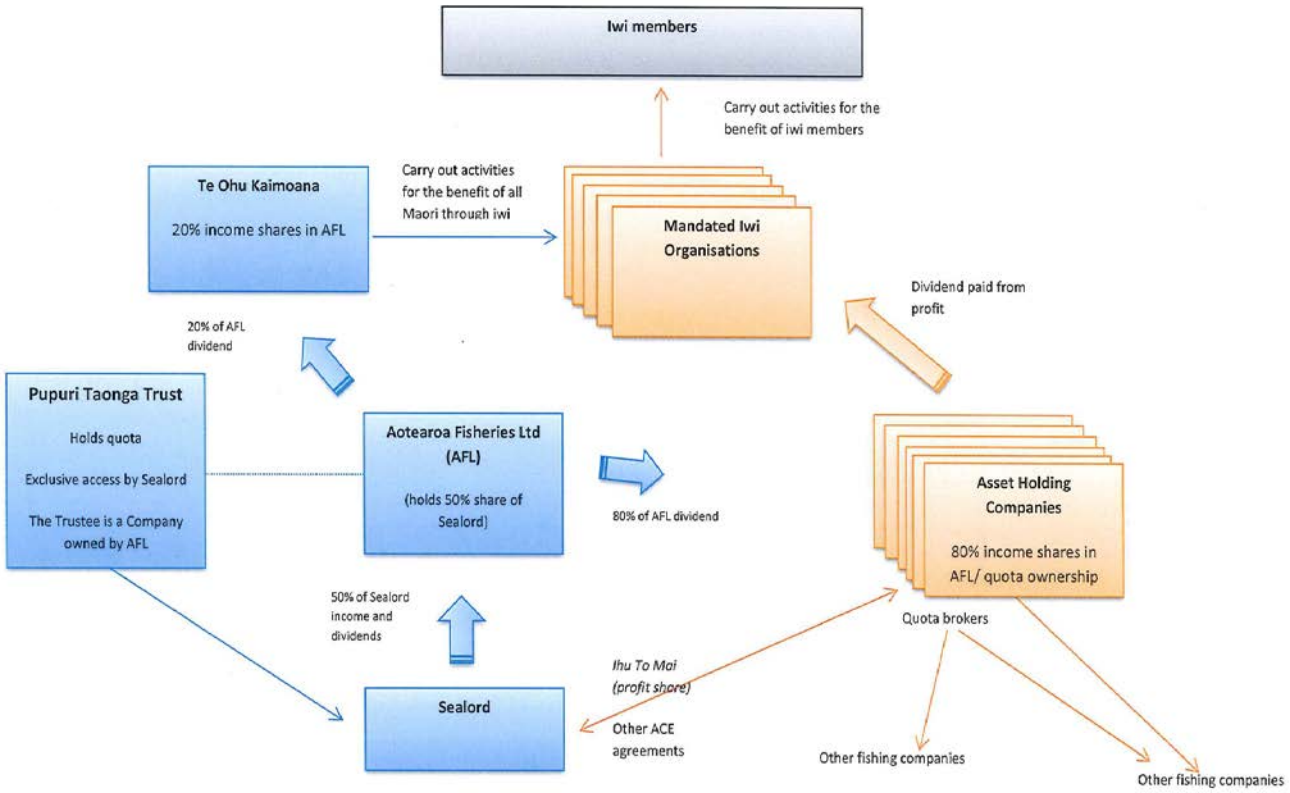


Figure 15. Fisheries Settlement – Flow of benefits (Source: Figure 2, Statement of Evidence of Kirstin Woods on behalf of Te Ohu Kai Moana Ltd, 12 September 2014)

617. Given that the economic interests and concerns of Māori and Moriori quota holders are in many respects the same as the interests of other fishing quota holders engaged in commercial fishing, the DMC has dealt with the commercial interests of iwi and imi quota holders together with commercial fishing interests more generally in Chapter 9.8.

9.4.2. Moriori ki Rekohu (Chatham Islands' Moriori)

618. Moriori claims are wide ranging and cover much of the Chatham Rise area. They remain unsettled at this time and are yet to be fully negotiated. Moriori however did accept the partial settlement of their fisheries claims through the acceptance of quota, and are in the business of fishing.

619. Mr Solomon, counsel for the Hokotehi Moriori Trust, stated in his submission: *"Moriori have historical and contemporary claims to negotiate and settle with the Crown, including claims to the 200 mile EEZ around our Islands. These are matters that the DMC are required to take into account as existing interests when making its decision on the application (Sections 2 and 59 of the EEZ Act 2012*)".[611]

620. On the fisheries settlement assets, Mr Solomon stated *"In 2005, after 10 years of advocacy, HMT finally received an allocation of individual transferable quota from Te Ohu Kaimoana. Moriori had argued for the previous 15 years that Rekohu was a special case for allocation and that all quotas held by TOKM within the 200nm zone around Rekohu should be allocated to the islands (show slide). This was because Moriori, more than any other iwi on the mainland, had a greater reliance on our fishery for our livelihood. Moreover, fisheries are the only natural resource of any real economic value that will ever be returned to Rekohu by way of Treaty settlement. Other tribes on the mainland have access to resources that simply not available to Rekohu, for example commercial properties, land, geothermal, rivers, forests and the list goes on".*[612]

621. In the end, Te Ohu Kai Moana accepted that Rekohu was a special case for allocation and Moriori, together with Ngāti Mutunga, received a share of the inshore quota and 50 % of the deep-water quota within the 200nm zone.[613]

622. Moriori and Ngāti Mutunga also successfully negotiated the establishment of their Chatham Rise "*Rohe Moana*". The Rohe Moana is the result of a memorandum of understanding between the Pā Tangaroa Forum partners and the Ministry of Fisheries.[614] It is based on regulations issued under the Fisheries Act 1993 in accordance with Section 10(c) of the Treaty of Waitangi (Fisheries Claim) Settlement Act 1992 and is therefore "*lawfully established*". The interests that arise in respect of the Rohe Moana (both in the sense of the physical activity of food gathering and in terms of the special relationship between tangata whenua and the Rohe Moana) constitute "*existing interests*" under the EEZ Act.

[611] Paragraphs 16 and 17, Opening Representation on behalf of Hokotehi Moriori Trust, 10 November 2014
[612] Lines 1 – 20, page 2115 of the Transcript, 10 November 2014
[613] Lines 24 – 27, page 2115 of the Transcript, 10 November 2014
[614] Lines 7 – 11, page 2127 of the Transcript, 10 November 2014

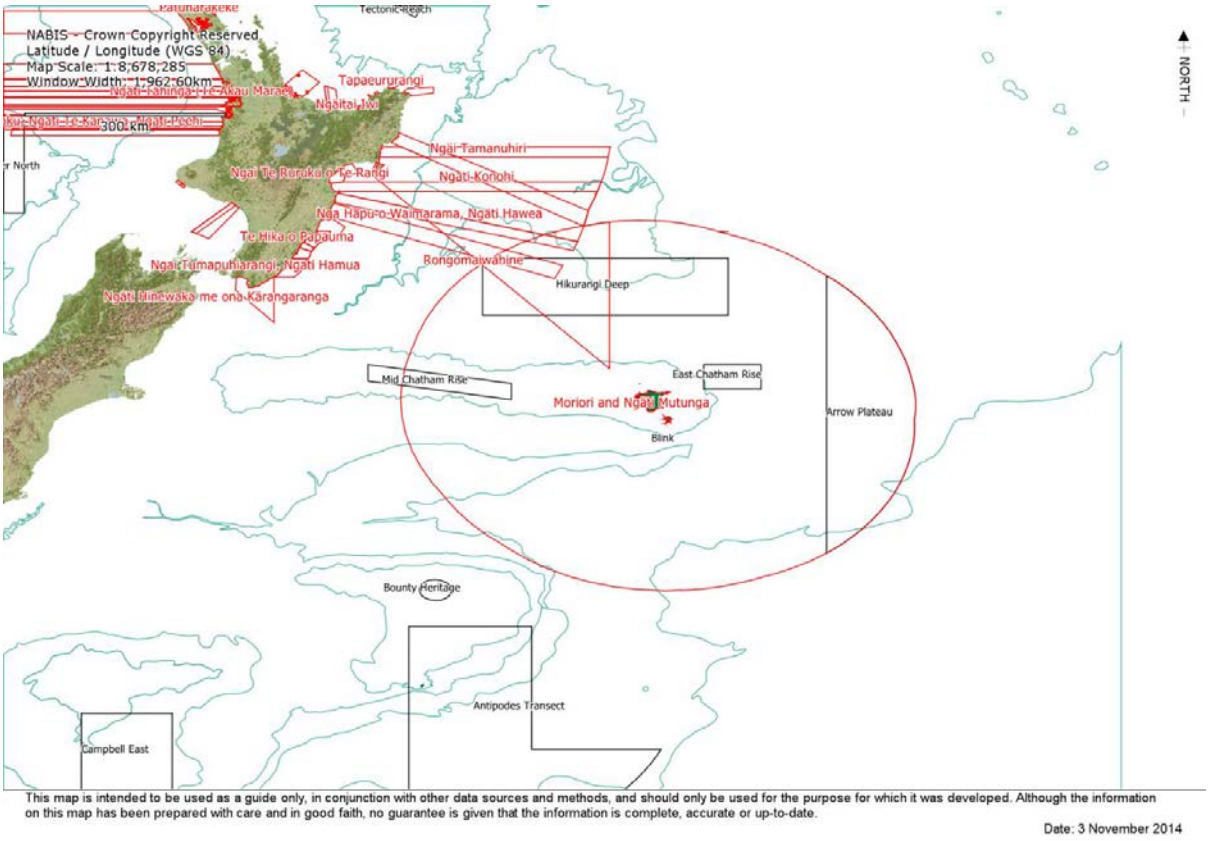


Figure 16. Nabis map of Moriori Rohe Moana (red circle) and the the Chatham Rise Benthic Protetion Areas (outlined in black). The proposed mining area falls within the Moriori Rohe Moana. (Source: map from PowerPoint presentation from Hokotehi Moriori Trust, 10 November 2014)

9.4.3. Ngāti Mutunga ki Wharekauri (Chatham Islands)

623. Ngāti Mutunga's claims involving the Chatham Rise are wide ranging. They have settled the majority of their fishing claims but are still engaged in negotiating other aspects of their claim with the Crown.

624. As Ngāti Mutunga's representative, Mr Kamo, told the DMC *"…our Ngāti Mutunga people engaged in a settlement process that was practically forced upon them by the arrival of the Māori Fisheries Act.*

We were forced into a settlement, being the first cab of the rank, that saw the bulk, as we are well aware, of our fishing interest given across to this pan-tribal, what we now call Te Ohu Kai Moana entity.

Our people at the time did the best that they could with the limited resource that was available to them in a largely hostile Crown of the day that was practically interested in talking about the relevance or significance of fishing to our island, and indeed we had some of our own Māori people turn up on this island and accuse our whānau here of being greedy for wanting to retain

the inshore fishery as a minimum for the use of its own people, both Moriori, Māori and local community as well."[615]

625. The Ngāti Mutunga o Wharekauri Iwi Trust summarised their position as follows:

- The risk to the applicant is a large amount of upfront capital. The reward is a large profit generated. This is not a problem for the iwi
- The risk to iwi is as follows:
    - its fishery economic base
    - its cultural base
    - its whānau base
    - its identity
- Currently the return to the island (and the iwi) if the initiative succeeds, is precisely zero.[616]

9.4.4. Ngāti Kahungunu

626. Mr Ngahiwi Tomoana provided the following testimony in evidence of the nature and extent of Ngāti Kahungunu's Treaty settlements relating to its 'Rohe', and the effects of the proposal on them: *"Ngāti Kahungunu has worked with other iwi over the last 20 to 30 years or so to achieve fisheries settlement…Ngāti Kahungunu is very susceptible to the fishery because, unlike other iwi, Ngāti Kahungunu have only claimed the fisheries and allowed all hapū to claim the lands. So we feel the impact of any fishing changes, the vagaries of the fishing season, and impacts externally on our fishery.*[617]

Ngāti Kahungunu along with Ngāi Tahu and other major fisheries players, work together with the fishing industry to create benthic protected areas to show our corporate citizenship and our Kaitiaki and our sustainability over the fisheries….it (mining) will undo the good intent of the fishing industry in creating those benthic protected areas.[618]

Our contract fishers are Sealord's so with all their boats in that area too we are very concerned that the interruption of fishing would diminish the ability to become better fishers. Hawkes Bay Seafood's as well. We hire 160 workers in the Napier area. Any impact on that fishery itself, because we mainly fish in the area, will have detriment to the economy of our whānau."[619]

[615] Lines 9 – 26, page 2183 of the Transcript, 12 November 2014
[616] Section 6, Ngāti Mutunga o Wharekauri Iwi Trust submission, Submission 110139, July 2014
[617] Lines 39 – 45, page 1443 of the Transcript, 21 October 2014
[618] Lines 16 – 21, page 1444 of the Transcript, 21 October 2014
[619] Lines 1 – 6, page 1445 of the Transcript, 21 October 2014

9.4.5. Customary (hapū, whānau and iwi / imi) fishing

627. The DMC heard evidence from a number of submitters who were directly involved in the business of whānau, hapū and iwi / imi fishing — and in many cases had been involved for many generations. These people were particularly concerned about the likely effects of the proposal on price premium. They also expressed their apprehension about the effects of mining on the cultural interests and values that underpinned their tikanga practices and the contribution to their sense of identity of fishing and their other activities at sea.

628. On the matter of customary fishing, Mr Tomoana of Ngāti Kahungunu recited the following whakapapa to explain the nature and extent of this relationship based on Ngāti Kahungunu cultural values: "…*we see ourselves as Kaitiaki over the whole area (land and sea) based on our whakapapa to Tangaroa (God of the Sea). Ranginui (sky) and Papatūānuku (earth) had 70 offspring, 13 of which are Kaitiaki over the sea and the fishes, and the seabed. Everybody knows Tangaroa, but then there are the Atua (Gods) over the ocean currents, tides, winds, moons. Atua Te Kehu is over whales, Puwhakahara over porpoises and dolphins, Awawaru over shellfish, Te Kahu over sharks, and so on…*"[620]

629. A valued mahinga kai (food gathering), once common throughout New Zealand but unique to the Chatham Islands and South Island today is titi gathering. Titi (shearwater birds) frequent the Chatham Rise and come ashore on offshore islands to burrow and breed. The gathering of juvenile birds in their burrows is a long-standing practice of local iwi and imi for both consumption and trade with other iwi groups throughout New Zealand and abroad. For some Ngāti Mutunga and Moriori, trading titi forms an important part of their culture and therefore identity. It also supplements whānau incomes in season. Titi gathering rights are protected by law on some offshore islands.

[620] Lines 22 – 28, page 1443 of the Transcript, 21 October 2014

9.5. Te Rūnunga o Ngāi Tahu

630. In his statements, Mr Christensen counsel for Te Rūnunga o Ngāi Tahu expressed Ngāi Tahu's strong opposition to the application, referring to Ms Bartlett's summary of the five most concerning effects on Ngāi Tahu as follows:[621]

- *"mobile species (including taonga species' within the mining area but outside the Ngāi Tahu takiwā boundary) that form part of Ngāi Tahu fisheries (as described in the Ngāi Tahu Sea Fisheries Report) and that are reliant on benthic habitat and ecosystem function (the mauri of the area as an intact habitat) — mauri indicated by fossil bones and corals of advanced age, alongside the undisturbed state of BPA — 820km^2 area of destruction impacts mauri, habitat and ecosystem function, affecting mobile species using the area*
- *plume effects flowing into the Ngāi Tahu takiwā, directly affecting Ngāi Tahu fisheries (as described in the Ngāi Tahu Sea Fisheries Report) to an uncertain extent*
- *commercial quota assets in QMAs crossing the mining footprint, two thirds from Settlement*
- *overall fisheries management (QMAs, BPAs, MSC) as the means that the Crown appropriately maintains the health of Ngāi Tahu fisheries and upholds Treaty obligations*
- *settlement integrity, including the development right of Ngāi Tahu (as described in the Ngāi Tahu Sea Fisheries Report), and all values and practices associated with Ngāi Tahu fisheries."*

631. Mr Winchester for the applicant stated that *"…. For the avoidance of doubt, CRP accepts that Ngāi Tahu is in a special and different position and it has a range of existing interests, some of which involve cultural interests as a consequence of this specific recognition of those interests through legislation and Treaty settlements. CRP cannot and does not dispute those interests exist. Rather it considers that there is some doubt that those interests are adversely affected by its proposal, and certainly not to the extent claimed".'*[622]

632. In his closing statement[623], Mr Christensen for Ngāi Tahu questioned the likely economic benefit of the proposal to New Zealand. He repeated his earlier criticism of the way in which the risks to commercial fishing and marine eco-tourism had been dismissed by the applicant and he argued that more attention should have been paid to the likely impacts of the proposal on Ngāi Tahu's cultural values and rights. In addition he was critical of the applicant's proposal to establish an Environmental Compensation Trust; and suggested that the proposal had to be rejected on the

[621] Attachment 4, Te Rununga o Ngāi Tahu Closing Statement, 18 November 2014
[622] Lines 38 – 45, page 2546 of the Transcript,19 November 2014
[623] Pages 2495 – 2511 of the Transcript, 18 November 2014

basis of continuing uncertainties about its effects on the marine environment and the impact it would have on the Chatham Rise BPA. He summed up: *"The proposal raises serious concerns for Ngāi Tahu in terms of their commercial and cultural interests and the integrity of their settlement with the Crown."*[624]

633. Mr Summerton of Ngāi Tahu, a Director of Okains Long Line Ltd, expressed his concerns about the nature and extent of the proposal's effects, concluding that *"Our iwi (Ngāi Tahu) leaders fought hard for the outcome of the Ngāi Tahu Sea Fisheries Report, and achieved a Treaty Fisheries Settlement. The Settlement includes the rights of iwi, and Ngāi Tahu hapū to develop their future Fishing interests."*[625]

634. Sections of the Ngāi Tahu Deed of Settlement were referred to by Mr Christensen in his closing statement. He stated *"A decision of the Crown cannot lawfully erode the Value of rights or assets of Māori which are either protected under the Treaty of Waitangi, or which comprise part of Treaty Settlements, which were the Crown's final redress for failing to protect and conserve sea fisheries and the historical material and cultural deprivation of Ngāi Tahu Whanui. All of these rights (both tangible and intangible) and assets comprise aspects of the existing interests of Ngāi Tahu as expressed by Te Runanga."*[626]

9.6. Marine ecotourism

635. Whale Watch Kaikoura was formed in 1987 as a whānau business on the North–East coast of Te Waipounamu (South Island). The business was based on the nutrient rich currents that converge on the Chatham Rise over a subterranean topography that provides the habitat required by whales and other marine biota from the Chatham Islands to Kaikoura. As the business developed, members of the Hapū of Ngāti Kuri invested in the venture. Some years later the iwi authority for Ngāi Tahu became a major investor in the business.[627]

636. Whales feature prominently in the whakapapa of Ngāi Tahu, Ngāti Kahungunu, Moriori, and Ngāti Mutunga. One of the most common korero pūrākau relates to the ancestor 'Paikea' (whale rider). The relationship between Māori and sea mammals is based on the interaction of Māori over many generations with the sea and their whakapapa to whales and other species of the sea. Submitters from iwi and imi clearly hold significant cultural concerns about the application and how it might affects the taonga species of whales. Concern was also expressed to the DMC

[624] Lines 30 – 32, page 2511 of the Transcript, 18 November 2014
[625] Paragraph 39, Statement of Evidence of Greg Summerton, 29 September 2014
[626] Paragraph 12a, Statement of Evidence of Mr Stephen Christensen on behalf of Te Rūnanga o Ngāi Tahu, 25 September 2014
[627] Page 6, Statement of Evidence of Kauahi Ngaporo on behalf of Kaikoura Whale Watch, 11 September 2014

about the possible economic consequences for marine eco-tourism if the mining operation were to harm or displace marine mammals.

637. In the words of Mr Ngaporo:[628] *"The Chatham Rock Phosphate proposal has the potential to harm Chatham Rise feeding grounds used by the Kaikoura whales and to impact marine mammals in ways that are not well understood"*; and *"The whales are dependent on the Chatham Rise ecosystem and we are dependent on the whales. Our destinies are linked."*

9.7. Consultation with existing interests

638. Although there is no requirement under the EEZ Act for an applicant to consult with existing interests in developing its case for a marine consent, it is clear that in order to understand and address the concerns of existing interest groups, a certain level of consultation is necessary. Moreover, in order to be effective the consultation needs to be undertaken with a degree of sensitivity and care. While this is particularly the case for tangata whenua, it is also important for other stakeholders and interested parties.

639. Ms Sanders provided the hearing with a comprehensive account, from the applicant's point of view, of the consultations undertaken by the applicant. She reported that since 2010 it had engaged with key stakeholders such as the fishing industry, iwi and imi, the Chatham Islands community, government agencies, non-governmental organisations and a range of environmental groups.[629] This had been by means of meetings, the provision of updates by email and telephone, newsletters, media releases and presentations. Consultants with specialist experience in dealing with Māori had been engaged to assist with the applicant's engagement with iwi and imi. The stated purpose of the consultations was, in Ms Sanders' words, "*to inform and educate interested persons so that they can reach their own conclusions about the project's merits, and to receive feedback about the project, including any concerns, so that we can consider ways to improve the project*". She went on to note instances where the applicant had refined the design of the proposal and undertaken additional research as a result of the feedback received. She then gave a detailed account of the process follow in respect of key stakeholders.

640. Although a number of submitters gave credit for the efforts made by the applicant to engage with stakeholders, the process was the subject of criticism from such groups as the fishing industry, a number of iwi and imi and environmental groups. It was clear that some groups believed that the applicant had not done as much as it should have to provide accurate and timely information on the proposal, answer questions or listen and respond to their concerns.

[628] Paragraphs 10 and 13, Statement of Evidence of Kauahi Ngaporo on behalf of Kaikoura Whale Watch, 11 September 2014
[629] Paragraph 16, Statement of Evidence of Linda Sanders for CRP, 28 August 2014

641. Thus, Ms Tuuta's statement of evidence[630] commented that *"The applicant's consultation has been incomplete, insufficient and lacking in integrity in the sharing of information".* Ngāi Tahu's opening statement referred to the applicant's *"lack of understanding of and attention to Māori values."*[631] The Deepwater Group contested Ms Sanders' account of the applicant's engagement with it in its opening statement.[632] In his opening statement, counsel for the Hokotehi Moriori Trust was questioning of the approach taken by the applicant to its engagement with the Chatham Islands community.[633]

642. Whatever the merits of the approach taken by the applicant to consult with interested parties (and, as indicated above, a number of participants were prepared to acknowledge the efforts it had made) it was evident that the majority of existing interest groups ended up not only opposing the proposal but feeling that their concerns had not been taken sufficiently on board by the applicant.

9.8. Effects on commercial fishing interests

9.8.1. Importance of the Chatham Rise fisheries

643. New Zealand's fishing industry is a significant existing interest in the context of this application. Stakeholders include the 57 iwi and imi which hold fishing quotas under the Treaty of Waitangi (Fisheries Claim) Settlement Act 1992. Section 59(2)(h) of the EEZ Act requires the DMC to take into account the nature and effect of other marine management regimes such as the quota management system (QMS).

644. The Chatham Rise is one of New Zealand's most productive and important commercial fishing grounds. It is regarded as an unusually rich and diverse ecosystem that includes numerous fish species of commercial importance. Commercial species caught on the Rise include hoki, hake, ling, orange roughy, black and smooth oreos and scampi. Its importance to the fishing industry was described by Dr Helson of Fisheries Inshore New Zealand as follows:[634] *"The Chatham Rise fisheries are of national significance and account for over two thirds of New Zealand's total catch of orange roughy and oreos, a third of the total hoki catch, over 40 percent of total catch of scampi and silver warehou and around a quarter of the total ling catch".*

[630] Page 14, Statement of Evidence of Evelyn Tuuta and Mokopuna Te Moananui a Kiwa Erueti – Newman, 16 September 2014
[631] Paragraph 17, Opening Representation on behalf of Te Rūnunga Ngāi Tahu, 25 September 2014
[632] Paragraphs 79 – 80, Opening Representation on behalf of the Deepwater Group Limited, 26 September 2014
[633] Lines 35 – 38, page 2130 of the Transcript, 10 November 2014
[634] Paragraph 12, Statement of Evidence of Statement of Evidence of Dr Jeremy Helson on behalf of the Deepwater Group Limited, 12 September 2014

645. Dr Helson went on to note that in 2013 fisheries on the Chatham Rise had produced over $130 million in export earnings and that Marine Stewardship Council (MSC) certification had been secured for the hoki fishery and was being sought for hake and orange roughy.[635]

646. The DMC heard evidence from numerous witnesses about fish and fishing. This included technical experts, fisheries managers and skippers and experienced local fishermen both from the mainland and from the Chatham Islands.

647. Dr O'Driscoll, a witness for the applicant, confirmed that the Chatham Rise was an important area for fish and fisheries, noting that more than 250 fish species had been caught in research trawls on the Chatham Rise at depths ranging from 200m to 800m.[636]

648. The DMC was informed that of the 63 species identified in the prospecting licence area, no important commercial and fish species had more than 10 % of their Chatham Rise estimated biomass (averaged over the past 10 years) within the revised marine consent area.[637]

649. However, Dr O'Driscoll acknowledged that there had been very little commercial catch effort information from within the revised marine consent area since 2003, mainly because of the establishment of the BPA in 2007.[638]

650. Ms Baird noted[639] that there was little overlap between the bottom longline ling fishery and the three permit / licence areas.

651. Dr Tuck's evidence related to a comparative analysis of sediment suspension arising from demersal trawling and mining and its effect on benthic species. That has been covered elsewhere in this decision in the context of the sediment plume and is not further discussed in this chapter.

652. Dr Helson confirmed[640] that the main deepwater and middle-depth commercial fisheries on the Chatham Rise were:

- a trawl fishery for hoki and associated species such as silver warehou, hake and ling at depths of 200 to 600 m
- trawl fisheries for orange roughy and oreos at depths of 700 to 1,000 m

[635] Paragraphs 11 – 12, Statement of Evidence of Statement of Evidence of Dr Jeremy Helson on behalf of the Deepwater Group Limited, 12 September 2014
[636] Paragraph 1, Statement of Evidence of Richard O'Driscoll for CRP, 28 August 2014
[637] Dr O'Driscoll confirmed that there was nothing magical about the 10 % — simply the highest number of 9.9 % rounded up.
[638] Paragraph 36, Statement of Evidence of Richard O'Driscoll for CRP, 28 August 2014
[639] Slide 4, Summary of Evidence of Susan Jane Baird, 16 October 2014
[640] Paragraphs 28 – 29 and 69, Statement of Evidence of Dr Jeremy Helson on behalf of the Deepwater Group Limited, 12 September 2014

- a ling longline fishery.

653. He added that other commercial species included jack mackerel, alfonsino, scampi, barracouta, squid and groper (hapuku or bass).

9.8.2. Fishermen

654. While the evidence of the fishing industry witnesses was highly critical of what it considered deficiencies in the underlying modelling assumptions and conclusions, it did not generally challenge the expert witness' views summarised in the above paragraphs.

655. Mr Connolly observed[641] that the hoki fleet rarely trawled above the 400 m isobath in order to avoid the scampi and juvenile hoki, ling, and silver and white warehou, as well as avoiding those areas where ling long liners and scampi trawlers fish.

656. Mr Karatea noted[642] that during his 25 years at sea on the Chatham Rise he had caught crayfish, orange roughy, hapuka, bass, tarakihi, scampi, trumpeter, ling, hoki, blue cod, paddle crabs, jock stewarts, and green bone blue nose.

657. Mr Patrick noted[643] concern about the juvenile commercial fish (particularly hoki) that congregate in the shallower parts of the Chatham Rise.

658. Mr Summerton noted that 78 % of Okains Bay fish, primarily ling and deep sea cod, was caught around the proposed Chatham Rise mining area, and he provided helpful illustrative evidence of the positions and directions of lines set by his activities, and the direction of currents, although the DMC notes that these tended to be on the flanks of the Rise rather than the crest where the proposed mining would take place.

9.8.3. The fishing industry

659. The fishing industry was strongly opposed to the proposal. Groups such as the Deepwater Group, Te Ohu Kai Moana, the Sealord Group, Ngāi Tahu, Ngāti Mutunga and Moriori were unanimously of the view that it posed an unacceptable risk in terms of a reduction in fish stocks from loss of habitat, the potential displacement of certain species of fish and the possible loss of MSC certification. These concerns were echoed by a number of individual submitters and witnesses.

[641] Paragraph 9. Statement of Evidence of Peter Connolly on behalf of the Deepwater Group Limited, 12 September 2014
[642] Paragraph 51, Statement of Evidence of Turoa Karatea on behalf of Whanua o Evelyn Tuuta and Mokopuna Te Moananui a Kiwa Erueti-Newman, 12 September 2014
[643] Paragraphs 14 – 15, Statement of Evidence of Christopher Patrick on behalf of the Deepwater Group Limited, 12 September 2014

660. Mr Paulin of the Sealord Group (in which iwi hold a significant interest) explained the importance of the Chatham Rise fisheries and the BPA to his company. He was particularly concerned about the risk of a reduction of productivity and the possible effect of the mining operation on MSC certification.[644]

661. In his opening statement, Mr Christensen for Ngāi Tahu commented *"There are significant limits to the stock assessment modelling, and it is just not possible based on current modelling to estimate the amount of catch that may be displaced nor the cost to the fishing industry generally, and to individual companies such as Okains Bay, of losing decades of acquired knowledge of fish aggregation, spatial / temporal movements and life cycle changes. Displacement of commercial fishing activity and loss of value is likely to arise from the cumulative effects of displacement from multiple mining blocks, wider environmental effects of mining on fish behaviour and consumer concerns about seafood quality."*[645]

662. Ms Woods of Te Ohu Kai Moana requested that the application be declined on the grounds that "*the proposed benefits do not warrant the risks the activities will create to commercial and non-commercial aspects of the Māori Fisheries Settlement or to the wider fishing industry*".[646] She went on to explain the importance of the Chatham Rise fishery to iwi, noting that the Māori Fisheries settlement was based on the premise that the benefits of the 1992 agreement with the Crown would endure.

663. Speaking on behalf of the Deepwater Group, Mr Clement asserted that the proposal had the potential to disrupt the incentives that underpin the successful operation of the QMS,[647] and was likely to damage the integrity of the Mid Chatham Rise BPA. He warned that the mining operation would increase costs to the fishing industry, reduce the value of quota rights and put at risk the industry's MSC sustainability certification. He saw no possibility of the adverse effects of the proposal being avoided, remedied or mitigated through proposed conditions or the adoption of an adaptive management approach.[648] He warned that no weight could be attached to the stated intention of the applicant to establish mining exclusion zones in the marine consent area.

664. Mr Connolly, a fishing boat operator, gave an account of his first-hand experience on the Chatham Rise, raising questions about the impact of the weather on the viability of the mining operation, the information provided by the applicant's experts on tidal currents and other claims

[644] Paragraph 27, Statement of Evidence of Colin Douglas Paulin on behalf of the Deepwater Group Limited, 12 September 2014
[645] Paragraph 72, Opening Representation on behalf of Te Rūnanga o Ngāi Tahu, 25 September 2014
[646] Paragraph 15, Opening Statement of Kirstin Woods on behalf of Te Ohu Kai Moana Trustee Ltd, 25 September 2014
[647] Paragraph 8, Statement of Evidence of Ian Thomas (George) Clement for the Deepwater Group Limited, 12 September 2014
[648] Paragraph 81, Statement of Evidence of Ian Thomas (George) Clement for the Deepwater Group Limited, 12 September 2014

made about the distribution of fish, mammal and other marine species on the Rise.[649] Other individual witnesses involved in the fishing industry as commercial fishers were similarly opposed to the proposal, primarily on the grounds that it was likely to have a detrimental effect on the marine environment, the fisheries on the Chatham Rise and their families' livelihoods.

9.8.4. The applicant's position

665. The applicant did not disagree about the importance of the Chatham Rise to the fishing industry. It noted that the nutrient-rich waters of the Chatham Rise drove high levels of phytoplankton productivity that supported commercially important populations of demersal and deep water fish. It disagreed however that the mining operation would pose a significant risk to the commercial fishing industry, expressing the view that potential impacts on the fisheries were considered to be of low risk.[650]

666. As noted above, the applicant called a number of expert witnesses to refute criticisms that the proposal would impact in any material way on commercial fishery stock levels. The applicant was also strongly critical of the fishing industry for opposing the applicant's mining proposal when they were continuing bottom trawling over significant areas of the Chatham Rise.

9.8.5. Expert conferencing on commercial fishing

667. The expert conferencing on commercial fishing agreed[651] on a number of propositions relating to the spatial and temporal overlap between mining and fishing interests on the Chatham Rise. Participants were agreed for example that the Chatham Rise was an important area for commercial fish and fisheries; that only limited fishing had occurred in the consent area in recent years; that the revised consent area represented only a small part of the Chatham Rise; and that if the direct and indirect impacts of mining were restricted to the revised consent area, the effects on commercial fish catch and effort would be small.

668. However, there was also agreement that the effects would be larger if the impacts of mining extended beyond the revised consent area and that there was a lack of information on the distribution of some fish species over an annual cycle. The experts concluded that further information would be helpful and suggested that the applicant's proposed conditions and adaptive management regime needed more work.

[649] Paragraph 6. Statement of Evidence of Peter Connolly on behalf of the Deepwater Group Limited, 12 September 2014
[650] Summary (page 7), Marine Consent Application and EIA, May 2014
[651] Issue 1, Joint Statement of Experts in the Field of Commercial Fishing, 19 September 2014

669. The conference of experts in the field of economics[652] took the view that it was not competent to arbitrate between the range of scientific views as to the impact of mining on fish stocks. Participants did however agree that the science indicated that some negative impacts would occur. It could not reach agreement on the probability of the mining affecting the industry's sustainability accreditation standing. The views of individual economics witnesses are outlined in Chapter 11 dealing with the question of economic benefits to New Zealand.

9.9. Sustainability certification

670. The fishing industry attached considerable importance to the maintenance of its current MSC certification. It also hoped to secure certification for further species of fish in the near future. The DMC heard testimony about the premium prices that are possible with this certification. It forms part of the industry's strategy to strengthen New Zealand's international reputation for sustainably managed fisheries. The disagreement between the industry and the applicant in this area turns essentially on the question of what, if any, effect the proposed mining activity would have on the industry's MSC certification.

671. MSC certification is administered by an international independent non-profit council that assesses a fishery against three core principles: sustainability of exploited stocks (the fishing activity must be at a level which ensures it can continue indefinitely); maintenance of the ecosystem on which the fishery depends (fishing operations must be managed to maintain the structure, productivity, function and diversity of the ecosystem); and effective and responsible management (the fishery must comply with relevant laws and have a management system that is responsive to changing circumstances).

672. The Marine Stewardship Council's website lists the key benefits to the fishing industry and fish processors as:

- existing markets accessed
- access to new markets
- livelihoods protected
- reputation enhanced
- possible price premiums
- promotional opportunities.

673. The DMC was told that "*…New Zealand hoki, which received MSC certification in 2001, was the first major white fishery in the world to be certified. This market advantage provides a premium of $200 per tonne for hoki block. Once other major whitefish fisheries (especially Alaskan Pollock) gained certification, the financial premium became less important, although the*

[652] Issue 4A – C, Joint Statement of Experts in the Field of Economics, 18 September 2014

reputational benefits ensured New Zealand's certified seafood products were always saleable. For example, during the global financial crisis in 200, the Sealord-produced Argentinean hoki block did not sell for almost12 months. In contrast, Sealord's MSC certified New Zealand hoki continued to sell at good prices right through this period."[653]

674. The DMC also heard that *"New Zealand's fisheries will be less likely to be able to obtain or maintain independent third party sustainability certification such as that provided by the Marine Stewardship Council (MSC) because BPAs help meet the MSC requirement that fisheries do not cause serious or irreversible harm to habitat structure. In the absence of environmental certification, access to premium seafood markets in the European Union, Australia, and the United States will be lost, and the value of New Zealand's seafood exports will be reduced. As a result of the above impacts, deep-water quota owners face increased costs and quota value may decline."*[654]

675. The applicant disputed any effect on the MSC certification. Evidence from Dr Pierre, an experienced MSC auditor, expert assessor and peer reviewer, and expert witness for the DMC, outlined the sort of considerations required by the certification process. She confirmed in response to questioning from the applicant's counsel, Mr Harwood[655] that she was not aware of any fishery having lost its certification due to third party activity. Mr Harwood provided[656] three examples of fisheries that occur within areas of quite intensive third party activity (including oil and gas production, wind farms, fish farming and commercial shipping) that are either certified or were going through the certification process, being the Norway North-East Arctic and North Sea saithe fisheries, the Louisiana Blue Crab fishery (certified) and the Louisiana Oyster, Dredge, Scraper and Tong fishery. Dr Pierre advised the DMC however that the DMC should treat the concerns regarding the BPA concern issue seriously as it was "*one of the more important issues in the broader fisheries context that this process has to consider*"[657].

9.10. Maritime and navigation

676. Mining vessels would be subject to the ordinary rules and regulations of working vessels at sea, primarily through the Maritime Transport Act 1994 (MTA) as outlined by Maritime New Zealand in its response to the EPA of 18 July 2014.

[653] Paragraph 59, Statement of Evidence of Ian Thomas (George) Clement for Deepwater Group Limited, 12 September 2014
[654] Paragraph 10.3 – 10.4, Statement of Evidence of Ian Thomas (George) Clement for Deepwater Group Limited, 12 September 2014
[655] Paragraph 216, Closing Submission for CRP, 19 November 2014
[656] Paragraphs 219 – 226, Closing Submission for CRP, 19 November 2014
[657] Lines 19 – 20, Page 1269 of the Transcript, 17 October 2014

677. Minimum requirements for matters such as night lighting and navigation would apply as set out in the Maritime Rules for New Zealand Waters made under Part 4 of the MTA. Those rules do not however appear to apply beyond the territorial waters of New Zealand, and the DMC was left uncertain as to whether the same or different would apply in the EEZ (although the DMC presumes that the same would be adopted as best practice even in the absence of any specific requirement, noting that New Zealand is a signatory to the IMO Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs**)** which apply). Working lights would be at the operator's discretion, tempered by any regulations that may be required by applicable employment regulations (see below) and the observance of informal codes such as the 2013 National Action Plan Seabirds designed to reduce incidental seabird capture and Vessel Management Plans.

678. In addition the vessel would be required to comply with the Marine Mammals Protection Act 1978 and the Wildlife Act 1953, the latter particularly relating to seabirds, although Mr Prebble noted[658] that this function is primarily managed through the relevant provisions of the Fisheries Act 1996.

679. Questions arose, particularly from Mr Currie, regarding the implication of Boskalis' vessels being flagged to Cyprus if working in New Zealand's EEZ. The DMC was advised that the Health and Safety Reform Bill, currently before the House (introduced on 10 March 2014) specifically provides for the application of the Health and Safety in Employment Act 1992 to foreign vessels on demise charter to a New Zealand operator and working in the EEZ. That legislation is expected to pass in 2015, although the DMC can make no presumptions regarding either the form or content of any relevant sections prior to passage or the likely structure of the mining company applying for the marine consent.

680. Proposed Condition 6 required a Coastal Navigation Warning or other appropriate navigation warning to be promulgated at least one day prior to mining commencing on each mining block. Coastal navigation warnings are issued by the Maritime New Zealand (MNZ) Maritime Operations Centre and cover coastal waters out to a distance of 250 miles from the coast. This would be just a one-off warning, and although it might be sufficient to warn other maritime traffic that mining is about to commence, it would not be a continuous warning that mining is taking place. While the DMC notes the EPA's comments as to whether the one day notification timeframe is in accordance with requirements[659], it considers that there should be an ongoing method of warning that mining is occurring and that a large vessel would be operating over any given mining block.

[658] Paragraph 9, Memorandum of counsel for the Crown in response to a question regarding vessel management and fisheries requirements, 14 October 2014
[659] Page 3, EPA Comment on CRP Conditions, 14 November 2014

681. Proposed Condition 8 required sewage and greywater treatment systems to comply with the Grade A standards as defined in Schedule 6 of the Resource Management (Marine Pollution Regulations) 1998. The DMC considers that this condition would have been appropriate notwithstanding that it does not fall within the EPA's jurisdiction.

682. The DMC is satisfied that appropriate controls for the proposed operation could be set under the relevant marine management regimes, and in accordance with best practice. If the concern raised by Mr Currie was not finally addressed through passage of the Health and Safety Reform Bill, then any necessary remedy would be a matter for the government of the day.

9.11. Mid Chatham Rise Benthic Protection Area

683. The fishing industry attaches considerable importance to the maintenance of the Mid Chatham Rise BPA. The fact that some 90 % of the mining permit area overlaps with the BPA is a significant factor in the industry's opposition to this proposal. Because the BPA also has wider significance in terms of New Zealand's international commitments in the field of biodiversity, the DMC has dealt with this issue separately in Chapter 10.

9.12. Rock lobsters and paua

684. A number of submitters expressed concern over the possible impact of the proposed mining activities on the various life phases of red rock lobsters (also known as koura, crayfish and *Jasus edwardsii*).

685. The DMC heard from Dr MacDiarmid that rock lobster have a number of phases in their life cycle; a long-lived (18 months) and widely dispersed planktonic larval stage (seemingly confined to the upper 200 m of the watercolumn), a post-larval settlement stage that swims inshore to locate suitable settlement habitats, and benthic juvenile and adult phases.[660] The DMC considered the potential effects of the proposal on all phases of the rock lobster's lifecycle.

[660] Paragraph 23, Statement of Evidence of Dr Alison MacDiarmid for CRP, 25 August 2014

686. Dr MacDiarmid told the DMC that no evidence of rock lobsters occurring on the crest of the Chatham Rise in any of the phosphorite nodule mining licence areas had emerged over 50 years of research. Mr Sykes, representing CRA6 Rock Lobster Industry Association, cautioned however they had not fished there and the research had not been targeted on rock lobster.[661]

687. The relevant experts identified the three main risks to rock lobster as:

- interference with the transport of larvae
- interruption to migration
- nutrient runoff.

688. Dr MacDiarmid told the DMC that juvenile and adult phase red rock lobsters are restricted to depths shallower than 250 m. Given that there is a distance of some 170 km between the eastern end of the permit area and the western extent of the 250 m bathymetric contour around the Chatham Islands, she concluded that it was unlikely that there would be any direct impact from the proposed mining operations on rock lobster populations around the Chatham Islands.[662]

Interference with the transport of rock lobster larvae

689. Potential interference with the transport of larvae to the Chatham Islands was considered by the experts involved in the rock lobster conferencing to be the most significant threat to the Chatham Islands rock lobster fishery.[663]

690. They agreed that significant interference to the transport of larvae to the Chatham Islands would constitute a threat to larval settlement.[664]

691. Due to the larvae being entrained in eddy systems to the north of the Chatham Rise, Dr MacDiarmid considered that they were highly unlikely to spend time over the crest of the Chatham Rise in areas potentially affected by sediment plumes from the mining operation.[665]

692. Overall, Dr MacDiarmid concluded that the proposed mining activities were highly unlikely to have any effect on lobster larvae critical to supporting the lobster fishery around the Chatham Islands.[666]

[661] Lines 29 – 33, page 1663 of the Transcript, 22 October 2014
[662] Paragraph 2, Statement of Evidence of Dr Alison MacDiarmid for CRP, 25 August 2014
[663] Issue 1, Joint Witness Statement of Experts in the Field of Rock Lobsters, 16 September 2014
[664] Issue 1, Joint Witness Statement of Experts in the Field of Rock Lobsters, 16 September 2014
[665] Paragraph 4, Statement of Evidence of Dr Alison MacDiarmid for CRP, 25 August 2014
[666] Paragraph 9, Statement of Evidence of Dr Alison MacDiarmid for CRP, 25 August 2014

693. Both Dr MacDiarmid and Mr Sykes agreed that this assessment depended on the accuracy of the sediment plume model and the larval transport settlement model. It was agreed that models have inbuilt uncertainties.[667]

Interruption to rock lobster migration

694. The experts also saw potential for migration paths through the proposed mining site and areas affected by the sediment plume and deposition area to be interrupted.[668] The DMC heard that rock lobster abundance around the Chatham Islands was reliant on the immigration of larger lobsters from deeper water, although there was uncertainty about the depth range and distance of immigration.[669]

695. As the mining was proposed at depths greater than 250 m, it was agreed by Dr MacDiarmid and Mr Sykes that the proposal was unlikely to affect adult rock lobster migration.[670]

696. The DMC heard from Mr Cameron on the Chatham Islands representing PAUAMAC4 Industry Association Incorporated. He cited his main concerns as being impacts on the coastal ecosystems of the Chatham Islands and risks related to vessels, such as an increased risk of oil spills.[671]

Nutrient runoff

697. The experts on rock lobsters discussed the possible impact of nutrient runoff resulting from increased application of rock phosphate fertiliser on the Chatham Islands, if that were to happen. The experts could not agree on whether the effects of any increased use of rock phosphate should be considered as a potential effect of the mining operation. The DMC did not consider that it should be.[672]

9.13. Proposed conditions

698. The establishment of the Environmental Reference Group through Proposed Conditions 47 – 53 appeared to be the main mechanism put forward by the applicant for addressing the concerns of existing interests. The Group would include:

- the consent holder
- a technical specialist in the field of deep-water marine ecology

[667] Issue 1, Joint Witness Statement of Experts in the Field of Rock Lobsters, 16 September 2014
[668] Issue 2, Joint Witness Statement of Experts in the Field of Rock Lobsters, 16 September 2014
[669] Issue 2, Joint Witness Statement of Experts in the Field of Rock Lobsters, 16 September 2014
[670] Issue 2, Joint Witness Statement of Experts in the Field of Rock Lobsters, 16 September 2014
[671] Lines 40 – 45, pages 2191 – 2192 of the Transcript, 12 November 2014
[672] Issue 3, Joint Witness Statement of Experts in the Field of Rock Lobsters, 16 September 2014

- a specialist in the field of marine sediments and sediment plume dispersion
- Department of Conservation
- a representative of the deep-water fishing industry
- a delegate from the Chatham Islands
- a non-governmental organisation with an interest in the marine ecosystems of the EEZ
- an iwi / imi representative from the collective of Ngāti Mutunga, Moriori, and Ngāi Tahu.

9.14. DMC findings on existing interests

699. The existing interests involved in this application are many and varied. Without exception, the submitters in the process representing existing interests were opposed to it. Although the applicant had made an effort to consult with a wide range of parties with an existing interest, the engagement seemed not to have narrowed the differences to any appreciable extent. The uncertainties surrounding the mining operation were of evident concern to a wide range of existing interest groups, and the proposal was seen as putting their commercial and other interests at risk.

700. The evidence presented to the DMC during the hearing, particularly the views of relevant expert groups, did not support the full extent of claims made by existing interest groups as to the likely adverse effects of the mining operation. There were however uncertainties and therefore risks involved in the proposal that had the potential to impact on existing interests.

701. For iwi and imi holding fishing quota, there was a concern that adverse effects from the proposed mining operation would reduce the value of their present assets and future development rights as well as undermine important concepts such as Rangatiratanga and Kaitiakitanga. Similar concerns were held in respect of rock lobsters, paua and eels.

702. In the area of commercial fishing generally, risks were identified in terms of stock reduction, displacement, product branding and sustainability certification. The DMC considers that a robust set of conditions and appropriate adaptive management regime could significantly lower the probability of an effect to a low level. Fishing interests (including iwi and imi) were nevertheless clear that they should not be required to carry such a residual risk, however small. The DMC acknowledges that the Act requires it to take into account potential effects of low probability that have a high potential impact. On the evidence it heard, the DMC was not persuaded that the potential impact on fishing interest would be more than moderate.

703. With regard to marine eco-tourism and specifically Kaikoura Whale Watch Ltd, the marine mammals experts were not in full agreement about the nature and extent of effects of the proposal on marine mammals. There was a degree of uncertainty arising from the fact that evidence of whale sightings was opportunistic and there had been no systematic survey of the distribution or movement of whales on the Chatham Rise. It was generally agreed that the two greatest risks to whales lay in the noise generated by the mining operations and the possibility of collision with mining vessels. Most witnesses seemed to accept however that these risks could be managed through an appropriate set of proposed conditions and a robust adaptive management plan and the DMC agrees. At the same time, it was evident that further research and validation of results would be required to provide certainty about the effects of the proposed mining operation on whales. The DMC accepts this assessment.

704. On maritime and navigation issues, the DMC considers that appropriate controls could be set under the relevant marine management regimes. If the concern raised by Mr Currie was not finally addressed through passage of the Health and Safety Reform Bill, then any remedy would be a matter for the government of the day.

705. While the effects of the proposal on the Rohe Moana cannot be predicted with any certainty, this is clearly a matter of concern to members of the Pā Tangaroa Forum. The DMC acknowledges their concerns. It understands that no group appreciates being asked to carry risks to its livelihood or way of life without its consent, particularly as there is a spatial overlap between the proposed mining area with the Mid Chatham Rise BPA and the Chatham Islands Rohe Moana.

706. On the balance of the information and evidence placed before it, however, the DMC did not feel able to conclude that the mining operation, if the consent were granted and accompanied by a suitable set of conditions, would have had material adverse effects on the Rohe Moana.

707. On the evidence and testimony it heard, the DMC judges that the effects of the mining proposal on existing interests generally are unlikely to arise to the extent submitted and are not determinative of the application. However, the DMC acknowledges the concerns of existing interest holders regarding the mining proposal which they see as involving a number of uncertainties and posing risks to their livelihood and wellbeing.

10. Marine Management Regimes

708. Section 59(2)(h) requires the DMC to take into account the nature and effect of other marine management regimes. The regimes considered during this application were those managed by the Ministry for Primary Industries (Fisheries Act, Fisheries (Benthic Protection Areas) Regulations and Biosecurity Act); the Department of Conservation (Marine Mammals Protection Act, Wildlife Act and Code of Conduct on Acoustic Disturbances); Maritime New Zealand (Maritime Transport Act and HSE Act); and the Ministry of Business, Innovation and Employment (Crown Minerals Act). Each of these regimes has a bearing on some aspect of the proposed activity but the DMC considers the only regimes of any material relevance to our assessment are those covered below.

10.1. Fisheries (Benthic Protection Areas) Regulations 2007

709. Almost the entire proposed mining operation would take place within the 8,732 km^2 Mid Chatham Rise BPA.

710. Mr Winchester advised[673] that the revised marine consent area constituted 55 % of the BPA, and that 92 % of the revised consent area lay within this BPA.[674] Over the first 15 years mining would take place in 9 % of the revised consent area (ie 450 km^2), although the effects would be experienced more widely.

711. As noted earlier in this decision, the BPA network was established by the Fisheries (Benthic Protection Areas) Regulations 2007 (the Regulations), regulations promulgated under the Fisheries Act 1996 which came into force on 15 November 2007. This thereby constitutes a marine management regime matter (Section 7(2) of the EEZ Act) that the DMC is required to take into account under Section 59(2)(h) of the EEZ Act.

712. The four purposes of New Zealand's 17 BPAs is generally stated in Regulation 3 of the Regulations:

> *The purposes of these regulations are—*
>
> *(a) to establish benthic protection areas within New Zealand's fishery waters*
>
> *(b) to set out rules that apply to vessels trawling within the benthic protection areas*
>
> *(c) to prohibit the use of a dredge within the benthic protection areas*
>
> *(d) to create offences and penalties in relation to any breach of these regulations.*

[673] Paragraph 166, Opening Submissions for CRP, 25 September 2014
[674] We note that in the transcript (page 64) these numbers are cited as "roughly 90 %" and "roughly two thirds" respectively

713. The Regulations essentially prohibited the use of trawl nets and dredges used primarily for the collection of shellfish within 100 m directly above the seabed in the 17 identified BPAs. Regulation 9 sets the requirements for the use of trawl nets within any BPA above the 100 m upper buffer zone.

714. The Regulations contain no explanation or rationale for the particular locations or dimensions of the BPAs, although the DMC heard that reasonable size, representativeness and simplicity of shape were factors in the Minister's direction.

715. In its written advice to the DMC, the Ministry for Primary Industries[675] noted that the BPAs started as a fishing industry proposal to close 17 areas of the EEZ to bottom trawling and shellfish dredging in order to address the adverse effects of fishing deepwater marine habitats and ecosystems. This resulted in an Accord signed with the Minister of Fisheries which subsequently progressed into the Regulations. The Accord acknowledged the adverse effects of these fishing methods and sought to set aside some 30 % of New Zealand fisheries waters. Significantly, that correspondence notes that the Minister of Fisheries agreed that the closure was a significant contribution to meeting Government's legislative obligations regarding the adverse effects of such fishing methods on the aquatic environment. The Ministry also noted that other risks to benthic biodiversity from activities other than fishing (eg mining or drilling) were not prohibited under the Regulations.

716. It was common ground that this matter must be addressed. For example, in opening Mr Prebble submitted:[676] *"The impact on the environment within the BPA is a matter that must be considered by the DMC (s 59(2)(d) and (e) of the EEZ Act)."*

717. Mr Winchester submitted[677] that the BPAs were not closed to activities other than those specifically prohibited, noting that Parliament could have prohibited applications for other activities either specifically or generally at the time, or regulations to the same effect could have been gazetted subsequently, but were not. Furthermore,[678] he noted that during the passage of the EEZ Act the Parliamentary Commissioner for the Environment had specifically sought the exclusion of other activities in the BPAs but this was not adopted. Mr Winchester advised caution[679] regarding the making of judgements on the general policy question of marine protected areas because of the wider policy issues involved. Mr Winchester also observed that the Crown's opening position was one of neutrality with respect to the proposal and that it did

[675] Ministry for Primary Industries report provided in accordance with Section 44 of the EEZ Act, 18 July 2014
[676] Paragraph 23, Crown's Opening Submissions, 25 September 2014
[677] Paragraph 169, Opening Submissions for CRP, 25 September 2014
[678] Footnote 62 to paragraph 173, Opening Submissions for CRP, 25 September 2014
[679] Paragraph 12, Opening Submissions for CRP, 25 September 2014

not actively seek protection for the Mid Chatham Rise BPA, although noting[680] that mining would be inconsistent with the fishing industry and decision-makers intent, and could undermine international recognition as a protected area.

718. The DMC was told that the BPAs contribute to New Zealand's targets under the United Nations Convention on Biological Diversity (CBD) 1992 (a matter directly relevant under Section 11 of the EEZ Act). In that regard, the DMC notes Mr Prebble's remarks in his opening statement on behalf of the Crown [681] that while the existence of the BPA does not preclude a grant of consent: *"... mining in the Mid Chatham Rise BPA would be inconsistent with the fishing industry and decision-maker's intent in establishing the BPA network and could undermine international recognition of the area's status as a protected area (which goes towards meeting New Zealand's international obligations arising primarily from the CBD)."*

719. Furthermore, he repeated that submission in closing[682], observing that *"There are a number of international obligations that New Zealand has which relate to BPAs and which will be relevant to consider should consent be granted."*

720. And in a footnote to that remark he noted[683] *"New Zealand has promoted the BPAs as meeting the obligations under CBD on the world stage (IUCN definition for protected areas). This is on the basis the BPA meets both the following criteria in the IUCN definition for a protected area: (1) the primary objective must be conservation; and (2) the management of the area must result in proper conservation from all types of activities that could negatively impact it."*

721. In answer to a question as to whether granting the application in this particular BPA would have implications for the entire BPA network, and therefore affect New Zealand's obligations under CBD, Mr Prebble was unable to provide a categorical answer[684] but advised *"... all I can say at this point is that if consent were granted I think the Crown would have to undertake a consideration of what was the implications of that more broadly. I don't have an answer for you on that specific point."*

722. The potential adverse effects in terms of mining activity within the BPA was addressed from two angles:

- whether the activity of mining is contrary to the purpose and function of the BPA
- whether the activity of mining in the BPA would adversely affect the MSC certification held (or currently applied for) by the fishing industry.

[680] Line 45, page 65 of theTranscript, 25 September 2014
[681] Paragraph 28, Crown's Opening Submissions, 25 September 2014
[682] Paragraph 67, Crown's Closing Submissions, 18 November 2014 (note the submission states 18 October 2014
[683] Footnote 72 of paragraph 67, Submissions, 18 November 2014 (note the submission states 18 October 2014
[684] Lines 10 – 15, page 2492 of the Transcript, 18 November 2014

723. The DMC has addressed the MSC matter in Chapter 9.9.

724. Turning to the first matter, many parties in opposition submitted that mining in the BPA was essentially an incompatible activity. Rather than cite all those, and for the sake of brevity, the DMC has focused on the evidence of Mr Clement as a proxy for that argument.

725. Mr Clement is chief executive of the Deepwater Group and the chairman of Seafood New Zealand Limited, and advised the DMC[685] that he was the initiator of the BPA concept. He explained that as fishing was the only significant commercial human activity occurring beyond the territorial sea at the time, and marine protection legislation seemed to be stuck, it was decided to use the Fisheries Act to promote the establishment of protected areas beyond the territorial sea, and as trawling and shellfish dredging were only the two activities causing benthic damage, these were the focus of the regulations.

726. Mr Clement further explained the basis for the representative series of BPAs ranging from the sub-Antarctic to the subtropics and covering both east and west of New Zealand encompassing the two key geological plates, based on what was then the best available information. While he acknowledged that overall these 17 areas were not commonly trawled or dredged because of their general depth, he denied that this was either intentional and / or self-serving of the industry. In that regard he opined[686] that the Mid Chatham Rise BPA, while being shallower and therefore within range of these prohibited methods, was a vital component in the network, comprising habitat not well represented elsewhere in the EEZ. Furthermore, he observed that because of the BPA network New Zealand (taking into account other marine protected areas and seamounts) is one of only 28 countries internationally who have met or exceeded the goal of 10 % marine area protection (Mr Clement[687] gives a figure of 30 %).

727. Mr Clement concluded[688] that *"... our global credibility in this regard would be weakened if our MPAs and the BPAs are no longer seen to be provide secure broad scale and representative protection for benthic biodiversity."* He stated that *"the confidence that the New Zealand and global community might have in the integrity of the BPA network would be jeopardised if mining were to be permitted, regardless of how comparatively small an area (in terms of the whole BPA network) is involved."*

728. The applicant disputed this line of argument. Its response to this matter, other than the strict legal interpretation given by Mr Winchester, was provided by Mr Wood (who was involved as a consultant to the Deepwater Group in 2006 when the BPAs were being drafted, although not

[685] Line 30, page 1823 of the Transcript, 4 November 2014
[686] Line 10, page 1826 of the Transcript, 4 November 2014
[687] Lines 30 – 33, page 1826 of the Transcript, 4 November 2014
[688] Lines 20 – 25, page 1827 of the Transcript, 4 November 2014

involved in the industry discussions[689]). His evidence was to the effect that he had made officials aware at the time that winnable minerals existed throughout the proposed BPAs but that they were interested only in fishing-related activities.[690] Furthermore, he advised that the Mid Chatham Rise BPA was based on Marine Environmental Classification (MEC) Class 63, which comprised an area stretching from the Chatham Islands (and beyond) to the east coast of the South Island, within which the BPA could have been (and could yet be) configured. He included two slides[691] showing, for argument's sake, two additional areas (each) on the Rise in proximity to the BPA which fell within the MEC Class 63 and over which no or little evident trawling effort had taken place according to recent data. The applicant's argument was that through better spatial planning, using a tool such as Zonation, more precisely justified protection areas could be established so that there would be no net loss in effect from the mining but rather a conservation gain. Additionally, a network of proposed exclusion areas had been identified using the Zonation tool within the wider mining licence and proposed prospecting permit areas in which no-mining is proposed because of their high biodiversity value, and for which the applicant offers a "*best endeavours*" condition to secure their longer term protection.

729. Ms Appleyard[692] (and other counsel) responded that regardless of the merits of that proposition, merits that she did not accept, the applicant could not guarantee exclusion areas in perpetuity, neither could the present process achieve any realignment or establishment of new BPAs, indeed the processes for both lay entirely beyond the jurisdiction of the DMC. This point was not disputed.

730. Ms Appleyard[693] also made reference to the Denniston Plateau / Escarpment Mine case in which the Court accepted the offer of future protection as compensation precisely because two Ministers of the Crown wrote to the Court indicating their willingness to facilitate the formal protection of the Denniston Plateau Protection Area in the event of a grant of consent. That, she opined, was a materially different circumstance to that offered by the applicant and should be distinguished accordingly. In the present instance, there is no evidence before the DMC of any such intent on the part of Government.

10.1.1. Findings

731. The DMC takes the view that mining the seafloor in an area in which a comparable activity is prohibited would be, at the very least, contradictory. Notwithstanding the argument that mining *per se* is not prohibited and is therefore lawful for the purposes of the Regulations, the DMC

[689] Lines 35 – 30, page 226 of the Transcript, 26 September 2014
[690] Paragraph 107, Statement of Evidence of Raymond Allen Wood for CRP, 28 August 2014
[691] Slides 4 and 5, Benthic Protection Areas and Marine Resources presented with evidence by Raymond Allen Wood, 26 September 2014
[692] Paragraph 16, Closing Statement on behalf of Deepwater Group Ltd, 18 November 2014; Lines 25 – 32, Pages 143 of the Transcript, 26 September 2014; and Lines 45 – 28, pages 2419 – 2420 of the Transcript, 18 November 2014
[693] Paragraph 78, Closing Statement on behalf of Deepwater Group Limited, 18 November 2014

finds such a position untenable from a benthic ecology point of view. The net effect, being the destruction of a sizeable benthic area that is protected from an activity similar to mining, is clearly contrary to purpose (a) of the BPA, which is not just to prohibit the specific activities of trawling and dredging but also to protect the benthos.

732. The DMC accepts that the BPAs are creatures of subordinate legislation and, like many such entities, are not set in stone. The Minister clearly has the ability to amend the regulation, and this could be based on updated information received as a result of the sort of Zonation spatial planning tool utilised by the applicant, appropriately ground-truthed for verification, in consultation with relevant stakeholders. As the applicant submitted, such an approach could lead to more refined BPAs. However, and in this Mr Winchester and Ms Appleyard held common ground, this is beyond the DMC's jurisdiction.

733. The DMC notes however that evidence was presented that a significant area of potential stony coral dominated habitat exists to the north west of the mining permit and western prospecting permit application areas, predominantly outside but contiguous with the BPA. Without verification that the particular ecological communities of concern are more widely distributed and of an appropriate order of magnitude in abundance, the DMC would find that destroying the existing protected benthic biodiversity would put in question the integrity of the Mid Chatham Rise BPA. A problem for this application, then, is that even if such comparable communities were found beyond the BPA, presumably in areas currently open to fishing (both trawling and longline), their protection could not be guaranteed by any decision of the DMC. Moreover, and despite the applicant's offer of best endeavours, there was no indication from the Crown that such an option was either currently contemplated or would be pursued.

734. A related concern of the DMC is the applicant's proposed conditions as drafted appear to set the mining blocks for the first three years in Attachment B with little opportunity to change. This would result in three years of destructive activity in the identified mining blocks, potentially containing unique benthic communities, irrespective of what may or may not be found in the area to the north-west. Verification that the potentially unique ecological communities of concern are more widely distributed and of an appropriate order of magnitude and abundance would need to be established prior to mining commencing.

735. Proposed Condition 60 acknowledged the need for a legal mechanism to provide protection for any mining exclusion areas from uses other than mining. The difficulty with this proposed condition is that any legal mechanisms cannot be implemented by the applicant and must rely on the actions of third parties such as Ministry for Primary Industries and the Department of Conservation. As stated in the opening legal submissions for KASM, Greenpeace and DSCC,

this is an entirely different process with entirely different participants.[694] The DMC understands that this is the primary reason for the use of "*best endeavours*" in the proposed condition; in that the applicant may not have any control over the establishment of protection over the mining exclusion areas other than refraining from mining them. The DMC agrees with the EPA comments that such a condition may not be enforceable. [695] The DMC considers this proposed condition could not realistically be relied upon to provide protection for mining exclusion areas and does not provide assurance that an alternative BPA would be identified or provided.

736. The DMC concludes that granting consent to this application would effectively negate, and make redundant, one of the purposes and the effect of the Mid Chatham Rise BPA.

10.2. Biosecurity

737. Biosecurity issues are likely to occur in association with the arrival of the mining vessel and other vessels such as AUVs into New Zealand waters. Ballast water, vessel biofouling and aquatic equipment are potentially biosecurity risks.

738. The application[696] adequately addressed the question of ballast water (in terms of New Zealand's Import Health Standard for Importing Ballast Water from all Countries) and expressed the applicant's commitment to following New Zealand's obligations under international treaties and agreements. The vessel would re-ballast en route to New Zealand. Once operating in New Zealand, the vessel would ballast at New Zealand ports and discharge the water on the Chatham Rise. This means there would be no ballast biosecurity issue and re-ballasting would not need to occur unless the vessel went overseas (for example, for other mining operations, inspection or dry docking).

739. The applicant committed[697] to managing biofouling in accordance with the Biosecurity Act 1993. The vessel's hull would be clean when it arrives in New Zealand and would be kept free of visible biofouling (except for a slime layer).

740. The Crown sought that the applicant explicitly addressed the biosecurity risks associated with mining equipment in its biosecurity management plan. The applicant had not done this by the conclusion of the hearing. Underwater equipment such as anchors, chains and components of the mining system including the pump unit, drag-head and riser were seen as biosecurity concerns that needed to be accounted for and managed under the relevant Import Health

[694] Paragraph 51, Opening Submissions by KASM, Greenpeace and DSCC, 26 September 2014
[695] Page 16, EPA Comment on CRP Conditions, 14 November 2014
[696] Paragraphs 107 – 108, Statement of Evidence of Gerard van Raalte for CRP, 28 August 2014
[697] Paragraph 109, Statement of Evidence of Gerard van Raalte for CRP, 28 August 2014

Standard (ie Import Health Standard for Used Equipment Associated with Animals or Water, Import Health Standard for Vehicles, Machinery and Tyres).

741. The Crown in its closing statement continued to seek a requirement that the biosecurity risks associated with mining equipment be explicitly addressed in the biosecurity management plan and that the voluntary Vessel Biofouling Craft Risk Management Standard (CRMS) be applied from the outset. The Crown acknowledged that the Vessel Biofouling CRMS was voluntary until 2018 and that the jurisdiction of Import Health Standards and CRMSs did not currently extend beyond New Zealand's territorial waters (12 nautical mile limit). The Crown considered that these limitations posed a challenge for managing marine biosecurity risks in the EEZ and that it was desirable to make vessel biofouling management a consent condition.[698] However the DMC notes that after 2018 and once inside New Zealand's territorial waters, on each return to port, the CRMS would apply.

742. Only Proposed Condition 29(e) made reference to biosecurity management of the mining vessel and its equipment, as a component of the standard operating procedures in the Environmental Management and Monitoring Plan (EMMP).

743. The DMC understands the Crown's concerns but sees no reason why those issues could not have been addressed in the EMMP. Proposed Condition 32 would require the Chief Executive of the EPA to certify that the EMMP met the requirements of Proposed Conditions 29 or 30, advise the consent holder that amendments were required or advise the consent holder of a timeframe extension for further evaluation of the EMMP, including possible assessment by an external reviewer. The DMC considers that this process would have allowed the concerns raised by the Crown in terms of biosecurity to be addressed.

[698] Paragraphs 52 – 53, Crown's Closing Submissions, 18 November 2014 (note the submission states 18 October 2014)

11. Economic Benefit to New Zealand

11.1. The issues

744. Section 59(2)(f) of the EEZ Act requires the DMC to take into account the economic benefit to New Zealand of allowing the application. In addition Section 10(2) of the EEZ Act provides an economic dimension to the definition of sustainable management, with its reference to enabling people to provide for their economic wellbeing.

11.2. Economic benefit to New Zealand

745. The Crown's submission discussed the potential for the mining of phosphorite from the Chatham Rise to increase New Zealand's export earnings, boost employment, support other businesses such as ports and encourage further investment in the mining industry. Quoting from World Bank and other forecasts concerning the global phosphate supply and demand situation, however, the Crown warned that price forecasts needed to be treated with considerable caution given changing market dynamics and recent price volatility.[699]

746. Mr Castle for the applicant noted in his evidence that phosphate accounted for some 40 % of the fertiliser used in New Zealand agriculture and horticulture and that all our phosphate was currently imported from Morocco in the form of rock phosphate, most of which is converted to superphosphate by a process known as beneficiation. Statistics New Zealand put the present level of imports of rock phosphate into New Zealand at around 770,000 tonnes per year.[700] Mr Castle's own view was that the average annual demand in New Zealand was likely to be closer to one million tonnes per year.[701]

747. The applicant produced an analysis from the New Zealand Institute of Economic Research (NZIER) suggesting that, on the basis of the information provided in CRP's prospectus, a predicted future world phosphate rock price of US$ 184 per tonne with an assumed exchange rate of US$ 0.80 to NZ$ 1.00, the proposed mining activity would boost New Zealand's GDP by some NZ$ 280 million per year and produce a net welfare gain of NZ$ 130 million per year.[702] According to NZIER, some 40 % of this benefit would accrue to New Zealanders not involved with the applicant.[703] A subsequent re-run of the Institute's economic model using a lower forecast world phosphate price ($US 108 per tonne) still produced a positive, albeit reduced,

[699] Paragraph 22, part 1, Submission of The Crown, 10 July 2014
[700] Page(i) of Appendix 6 of the EIA, Economic Assessment of Chatham Rock Phosphate – Input to the EIA, March 2014
[701] Paragraph 28, Statement of Evidence of Christopher David Castle for CRP, 28 August 2014
[702] Section 6.2 of Appendix 6 of the EIA, Economic Assessment of Chatham Rock Phosphate – Input to the EIA, March 2014
[703] Section 5.1.3 of Appendix 6 of the EIA, Economic Assessment of Chatham Rock Phosphate – Input to the EIA, March 2014

estimated welfare benefit to New Zealanders of NZ$ 110 million per year over the first fifteen years of the proposal.[704]

748. Taxes and royalties payable to the Government were initially estimated by NZIER to be of the order of $46 million per year.[705] This figure was however subsequently reduced by the applicant to an estimated $24 million per year.[706] NZIER estimated the proposal's direct domestic expenditure at NZ$ 12 million per year for fuel, labour and overheads.[707] Attention was drawn to the expected environmental benefits of using Chatham rock phosphate on New Zealand farms, such as lower cadmium levels in soils, reduced emissions from shipping and a slower rate of phosphate leaching if the rock phosphate were applied directly rather than in the form of superphosphate.[708] Other benefits noted by NZIER and the applicant were: modest employment gains; flow-on benefits to ports, port services and the transport sector; security of supply; a measure of import substitution (some 25 % of the estimated annual production of 1.5 million tonnes was projected by the applicant to be sold in New Zealand); and increased export earnings (the remaining 75 % of the proposal's production was expected by the applicant to be exported to Australia and South East Asia).

749. On the economic consequences of its effects on the environment, Mr Clough of NZIER argued that the comparatively small size of the mining area (estimated by the applicant to be around 0.5 % of the total area of Chatham Rise above the 1,000 m depth contour), coupled with its distance from land, meant that the mining activities would have a very small environmental footprint.[709] Mr Clough acknowledged the difficulty of putting a dollar value on the proposal's environmental effects.[710] NZIER believed however that the economic consequences of any environmental effects of the proposal would not outweigh the economic benefits to New Zealand as estimated from the computable general equilibrium (CGE) model.[711]

750. The NZIER report also concluded, on the basis of information supplied by the applicant, that the proposal did not pose a significant risk to New Zealand's fishing industry. In Mr Clough's words, *"the commercial values at risk from the CRP mining proposal appear so small as to be negligible".*[712]

[704] Paragraph 32, Statement of Evidence of Peter Clough for CRP, 28 August 2014
[705] Section 4.1.2 of Appendix 6 of the EIA, Economic Assessment of Chatham Rock Phosphate – Input to the EIA, March 2014
[706] Paragraph 9, Supplementary Statement of Evidence of Evidence of Christopher David Castle for CRP, 7 November 2014
[707] Section 4.1.2 of Appendix 6 of the EIA, Economic Assessment of Chatham Rock Phosphate – Input to the EIA, March 2014
[708] Section 4.2 of Appendix 6 of the EIA, Economic Assessment of Chatham Rock Phosphate – Input to the EIA, March 2014
[709] Paragraph 35, Statement of Evidence of Peter Clough for CRP, 28 August 2014
[710] Section 2.4 of Appendix 6 of the EIA, Economic Assessment of Chatham Rock Phosphate – Input to the EIA, March 2014
[711] Section 6.2 of Appendix 6 of the EIA, Economic Assessment of Chatham Rock Phosphate – Input to the EIA, March 2014
[712] Lines 36 – 37, page 1023 of the Transcript, 15 October 2014

751. In summary, NZIER's assessment was that the proposal should result in a significant overall net benefit for the New Zealand economy.[713] This view was endorsed by a number of submitters who supported CRP's application.[714]

752. An important caveat entered by NZIER to this positive assessment however was that the proposal needed to be assessed by the applicant as commercially viable and should proceed as planned.[715] On the proposed company structure, the DMC was told that some 50 % of the proposal was likely to be under foreign ownership, that the only significant assets to be owned by CRP were the mining permit and the marine consent; and that the operating assets would be owned and managed by an overseas company.[716] CRP's likely partner in this venture was Boskalis.

753. The DMC was told that the applicant planned to negotiate a contract for Boskalis to contract-mine the Chatham Rise phosphate rock for at least 15 years if the application for a marine consent was successful.[717] Although no contracts had been finalised at the time of the hearing, Boskalis' expert witnesses confirmed in their evidence that their company had confidence in the applicant's proposal and was strongly committed to it.[718]

754. Mr Clough described at some length the CGE model used to estimate the likely direct, indirect and induced effects of the applicant's operations on the New Zealand economy. He explained that it was believed this was the most appropriate model to use because it would capture the linkages between the mining sector and the wider economy.[719] He acknowledged that the model had some drawbacks, for example, a number of external factors were outside its scope and it had not previously been used for a mining activity, but noted that had been used by a number of agencies over a range of fields in New Zealand.[720]

755. Dr Nana of Business and Economic Research Limited, who had specialised knowledge of CGE models, affirmed in his evidence that the CGE model was, in his view, well suited to an assessment of the economic impact of a phosphate mining proposal.[721] His own assessment was that the proposal's impacts would be positive, although relatively small, in terms of both New Zealand's GDP and economic welfare gains.[722] He acknowledged however that he had not

[713] Section 6.2 of Appendix 6 of the EIA, Economic Assessment of Chatham Rock Phosphate – Input to the EIA, March 2014
[714] Section 5, bullet point 1, Analysis of Submissions Report July 2014
[715] Paragraph 2, Statement of Evidence of Peter Clough for CRP, 28 August 2014
[716] Paragraphs 9 – 10, Executive Summary of Evidence of Christopher David Castle for CRP, 26 September 2014
[717] Lines 9 – 11, page 193 of the Transcript, 26 September 2014
[718] Paragraph 96, Statement of Evidence of Sander Steenbrink for CRP, 28 August 2014 and line 38, page 605 of the Transcript, 1 October 2014
[719] Paragraph 21, Statement of Evidence of Peter Clough for CRP, 28 August 2014
[720] Page 5, Response to EPA Request for Further Information 28 – 33, Memo from Peter Clough to EPA regarding Further Information Request from EPA, 27 June 2014 (date on EPA website — 1 July 2014)
[721] Paragraph 14, Statement of Evidence of Dr Ganesh Nana for CRP, 28 August 2014
[722] Paragraph 41, Statement of Evidence of Dr Ganesh Nana for CRP, 28 August 2014

verified the data provided to NZIER by the applicant. In his view, the world price of phosphate was a particularly important assumption in terms of influencing the assessment of the proposal's overall economic impact on New Zealand.[723]

756. Dr Nana expressed the view that an increase in foreign ownership would not affect the estimated GDP increase although it would reduce the welfare benefits of the model[724] since more of the economic benefits would flow overseas. Dr Nana noted that environmental and cultural costs were not included in the modelling and that the model was *"agnostic to environmental costs".*[725] Dr Clough confirmed that his assessment had not addressed adverse impacts on cultural values.[726]

757. NZIER's initial analysis was reviewed by the Sapere Research Group, which raised questions about the data used by NZIER and questioned the choice of the CGE model to estimate the economic benefits to New Zealand of this kind of proposal.[727] Sapere observed that the results of the modelling did not appear to have been subjected to critical evaluation and testing and questioned whether anyone in New Zealand had the right experience to model the economic effects of undersea mining.[728] Querying the decision to assume a market price of US$ 184 per tonne for the modeling exercise, Mr Murray of Sapere noted that the January 2014 World Bank forecasts of phosphate prices had ranged from US$ 110 per tonne in 2014 to US$ 90 per tonne in 2025 and that the world price presently sat at around US$ 110 per tonne.[729] In his opinion, the economic benefits predicted by the CGE model were overly optimistic.[730] He did agree however that, regardless of the economic model used, there stood to be a positive impact on the New Zealand economy if the proposal went ahead, and if the key assumptions and forecasts used in CRP's prospectus proved well founded.[731]

758. Mr Sundakov, an expert witness called by Ngāi Tahu, was strongly critical of the NZIER assessment. In his view, the net economic effects of the proposal were more likely to be negative than positive.[732] He questioned both the data used by NZIER in its modeling and the appropriateness of the CGE model. In his view, a partial equilibrium model would have been more appropriate, and would have given decision-makers more certainty, because of the limited

[723] Paragraph 42, Statement of Evidence of Dr Ganesh Nana for CRP, 28 August 2014
[724] Line 10, page 1072 of the Transcript, 15 October 2014
[725] Line 5, page 1072 of the Transcript, 15 October 2014
[726] Line 10, page 1054 of the Transcript, 15 October 2014
[727] Paragraphs 26 and 46 of Annexure B (Review of economic gains expected from Chatham Rock Phosphate mining proposal) of the Statement of Evidence of Kieran O'Neill Murray: Economic Impact, 12 September 2014
[728] Paragraph 26 of Annexure B (Review of economic gains expected from CRP mining proposal) of the Statement of Evidence of Kieran O'Neill Murray: Economic Impact, 12 September 2014
[729] Paragraph 2 of Annexure B (Review of economic gains expected from Chatham Rock Phosphate mining proposal) of the Statement of Evidence of Kieran O'Neill Murray: Economic Impact, 12 September 2014
[730] Lines 19 – 20, page 1138 of the Transcript, 16 October 2014
[731] Lines 6 – 8, page 1140 of the Transcript, 16 October 2014
[732] Paragraph 88, Statement of Evidence of Aleksandr Sundakov on behalf of Te Rūnanga o Ngāi Tahu and Deepwater Group Limited, 11 September 2014

linkages of the project to New Zealand's wider economy.[733] He believed the rock phosphate prices used in the NZIER assessment to be optimistic.[734]

759. Mr Sundakov also questioned whether the potential downside of the proposal had been properly assessed, noting that his own research had led him to the view that the negative effects of the proposal on commercial fisheries and the damage to the natural environment, although uncertain and difficult to quantify, could be very large.[735] This was attributable not so much to the possible depletion of fish stocks as to the potential loss of MSC certification and the adverse effect this, and any other reputational damage the proposal might cause, would have on the industry's market access and prices.[736] He estimated the potential costs to the fisheries industry to be in the range of NZ$ 270 million to NZ$ 1.5 billion per year, noting that Māori stood to be directly affected both as quota owners and as part owners of Sealord.[737] (Mr Murray suggested during the hearing that these figures were overstated and that the probabilities of each scenario used by Mr Sundakov needed considerably more work).[738] Mr Sundakov's view, in short, was that the benefits of the proposal did not outweigh the potential risks to third parties and the environment.[739]

760. Mr Sundakov's concerns about the possible adverse effects of the proposal on the commercial fishing industry were echoed by a number of submitters and witnesses. The Deepwater Group described the proposal as *"fundamentally incompatible with the purpose of the Mid Chatham Rise BPA"*[740] and expressed concern at the possible impact of the proposal in terms of disruption to Quota Management System incentives, the integrity of New Zealand's BPA network, its shareholders' interests and consumer perceptions of the sustainability of New Zealand seafood.[741]

[733] Paragraph 18, Statement of Evidence of Aleksandr Sundakov on behalf of Te Rūnanga o Ngāi Tahu and Deepwater Group Limited, 11 September 2014
[734] Paragraph 32, Statement of Evidence of Aleksandr Sundakov on behalf of Te Rūnanga o Ngāi Tahu and Deepwater Group Limited, 11 September 2014
[735] Paragraph 10, Statement of Evidence of Aleksandr Sundakov on behalf of Te Rūnanga o Ngāi Tahu and Deepwater Group Limited, 11 September 2014
[736] Paragraph 51, Statement of Evidence of Aleksandr Sundakov on behalf of Te Rūnanga o Ngāi Tahu and Deepwater Group Limited, 11 September 2014
[737] Paragraph 87, Statement of Evidence of Aleksandr Sundakov on behalf of Te Rūnanga o Ngāi Tahu and Deepwater Group Limited, 11 September 2014
[738] Line 40, page 1140 of the Transcript, 16 October 2014
[739] Paragraph 10, Statement of Evidence of Aleksandr Sundakov on behalf of Te Rūnanga o Ngāi Tahu and Deepwater Group Limited, 11 September 2014
[740] Paragraph 10, Statement of Evidence of Ian Thomas (George) Clement for the Deepwater Group Limited, 12 September 2014
[741] Paragraphs 71 – 80, Statement of Evidence of Ian Thomas (George) Clement for the Deepwater Group Limited, 12 September 2014

761. Mr Summerton saw a range of adverse effects in the proposal, including damage to the Chatham Rise ling spawning areas, the effects of sedimentation and risks to customer perceptions of the New Zealand brand.[742]

762. Ngāi Tahu's opening statement asserted that "*the best available information will confirm that CRP's proposal will deliver small and uncertain economic benefits to New Zealand while destroying or putting at risk unique biodiversity, cultural taonga and highly valuable fishing grounds and spawning areas*".[743] As against this, it was generally agreed among fisheries experts that the impact of the proposal on commercial fishing would not be as significant as some submitters feared.[744]

763. Pre-hearing conferencing did little to narrow the gaps among expert economic witnesses. There was, for example, continued disagreement about the appropriateness of the CGE model and the data used by NZIER. The experts could not agree on an economic value for the lower cadmium content and slower leaching properties claimed for Chatham rock phosphate or whether greenhouse gas emissions would be reduced or increased by changes in shipping patterns arising from the export of Chatham rock phosphate. Similarly, they could not reach an agreed position on the economic consequences of the proposed mining operation on fish stocks or the possible impact on New Zealand's fishing industry in such areas as sustainability certification and market reputation.[745] (As indicated above, fisheries experts were generally less concerned about the risks posed by the proposal to the commercial fishing industry than industry and individual submitters). The economic experts remained divided on the probability and economic consequences of adverse environmental effects.[746]

764. The differences of view noted in the expert conferencing report were not narrowed to any appreciable extent during the hearing. Questions persisted about the data on which the modelling was based, the appropriateness of the CGE model in this situation and NZIER's apparent dismissal of the possible adverse effects of the proposal on existing interests and the environment as being of little or no significance.

765. Mr Ngapora, General Manager of Whale Watch Kaikoura Ltd, expressed concern that the proposed mining operation could have an adverse impact on his company, on Kaikoura's tourism industry (estimated to be worth around $134 million per year in direct benefits to the Kaikoura community) and on Ngāi Tahu's commercial interests.[747] He advocated a

[742] Paragraphs 67 – 106 Amended Statement of Evidence of Greg Summerton on behalf of Te Rūnanga o Ngāi Tahu, 29 September 2014
[743] Paragraph 1, Opening Representation on behalf of Te Rūnanga o Ngāi Tahu, 25 September 2014
[744] Issue 4A, Joint Witness Statement in the field of Economics, 18 September 2014
[745] Issue 4, Joint Statement of Experts in the Field of Economics, 18 September 2014
[746] Issue 5, Joint Statement of Experts in the Field of Economics, 18 September 2014
[747] Paragraph 24, Statement of Evidence of Kauahi Koroneho Ngāpora on behalf of Te Rūnanga o Ngāi Tahu, 11 September 2014

precautionary approach to the proposed mining activity in the absence of robust scientific evidence.

766. In the course of its stakeholder consultation programme, the applicant had canvassed various possibilities for improving the economic situation of the Chatham Islands community. Consideration had been given to a range of options, including evaluating the possibility of developing a port in the Chatham Islands and supplying unprocessed rock phosphate to local farmers at cost or lower. Finally, it was instead proposed by the applicant that a Chatham Islands Trust be established to which the applicant would contribute $200,000 per year (inflation adjusted) for farming activities and a further $80,000 per year for education opportunities and cultural activities. It was also anticipated that the applicant's proposed Environmental Trust would direct funds towards Chatham Islands conservation proposals. In addition, the applicant offered to support local efforts to obtain a share of the government's royalties, stated its commitment to using Chatham Islands input as much as possible and invited further ideas as to ways in which the Chatham Islands could benefit from the proposal.[748]

767. In his opening representation on behalf of the Hokotehi Moriori Trust, Mr Solomon asserted that the proposal had the potential to seriously and adversely impact on the Rekohu (Chatham Islands) economy yet provided negligible benefits to Rekohu.[749] This sentiment was echoed in the statements made on behalf of Ngāti Mutunga at the session of the hearing held in Chatham Islands. The Chair of the Trust spoke of the uncertainty surrounding the impacts of the proposal and commented *"we don't want to be the guinea pigs"*.[750] Mr Kamo, Chief Executive of the Trust, questioned the reliability of the modelling used in the proposal and, while acknowledging the efforts made by the applicant to try and develop a partnership with the Chatham Islands community, criticised what he termed the "risk to return ratio" now proposed for Chatham Islanders in the following terms: *"What we are concerned about is that the risk that the iwi here, and in fact the community, has been asked to take on, is a risk to its fishery economic base, its cultural base, its Whānau base and its identity. …And we are concerned that (our identity) could be impacted over time to the extent that whilst the economic loss would be devastating, the cultural loss to our identity would be incalculable."*[751]

768. The representation made by the Chatham Islands Council affirmed that its position was one of neutrality rather than, as had first been indicated, conditional support. It noted that a number of concerns had been raised about the proposal and that the Council would not support it until answers had been received to the questions it had raised, the concerns it had voiced had been

[748] Lines 28 – 34, page 2163 of the Transcript, 12 November 2014
[749] Paragraph 4, Opening Representation on behalf of Hokotehi Moriori Trust, 10 November 2014
[750] Line 45, Page 2171 of the Transcript, 12 November 2014
[751] Line 5, page 2176 of the Transcript, 12 November 2014

satisfied and a commitment had been made to maximise the economic and social benefits to the Chatham Islands.[752]

11.3. Proposed conditions

769. Economic benefits are difficult to condition, particularly when they are related to taxes and royalties. Proposed Conditions 54 – 56 would establish an Environmental Compensation Trust for those environmental impacts that could not be avoided, remedied or mitigated. Proposed Conditions 57 – 59 would set up a Chatham Islands Trust to support initiatives that benefited the Chatham Islands community, Ngāti Mutunga and Moriori. The applicant's offer of a bond left open a number of questions such as what would trigger the release of the funds and where the payments would go.

11.4. DMC findings

770. The DMC accepts that if the applicant's operating cost forecasts and its other assumptions and projections (for example, concerning the company's structure, the mining operation, the international supply and demand situation, the New Zealand market for direct application phosphate fertiliser, global rock phosphate prices and the NZ$ exchange rate) were borne out and the proposal were to proceed as planned, there would be some positive economic spinoff to New Zealand. The return to the government from taxes and royalties in that situation was estimated by the applicant to be of the order of $24 million per year.[753] There would be some modest employment gains (primarily an estimated 50 crew positions on the mining vessel) and a positive flow-on economic impact on one or more ports, port engineering services and the transportation sector.

771. On the proposal's less quantifiable benefits, while it is not possible to put a figure on security of supply and the environmental benefits claimed for Chatham rock phosphate over imported Moroccan phosphate, these factors could well work to New Zealand's advantage. The DMC was assured that Chatham rock phosphate's higher than average uranium content, while it would over time result in higher levels of accumulation in the soil, was not an immediate problem. Chatham rock phosphate's lower than average cadmium content was seen as an advantage, as were the expected slower leaching rates to the extent that Chatham rock phosphate was used in New Zealand as a direct application fertiliser.

772. The applicant confirmed to the DMC that, based on the assessments made by various international agencies, it was confident that there would be a significant export market for its

[752] Submission from Chatham Islands Council and Statement of Evidence of Alfred Preece on behalf of Chatham Islands Council, 12 November 2014
[753] Section 4.1.2 of Appendix 6 of the EIA, Economic Assessment of Chatham Rock Phosphate – Input to the EIA, March 2014

phosphorite.[754] The applicant also drew attention to the improved understanding of New Zealand's marine environment that would flow from its further surveys and research[755] and its offer to establish a trust fund for environmental research.[756]

773. The future world price of phosphate was generally agreed to be of critical importance in any assessment of the proposal's economic impact on New Zealand, and yet it was the subject of strong disagreement among the experts. It seemed to be generally agreed that a price of around US$ 125 per tonne would constitute a break-even point for the proposal. It was suggested by the applicant that long run contract prices would be more important than spot prices in determining the success of the proposal.[757]

774. The DMC heard a good deal of questioning of the use of the CGE model in assessing the wider economic benefits to New Zealand of this kind of proposal. While the DMC is not in a position to make a definitive finding as to the respective merits of the various economic models available for this kind of assessment, it shares the view expressed by some experts that the results produced by the CGE model were overly optimistic.[758]

775. Notwithstanding Dr Mackay's evidence about the potential for using slow release fertiliser on land with a low, short-term requirement for phosphorous, there remains a question about the extent of the future demand in New Zealand for direct application fertiliser (given that the Chatham rock phosphate would be sold at world market prices) as well as about the global supply and demand situation that would prevail in the years ahead.[759]

776. Finally, the DMC was not persuaded that the NZIER analysis took sufficient account of the proposal's possible adverse impact on existing interests, primarily the commercial fishing industry. Certainly, the applicant's proposal attracted widespread criticism and opposition from such groups as the Deepwater Group, Ngāi Tahu and Kaikoura Whale Watch. It might well be the case, as the applicant argued, that the proposal would not deplete commercial fish stocks to any significant extent, would not result in the loss of MSC certification and would not cause reputational damage that would reduce the value of the industry's exports. These risks, however small, do exist, and in our view the possible economic impacts of the proposal in those areas were deserving of more careful analysis by the applicant. Similarly, the consequences for existing interests of the proposal's adverse impacts on the Chatham Rise environment should have been considered more closely. While such uncertainty surrounds these issues, the overall net economic impact of the proposal cannot be predicted with confidence.

[754] Paragraph 20, Statement of Evidence of Christopher David Castle for CRP, 28 August 2014
[755] Paragraph 220, Opening Submissions for CRP, 25 September 2014
[756] Section 10.5, Marine Consent Application and EIA, May 2014
[757] Paragraph 4, Supplementary Statement of evidence of Christopher David Castle for CRP, 7 November 2014
[758] Lines 19 – 21, page 1138 of the Transcript, 16 October 2014
[759] Statement of Evidence of Dr Alec Donald Mackay for CRP, 28 August 2014

12. Other Matters

777. Section 59(2)(m) of the EEZ Act requires the DMC to take into account any other matter the EPA considers relevant and reasonably necessary to determine the application.

12.1. The Chatham Islands community

778. A session of the hearing was held in Chatham Islands and a number of Chatham Islanders expressed their views in submissions or in representations. The applicant recognised that "*Chatham Islanders have a direct connection to the Chatham Rise and the activities that occur there*".[760] The applicant proposed a specific condition establishing a Trust Fund for Chatham Islanders and the Chatham Islands community.

779. The views of Ngati Mutunga and the Hokotehi Moriori Trust on the application, in both cases opposed, are described elsewhere in this report. Mr Kamo, CEO of the Ngati Mutunga Trust, commented as follows: *"I'm also wanting to make it clear to the DMC that the idea that nothing should happen in case something bad happens, is generally not the view that's here on the island, the island is well aware that economic development is vital to itself. But it is the level of reassurances required that is currently not being met in the proposal in front of the community at this stage."* [761]

780. Individual Chatham Islanders expressed opposition to the proposal. In addition to general concerns about the effects of mining on the Chatham Rise seabed and wider environment, submitters were worried about the risks a mining operation posed for their commercial fishing industries (including paua and rock lobster) and customary fishing activities; the undermining of cultural values and tikanga; the risks and uncertainties surrounding various aspects of the proposal; the likely adverse effects on seabirds and marine mammals; the proposal's perceived incompatibility with the Mid Chatham Rise BPA and Rohe Moana; and ongoing uncertainty as to how, if at all, the Chatham Islands would benefit from the activity.

781. In its prepared statement, the Chatham Islands Council commented *"The Chatham Islands has a rich fishing industry, however there has been a history of significant exploitation of this resource with very little reinvested in the community. Fishing today remains the mainstay of the island economy."*[762]

[760] Page 14, Marine Consent Application and EIA Non-technical Summary, May 2014
[761] Line 20 – 25, page 2173 of the Transcript, 12 November 2014
[762] Paragraph 10, Statement of Evidence of Alfred Preece on behalf of the Chatham Islands Council, 12th November 2014

782. The Chatham Islands Council's submission went on to say that the Council needed more information about the likely impact of the proposal and had a number of concerns which would have to be addressed before it could support the application. It accordingly took a neutral position on the proposal. In its words: *"The Councils submission listed a number of concerns which will have to be addressed before it can support this application with the most important being protecting the fishing resource, the marine ecosystem and the economic and social benefit to the Chatham Islands community".*[763]

783. The following comments convey something of the flavour of the views expressed to the DMC by individual Chatham Island submitters:
"…my main concern, was who is going to pay for it if it stuffs up, and I would like to have a name, somebody to sign a piece of paper saying if there is a problem on the Chatham Islands, we lose our fishery, somebody else is paying for it, not us, because we pay every time." [764]

"…there is no compensation package offered should there be decimation of the marine environment and the destruction of the Chatham Islands fisheries. No amount of research predictions of what could happen can generate what actually happens …. The compensation package must cover total loss in its entirety."[765]

12.1.1. Conditions

784. Proposed Conditions 57 – 59 would establish a Chatham Islands Trust in order to support initiatives designed to benefit the Chatham Islands and Chatham Islands community. The Trust would administer $280,000 per annum (annually adjusted for inflation). Proposed Condition 59 set reasonably clear parameters for the Trust: $200,000 to fund maintenance and enhancement of farming activities and enhancement of economic development opportunities, while $80,000 (minus the cost of administering the Trust) to support education opportunities and cultural development initiatives. The DMC understands from Ms Taylor the Chatham Island's Trust evolved out of a commitment made by Chatham Rock as a result of consultation and was not directly linked to any environmental impact.[766]

[763] Paragraph 11, Statement of Evidence of Alfred Preece on behalf of the Chatham Islands Council, 12th November 2014
[764] Line 34 – 38, page 2199 of the Transcript, 12 November 2014
[765] Line 38 – 45, page 2204 of the Transcript, 12 November 2014
[766] Lines 39 – 42, page 2386 of the Transcript, 18 November 2014

12.1.2. DMC findings

785. The DMC acknowledges the importance attached by members of the Chatham Islands community to activities on the Chatham Rise that might affect their livelihood. Most of these concerns are addressed elsewhere in the decision, where the DMC has discussed the risks to the Chatham Rise marine environment and the proposal's potential impact on the commercial fishing industry, the Mid Chatham Rise BPA and the Chatham Rise Rohe Moana. On the basis of the evidence and testimony it heard, the DMC did not find it possible to establish with any certainty just what additional adverse effects the mining project would have had on the interests of the Chatham Islands community. In the particular circumstances of this application, the Chatham Islands community's concerns did not materially influence the DMC's decision. It was not however surprising to the DMC that members and representatives of the Chatham Island community wanted more certain information about the project and did not appreciate being asked to accept the risks it involved, however low, without their consent. It is unfortunate that the differences between the applicant and the Chatham Islands community were not narrowed or resolved through the consultation process at an earlier stage.

12.2. Cultural issues

786. The DMC considered that it should take account of the cultural values and interests of Māori and Moriori. It was encouraged in this by the statement of the applicant that "*CRP recognises the important spiritual and cultural connection that Māori and Moriori have with their physical environment, and their role as kaitiaki (guardians).*"[767]

12.2.1. Report of Ngā Kaihautū Tikanga Taiao

787. The EEZ Act provides (under Section 12) for the EPA to receive advice on marine consent applications from its Māori Advisory Committee, Ngā Kaihautū Tikanga Taiao (Ngā Kaihautū) "*so that decisions made under this Act may be informed by a Māori perspective*". The report was provided in accordance with Section 44 of the EEZ Act. Section 59(3)(c) of the Act requires the DMC to have regard to any advice received from the Māori Advisory Committee.

788. Ngā Kaihautū's report on the proposal[768] gave a comprehensive and informative account of the Māori world view (paradigm), the nature of Māori environmental perspectives and the potential effects of the proposal on Māori interests and values. It described the values that underpin customary and contemporary practice and the principles underpinning Rangatiratanga (self-determination) and Kaitiakitanga (sustainable management). It emphasised that the exercise of

[767] Section 9.3, Marine Consent Application and EIA, May 2014
[768] Ngā Kaihautū Tikanga Taiao Report — Application from CRP for marine consent to undertake the mining of phosphate nodules in the Chatham Rise, August 2014

these practices is intrinsically tied to Whakapapa (genealogy) and Matauranga Māori (knowledge), which are the foundation stones for the sustainable management of Te Taiao (the environment) and which regulate the interaction of Māori with both the land (Mana Whenua) and the sea (Mana Moana).

789. Ngā Kaihautū commented: *"Rangatiratanga is linked to the principle of active protection and recognises the rights of Māori to self-determination inherent in both the English and Māori translations of the Treaty of Waitangi (Te Tiriti o Waitangi). The Tribunal has noted in the Ngawha Geothermal Resources Report (1993), that Māori should be protected from the actions of others that impinge on their Rangatiratanga by adversely affecting their continued use or enjoyment of their resources, whether in physical or spiritual terms".*[769]

790. Ngā Kaihautū registered its ongoing concern at the difficulties faced by Māori in participating fully in the current regulatory regime for applications of this nature. It drew attention to tensions between the Māori view of the environment and the Western approach to development and stressed the importance of observing the principles of the Treaty of Waitangi in considering marine consent applications. It asked that special consideration be given to the principle of active protection and to the impact of the proposed activity on the cultural values of Māori.

791. On the implications of the proposal for the environment, Ngā Kaihautū expressed concern at the damage that would be caused to the benthic habitat of the Chatham Rise and the likely effects of increased sedimentation on the wider marine environment. It noted the information gaps and uncertainties surrounding many of the impact assessments, including on marine mammals.

792. On the economic impact of the application on Māori, Ngā Kaihautū rehearsed the concerns expressed by a number of submitters on the potential adverse effects of the proposal in the areas of fisheries and eco-tourism. It considered that the economic benefits of the proposal had been overstated and the environmental costs not properly accounted for.

12.2.2. Other parties

793. The applicant contended that cultural concerns, which do not qualify as an existing interest, should not be given undue weight in the decision-making process.[770] Mr Winchester went on to assert that while social or cultural considerations may be relevant, they deserved less weight except to the extent that they may be captured in defined terms such as existing interest.[771]

[769] Paragraph 11, Ngā Kaihautū Tikanga Taiao Report, 2014
[770] Paragraph 107, Closing Legal Submissions for CRP, 19 November 2014
[771] Paragraph 56, Closing Legal Submissions for CRP, 19 November 2014

794. The DMC accepts that the EEZ Act definition of an existing interest is constrained as outlined in the legal memorandum to the DMC.[772] However Section 59(2)(m) of the EEZ Act allows the DMC to consider cultural matters if it considers them relevant and reasonably necessary in its determination of the application.

795. A feature of the testimony of several Māori quota holders was their strong concern about the impact of the proposal on tikanga and a range of cultural beliefs, interests and values. This was a recurrent theme in the report of the Ngā Kaihautū. It also came through strongly in the eloquent testimony of Mrs Tuuta of Ngāti Mutunga, who stated *"It is of great concern that the mana of my whakapapa has been put at risk by the application of Chatham Rock Phosphate Ltd….. and I have opposed the application."*[773]

796. Similarly strong concern about the impact of the proposal on cultural values and tikanga was expressed by Mr Summerton, a third generation commercial fisher from Ngāi Tahu. He commented *"There will be irreversible impacts on our business, on our values as Kaitiaki, and on the business of our iwi, on our development right, and rights of our iwi, if the application is granted."*[774]

797. A lively discussion took place during the hearing as to whether, and if so to what extent, cultural beliefs, values and interests should be taken into account in consideration of the application.

798. The applicant took the view[775] that while cultural matters might be relevant under Section 59(2)(m) as "*any other matter that the EPA considers relevant and reasonably necessary to determine the application*", they were not an existing interest under paragraph (a) of the Act's definition. In support of this approach, the applicant's counsel noted that the definition of sustainable management in the EEZ (in contrast to that in the Resource Management Act) did not include social or cultural wellbeing and that purely cultural interests fell outside the definition of "*existing interests*" because they could not be considered an activity.[776] Mr Winchester went on to caution against any double counting of effects.

799. At the same time, the applicant did acknowledge the right of interested parties to assert a cultural interest:

- it accepted that Ngāi Tahu was a special case
- it noted that it had actively engaged with iwi on the impact of its proposal, including on cultural interests

[772] Memorandum of Counsel to assist the Decision-making Committee, 12 November 2014
[773] Lines 26 – 29, page 1331 of the Transcript, 20 October 2014
[774] Para 105 Amended Statement of Evidence of Mr Greg Summerton, on behalf of Te Runanga o Ngāi Tahu 29 Sept 2014
[775] Paragraph 77, Opening Submissions for CRP, 25 September 2014
[776] Paragraph 78, Opening Submissions for CRP, 25 September 2014

- it cited instances where it had adjusted its application to take those interests into account, and
- it observed that provision had been made for cultural interests to be brought to bear through its proposed Environmental Reference Group, Chatham Islands Trust and Environmental Compensation Trust.[777]

800. The applicant in its closing statement considered that it had addressed the cultural concerns associated with the fossilised whale bones by reducing the marine consent area and including any remaining identified areas within mining exclusion areas. The applicant indicated its preparedness to enable cultural interests to be brought to bear on an ongoing basis through its proposed Environmental Reference Group, its Chatham Islands Trust, and the Environmental Compensation Trust.[778]

801. On the other hand, a number of submitters argued that their cultural interests were directly relevant to the application whether or not an "*activity*" could be shown to have taken place. For example, Ngāti Mutunga registered its concerns at the impact of the proposal on its cultural values and identity.[779]

802. Counsel for Ngāi Tahu criticised the applicant for failing to take sufficient account of the social and cultural impacts of the proposal on Māori and for its lack of attention to Māori values more generally.[780] He maintained that the mainstream cultural values and rights woven into the settlement of Ngāi Tahu's historical claim were clearly existing interests under the relevant provisions of the EEZ Act. This was also the approach of Ms Bartlett, an expert witness called by Ngāi Tahu, who stressed the significance of Ngāi Tahu's kaitiakitanga role in protecting mauri and its duty to pass the environment on to future generations in a good state. [781]

803. Speaking for the Hokotehi Moriori Trust, Mr Solomon commented *"The application fails to give effect to the principles of the Treaty of Waitangi in Section 12 of the Act in the following respects; it fails to actively protect Moriori taonga tuku iho; fails to provide for Moriori tchieki, and tchieki is the Moriori dialect for Kaitiaki, responsibilities within our Rohe Moana, and thirdly, fails to provide for the expression of Moriori Rangatiratanga within our Rohe Moana".*[782]

[777] Paragraph 88 – 89, Opening Submissions for CRP, 25 September 2014
[778] Paragraph 106, Closing Submissions for CRP, 19 November 2014
[779] Section 5.3, Ngāti Mutunga o Wharekauri Iwi Trust submission, Submission 110139, July 2014
[780] Paragraphs 16 – 17, Opening Representation on behalf of Te Rūnanga o Ngāi Tahu, 25 September 2014
[781] Paragraph 62, Statement of Evidence of Deborah Maria Bartlett on behalf of Te Rūnanga o Ngāi Tahu, 12 September 2014
[782] Lines 5 – 10, page 2110 of the Transcript, 10 November 2014

804. In a paper circulated to parties to the hearing on 12 November 2014 counsel assisting the DMC outlined a view on various aspects of the question as to whether cultural values should be taken into account as interests in lawfully established existing activities in this application.[783]

805. After commenting on the complexity of the issue, the paper noted that there was no significant disagreement over whether relevant cultural values could in principle be taken into account under paragraphs (d) and (e) of the Act's definition of existing interests (ie historical and contemporary claim settlements under the Treaty of Waitangi Act 1975).

806. On the disagreement over cultural values arising in relation to a fishing activity, ie under paragraph (a) of the Act's definition, the paper concluded that the term 'interests' ought to be read more broadly than had been suggested by the applicant and that an overlap of commercial and cultural interests should not in principle preclude consideration being given to both. It added however that special care needed to be taken in assessing the two different effects in such an overlap situation.

807. On cultural interests outside the exercise of kaitiakitanga, the paper suggested that the crux of the issue was the level of engagement or involvement required in order for there to be an existing activity within the meaning of the EEZ Act. It noted that Section 10 of the EEZ Act and its definition of environment was notably less broad than their counterparts in the Resource Management Act but suggested that it would not be inconsistent with the purpose of the Act to allow effects of a purely cultural nature to be taken into account.

12.2.3. DMC findings

808. The DMC heard from a number of submitters and from Ngā Kaihautū that the proposal was seen as having an adverse impact on the cultural interests and values of iwi and imi. There is no specific guidance in the EEZ Act as to just how adverse effects of this nature should be assessed and weighed in the consideration of marine consent applications.

809. The DMC accepts that the impact of this proposal on the cultural and spiritual values and sense of identity of iwi and imi is a matter of concern and importance to a number of individuals and groups with a direct interest in the application and that it is a matter that the DMC needed to take into account as relevant and reasonably necessary in terms of Section 59(2)(m) of the EEZ Act. While the DMC does not see these matters as determinative in the decision, it does wish to recognise the importance attached to these effects by a large number of submitters and witnesses.

[783] Memorandum of Counsel to assist the Decision-making Committee, 12 November 2014

13. The Decision Path

13.1. Information principles

810. Section 61 (1) of the EEZ Act requires the DMC to:

> *(a) make full use of its powers to request information from the applicant, obtain advice, and commission a review or report; and*
>
> *(b) base decisions on the best available information; and*
>
> *(c) take into account any uncertainty or inadequacy in the information available.*

13.1.1. Full use of powers

811. On the requirement in Section 61(1)(a), the DMC initially had available to it the application itself and six lodgement reports commissioned by the EPA. Requests were then made to the applicant for additional information covering 61 items. All these requests were met. Nine expert reports and an analysis of submissions were commissioned; five reports were sought and obtained from agencies with marine management regime responsibilities; reports on the application were received from EPA staff and Ngā Kaihautū; and joint witness reports were received on the twelve expert conferences and a pre-hearing meeting on Existing Interests arranged by the DMC. Further information was sought and obtained in the course of the hearing, including by extensive questioning of the applicant and other parties and submitters, and by requesting advice from the DMC's legal counsel on aspects of the application and the hearing. The DMC considers that it made full use of its powers to obtain the necessary information and advice on the application.

13.1.2. Best available information

812. "*Best available information*" is defined in Section 61(5) of the Act as "*the best information that, in the particular circumstances, is available without unreasonable cost, effort, or time*."

813. There will always be questions as to how much information could or should have been provided by the applicant in support of a proposal of this kind. There are some areas where it would have been helpful to the DMC to have additional data or earlier access to information provided after the initial application was lodged. This was particularly the case for the area beyond MPL 55549. Bearing in mind the current state of scientific knowledge about the Chatham Rise, the expense involved in conducting surveys in the open sea and the fact that much of the modelling could not be validated *in situ* until mining commenced, however, the DMC is satisfied that the information it received met the definition in the EEZ Act of "*best available information*" in respect of the whole marine consent application area.

814. The applicant was also of the view that the information before the DMC was "*best available information"* as defined by the Act.[784] Mr Winchester noted in his closing statement that there were some areas where witnesses had suggested further information should have been obtained, citing marine mammals is an example. He considered that no further information needed to be gathered at this stage given the absence of risks associated with the subject matter and confirmed that additional data would in any case be gathered at both the pre-mining stage and after mining commenced. Mr Winchester submitted that there was no barrier based on a material inadequacy of information that would prevent the DMC from granting consent.[785]

815. The applicant offered to obtain any further information required by the DMC and affirmed that it would support any necessary extension of the decision-making time frame to that end. After examining the material and information before it following the adjournment of the hearing however, the DMC concluded that no further material was required in order for it to determine the outcome of the application, neither would any information that could be made available without unreasonable cost, effort or time materially alter that assessment.

13.1.3. Uncertainty or inadequacy of information

816. On the certainty and adequacy of the available information (Section 61 (1) (c)), many submitters and participants in the hearing were of the view that the baseline information provided by the applicant was both uncertain and inadequate and that a considerable amount of additional information was needed about the likely effects of the proposal on both the environment and existing interests.

817. Concerns about the uncertainty and inadequacy of information were registered in a number of expert conferencing reports.

a) Although it was generally agreed that there was sufficient information to inform decision-making on the mining permit area, the benthic ecology and spatial planning group referred to substantial gaps in knowledge of the hyperbenthic communities on the Chatham Rise, uncertainty about the full degree of biodiversity and missing information about the role of benthic communities in the ecosystem.[786]

b) The same report made several references to the uncertainty of information on the impact of mining on benthic communities, the insufficiency of information on changes to the sediment regime and the need to validate sediment plume modelling *in situ*.

[784] Lines 36 – 39, page 2524 of the Transcript, 19 November 2014
[785] Lines 40 – 5, pages 2524 – 5 of the Transcript, 19 November 2014
[786] Issue 2, Joint Witness Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 27 September 2014

c) The report on commercial fishing[787] referred to a lack of information on which to base conclusions and the need to obtain better information on such matters as the seasonal distribution and spawning of fish species. That report also drew attention to the need for further work on proposed conditions and the adaptive management plan.

d) The economics group[788] noted that the experts had not been able to agree on the sufficiency of evidence to reliably quantify the probability of the indirect impacts of mining on commercial fishing.

e) Experts on ecosystem effects[789] reached agreement on a number of issues but noted that the information on habitat effect did not cover all species and that there was a lack of survey data on densities of seabirds and whales on the Chatham Rise.

f) The joint expert witness statements on impacts on fish[790] and radioactivity[791] drew attention to information limitations and uncertainties and called for further sampling and research.

g) Experts on rock lobsters[792] spoke of the need to ground-truth the sediment plume modeling and a lack of information on larval transport and biophysical processes in the water column.

h) The seabirds conference report[793] referred to imperfect data quality and gaps in the available information.

i) Similar references to uncertainty and the need for more information were made in the reports of the expert groups on sediment modelling[794] and toxicology and water quality.[795]

818. Criticisms relating to the uncertainty and inadequacy of information on the application were particularly strong in respect of the broader marine consent area, where fewer surveys had

[787] Issue 1, Joint Witness Statement of Experts in the Field of Commercial Fishing, 19 September 2014
[788] Issue 4B, Joint Witness Statement of Experts in the Field of Economics, 18 September 2014
[789] Joint Witness Statement of Experts in the Ecosystem Effects, 17 September 2014
[790] Joint Witness Statement of Experts in the Field of Impacts on Fish, 18 September 2014
[791] Joint Witness Statement of Experts in the Field of Radioactivity, 16 September 2014
[792] Issue 1 – 2, Joint Witness Statement of Experts in the Field of Rock Lobsters, 16 September 2014
[793] Joint Witness Statement of Experts in the Field of Seabirds, 29 September 2014
[794] Joint Witness Statement of Experts in the Field of Sediment Monitoring, 26 September 2014
[795] Joint Witness Statement of Experts in the Field of Toxicology and Water Quality, 19 September 2014

been conducted, less data was available, no mining plan had been provided and the economic analysis extended to only the first 15 years of mining.

819. There was also criticism from submitters that not enough was known about the applicant's company structure (although Boskalis and the applicant expressed confidence that they would be partners in the proposal, no contract had been signed by the conclusion of the hearing); that the technology and equipment planned to be used in the proposal was unproven at the depths envisaged and in the conditions of the Chatham Rise; that too much reliance was being placed on modelling (for example, of the spread and effects of the sediment plume) which had not been validated or ground-truthed in the proposed mining area; that the economic benefits claimed for the proposal were at best arguable; that it had not been shown that the proposed recolonisation experiments in the mined areas were likely to succeed; and that insufficient research had been done into the possible effects of the proposal on the benthic environment and wider marine environment.

820. In response, the applicant argued that a significant amount of research had been carried out on the Chatham Rise over a number of years; that it had commissioned a range of expert reports on various aspects of the proposal; and that the expert conferencing reports indicated that the information placed before the DMC constituted an adequate basis on which to make a decision.

821. The initial EPA staff report identified a number of gaps and uncertainties in the information provided as at early August 2014 by the applicant.[796] A supplementary staff report completed in October confirmed that a number of the concerns expressed in the initial report had been eased or removed by the provision of additional information and evidence, including many of the expert conferencing reports. It noted however, that *"some uncertainty remains with respect to some of the potential effects on the environment and existing interests from CRP's proposed mining activities"*[797]. It also identified a number of specific areas in which there was a continuing lack of baseline information or a lack of certainty about the potential effects of the proposed activities.[798]

822. The report tabled by the EPA's Ngā Kaihautū[799] commented that an underlying issue was *"…the uncertainty created due to a lack of detailed information regarding the existing environment, the mining approach, contaminants and mining debris, adaptive management, monitoring processes and the environmental impacts of the mining activity on commercial fish species".* The report stated that this concern was shared by key affected communities and industry groups.

[796] EPA Staff Report – Chatham Rock Phosphate Limited Marine Consent Application, August 2014
[797] Paragraph 4.1.15, Supplementary EPA Staff Report, 22 October 2014
[798] Paragraph 4.1.17, Supplementary EPA Staff Report, 22 October 2014
[799] Paragraph 31, Ngā Kaihautū Tikanga Taiao Report, 2014

13.1.4. DMC Comment

823. The DMC recognises that considerable efforts were made by the applicant to provide the necessary baseline information on the marine environment in the consent area and to commission expert modelling and analysis in support of the application. However it is incontestably the case that there remained significant gaps in the data and information provided about the consent area's marine environment as well as uncertainty about the impact of the proposal on existing interests and the environment. This was particularly the case with regard to the wider consent area, where much less information had been assembled by the applicant. As already noted above, the applicant was proposing to collect additional baseline information prior to mining commencing and after the consent was granted.

824. The DMC interprets the wording of the legislation to mean that a complete understanding of the environment and absolute certainty about the risks posed by the proposal are not a prerequisite to the granting of a consent. On the other hand, scientific knowledge of the Chatham Rise ecosystem is manifestly incomplete and the DMC does need to have sufficient, and sufficiently certain, information to identify and evaluate the risks involved in a proposal such as this. A good level of baseline information is also necessary in determining the standards, limits, thresholds and triggers for any proposed conditions or adaptive management framework applied to a consent.

825. Of particular concern to the DMC are the uncertainties associated with modelling that could not be empirically and *in situ* validated before the commencement of mining, for example in respect of the nature, spread and impact of sedimentation caused by the return to the seabed of waste material (although the DMC acknowledges some internal model validation has occurred). As indicated above, there was a large measure of agreement among experts in a range of fields that more, and more certain, information was needed on which to base assessments of the impact of the proposal on the environment and existing interests, which the DMC found persuasive.

826. The DMC's overall conclusion is that the information made available to it on the application, while it met the EEZ Act's definition of best available, was uncertain and in some areas inadequate. The DMC did not take up the offer made by the applicant in its closing statement to provide more information because it judged that the kind of additional information that would have been useful (for example, from further surveys to obtain better baseline information and from model validation tests) could not have been obtained at reasonable cost, effort and time.

827. To favour caution and environment protection would in this case mean that the proposal would be likely to be refused consent. The DMC was therefore required to consider whether taking an adaptive management approach would allow the proposal to proceed. This is addressed in the following chapter.

14. Adaptive Management

14.1. Adaptive management

828. Section 61(3) of the EEZ Act directs that if favouring caution and environmental protection (as directed under Section 61(2) of the Act) means that consent is likely to be refused, then the option of adaptive management must first be contemplated.

829. Adaptive management is defined in Section 64 of the Act to include:

> *(a) allowing an activity to commence on a small scale or for a short period so that its effects on the environment and existing interests can be monitored:*
>
> *(b) any other approach that allows an activity to be undertaken so that its effects can be assessed and the activity discontinued, or continued with or without amendment, on the basis of those effects.*

830. Further direction is given regarding the imposition of proposed conditions relating to the staging of activities, including the scale, intensity and nature of the activity as well as duration.

831. Mr Winchester noted[800] in his opening legal submissions for the applicant that an adaptive management approach was proposed not because the application raised such uncertainty but because such an approach is a relatively common resource management tool for complex and lengthy proposals, characterised[801] in terms of "*learning by doing*", similar to Ms Rickard's[802] "*learning as you go*". Mr Winchester submitted[803] that lack of detail should not be confused with lack of certainty, and that more detail would not necessarily clarify matters, suggesting that the lens of risk and risk management provided a more appropriate focus. While the DMC maintain that uncertainty has to be addressed, it agrees that adaptive management is a common approach.

832. The DMC also agrees that adaptive management is not constrained by Section 61(3). As Mr Winchester noted,[804] the two examples provided under that section are not exclusive and therefore other approaches to managing risk are available.

833. Given the apparent similarities with resource management it was perhaps not surprising that many parties cited and encouraged the DMC to adopt and adhere strictly to the now familiar findings of the Supreme Court in *Sustain Our Sounds v NZ King Salmon* in which King Salmon had proposed three inter-related adaptive management approaches involving staged

[800] Paragraph 241, Opening Submissions for CRP, 25 September 2014
[801] Paragraph 128, Closing Legal Submissions for CRP, 19 November 2014
[802] Paragraph 32, Statement of Evidence of Andrea Judith Rickard on behalf of Te Rūnanga o Ngāi Tahu and Deepwater Group Limited, 5 September 2014
[803] Paragraph 48, Opening Submissions for CRP, 25 September 2014
[804] Paragraph 242, Opening Submissions for CRP, 25 September 2014

development, a tiered approach to monitoring, and on-going adaptive management. In that case, and under the Resource Management Act 1991 and its various layers of planning documents, the Court considered whether taking a precautionary approach would preclude adaptive management, and held that this depended on assessing a combination of factors, which it stated as[805]:

> *(a) the extent of the environmental risk (including the gravity of the consequences if the risk is realised);*
>
> *(b) the importance of the activity (which could in some circumstances be an activity it is hoped would protect the environment);*
>
> *(c) the degree of uncertainty; and*
>
> *(d) the extent to which an adaptive management approach would sufficiently diminish the risk and the uncertainty.*

834. In relation to item (d), which it described as the "*vital part of the test*", the Court accepted the Board of Inquiry's finding that there were four factors appropriate to consider when making the assessment, being:[806]

> *(a) there would be good baseline information about the receiving environment;*
>
> *(b) the conditions provide for effective monitoring of adverse effects using appropriate indicators;*
>
> *(c) thresholds are set to trigger remedial action before the effects become overly damaging; and*
>
> *(d) effects that might arise can be remedied before they become irreversible.*

835. Under the EEZ Act the test is arguably dissimilar. It seems evident from the wording of Section 61(3) that an adaptive management approach is not inherently inconsistent with favouring caution and environmental protection, and therefore the particular threshold question addressed by the Court in *King Salmon* may be unnecessary.

836. That does not, however, in the DMC's view call into question the Court's findings on the broader question of adaptive management, and effectively, what constitutes good practice. In that regard the DMC finds both the four factors stated by the Court and the further four risk and uncertainty factors adopted from the Board of Inquiry as both appropriate and helpful to its inquiry.

[805] SC 84/2013 [2014] NZSC 40 At [129].
[806] SC 84/2013 [2014] NZSC 40 At [133].

837. Mr Currie, for KASM, Greenpeace and DSCC, submitted[807] that the DMC could not apply adaptive management conditions in the hope that these would ameliorate problems in time; problems that are currently on the table rather than those that may arise and are not presently identified. While the DMC generally agrees with the import of that proposition, it does not hold necessarily in all circumstances. That essentially, is why staging is a reasonably fundamental aspect of adaptive management. It recognises that certain effects may arise and be addressed at a future time; and puts in place objectives, thresholds, responses, triggers, limits, standards, restart parameters, and so on, precisely to allow that decision point to be deferred to a future time but within the ambit of the consent granted.

838. In closing submissions a number of counsel[808] addressed the overlap between precaution and caution as those matters relate to adaptive management. Without needing to rehearse their particular submissions, it is sufficient to record that all agreed whatever line might be drawn between the two concepts had little practical import, and, for all intents and purposes, the DMC might (and, the DMC understood, should) read those constructs interchangeably. Mr Prebble, for example, referred the DMC to relevant sections of various reports, advice and speeches provided during the passage of the EEZ Bill and concluded[809] *"Given the adoption of the precautionary approach under both the RMA and the Fisheries Act 1996 and the parallels between both of those and the EEZ Act, as well as the parliamentary debate, it seems a reasonable conclusion that favouring caution and environmental protection effectively amounts to incorporation of the precautionary approach into the EEZ Act."*

839. While Mr Winchester also addressed this question, the DMC did not understand him to take a materially different view.

840. Mr Anderson submitted in closing that before an adaptive management approach can be adopted it is necessary that the adverse effects are identified and can be remedied, and certainly before they might become irreversible. Furthermore he contended[810] that there needed to be sufficient certainty that unanticipated effects can be managed when they arise, although it is in the nature of unanticipated effects that the effects are not certain.

841. The DMC notes that in *King Salmon* the Court referred (paragraph 114) to a line of Environment Court decisions involving adaptive management observing that *"The Court said that it should not put an applicant in a position of anticipating and researching all hypotheses before making*

[807] Paragraph 77, Opening Submissions by KASM, Greenpeace and DSCC, 26 September 2014
[808] Mr Currie; Ms Appleyard, Mr Anderson and Mr Prebble
[809] Paragraph 66, Crown's Closing Submissions, 18 November 2014 (note the submission states 18 October 2014)
[810] Paragraph 34, Closing Submissions on behalf of the Royal Forest and Bird Protection Society of New Zealand Incorporated, 18 November 2013

an application."

842. The Court noted that the issue of sufficiently diminishing risk and uncertainty (about which Mr Winchester made a particular point in both opening and closing) depends on the extent to which risk and uncertainty remains and the gravity of the consequences if the risk is realised. Mr Winchester repeatedly stressed[811] that context is important and the lens of risk management is the proper tool.

843. Finally the DMC notes that the Court did not, in our understanding, propose that its approach was intended to cover all instances where an adaptive management approach might be under consideration. The Court explicitly qualified its findings with the phrase "*at least in this case*". [812] In that regard the DMC is mindful of the fact that the proposed activity is intended in the open ocean, at depth and in an environment about which there exists significant uncertainty of knowledge and consequence.

844. Ms Rickard made similar observations in her supplementary evidence,[813] acknowledging that uncertainty is not, by that fact alone, "*bad*" and that sustainable management requires provision for innovation and new practice. The critical issue for her in adaptive management, on which there was no evident disagreement, is clear objectives and the progressive circularity of the feedback loop process.[814]

845. The DMC accepts the argument that the issue is not about uncertainty *per se* but about what is an acceptable and appropriate level of risk in the gap between certainty and uncertainty. That gap is never likely to close entirely for a proposal of this scale in the environment in which it is proposed. Closing the gap to an acceptable risk-tolerance point is, however, critical to the granting of consent under the EEZ Act.

846. In line with that reasoning, the DMC considers that steps to establish empirically the predictions made and conclusions drawn from the various modelling exercises undertaken by the applicant are a legitimate part of an adaptive management approach. Indeed, this is clearly intended by Section 63 of the EEZ Act.

847. The DMC therefore considered whether a three-stage adaptive management approach, incorporating a data gathering stage ahead of actual mining by way of a condition precedent, would be practicable. In other words, as part of an adaptive management proposed consent

[811] For example, paragraph 25, Closing Legal Submissions for CRP, 19 November 2014
[812] For example, in paragraph 133 of that decision
[813] Paragraph 15, Supplementary Statement of Evidence of Andrea Judith Rickard on behalf of Te Rūnanga o Ngāi Tahu and Deepwater Group Limited, 16 November 2014
[814] Paragraph 37, Statement of Evidence of Andrea Judith Rickard on behalf of Te Rūnanga o Ngāi Tahu and Deepwater Group Limited, 5 September 2014

condition, imposing a requirement to collect sufficient field data to confirm the habitat predictions that emerge from the Zonation spatial planning model prior to any operational mining. This would be required in order to demonstrate the existence beyond the mining application area of significant comparable stony coral-dependent benthic communities in sufficient abundance and density, presumably unaffected by recent trawling or dredging activities, such that the loss of those same communities through mining might be said to be acceptable.

848. The reason this would constitute a no-mining stage is because it seems to the DMC unwise to allow benthic destruction while the communities in question are considered potentially unique. If this were disproven, a trial mining stage to validate the plume model (in terms of direction, decay, sedimentation and suspended sediment characteristics) over a three block, one-year period (for example) could be authorised. Only then, and provided any adjustments to the modelling arising from those results concluded that the adverse effects were the same as or less than the current predictions, would full operational mining be permitted. The first two stages would therefore each contain a go / no-go trigger, which could effectively terminate the consent if the field evidence is sufficiently contrary to prediction.

849. In passing, the DMC notes that information gained from stage one of the above option would also likely be of considerable assistance to the Director-General of Conservation in determining CRP's application under the Wildlife Act 1953 for permission to destroy a Schedule 7A animal, being Cnidaria / Anthozoa (corals and sea anemones) / Stony corals, all species in the order Scleractinia.

850. Towards the end of the hearing, the DMC invited parties to the application to comment on a staged approach as outlined in Section 64 of the EEZ Act. In his closing statement, legal counsel for the applicant stated in relation to a staged approach or trial run: "*given the economics of this project, is simply never going to fly for the applicant because the upfront investment is too great to take a risk of a trial run and the quid pro quo of that, in terms of Chatham Rock's view of the evidence, is that a trial run isn't necessary based on risks and effects*".[815]

851. The DMC also invited parties to the application to comment on the option of a partial approval as provided for in Section 62 of the EEZ Act, noting that considerably more information and evidence had been received on the proposed activities in mining area MPL 55549 than for mining in the wider consent application area. The applicant responded "*that is obviously not Chatham Rock's preference but it would take the view that a consent which enabled it to mine*

[815] Line 45, page 2594 of the Transcript, 19 November 2014

and do so in accordance with at least its current business plan is better than none."[816] Parties opposing the application were resistant to the idea of even a partial approval.

14.2. DMC Findings

852. The DMC finds that an adaptive management approach would not resolve the primary question of the adverse effect on the benthic environment without considerable pre-mining research and model validation *in situ*, which the applicant informed the DMC was not a viable option.

853. The DMC gave careful consideration to the option of partial approval. Its conclusion is that the destructive impact of mining on the area in MPL 55549, coupled with the potential adverse effects on the wider marine environment, ruled out such a partial approval.

[816] Lines 5 – 9, page 2595 of the Transcript, 19 November 2014

15. Consideration of the Application and Decision

854. In this chapter the DMC considers the proposed activities against the decision-making matters to be taken into account under Section 59 of the EEZ Act, cross checks its findings for consistency with the purpose of the EEZ Act and give its decision.

855. This chapter is a summary of the key conclusions reached by the DMC and is not intended to be an exhaustive analysis against the EEZ Act's provisions. For that latter purpose, the entire decision document is relevant. However, it is intended to satisfy the principal requirement of Section 69 of the EEZ Act regarding the reasons for the DMC's decision in the sense that the matters summarised are those that the DMC considers determinative of that decision.

15.1. Section 59(2)(a) effects on the environment

856. Section 59(2)(a) requires the DMC to take into account any effects on the environment of allowing the activity, including cumulative effects and effects that occur in New Zealand or in the waters above and beyond the continental shelf beyond the outer limits of the EEZ.

857. The most significant adverse effect would be that caused by the extractive part of the mining operation itself. This would result in the physical removal of phosphorite nodules and associated surface sediment along with all benthic biota living within and on the seabed over an area of between 450 km^2 (15 year consent) and 1050 km^2 (35 year consent) to a depth of up to 0.5 m. This would include the epifauna communities described by Dr Rowden which are dominated by the stony coral *G. dumosa* and are potentially unique to the central crest of the Chatham Rise[817] and which the DMC concludes are rare and vulnerable ecosystems which merit protection.

858. In addition to the removal of habitat and mortality of benthic biota, the benthic communities surrounding the worked mining block would be impacted by deposition of the returned sediment discharged from the mining vessel.[818] That deposition (at a depth of 1 mm) is modelled to extend at least 10 km beyond the consent area sought after 15 years of mining, 1 mm being a reasonable precautionary threshold for potentially adverse effects on sensitive benthic organisms as identified by Dr Hewitt and broadly agreed.[819]

[817] Issue 1, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014
[818] Paragraph 75, Statement of Evidence of Paul Cameron Kennedy for CRP on Environmental Impacts (updated), 29 August 2014 (amended 14 November 2014)
[819] Line 44 – 45, page 727 of the Transcript and lines 40 – 41 page 728 of the Transcript, 3 October 2014

859. The mining would result in a long term change in habitat from a mixed phosphorite nodule / soft sediment habitat to a graded soft sediment habitat.[820] Restoration of the area to its original state is not expected as stony coral and other sessile organisms found in the marine consent area are dependent on hard substrate for settlement.[821] Re-establishment of communities following mining is uncertain and at best would take decades. Moreover the re-established communities would be based on soft sediment rather than hard coral.[822]

860. The spatial and temporal extent of the indirect impacts of mining are, however, uncertain as the modelling has yet to be verified *in situ*.

861. Almost the entire proposed mining operation would take place within the 8,732 km² Mid Chatham Rise BPA, which is discussed below under Section 59(2)(h). The DMC concludes that the environmental protection afforded by that mechanism would then be rendered redundant.

862. The DMC recognises that cumulative effects in conjunction with fishing industry activities across the Chatham Rise might eventuate, but the DMC is unable to conclude from the evidence received that they would necessarily arise or, if they did, what their magnitude and significance would be.

863. On the effects that might occur in New Zealand arising from the application of mined phosphorite, the DMC found that there was uncertainty as to the extent and nature of its use in New Zealand and, given its distance from the marine consent, this issue was not material to the DMC's decision.

864. The DMC concludes that there would be significant and permanent adverse effects on the existing benthic environment. The DMC considers this is a significant factor amongst all the matters that it is required to take into account.

15.2. Section 59(2)(a) effects on existing interests

865. Section 59(2)(a) of the EEZ Act requires the DMC to consider any effects on existing interests of allowing the activity, including cumulative effects and effects that may occur in New Zealand or in the waters above or beyond the continental shelf beyond the outer limits of the exclusive economic zone.

[820] Paragraph 76, Statement of Evidence of Paul Cameron Kennedy for CRP on Environmental Impacts (updated), 29 August 2014 (amended 14 November 2014)
[821] Issue 1, Joint Statement of Experts in the Field of Benthic Ecology and Spatial Planning, 16 and 27 September 2014
[822] Pages 2002 – 2003 of the Transcript, 6 November 2014

866. Existing interests identified in connection with this application were the interests of: iwi and imi holding fishing quota rights under the Treaty of Waitangi (Fisheries Claim) Settlement Act 1992; Ngāi Tahu; marine eco-tourism operators; commercial fishing operators; and marine traffic operators.

867. The DMC found it difficult to establish with any certainty just how and to what extent the interests of these groups might be affected by the mining operation. The concerns raised by existing interests holders frequently centred on the accuracy of the various models being used by the applicant to predict effects, for example, in the assessments of fish stocks and the dispersal of sediment. If those models were to prove accurate, or to fall within reasonable bounds, then the proposal would be unlikely to have significant effects on the interests of existing interests groups.

868. There was little agreement between the applicant and commercial fishing interests as to the level of risk that the mining operation represented in terms of stock reduction, displacement or product branding and sustainability certification. Concerns were also held by those with rights to the Chatham Rise Rohe Moana and those representing customary fishing interests. The relevant expert group however agreed that the risks posed to commercial fishing were not as serious as the industry claimed. The DMC accepts this view.

869. The DMC acknowledges the views expressed to it that the proposal risked undermining Treaty of Waitangi settlement provisions such as the development right and the value of Treaty settlement–based fish quotas. However the general view of fisheries experts, and Dr Pierre with respect to MSC certification, was that the adverse effects of the proposal would not be as serious as was suggested by the industry. At the same time, the DMC understands the concern expressed by virtually all existing interest groups at the prospect of being forced to carry risks to their livelihood and wellbeing, however small, without their consent.

870. On the likely effects on marine eco-tourism activities, the DMC concludes that the proposal would pose only a low risk to mammals on the Chatham Rise and that a suitable set of conditions could have been developed to address that risk.

871. On the customary fishing rights of Māori and Moriori, including within the Rohe Moana, the DMC was unable to establish on the basis of the evidence provided to it that the proposal would have any significant impact. It acknowledges however the levels of concern and apprehension expressed to it by the relevant groups.

872. The transiting of the general area by shipping is a matter that may occur periodically but is not affected by the proposed mining activity to any extent greater than might currently be

experienced with the fishing fleet and could, in the DMC's view, be readily managed through standard maritime notice requirements.

873. Overall, the DMC concludes that the effects on existing interests that it needs to take into account are principally the effects on fishing interests, which are of low probability and potentially moderate impact. Such effects are not determinative of the application and, relative to some of the other factors that the DMC must take into account, are of limited weight in the overall assessment.

15.3. Section 59(2)(b) Effects of other activities undertaken in the application area

874. Section 59(2)(b) requires the DMC to take into account the effects on the environment or existing interest of other activities undertaken in the area covered by the application or in its vicinity, including the effects of activities that are not regulated under the EEZ Act; and effects that may occur in New Zealand or in the waters above or beyond the continental shelf beyond the outer limits of the exclusive economic zone. The DMC interprets this provision to be aimed at ensuring marine consent decisions take into account the potential for cumulative effects to arise out of the combination of effects of the proposed activity and effects of other activities already undertaken in the area or vicinity of the proposal. The only other activity presently undertaken on a material scale in the area covered by the application or in its vicinity is commercial fishing and so the DMC's consideration under Section 59(2)(b) focuses on that.

875. As there is limited, if any, spatial overlap of fishing and the proposed mining (although noting that longlining is permitted within the BPA), the applicant did not consider it necessary to assess the combined effect of both activities on the Chatham Rise. The DMC was provided with a comparison of trawling scale and intensity by Mr Tuck[823] and is satisfied that the mining activity would take place in a considerably smaller area than the fishing activity, but with greater intensity.

876. The DMC agrees there is limited spatial overlap between fishing and the proposed mining and concludes that there are unlikely to be any adverse effects of other activities undertaken in the area material to the outcome of this application.

[823] Paragraphs 6 and 10, Statement of Evidence of Dr Ian Tuck for CRP, 28 August 2014

15.4. Section 59(2)(c) Effects on human health

877. Section 59(2)(c) requires the DMC to take into account the effects on human health that may arise from effects on the environment.

878. Two main areas of health concern were raised in terms of the human consumption of seafood; trace elements (including heavy metals) and radioactive substances. It was common ground that there would be no biomagnification of trace elements either in particular species or through the food chain because the biological uptake of any trace elements released into the water column as a result of mining was likely to be insignificant.

879. The most important radionuclide in terms of human exposure from marine organisms was polonium. However, it was generally agreed that it would not biomagnify through the food chain because, even though it may transfer from one trophic level to the next, polonium tends not to get to higher concentration levels up the food chain.[824]

880. Regarding the health and safety of workers on the mining vessel, the DMC understands that phosphorite is not classed as a hazardous substance, is not corrosive and has low toxicity and irritant tendencies. It may accordingly be handled, stored and transported by any person. Similarly, Chatham Rise phosphate rock is not classed as a radioactive material.[825]

881. On the matter of air quality, Boskalis confirmed that the operation would adhere to international laws and standards (specifically MARPOL) as well as comply with any additional requirements under New Zealand law. A proposal specific environment and management plan would be drafted and agreed before the start of mining, outlining all proposal rules and standards applying to oily water, hazardous substances, wastewater, garbage (solid waste) emissions to air, ballasting and hull bio-fouling.

882. The DMC concludes that there are unlikely to be any significant adverse effects on human health arising from effects of the proposal on the environment.

15.5. Section 59(2)(d) Protecting biological diversity and integrity

883. Section 59(2)(d) requires the DMC to take into account the importance of protecting the biological diversity and integrity of marine species, ecosystems and processes. Biological diversity is defined in Section 4(2) of the EEZ Act to have the same meaning as in the RMA,

[824] Lines 24 – 28, page 898 of the Transcript, 14 October 2014
[825] Paragraph 27, Statement of Evidence of Dr Nikolaus Hermanspahn for CRP, 29 August 2014

which is "*the variability among living organisms, and the ecological complexes of which they are a part, including diversity within species, between species, and of ecosystems*".

884. Communities with a high abundance of *G. dumosa* were acknowledged by the applicant to be habitat forming communities which to date have not been found outside the marine consent area. *G. dumosa* as a species is not endemic to Chatham Rise (it is found elsewhere in the EEZ) but it is protected under the Wildlife Act 1953. However an application for authority to kill *G. dumosa* was made to the Director-General of Conservation and the DMC heard that it is formally on hold pending the DMC's decision on the present application. Experts agreed that communities with a high abundance of the stony coral met the definition of a 'sensitive environment' under EEZ regulations.[826]

885. The question arose during the hearing as to the difference in meaning between 'ecosystems' and 'communities'. Neither is defined in the EEZ Act. Dr Rowden's view was "*So people will call a coral reef an ecosystem, whereas I might say that a coral reef is really a community*". [827] The DMC's conclusion is that the words could be used interchangeably.

886. The phosphorite nodule habitat is considered unique in New Zealand's EEZ[828]. In addition Dr Rowden described the Chatham Rise "*as one of the most obvious and distinct ecosystems we have in the EEZ and it is one of the most productive*."[829]

887. The DMC was persuaded that communities dominated by *G. dumosa* (among others) in the mining area fall within the scope of Section 59(2)(d) and notes that the applicant reached a similar conclusion.[830] The extractive activity would not protect those communities. The DMC considers this is a significant factor amongst all the matters that it is required to take into account.

15.6. Section 59(2)(e) Protecting rare and vulnerable ecosystems

888. Section 59(2)(e) requires the DMC to take into account the importance of protecting rare and vulnerable ecosystems and the habitats of threatened species. The EEZ Act does not define 'rare and vulnerable ecosystems'.

[826] Issue 1, Joint Witness statement on Benthic Ecology and Spatial Planning, 16 and 27 September 2014
[827] Line 30, page 2014 of the Transcript, 6 November 2014:
[828] Section 6.3.4.3 of the Marine consent applicant and EIA, May 2014
[829] Lines 39 – 41, page 2032 of the Transcript, 6 November 2014
[830] Paragraph 152, Closing Legal Submissions for CRP, 19 November 2014

889. While a number of the marine mammals species recorded in the general application area have a national or international threat classification,[831] the DMC was persuaded that the mining consent area did not constitute a particularly significant habitat for those species.

890. Dr Thompson stated that four taxa of seabirds likely to be found in the marine consent application area were classified as 'threatened' under New Zealand's threat classification system. The Antipodean albatross, Salvin's albatross and magenta petrel (also known as the Chatham Island taiko) have a conservation status of 'nationally critical', and Chatham petrel has a conservation status of 'nationally vulnerable'.[832] Mr Taylor confirmed that the Chatham Island taiko was critically endangered, with just 20 known breeding pairs, and that recent DOC tracking studies showed that they forage occasionally over the proposed mining application area.[833] However, while the Chatham Rise could be considered part of those species' habitat for foraging purposes, the DMC was persuaded that neither the mining operation nor its effects would constitute a material risk.

891. Mr Winchester submitted that 'ecosystem' in the context of Section 59(2)(e) referred to the Chatham Rise ecosystem rather than the particular *G. dumosa* dominated areas, which in his view were better described as 'communities'.[834] In support of this submission, Mr Winchester cited the Joint Statement of Experts on Benthic Ecology and the agreement that the Chatham Rise was one of the most productive ecosystems within New Zealand's EEZ.

892. The DMC finds that interpretation unnecessarily restrictive, noting that the reason the Joint Statement of Experts concluded as it did was because the scale on which the relevant evidence was provided was at the scale of the wider Chatham Rise.

893. Mr Winchester also argued that the potentially unique communities of *G. dumosa* did not appear to fall with the scope of Section 59(2)(e) because they were neither *"rare or vulnerable ecosystems"* nor *"habitats of any threatened species".*[835] However it was Dr Rowden's opinion that the coral based communities could be said to be a vulnerable marine ecosystems according to the definition used by the FAO.[836] The FAO International Guideline for Management of Deep-sea Fisheries in the High Seas defines a vulnerable marine ecosystem as ecosystems that are "*rare or unique, functionally significant, fragile, slow to recover and structurally complex*." The DMC finds that the communities dominated by *G. dumosa* are highly likely to meet this definition.

[831] Table 1, Statement of Evidence of Simon John Childerhouse for the Crown, 17 September 2014
[832] Paragraph 21 – 22, Statement of Evidence of Dr David Thompson for CRP, 25 August 2014
[833] Paragraph C, Statement of Evidence of Graeme Andrew Sydney Taylor for the Crown, 12 September 2014
[834] Paragraph 154–155, Closing Legal Submissions for CRP, 19 November 2014
[835] Paragraph 157, Closing Legal Submissions for CRP, 19 November 2014
[836] Lines 35 – 5, pages 2012 – 2013 of the Transcript, 6 November 2014

894. While the DMC notes Dr Rowden's comment that in the deep sea rarity could simply be a sampling artefact,[837] the DMC attributes some weight to the fact that *G. dumosa* is a species that is afforded absolute protection under the Wildlife Act.

895. The high density of *G. dumosa* forming communities in the mine permit area is strongly correlated with the presence of phosphorite nodules. These nodules also occur in high density in the mine permit area, hence the applicant's focus on this area of the Chatham Rise. The DMC accepts the evidence of Drs Rowden and Berkenbusch that the communities dominated by *G. dumosa* are potentially unique, and in the absence of any strong evidence on the presence or abundance of such communities beyond the mining permit area (and given the requirement to favour caution and environmental protection), the DMC finds it more than likely that such communities are rare. That, in combination with their vulnerability, signifies that the DMC must take into account the importance of protecting those communities. The DMC concludes that the potentially unique communities of *G. dumosa* in the mining areas are rare and vulnerable ecosystems which merit protection. The DMC considers this a significant factor amongst all the matters that it is required to take into account.

15.7. Section 59(2)(f) Economic benefit to New Zealand

896. Section 59(2)(f) requires the DMC to take into account the economic benefit to New Zealand of allowing the application.

897. The DMC accepts that the proposed mining operation, if it were to proceed as currently planned and if the various assumptions and forecasts on which NZIER based its modelling are borne out, would have some economic benefits for New Zealand. Among the specific benefits the proposal might generate are the taxes and royalties payable to the government, modest employment gains, and flow-on benefits at the chosen port or ports and in the transport sector. The availability of direct application Chatham rock phosphate in New Zealand would also hold out some advantages.

898. The assumptions and forecasts used by NZIER and therefore the credibility of the figures produced by the CGE economic model however remained in dispute. The DMC considers that the potential economic benefit to New Zealand was overstated in the application, although it does not accept the most pessimistic of the expert opinions.

899. The DMC concludes that the proposal would be unlikely to generate more than a modest economic benefit to New Zealand and that the quantum and distribution of that benefit remains

[837] Lines 7–10, page 2014 of the Transcript, 6 November 2014

uncertain. The DMC observes that economic benefit to New Zealand is one of the few criteria in Section 59(2) that focuses on the benefits, as opposed to the environmental costs, of a marine consent proposal. Having found that the economic benefit to New Zealand of this proposal is unlikely to be more than modest, the DMC must weigh that alongside the significant and permanent adverse effects on the benthic environment and other potential environmental adverse effects of the project.

15.8. Section 59(2)(g) Efficient use and development of natural resources

900. Section 59(2)(g) requires the DMC to take into account the efficient use and development of natural resources.

901. In its opening submission, the Crown outlined the Government's position on the contribution of mining to New Zealand's economy and drew attention to the potential of the mineral and marine assets in the EEZ to generate wealth for New Zealanders. It affirmed that the Government wished to encourage the environmentally responsible efficient development and use of the country's diverse energy and mineral resources.[838]

902. This matter was addressed by the applicant solely with respect to the mining of phosphorite nodules. In that regard the DMC notes no reasonably comparable application or operation was put before the DMC against which the efficiency of the applicant's proposed use and development could be assessed. The DMC also received no compelling evidence that the proposal was not an efficient use and development of the phosphorite resource. The DMC also accepts that if the product found its way into the market for direct application, rather than as a superphosphate blend, this would represent efficient use and development.

903. A caveat to this conclusion is that the EEZ Act defines natural resources to also include seabed, subsoil, water and all forms of organisms (whether native to New Zealand or introduced). The proposal could not be said to be an efficient use and development of those "*residual*" natural resources.

904. The DMC concludes that this aspect of Section 59(2) is of limited relevance to the overall determination of the application.

[838] Paragraphs 10 – 15, The Crown's Opening Representation, 25 September 2014

15.9. Section 59(2)(h) Nature and effect of other marine management regimes

905. The DMC considers the only marine management regime, the nature and effect of which is material to our assessment, is the Fisheries (Benthic Protection Areas) Regulation and the resultant Mid Chatham Rise Benthic Protection Area. There is little doubt that mining the seafloor in an area in which the only other significant and potentially destructive activity (bottom trawling) is prohibited is, at the very least, contradictory, and that the resultant effect of mining 1050 km^2 of the seabed over 35 years would negate the effect that the Mid Chatham Rise BPA has had for protecting that benthic environment. What effect that might have on the BPA network as a whole, and what response, if any, might be required of government was left unanswered at the hearing.

906. The DMC concludes that there would be a significant adverse effect on the Fisheries (Benthic Protection Areas) Regulations with respect to the Mid Chatham Rise BPA and that one of the purposes and the effect of the BPA would be undermined if the application were granted. The DMC considers this is a significant factor amongst all the matters that it is required to take into account.

15.10. Section 59(2)(i) Best practice

907. Section 59(2)(i) requires the DMC to take into account best practice in relation to an industry or activity. While the Boskalis representatives told the DMC the technology and practices involved in this proposal were well understood and that Boskalis is a leader in the industry, the proposed mining method and equipment to be used on the Chatham Rise has not been used at similar depths anywhere in the world. The DMC understands that globally marine mining is an industry in its gestation[839] and that guidance on best practice for deep-sea mining is therefore limited. However, Boskalis stated that the operation on board the vessel would adhere to international laws and standards (specifically MARPOL), as well as the additional requirements that follow from New Zealand law. In addition Mr Ross-Watt for Ngāi Tahu identified a number of good practice codes and guidelines that might be appropriate, for example the International Marine Minerals Society's Code for Environmental Management of Marine Mining (IMMC), the Noumea Convention, the London Protocol and the Mining Code issued by the International Seabed Authority.[840]

[839] Page 8, M.Beggs submission 109926
[840] Paragraph 15, Statement of Evidence of Mr Tara Ross-Watt on behalf of Te Rūnanga o Ngāi Tahu, 11 September 2014

908. The DMC concludes that regardless of the present uncertainty about what might constitute best practice for this operation (a matter that would inevitably and necessarily evolve over a 35 year consent duration) conditions could be developed, including explicit review conditions, that would ensure best practice was implemented, maintained and amended appropriately throughout any consent duration.

15.11. Section 59(2)(j) Imposing conditions to avoid, remedy or mitigate adverse effects

909. Section 59(2)(j) of the Act requires the DMC to take into account the extent to which imposing conditions under Section 63 might avoid, remedy, or mitigate the adverse effects of the activity.

910. The DMC has discussed the matter of conditions proposed throughout this decision. The DMC notes that the applicant accepted that there were no avoidance, remediation or mitigation measures that could be applied to the direct loss of benthic communities within and alongside the mining block. It did however propose conditions and measures which it believed would contribute to protecting specific benthic habitats beyond the mining blocks and providing opportunities for habitat enhancement elsewhere within the wider application area.

911. As discussed, the DMC does not accept that the proposed mining exclusion areas could be considered compensation for the damage from mining because if they are within the BPA then these areas are already protected from disturbance from bottom trawling and shellfish dredging. If they are not within the BPA, then the DMC could have no certainty that the areas would be protected from any activity other than the present application.

912. The DMC also notes that the mining exclusion areas, as proposed, did not appear to encompass habitat that is suitable for potentially unique epifaunal communities and at least one infaunal community.[841]

913. Similarly the DMC cannot accept the proposed recolonisation trials with introduced substrate as any form of positive mitigation because the likelihood of success at any reasonable scale remains uncertain at best.

914. The applicant also offered an environmental package to help address the adverse effects of mining. This included an Environmental Compensation Trust Fund, the funding of an Environmental Reference Group and the establishment of a Chatham Islands Trust Fund.

[841] Lines 1 – 5, page 2032 of the Transcript, 6 November 2014

915. The DMC notes that these are not mitigation measures because they do not directly relate to any particular adverse effect of the mining. Rather, they are an indirect offset, the logic and rationale (including the quantum proposed) of which was not clearly evident.

916. The DMC concludes that conditions could be refined to address many of the matters discussed throughout this decision. However, no avoidance, remediation or mitigation measures could be applied to the direct loss of benthic communities within and alongside the mining block. This is seen by the DMC as a significant matter.

15.12. Section 59(2)(k) Relevant regulations

917. Section 59(2)(k) requires the DMC to take into account any relevant regulations. The DMC has discussed marine management regimes above. No other relevant regulations were brought to its attention.

15.13. Section 59(2)(l) Any other applicable law

918. Section 59(2)(l) requires the DMC to take into account any other applicable law. The DMC has considered other applicable laws along with marine management regimes. No other relevant applicable law was brought to the DMC's attention.

15.14. Section 59(2)(m) Any other matter the EPA considers relevant and reasonably necessary to determine the application.

919. Section 59(2)(m) requires the DMC to take into account any other matter considered relevant and reasonably necessary to determine the application.

920. The DMC considered that Māori and Moriori cultural values and Chatham Islands community concerns fell into this category.

921. The DMC is mindful of the risk of double counting where there is an overlap of effects. The DMC was unable to establish with certainty just what additional adverse effects the mining proposal would have had on the Chatham Island community beyond the effects accounted for elsewhere in this decision. It accepts that the impact of this proposal on the cultural and spiritual values and sense of identity of iwi and imi is a matter of concern and importance to a number of individuals and groups with a direct interest in the application and that it is a matter that the DMC needed to take into account. While these matters were not determinative in the decision,

the DMC does wish to recognise their importance to a large number of submitters and witnesses.

15.15. Conclusion

922. This chapter has summarised the key conclusions of the DMC's consideration of the proposal against the matters that the DMC must take into account in accordance with Section 59 of the EEZ Act and favouring caution and environmental protection as required by Section 61(2).

923. The DMC concludes that there would be significant and permanent adverse effects on the existing benthic environment. The most significant adverse effect would be the physical removal of phosphorite nodules and associated surface sediment along with all benthic biota living within and on the seabed over an area of up to 1050 km^2 over 35 years, to a depth of up to 0.5 m. This would include communities which are dominated by the stony coral *G. dumosa* and are potentially unique to the central crest of the Chatham Rise, and which the DMC concludes are part of rare and vulnerable ecosystems which merit protection. In addition to the removal of habitat and the mortality of benthic biota, the benthic communities surrounding the worked mining block would be impacted by deposition of the returned sediment discharged from the mining vessel. That deposition (at a depth of 1 mm) is modelled to extend at least 10 km beyond the consent area sought after 15 years of mining. The mining would result in a long term change in habitat from a mixed phosphorite nodule/soft sediment habitat to a graded soft sediment habitat.

924. The DMC concludes that the project was unlikely to generate more than a modest economic benefit to New Zealand and that the quantum and distribution of that benefit were uncertain. As against this, there would be significant and permanent adverse effects on the benthic environment and other potential environmental adverse effects. The DMC finds the economic benefits of the proposal to New Zealand to be insubstantial relative to potential adverse environmental effects of the proposal.

925. The DMC also concludes that the proposal would have a significant adverse effect on the Fisheries (Benthic Protection Areas) Regulations with respect to the Mid Chatham Rise Benthic Protection Area, and that at least one of the purposes and the effect of the BPA would be undermined if the application were granted.

926. Taking these matters into account, and favouring caution and environmental protection (in light of the uncertainties and inadequacy inherent in the information), the DMC concludes that consent for the proposal must be refused unless there were some way in which an adaptive

management regime could overcome its concerns or the outcome were somehow contrary to the purpose of the EEZ Act.

927. The DMC has considered the adaptive management approach offered by the applicant and finds that it would not address its fundamental concerns such as the need to validate the habitat predictions of the Zonation model in advance of mining, and to validate the sediment modelling *in situ* through a limited preliminary mining trial. However, an adaptive management approach designed to address those concerns would render the project unviable for the applicant, and could not be imposed without frustrating the consent.

928. The DMC has also considered whether the conclusion it reached, guided by the specific decision-making criteria, the information principles, and in particular the requirement to favour caution and environmental protection, is in keeping with the express purpose of the EEZ Act. Unlike the RMA, the detailed machinery provisions for guiding the DMC's decision are not subservient to the legislative purpose. It is still however relevant to consider in the round whether the decision is consistent with the EEZ Act's purpose. Similar to the RMA, the purpose of the EEZ Act balances a number of potentially competing factors whose relevant weight depends on the facts of the application being considered.

929. In this instance, the DMC is convinced that the proposal would create significant and permanent adverse effects on the environment which are incapable of being avoided, remedied or mitigated, and that this aspect of sustainable management is of paramount concern in this instance. The DMC finds nothing in the purpose of the Act that suggests it is inappropriate for it to be guided by that concern, particularly when the requirement to favour caution and environmental protection has been invoked.

15.16. Decision

930. The DMC's decision is to refuse the application by Chatham Rock Phosphate Limited for a marine consent to mine phosphorite on the Chatham Rise.

Mr Neil Walter (Chair) .....

Dr Nicola Crauford (EPA Board Member) .....

Mr David Hill .....

Mr Lennie Johns .....

Dr Greg Ryder .....

10 February 2015

Appendix 1: Procedural History

1. On 14 May 2014 Chatham Rock Phosphate Limited (CRP) submitted an application under Section 38 of the EEZ Act for a marine consent to mine phosphate nodules on the crest of the Chatham Rise for a period of 35 years.

2. Six lodgement reviews of the application were commissioned by the EPA. CRP was informed on 28 May 2014 that the application had been reviewed and would not be returned as incomplete under Section 41 of the EEZ Act.

3. On 16 May 2014 the Environmental Protection Authority (EPA) appointed the following persons to be a committee to consider the marine consent application lodged by CRP:
    - Mr Neil Walter (Chair)
    - Dr Nicola Crauford
    - Mr David Hill
    - Mr Lennie Johns
    - Dr Gregory Ryder

4. On 9 June 2014 the EPA requested the applicant to provide 44 items of further information under Section 42 of the Act. Responses to all the requests were provided by the applicant between 27 June and 2 September 2014.

5. In accordance with Section 45 of the Act, the application was notified to: Government Ministers with responsibilities that may be affected by the application; Maritime New Zealand; iwi authorities; customary marine title groups; protected customary rights groups; and other groups and persons with interests that may be affected by the application, including regional councils.

6. The application was publicly notified on 12 June 2014. A total of 1,037 parties were served a copy of the public notice, including ten Government Ministers, Maritime New Zealand, 98 iwi authorities and a range of parties considered to have an existing interest (including Chatham Island groups, commercial fishers, the Deepwater Group, Seafood New Zealand, the Department of Conservation and Environment Canterbury). The public notification included an invitation to make submissions.

7. The closing date for submissions on the application was 10 July 2014. A total of 294 submissions were received, with 75 submitters indicating that they wished to present their submissions in person at the hearing. The submissions came mainly from within New Zealand, with the highest number being received from Wellington, the Waikato, Auckland, Taranaki, Canterbury, Otago and the Chatham Islands, in that order. 24 submissions came from overseas.

8. Of the 294 submissions received, 97 (33 %) supported the proposal either in full or in part; 194 (66 %) opposed it either in full or in part; two were neutral; and one submitter did not state a clear position. Eight submissions were not in the prescribed form but were accepted by the DMC. Seven late submissions were also accepted by the DMC.

9. On 27 June advice on relevant marine management regimes was sought from the Ministry for Primary Industries; WorkSafe New Zealand; the Department of Conservation; Maritime New Zealand; and New Zealand Petroleum and Minerals.

10. On 17 and 25 July 2014 the applicant was requested to provide additional items of information. All but one of the requests was responded to by 29 August 2014, with the outstanding matter being addressed in evidence at the hearing.

11. Nine independent reviews of sections of the application were commissioned by the EPA and the DMC. An initial EPA staff report on the application was issued in August 2014, and a supplementary report in October 2014. The EPA was also commissioned in November 2014 to provide comment on the conditions and adaptive management regime proposed by CRP. The EPA's Māori Advisory Committee, Ngā Kaihautū Tikanga Taiao, submitted a report on the application on 4 August 2014.

12. On 1 August 2014 CRP informed the EPA of the removal of the eastern block (prospecting permit PP 55967) from its application. This left an application area of 5,207 km^2, including the mining permit area MPL 55549.

13. On 4 August 2014, the DMC issued a Minute deferring the commencement of the hearing by 15 working days (to 25 September 2014) in order to give the applicant more time to respond to its further information requests.

14. Formal notice of the hearing was issued on 28 August 2014. Earlier minutes had indicated sessions of the hearing would be held in Hamilton and the Chatham Islands as well as Wellington. Detailed hearing procedures were posted on the EPA website and notified to intending participants.

15. 35 statements of evidence were lodged by the applicant, and 41 by submitters, including supplementary and updated statements. A further nine statements of evidence were filed by experts commissioned by the DMC.

16. The DMC's Minute of 22 August extended the time limit for the filing of the applicant's and submitters' evidence.

17. Twelve expert conferences were arranged, on the subjects of: Benthic Ecology and Spatial Planning; Commercial Fishing; Economics; Ecosystem Effects; Impacts on Fish; Marine Mammals; Radioactivity; Rock lobsters; Seabirds; Sediment modelling; Toxicology and Water Quality; and proposed conditions. A pre-hearing meeting also took place on Existing Interests.

18. The hearing began in Wellington on 25 September 2014. In all there were 26 days of hearing, including two days in Hamilton and one in the Chatham Islands. 48 submitters were heard. The hearing was adjourned on 19 November 2014 and formally closed by the DMC on 12 December 2014.

19. Overall the DMC issued twenty two Minutes.

20. The DMC completed its deliberations and issued its decision on 10 February 2014.

Appendix 2: List of Presenters Who Appeared at the Hearing

Day 1— 25 September 2014

Basin Reserve, Wellington

Mr James Winchester on behalf of Chatham Rock Phosphate Ltd (CRP) — opening representation

Mr Jeremy Prebble and Ms Eleanor Jamieson on behalf of The Crown — opening representation

Mr Stephen Christensen on behalf of Te Runanga o Ngāi Tahu — opening representation

Ms Kirsty Woods on behalf of Te Ohu Kai Moana Trustee Ltd — opening representation

Day 2 — 26 September 2014

Basin Reserve, Wellington

Mr James Winchester on behalf of CRP

Mr Duncan Currie on behalf of Greenpeace, KASM, and DSCC — opening representation

Ms Jo Appleyard on behalf of Deepwater Group Limited — opening representation

Mr Peter Anderson on behalf of the Royal Forest and Bird Protection Society of New Zealand Incorporated — opening representation

Mr Rob Enwright on behalf of Environmental Defence Society — opening representation

Ms Nicola de Wit on behalf of Environmental Defence Society — opening representation

Mr Chris Castle representing CRP — evidence on company structure and background

Dr Robin Falconer appearing for CRP — evidence on project genesis and history

Mr Ray Wood appearing for CRP — evidence on research programme, monitoring, spatial planning

Day 3 — 29 September 2014

Basin Reserve, Wellington

Ms Linda Sanders appearing for CRP — evidence on consultation and communication

Mr Stephen Christensen on behalf of Te Rūnunga o Ngāi Tahu

Mr Maui Solomon on behalf of Hokotehi Moriori Trust

Ms Ruby Haazen on behalf of Greenpeace, KASM, and DSCC

Dr Katrin Burkenbusch appearing for Ngāi Tahu, Deepwater Group, Ngāti Kahungunu and Te Ohu Kaimoana (Ngāi Tahu et al.) — evidence on benthic ecology

Mr Duncan Currie on behalf of Greenpeace, KASM, and DSCC

Mr James Winchester on behalf of CRP

Mr Dan Govier appearing for Te Runuga o Ngāi Tahu — evidence on benthic monitoring and compliance

Day 4 — 30 September 2014

Basin Reserve, Wellington

Mr Jeremy Prebble on behalf of the Crown

Dr Thomas Hourigan appearing for the Crown — evidence on benthic issues

Mr James Winchester on behalf of CRP

Mr Duncan Currie on behalf of Greenpeace, KASM, and DSCC

Dr John Leathwick appearing for the Crown — evidence on Zonation / marine spatial planning

Professor Les Watling appearing for Greenpeace, KASM, and DSCC — evidence on benthic ecology

Dr David Thompson appearing for CRP — evidence on seabirds

Mr Peter Anderson on behalf of Royal Forest and Bird Protection Society of New Zealand incorporated

Mr Jeremy Prebble on behalf of the Crown Crown

Dr Graeme Taylor appearing for the Crown — evidence on seabirds

Ms Eleanor Jamieson on behalf of the Crown

Day 5 — 1 October 2014

Basin Reserve, Wellington

Mr James Winchester on behalf of CRP

Dr Jeremy Spearman appearing for CRP — evidence on sediment plume modelling

Mr Stephen Christensen on behalf of Te Rūnunga o Ngāi Tahu

Mr Jeremy Prebble on behalf of the Crown

Ms Eleanor Jamieson on behalf of the Crown

Mr Duncan Currie on behalf of Greenpeace, KASM, and DSCC

Mr Sander Steenbrink appearing for CRP — evidence on project background, project examples and capability

Ms Jamie Lescinski appearing for CRP — evidence on sediment plume

Mr Gerard van Raalte appearing for CRP — evidence on mining techniques and methodology

Mr Dougal Greer appearing for the DMC — evidence on sediment modelling

Mr Morgan Slyfield on behalf of the DMC

Dr Scott Nodder appearing for CRP — evidence on sedimentology

Day 6 — 2 October 2014

Basin Reserve, Wellington

Ms Eleanor Jamieson on behalf of the Crown

Dr Peter Longdill appearing for the Crown — evidence on sediment and the plume

Ms Ruby Haazen on behalf of Greenpeace, KASM, and DSCC

Mr James Winchester on behalf of CRP

Dr Diane Jones appearing for CRP — Noise and acoustics

Mr Ben Williams appearing for Deepwater Group

Mr Jeremy Prebble on behalf of the Crown

Emeritus Professor Arthur Popper appearing for CRP — evidence on noise

Dr Ian Tuck appearing for CRP — evidence on effect of trawling on the seabed

Dr Alison McDiarmid appearing for CRP — evidence on rock lobsters

Day 7 — 3 October 2014

Basin Reserve, Wellington

Mr James Winchester on behalf of CRP

Dr Judith Hewitt appearing for CRP — evidence on benthic Communities

Ms Ruby Haazen on behalf of Greenpeace, KASM, and DSCC

Mr Jeremy Prebble on behalf of the Crown

Mr Peter Anderson on behalf of Royal Forest and Bird Protection Society of New Zealand Incorporated

Mr Sandy Bartle appearing for Royal Forest and Bird Protection Society of New Zealand Incorporated — evidence on seabirds and ecological effects

Mr Morgan Slyfield on behalf of the DMC

Dr Leigh Bull appearing for the DMC — evidence on seabirds

Mr Hamish Harwood on behalf of CRP

Day 8 — 14 October 2014

Basin Reserve, Wellington

Mr Stephen Christensen on behalf of Te Rūnunga o Ngāi Tahu

Dr Ngaire Phillips appearing for Te Rūnunga o Ngāi Tahu — evidence on ecotoxicology

Mr James Winchester on behalf of CRP

Mr Duncan Currie on behalf of Greenpeace, KASM, and DSCC

Associate Professor Barrie Peake appearing for Greenpeace, KASM,, DSCC and EDS — evidence on marine chemistry

Mr Hamish Harwood on behalf of CRP

Mr Morgan Slyfield on behalf of the DMC

Dr Louis Tremblay appearing for the DMC — evidence on marine ecotoxicology

Dr Alec McKay appearing for CRP — evidence on agriculture and nutrients

Dr David Bull appearing for CRP — evidence on trace element accumulation in soils

Dr Nikolaus Hermanspahn appearing for CRP — evidence on uranium and radioactivity

Dr Ross Jeffree appearing for DMC — evidence on radionuclides in the marine environment

Dr David Santillo appearing for Greenpeace, KASM, DSCC and EDS — evidence on radioactive materials

Day 9 — 15 October 2014

Basin Reserve, Wellington

Mr James Winchester on behalf of CRP

Mr Paul Kennedy appearing for CRP — evidence on sediment and water quality

Mr Duncan Currie on behalf of Greenpeace, KASM, and DSCC

Mr Stephen Christensen on behalf of Te Rūnunga o Ngāi Tahu

Mr James Winchester on behalf of CRP

Dr Matt Pinkerton appearing for CRP — evidence on trophic model

Mr Jeremy Prebble on behalf of the Crown

Dr Beth Fulton appearing for the Crown — evidence on ecosystem effects

Mr Peter Clough appearing for CRP — evidence on economics

Ms Jo Appleyard on behalf of Deepwater Group Limited

Dr Ganesh Nana appearing for CRP — evidence on economics modelling

Day 10 — 16 October 2014

Basin Reserve, Wellington

Mr Stephen Christensen on behalf of Te Rūnunga o Ngāi Tahu

Mr Alexsandr Sundakov appearing for Deepwater Group, Ngāi Tahu, Ngāti Kahungunu and Te Ohu Kaimoana — evidence on economics

Mr James Winchester on behalf of CRP

Mr Morgan Slyfield on behalf of the DMC

Mr Keiran Murray appearing for the DMC — evidence on economics

Dr Richard O'Driscoll appearing for CRP — evidence on commercial fish and fisheries

Ms Jo Appleyard on behalf of Deep Water Group

Ms Susan Baird appearing for CRP — evidence on ling fisheries

Day 11 — 17 October 2014

Basin Reserve, Wellington

Ms Jo Appleyard on behalf of Deep Water Group

Dr Jeremy Helson appearing for Deepwater Group, Ngāi Tahu, Ngāti Kahungunu, Te Ohu Kaimoana and Fisheries Inshore New Zealand — evidence on fish stock

Mr James Winchester on behalf of CRP

Dr David Middleton appearing for Deepwater Group, Ngāi Tahu, Ngāti Kahungunu, Te Ohu Kaimoana and Fisheries Inshore New Zealand — evidence on fish stock

Mr Hamish Harwood on behalf of CRP

Mr Alistair Dunn appearing for CRP — evidence on fish stocks

Ms Amy Hill appearing for Deepwater Group, Ngāi Tahu, Ngāti Kahungunu, Te Ohu Kaimoana and Fisheries Inshore New Zealand

Mr Morgan Slyfield on behalf of the DMC

Dr Johanna Pierre appearing for the DMC — evidence on commercial fishing

Day 12 — 20 October 2014

Basin Reserve, Wellington

Dr Nick Roskruge appearing for Ngā Kaihautū Tikanga Taiao

Ms Evelyn Tuuta appearing for herself — representation

Mr Turoa Karatea appearing for Evelyn Tuuta — representation

Mr Te Moananui a Kiwa Erueti-Newman appearing for Evelyn Tuuta — representation

Mr Greg Summerton appearing for Ngāi Tahu — evidence on long lining fisherman

Mr James Winchester on behalf of CRP

Mr Kauahi Koroneho Ngāpora appearing for Whale Watch Kaikoura — evidence on Kaikoura whale watch

Mr Hamish Harwood on behalf of CRP

Mr Rodney Tribe appearing for Ngāi Tahu Seafoods — evidence

Ms Maria Bartlett appearing for Ngāi Tahu — evidence on existing interests

Ms Kirsty Woods appearing for Te Ohu kai Moana Trustee Ltd — representation on existing interests fisheries

Mr Laws Lawson appearing for Te Ohu kai Moana Trustee Ltd — representation on existing interests fisheries

Day 13 — 21 October 2014

Basin Reserve, Wellington

Mr Ngahiwi Tomoana appearing for Ngāti Kahungunu Iwi Incorporated — representation

Mr Duncan Currie on behalf of KASM, Greenpeace and DSCC

Associate Professor Liz Slooten appearing for KASM, Greenpeace and DSCC — evidence on marine mammals

Mr James Winchester on behalf of CRP

Mr Stephen Christensen on behalf of Te Rūnunga o Ngāi Tahu

Mr Tara Ross Watt appearing for Deepwater Group, Ngāi Tahu, Ngāti Kahungunu, Te Ohu Kaimoana — evidence on marine mammals and marine management regimes

Mr Duncan Currie on behalf of KASM, Greenpeace and DSCC

Dr Darlene Ketten appearing for CRP — evidence on effects of noise on marine mammals

Mr Jeremy Prebble on behalf of the Crown

Dr Simon Childerhouse appearing for the Crown — evidence on marine mammals

Mr Hamish Harwood on behalf of CRP

Mr Martin Cawthorn appearing for CRP — evidence on marine mammals

Ms Eleanor Jamieson on behalf of the Crown

Day 14 — 22 October 2014

Basin Reserve, Wellington

Mr Jeremy Prebble on behalf of the Crown

Mr Darran Humpheson appearing for the Crown — evidence on effects of noise on marine mammals

Mr Duncan Currie on behalf of KASM, Greenpeace and DSCC

Mr James Winchester on behalf of CRP

Mr Morgan Slyfield on behalf of the DMC

Dr Mike Huber appearing for the DMC — evidence on impacts on fish and mammals

Ms Ruby Haazen on behalf of KASM, Greenpeace and DSCC

Ms Eleanor Jamieson on behalf of the Crown

Mr Stephen Christensen on behalf of Te Rūnunga o Ngāi Tahu

Mr Darryl Sykes appearing for CRA6 Rock Lobster Industry Association — evidence on rock lobster fisheries management

Day 15 — 23 October 2014

Basin Reserve, Wellington

Mr Robert Goodden representing himself — representation

Mr Mac Beggs representing himself — representation

Mr Gareth Hughes representing the Green Party of Aotearoa — representation

Day 16 — 29 October 2014

Kingsgate Convention Centre, Hamilton

Mr Ray Wood on behalf of CRP

Ms Ruby Haazen on behalf of KASM, Greenpeace and DSCC — opening representation

Mr Phil McCabe representing himself — representation

Mr John Paul Martin representing himself — representation

Ms June Penn representing herself — representation

Ms Vera van der Voorden representing herself — representation

Ms Nora van der Voorden representing herself — representation

Ms Vera van der Voorden representing Swakopmund Matters — representation

Mr Paul Havemann representing himself — representation

Ms June Penn representing Felipe Bonfanti de Barros — representation

Ms Denise Davis representing herself — representation

Mr Apirana Daymond representing herself — representation

Day 17 — 30 October 2014

Kingsgate Convention Centre, Hamilton

Ms Nicole Hancock representing herself — representation

Ms Tui Allan representing herself — representation

Ms June Penn representing Linda Silvester — representation

Ms June Penn representing herself — representation

Ms Christine Rose representing herself — representation

Day 18 — 3 November 2014

Basin Reserve, Wellington

Mr James Winchester on behalf of CRP

Mr Richard Johnson representing the EPA

Mr Simon Lamping representing the EPA

Ms Amy Hill on behalf of Deepwater Group, Ngāi Tahu, Ngāti Kahungunu, Te Ohu Kaimoana and Fisheries Inshore New Zealand

Ms Gemma Couzens representing the EPA

Dr David Weller representing the EPA

Mr Manu Graham representing the EPA

Mr Jeremy Prebble on behalf of the Crown

Day 19 — 4 November 2014

Basin Reserve, Wellington

Mr John Lawson representing himself — representation

Ms Jo Appleyard on behalf of Deepwater Group and Sanford Limited

Mr George Clement appearing for the Deepwater Group — evidence

Mr James Winchester on behalf of CRP

Mr Hamish Harwood appearing for CRP

Mr Doug Paulin appearing for Deepwater Group — evidence on fisheries

Mr Peter Connolly appearing for Deepwater Group — evidence on fisheries

Mr Darryn Shaw appearing for Sanford Ltd — evidence on existing Interests

Mr Shane Walls appearing for Deepwater Group — evidence on fisheries

Mr Chris Patrick appearing for Deepwater Group — evidence on fisheries

Mr Andrew Smith appearing for Deepwater Group — evidence on fisheries

Day 20 — 5 November 2014

Basin Reserve, Wellington

Mr Brian Sandle representing himself — representation

Mr Joseph Hassell representing himself — representation

Day 21 — 6 November 2014

Basin Reserve, Wellington

Mr Campbell McKenzie appearing for CRP — evidence on phosphate mining and mining permits / licences

Mr Stephen Christiansen on behalf of Te Rūnunga o Ngāi Tahu

Ms Jo Appleyard on behalf of Deepwater Group

Mr James Winchester on behalf of CRP

Dr Ashley Rowden appearing for CRP — evidence on benthic communities, habitat modelling, recolonisation and spatial planning

Ms Ruby Haazen on behalf of KASM, Deepsea Conservation Coalition and Greenpeace

Ms Eleanor Jamieson on behalf of the Crown

Dr Paul Krause appearing for Deepwater Group, Ngāi Tahu, Ngāti Kahungunu and Te Ohu Kaimoana — evidence on impacts on fish

Mr Michael Page appearing for CRP — evidence on impacts of sediment plume on fish and fish eggs

Mr Jeremy Prebble on behalf of the Crown

Mr Barry Weeber and Catherine Wallace representing Environment and Conservation Organisations of New Zealand Inc — representation

Day 22 — 10 November 2014

Basin Reserve, Wellington

Mr Maui Solomon representing Hokitehi Trust — representation

Ms Ruby Haazen on behalf of KASM, Deepsea Conservation Coalition and Greenpeace

Dr Marie Brown appearing for Environmental Defence Society — evidence on proposed conditions

Day 23 — 12 November 2014

The Den, Chatham Islands

Ms Linda Sanders representing CRP

Mr Gary Cameron representing PauaMAC4 Industry Association Inc — representation

Ms Paula Paige and Mr Ward Kamo representing Ngāti Mutunga o Wharekauri Iwi Trust — representation

Mr Chris Castle representing CRP

Mr Jeff Clarke representing the Chatham Islands Council — representation

Mr Gary Cameron representing PauaMAC4 Industry Association Inc — representation

Mr Phillip Ross Christiansen representing himself — representation

Mr Jack Daymond representing himself — representation

Mr Jeff Clarke representing CRA 6 Rock Lobster Industry Association Inc — representation

Mr Ian Maxwell representing himself — representation

Day 24 — 17 November 2014

Basin Reserve, Wellington

Mr James Winchester on behalf of CRP

Mr Paul Kennedy appearing for CRP — evidence on assessment of environmental impact

Mr Duncan Currie on behalf of KASM, Deepsea Conservation Coalition and Greenpeace

Mr Stephen Christensen on behalf of Te Runanga o Ngāi Tahu

Mr Jeremy Prebble on behalf of the Crown

Ms Andrea Rickard appearing for Ngāi Tahu et al.— evidence on proposed conditions

Mr Christopher Rendall appearing for the Crown — evidence on proposed conditions

Mr Urs Signer representing himself — representation

Day 25 — 18 November 2014

Basin Reserve, Wellington

Mr James Winchester on behalf of CRP

Ms Carmen Taylor appearing for CRP — evidence on proposed conditions

Mr Stephen Christensen on behalf of Te Rūnunga o Ngāi Tahu — closing statement

Mr Duncan Currie on behalf of KASM, Deepsea Conservation Coalition and Greenpeace — closing statement

Ms Nicola de Wit on behalf of EDS — closing statement

Ms Jo Appleyard on behalf of the Deepwater Group — closing statement

Mr Peter Anderson on behalf of Forest and Bird — closing statement

Mr Jeremy Prebble on behalf of the Crown — closing statement

Day 26 — 19 November 2014

Basin Reserve, Wellington

Mr James Winchester on behalf of CRP — closing statement

Mr Hamish Harwood on behalf of CRP — closing statement

Appendix 3: CRP Proposed Conditions

Proposed Marine Consent Conditions

Purpose

To mine phosphorite from the Chatham Rise seabed and undertake associated surveying and monitoring, for a term of 35 years, subject to the following conditions:

Definitions

Chief Executive	The Chief Executive of the Environmental Protection Authority (or his or her designate appointed in writing).
EEZ Act	Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012.
EMMP	Environmental Management and Monitoring Plan.
EPA	Environmental Protection Authority, the consent authority for this marine consent under the EEZ Act.
ERG	Environmental Reference Group. A group established in accordance with the conditions of this consent. The purpose of the ERG is to provide independent and objective advice to both the Consent Holder and the Chief Executive in relation to all relevant matters covered by the conditions of this consent.
mining and mining activities	means the extraction of phosphorite nodules from the seabed by the mining vessel.
mining block	the areas, generally 5 by 2 km in dimension, that have been or are to be mined.
unexpected adverse impact	an adverse impact, after the application of avoidance, remediation and mitigation measures, which is beyond the scope and significance of those outlined in the marine consent application and associated EIA.

Explanatory Notes

(i) A number of the conditions in this marine consent rely upon a certification process which is to be carried out by the Chief Executive. The criteria to be used for the certification process are whether the intent and purpose of the condition is being met. For most of the certification conditions, the intent and purpose of the conditions are generally descriptive rather than prescriptive. In recognition of this approach, in all instances where a certification process is proposed, the condition provides the Chief Executive with the opportunity to seek expert advice from appropriate external reviewers and / or experts. This approach has been utilised as an alternative to a prescriptive peer review process.

(ii) In addition to complying with the conditions of this marine consent, granted under the EEZ Act, the Consent Holder must also ensure that it complies with the requirements of other relevant New Zealand statutes and Regulations. At the time that this marine consent was granted, this

includes, but is not limited to, the Biosecurity Act 1993, the Crown Minerals Act 1991, the Marine Mammals Protection Act 1978, the Maritime Transport Act 1994 and associated Rules, and the Wildlife Act 1953. Specific documentation, required under New Zealand statutes or Regulations, that is relevant to environmental management aspects of the Consent Holder's activities include: the approved International Oil Pollution Prevention Certificate for the mining vessel; the approved Shipboard Oil Pollution Emergency Plan for the mining vessel; a biosecurity clearance approval for the mining vessel upon first entry into New Zealand waters; the approved certificate for the environmental liability (marine oil spill) insurance held for the mining vessel; and, any permit under the Wildlife Act 1953 to take coral.

Mining Operations in Accordance with Application and Consent

1. The Consent Holder must undertake all activities in general accordance with the marine consent application, consisting of Volumes One and Two, entitled "Chatham Rock Phosphate Limited – Proposed Mining Operation – Marine Consent Application and Environmental Impact Assessment" submitted to EPA in May 2014~~, although subject to the subsequent information provided to the EPA as part of the processing of the marine consent application which has resulted in modifications to the proposal and which have been accommodated within these conditions~~.

   Where there is inconsistency or ambiguity between the ~~marine consent application (including the associated EIA)~~ documents listed in this condition and the conditions of this consent, these conditions prevail.

2. The Consent Holder must ensure that all personnel and contractors undertaking work and tasks authorised by this consent are made aware of the conditions of this consent and that all personnel and contractors undertake their operations to ensure compliance with those conditions.

3. At all times, a copy of all plans and management plans required in accordance with the conditions of this consent, including a copy of this marine consent, must be readily available at the Consent Holder's offices and on the vessel undertaking the mining operations and related activities.

Notices of Commencement – Monitoring and Mining

4. At least one calendar month prior to the initial commencement of the proposed monitoring outlined in Schedule 2A, the Consent Holder must advise the Chief Executive, in writing, of the proposed monitoring commencement date.

5. At least six calendar months prior to mining activities, the Consent Holder must advise the Chief Executive, in writing, of the proposed mining commencement date.

Mining Operations and Mining Vessel – Restrictions and Controls

6. The Consent Holder must ensure that a Coastal Navigation Warning, or other appropriate navigation warning, is promulgated at least one day prior mining commencing on each mining block. The purpose of this notice or warning is to advise other marine traffic, including fishing vessels, of the presence of the mining vessel and associated mining equipment within the area being mined.

7. The Consent Holder must~~shall~~ ensure that no food wastes are discharged from the mining vessel while mining or in transit to and from port. Food waste is to only be disposed of at appropriate facilities once the vessel returns to port. Food wastes, food products, and any biological material retained with the phosphorite nodules, are to be stored on the vessel in a manner that cannot be readily accessed by seabirds.

8. The sewage and greywater treatment system on the mining vessel must comply with the Grade A standard for wastewater treatment as defined in Schedule 6 of the Resource Management (Marine Pollution Regulations) 1998.

9. At all times, the Consent Holder, in order to carry out its mining operations in accordance with this consent, must only:

   (a) operate one mining vessel at any one time; and

   (b) mine 30 km^2 of seabed per year, averaged over the current year and the previous 4 years of mining, while mining is occurring and no more than 35 km^2 in any 12 month period; and

   (c) mine within a mining block with a single pass only of the drag-head.

10. During the first 5 years of mining operations, mining may only occur in a 820 km^2 area, located on the crest of the Chatham Rise, within the ~~Consent Holder's mining permit~~area marked ~~(~~MP~~)~~ 55549 on the map in Attachment A.

    After the first 5 years of mining and provided the adaptive management requirements of Condition 40 have been met, the Consent Holder may also undertake mining operations outside MP 55549, in the remainder of the marine consent area, as shown on the map in Attachment A. ~~in the following areas on the crest of the Chatham Rise, but only if the Consent Holder has obtained the relevant mining permits pursuant to the Crown Minerals Act 1991 (or any different resource access approval if this legislation is replaced):~~

    ~~that area of 2,886 km^2 associated with the minerals prospecting licence (MPL) 50270, which excludes the 1,019 km^2 relinquished by the Consent Holder and the 820 km^2 associated with MP 55549 located in the western end of MPL 50270; and~~

    ~~that area of 1,501 km^2 associated with the Consent Holder's application for a prospecting permit (PP) 55971 adjoining and located to the west of MPL 50270.~~

    ~~The locations of these areas are shown in the figure in Attachment A to this consent.~~

    Advice Note: The Consent Holder will also need to obtain and hold any other authorisations required under New Zealand.

11. During the first 3 years of mining operations, the Consent Holder must only carry out mining within the mining blocks identified in Attachment B of this consent. These mining blocks are:

    (a) sufficiently separated such that sedimentation impacts between the mining blocks are minimised in any given year; and

    (b) sufficiently removed from the areas predicted to have benthic communities with high biodiversity values, including but not limited to communities characterised by significant

densities of the cold water coral *Goniocorella dumosa,* so as to minimise potential adverse impacts from sedimentation and total suspended solids.

Advice Note:

(i) The mining restriction provided for by part (b) of this condition, enables the Consent Holder to firstly ground-truth the modelling upon which the initial identification of the mining exclusion zones are based and if need be, as provided for by Condition 14(b), identify amended or additional mining exclusion zones. Also, during this time the monitoring of the actual impacts from total suspended solids and sedimentation on benthic communities, as outlined in Schedule 2, will occur.

(ii) Attachment B identifies fifteen mining blocks. The mining blocks to be mined during the first 12 months of mining, including a reserve block, are identified in the attachment. For the second and third years of mining, the Consent Holder may choose to mine any six of the twelve remaining mining blocks that on-going exploration surveys identify as containing the most phosphorite. The annual Mine Plan for the second and third years of mining, as required by Conditions 25 to 28, will identify the mining blocks, including reserve blocks, to be mined in the coming year.

12. The Consent Holder must ensure that the material returned to the seabed from the mining vessel is:

(a) released at a height of 10 m above the seabed, on average, per mining block;

(b) released within ~~or alongside~~ the mining block that is being mined by the mining vessel; and

(c) released, at all times, through a diffuser or similar technology which ensures that the material is discharged at low outflow velocities (as close to zero, relative to the seabed) to minimise plume development.

The Consent Holder must implement and maintain a monitoring and record system that confirms the height at which the processed material from the mining vessel is released to the seabed and to calculate the discharge velocity by measuring the rate at which the material enters the sinker, ~~and~~ the mining vessel speed and the properties of the diffuser being utilised. At a minimum, monitoring shall ensure that appropriate data are collected, for these two key parameters, with at least thirty data points being collected during each hour that the sediment is being released. The Consent Holder must provide a record of this monitoring to the Chief Executive within 5 workings days of receiving a request for the data from the Chief Executive. The Consent Holder must also report on compliance with this condition in the report required by Conditions 38 and 39.

13. The Consent Holder may only carry out mining in areas where the sediment composition in the area to be mined has been determined by sample collection and particle size distribution analysis to confirm that the return of processed material from the mining vessel to the seabed will comply with the environmental thresholds outlined in Schedule 1. Sediment sample collection must consist of at least 40 representative cores per mining block.

14. The Consent Holder must ensure that mining does not occur in the following areas:

(a) the mining exclusion areas identified in the figure in Attachment C to this consent, including a 1,700 m buffer strip that extends around the mining exclusion areas;

(b) any amended or additional mining exclusion areas identified by the Consent Holder as a result of research undertaken prior to commencement of any mining operations as outlined in Schedule 2 or further prospecting activities, including areas of significant coral thickets, significant marine biodiversity and areas of cultural significance. Amended or new mining exclusion areas must provide for no decrease in the total coverage and biodiversity value of the mining exclusion areas within the areas covered by this consent. Any amended or additional mining exclusion areas that are identified are to be advised in writing to the Chief Executive for ~~review~~certification, including possible assessment by an appropriate external reviewer. Within one month of receiving this assessment, the Chief Executive must either certify that the proposed amended or additional mining exclusion areas meet the requirements of this condition, ~~request~~ require amendments and / or ~~request~~ advise the Consent Holder of a timeframe extension for further evaluation. Upon receiving certification for the amended or additional mining exclusion area, these areas are to be identified in a revised figure contained in Attachment C of this consent; and

(c) areas of igneous or metamorphic basement rock outcrops, at the seabed, greater than 2 km^2 in extent.

Advice Note: Condition 60 provides a best endeavours approach for the Consent Holder to advocate and support for striving to ensure protection mechanisms from a range of activities, not just mining, for the exclusion areas identified under parts (a) and (b) of this condition.

15. If, after the first five years of mining, the Consent Holder is able to commence mining outside of MP 55549 and within MPL 50270 during the months of August and September, which are the months associated with ling spawning, the Consent Holder must restrict its mining operations to the area west of longitude 180°.

16. If a ship wreck or evidence of the site of a ship wreck, where the wreck occurred before 1900, is identified at any time within any proposed mining block to be mined, the mining block associated with the wreck must not be mined by the Consent Holder. Within 24 hours of discovering any such site, the Consent Holder must notify the Chief Executive, ERG and Heritage New Zealand of the find. The site of any such wreck may only be mined if clearance is received from Heritage New Zealand and the Chief Executive.

Advice Note: The identification of any such wrecks or sites does not preclude the Consent Holder from moving its mining operations to another mining block, provided the new mining block is identified in the Mine Plan required by Conditions 25 to 28.

Environmental Management – Marine Mammals and Seabirds

17. The Consent Holder must ensure that at all times the personnel on the mining vessel, and any support or monitoring vessels, are informed and aware of their obligations under the Marine Mammals Protection Act 1978 and Part 3 of the Marine Mammals Protection Regulations 1992 or any legislation or regulation that replaces these requirements. This includes, but is not limited to, ensuring that:

(a) the masters of all vessels associated with the mining operations reduce speed to a safe minimum within 300 m of, and take all practical steps to avoid, any whales which may be observed; and

(b) reporting, within 5 working days~~immediately~~ to the Department of Conservation, any marine mammal strikes, injuries or deaths.

18. On every occasion that the mining vessel returns to the mining location from port and is in place to recommence mining activities, prior to mining recommencing, the Consent Holder must ensure that a mitigation zone extending from the mining vessel in all directions is visually checked. If marine mammals are observed within this zone, then mining operations must not commence. The Consent Holder may only commence mining operations once no marine mammals have been observed within this defined zone for a period of at least two hours. The mitigation zone, subject to ocean conditions enabling the zone to be visually checked, is:

(a) 1.5 km until and unless the results of the noise monitoring confirm that noise from the mining vessel and mining equipment is at or below the noise levels used in the acoustic modelling;

(b) a reduced zone having been certified by the Chief Executive following an assessment of the noise monitoring and any associated considerations (whether the noise levels are at or below the noise levels used in the noise modelling), including, if required, possible assessment and advice to the Chief Executive by an appropriate external reviewer.

Advice Note: The reference for the 'acoustic modelling' is - McPherson C, Wladichuk J, Schlesinger A 2014. Chatham Rock Phosphate Underwater Acoustic Modelling. JASCO Document 00874, Version 1.0. Technical report by JASCO Applied Sciences for Chatham Rock Phosphate.

19. (a) Subject to ensuring that all vessel health and safety requirements are complied with, the Consent Holder must ensure that, at a minimum, the following seabird impact avoidance measures are implemented on the mining vessel:

(i) use of lighting on the mining vessel is minimised;

(ii) where possible, the utilisation of green light sources is maximised;

(iii) deck lighting is shielded and / or faces downwards to minimise horizontal light emission;

(iv) lighting that is not needed at night is turned off;

(v) vessel portholes and windows are to be fitted with black-out blinds, and the use of these blinds is to be maximised, to reduce the potential for unnecessary light emissions;

(vi) the use of vertical wires and objects on the deck is minimised or such structures, if required, are designed to minimise any potential bird strike impacts;

(vii) maximise the use of low reflective paints on the mining vessel to minimise the potential for reflected light; and

(viii) ensure that the vessel deck and other surfaces are as free as practicable of oil and other substances that have the potential to adversely affect the functionality of seabird feathers.~~; and~~

(b) Within one month of completion of the design of components of the mining vessel that might impact on seabirds, namely vessel lighting and deck structures, the Consent Holder must forward to the Chief Executive for review the Lighting Management Plan, including a vessel lighting assessment, for the vessel. The purpose of the Lighting Management Plan is to ensure compliance with the requirements of part (a) of this condition and that potential impacts on seabirds are minimised. Within one month of receiving the Lighting Management Plan, the Chief Executive must either ~~certify that the Lighting Management Plan~~:

(i) certify that the Lighting Management Plan meets the requirements of this condition; or

(ii) advise the Consent Holder that amendments are required; and / or

(iii) ~~request a timeframe extension for further evaluation of~~ advise the Consent Holder that the time for evaluation the Lighting Management Plan has been extended and when that evaluation will be complete. ~~including possible assessment by an appropriately qualified and experienced external reviewer.~~

Prior to making a decision about whether or not to certify the Lighting Management Plan, the Chief Executive may seek an assessment of the Lighting Management Plan by an appropriately qualified and experienced external reviewer.~~If the Chief Executive requests amendments and / or a time extension in accordance with parts (ii) and (iii) of this condition, these steps must occur simultaneously~~.

If the Chief Executive advises that amendments are required in accordance with this condition, the Chief Executive must advise the Consent Holder within 10 working days of receipt of the revised Lighting Management Plan, or at a later time advised by the Chief Executive, whether it is certified or not. If the Chief Executive does not advise the Consent Holder within the timeframes specified within this condition, the Lighting Management Plan is deemed to be certified by the Chief Executive.

20. (a) For at least the first year of mining operations and for no more than two years of mining operations, the Consent Holder must ensure that independent and appropriately trained seabird and marine mammal observers are on the mining vessel while the mining vessel is at sea. These independent observers will be responsible for observing and recording the presence of seabirds and marine mammals in and around the mining vessel and the nature of interactions with the mining vessel, if any.

(b) No earlier than one year after the commencement of mining operations, the Consent Holder may submit to the Chief Executive for review, a report, prepared by appropriately qualified seabird and marine mammal experts, based on the observations of marine mammals and seabirds collected in accordance with part (a) of this condition, assessing the ongoing risk to seabirds and marine mammals from the mining operations. If the report identifies that the ongoing risk is low and that in the expert's opinion the independent observers are no longer required to carry out the role outlined in part (a) of this condition, then within one month of receiving the report, the Chief Executive

may accept, or decline, the recommendations of the report, or request a timeframe extension for further evaluation of the assessment including possible assessment by an external reviewer. If the Chief Executive accepts the recommendations of the report, the Consent Holder may cease using independent observers in accordance with this condition.

21. Once the independent and appropriately trained seabird and marine mammal observers are no longer required in accordance with Condition 20, the Consent Holder must ensure that relevant personnel on the mining vessel undertake appropriate training, in conjunction with the relevant regulatory authority, in the identification, recording and reporting of the presence of marine mammals and seabird species in and around the mining vessel. These trained personnel will be primarily responsible for continuing to observe and record the presence of seabirds and marine mammals in and around the mining vessel and the nature of interactions with the mining vessel, if any.

22. The Consent Holder must also ensure that all personnel undertaking work at sea are provided with a marine mammal and seabird species identification guide to help ensure accurate species identification. All personnel are to be instructed to report any relevant sightings to the trained observers.

23. The Consent Holder must record and maintain a log of all strikes of seabirds that occur on the mining vessel, including photographs (whole body and at least two head shots), date, time, weather conditions, species (where known) and whether the bird was dead or released alive. If they are able to be safely recovered, dead birds are to be bagged, labelled, frozen and provided to the Department of Conservation when the mining vessel next returns to port.

24. The Consent Holder must record and maintain a log of all sightings of marine mammals, including location, species and number of animals. Annually, on 31 October, the Consent Holder shall provide a copy of this log to the Chief Executive and the Department of Conservation.

Mine Plan

25. At least three calendar months prior to mining activities commencing, the Consent Holder must forward to the Chief Executive a Mine Plan. The purpose of the Mine Plan is to describe the operational mining activities, including vessel operations, which are to take place in the coming calendar year.

    The Mine Plan must provide, at least, the following information:

    (a) confirmation of the mining method to be utilised, including but not limited to, the seabed mining method, the separation method and the method used to return the processed material from the mining vessel to the seabed;

    (b) management and maintenance requirements for key components of the mining operations;

    (c) the location of the areas that are not to be mined (identified by latitude and longitude and associated maps), or which are not to be mined during specific time periods, in accordance with Conditions 14 and 15 of this consent;

(d) the location of the mining blocks to be mined over the next 12 months (identified by latitude and longitude and associated maps), including identification of a reserve mining block/s;

(e) identification of the predicted extent of sediment deposition associated with the return to the seabed of the processed material from the mining vessel, including the implications of the known sediment composition of the mining blocks as determined by sampling;

(f) restrictions, if any, that will apply to navigation while mining is occurring;

(g) contingency procedures to prevent and deal with unusual events, including but not limited to, extreme weather events and equipment failure; and

(h) other actions necessary to comply with the conditions of this consent and any other relevant regulatory or legislative requirements including any relevant environmental management requirements arising out of the EMMP required by Conditions 29 or 30 of this consent.

26. No later than 31 October of each year while mining operations continue, the Consent Holder must update the Mine Plan and forward the updated Mine Plan to the Chief Executive. The updated Mine Plan is to provide the information identified in Condition 25 above for the following calendar year, and at least the following additional information:

(a) confirmation of the areas mined in the previous 12 month period (identified by latitude and longitude and associated maps);

(b) the volume of material retained and transferred to port in the previous 12 month period; and

(c) any changes to the mining method utilised or mine plan approach as a result of:

(i) any adaptive management approaches that have been implemented in accordance with Condition 41;

(ii) an assessment of all ~~relevant~~ environmental and monitoring data that has been gathered by the Consent Holder; and

(iii) any environmental management considerations identified as a result of the EMMP's audit and review procedures (as required by Condition 29).

27. Within one month of receiving the Mine Plan from the Consent Holder in accordance with Conditions 25 or 26, the Chief Executive must either certify that the Mine Plan meets the requirements of Conditions 25 or 26, advise the Consent Holder that amendments are required and / or request a timeframe extension for further evaluation Mine Plan including possible assessment by an external reviewer. If the Chief Executive advises that amendments are required in accordance with this condition, the Chief Executive must advise the Consent Holder within 10 working days of receipt of the revised Mine Plan, or at a later time advised by the Chief Executive, whether it is certified or not. If the Chief Executive does not advise the Consent Holder within the timeframes specified within this condition, the Mine Plan is deemed to be certified by the Chief Executive.

28. The Consent Holder must ensure that mining operations are undertaken at all times in accordance with the certified Mine Plan.

Environmental Management and Monitoring Plan (EMMP)

29. At least three calendar months prior to the commencement of mining activities, the Consent Holder must forward to the Chief Executive an EMMP. The purpose of the EMMP is to provide a management and operational framework which continually guides and informs measures and management approaches, to ensure compliance with the conditions of this consent and in accordance with the avoid, remedy or mitigate hierarchy for the prevention or management of any adverse impacts associated with the Consent Holder's mining operations. The EMMP must include, but not be limited to:

    (a) the Consent Holder's environmental policy;

    (b) the purpose of and objectives for the EMMP;

    (c) a list of key personnel and points of contact, including but not limited to personnel with specific environmental management responsibilities under the conditions of the consent and the EMMP;

    (d) management procedures including, but not limited to, continued identification of potential environmental impacts, assessment of relevant legal requirements, development of an environmental programme for the management of environmental impacts, identification of roles and responsibilities, environmental and operations training requirements, internal and external communication, documentation and document control, the management of and response to environmental incidents, contingency planning, audit and review;

    (e) standard operating procedures, as they relate to potential environmental impacts. These procedures must include, but not be limited to, biosecurity management of the mining vessel and all mining equipment in water, potential interaction with wildlife including marine mammals, waste management (solid and liquid), vessel lighting and the management of interactions with seabirds, vessel and other operational noise, equipment loss at sea, hazardous substances management, mining operations, dealing with any spillages including of oil and hazardous substances and generally minimising potential environmental impacts associated with mining;

    (f) monitoring procedures required to implement the monitoring programme, including the monitoring described in Schedule 2 and Conditions 12, 13, 23 and 24 of this consent. Monitoring procedures must include, but not be limited to, the monitoring objectives, monitoring requirements and associated roles and responsibilities, calibration and repair requirements for the equipment, processes for monitoring compliance reviews and audits, non-conformance and corrective actions and control of monitoring records; and

    (g) other procedures or actions necessary to comply with all of the conditions of this consent and any other relevant regulatory or legislative requirements.

    The Consent Holder may prepare separate, but subsidiary to the EMMP, management plans to comply with this condition.

Advice Note: Within the marine consent application, the Consent Holder identified at least 2 separate but subsidiary management plans. These are the Lighting Management Plan, now specifically required by Condition 19 of this consent, and the Solid Waste Management Plan.

30. The Consent Holder must audit and review the EMMP as follows:

    (a) at a minimum, no later than 30 September of each year while mining operations continue;

    (b) if an environmental threshold identified is Schedule 1 is exceeded or an unexpected adverse impact triggers the adaptive management process outlined in Condition 41; and

    (c) if an environmental incident has occurred, or a complaint has been received, that has triggered the need to advise the Chief Executive in accordance with Condition 42 of this consent.

31. The Consent Holder must provide the Chief Executive with a copy of the EMMP within one month and no later than 31 October of it being reviewed and updated in accordance with Condition 30.

32. Within 1 month of receiving the EMMP from the Consent Holder in accordance with Conditions 29 or 30, the Chief Executive must either certify that the EMMP meets the requirements of Conditions 29 or 30, advise the Consent Holder that amendments are required and / or ~~request~~ advise the Consent Holder of a timeframe extension for further evaluation of the EMMP including possible assessment by an external reviewer. If the Chief Executive advises that amendments are required in accordance with this condition, the Chief Executive must advise the Consent Holder within 10 working days of receipt of the revised EMMP, or at a later time advised by the Chief Executive, whether it is certified or not. If the Chief Executive does not advise the Consent Holder within the timeframes specified within this condition, the EMMP is deemed to be certified by the Chief Executive.

33. At all times, the Consent Holder must ensure that all operations are undertaken in accordance with the requirements of the certified EMMP, including any subsidiary management plans which includes the Lighting Management Plan.

Monitoring

34. The Consent Holder must implement and carry out the monitoring programme described in Schedule 2.

35. At least one month prior to any component/s of the monitoring described in Schedule 2 commencing, the Consent Holder must forward to the Chief Executive for ~~review~~ certification a detailed methodology for the monitoring that is to be carried out. Within 10 working days of receiving the methodology, the Chief Executive must either certify that the methodology is appropriate for the monitoring that is to be carried out, advise the Consent Holder that amendments are required and / or ~~request~~ advise the Consent Holder of a timeframe extension for further evaluation of the methodology for the monitoring that is to be carried out.

    Prior to making a decision about whether or not to certify the methodology for the monitoring, the Chief Executive may seek an assessment of the methodology by an appropriately qualified and experienced external reviewer. ~~, including possible assessment by an external reviewer.~~

If the Chief Executive advises that amendments are required, the Chief Executive must advise the Consent Holder within 5 working days of receipt of the revised methodology, or at a later time advised by the Chief Executive, whether it is certified or not. If the Chief Executive does not advise the Consent Holder within the timeframes specified within this condition, the methodology for the component of the monitoring to which it applies is deemed to be certified by the Chief Executive.

Advice Note: It is anticipated that these monitoring methodologies, once mining activities commence and the EMMP is prepared, will form part of the monitoring procedures required by Condition 29(f) of this consent.

~~35.~~36. Once mining operations have commenced, irrespective of any reporting requirements in relation to monitoring, the Consent Holder must ensure that it has in place procedures that ensures that all monitoring data are routinely reviewed and assessed in terms of compliance with the conditions of this consent.

Advice Note: This procedure/s is to be included in the EMMP.

~~36.~~37. The Consent Holder must ensure that the reporting requirements for the monitoring programme, as described in Schedule 2, are complied with. The Consent Holder must provide copies of all monitoring reports to the Chief Executive and to the ERG.

Reporting

~~37.~~38. No later than 30 April and 31 October during the first two years of mining operations, and thereafter no later than 31 October of each year, the Consent Holder must forward a report to the Chief Executive and the ERG.

~~38.~~39. The report must include, but not necessarily be limited to, the following:

(a) assess compliance with the conditions of this consent and provide detailed explanations of any non-compliance and measures taken accordingly to remedy these;

(b) provide an appropriate record of the ERG meetings;

(c) analyse and summarise the results of monitoring undertaken in accordance with the conditions of this consent (as described in Conditions 12, 13, 23 and 24 and Schedule 2), and, if appropriate, make recommendations in relation to monitoring programme changes;

(d) report on the observed marine mammals and seabird sightings in and around the mining vessel, and a copy of the sighting logs;

(e) summarise and analyse incidents or complaints receiving during the reporting period;

(f) provide an overview of the funds held by the Trusts established in accordance with Condition 54 and 57, the activities funded by the Trust and the outcomes or results arising from this funding;

(g) provide an overview of other deliverables provided to the Chief Executive in accordance with the conditions of this consent. This includes, but is not limited to, whether any adaptive management process assessments have been or have been initiated, the Mine Plan, the EMMP and any other subordinate management plans; and

(h) detail any other issues considered important and relevant by the Consent Holder.

Adaptive Management Approach – Staged Mining

~~39.~~40. After the first five years of mining operations, the Consent Holder may undertake mining activity within areas outside of mining permit 55549 specified in Condition 10, provided the Consent Holder meets the following requirements:

(a) that an adaptive management response, as described in Condition 41, either:

(i) has not been triggered, as a result of an exceedance of an environmental threshold identified within Schedule 1, within the past 2 years; or

(ii) if an environmental threshold has been exceeded and a response has been triggered, then a successful adaptive management solution has been implemented that has ensured that the environmental threshold/s have not been exceeded over the preceding 12 months.

(b) in relation to a proposed additional area to be mined, the following prospecting activities, as outlined in Schedule 2C, have been completed:

(i) bathymetry has been confirmed;

(ii) sampling of the physical characteristics of the seabed has been carried out; and

(iii) sampling (defined as epibenthic photography and infaunal sampling) of the benthic ecology has been carried out.

(c) in addition to (a) and (b) above, the Consent Holder has performed additional plume modelling studies for the proposed additional mining area based on oceanographic (including current meter) data collected for the proposed mining area, and that the monitoring data which is relevant to the plume modelling and collected in accordance with Schedule 2 of this consent have been used to calibrate and validate the model. This includes confirming that the environmental thresholds identified in Schedule 1 will continue to be complied with.

(d) the Consent Holder has:

(i) from the information gathered in accordance with part (b) of this condition, identified additional areas that cannot be mined in accordance with Condition 14;

(ii) in accordance with Condition 47, provided the Environmental Reference Group (ERG) with the opportunity to evaluate and provide feedback to both the Consent Holder and the Chief Executive on the information gathered in accordance with this condition and all monitoring data collected and assessed in accordance with the conditions of this consent; and

(iii) been granted a mining permit in accordance with the provisions of the Crown Minerals Act 1991 (or any different resource access approval if this legislation is replaced).

(e) Provided a report to the Chief Executive on the location and nature of the additional mining area as well as compliance with the requirements of this condition.

(f) Within three months of the receipt of the report provided in accordance with part (e), the Chief Executive must provide certification to the Consent Holder, in writing, as to whether this condition has been complied with. The Chief Executive may advise the Consent Holder of a timeframe extension for further evaluation of the report, including possible assessment by an appropriately qualified and experienced external reviewer. Upon receipt of certification from the Chief Executive that this condition has been complied with, the Consent Holder may commence mining in the additional mining area.

Adaptive Management Approach – Unexpected Adverse Impacts

~~40.~~41. In circumstances where an environmental threshold identified in Schedule 1 has been exceeded or an unexpected adverse impact associated with the mining operation is identified by the Consent Holder and / or another party as a result of activities authorised by this consent, the Consent Holder must:

(a) as soon as practicable and no later than 5 working days of becoming aware of the exceedance of the environmental threshold identified in Schedule 1 or an unexpected adverse impact, advise the Chief Executive in writing;

(b) the Consent Holder may continue mining unless the Chief Executive determines that the adverse impact is significant and gives the Consent Holder express instruction in writing to cease until such time a solution can be put in place that ensures that the unexpected adverse impact can be avoided, remedied or minimised;

(c) within 1 month of advising the Chief Executive, unless a timeframe extension is requested by the Consent Holder, complete an assessment of adaptive management approaches that can be implemented that will avoid, remedy or minimise the exceedance of the environmental threshold identified in Schedule 1 or an unexpected adverse impact. The assessment must include consideration of relevant environmental and monitoring data. If a solution is identified, the assessment must identify the timeframe for implementation. This assessment must be provided to the Chief Executive for ~~review~~certification. Within one month of receiving this assessment, the Chief Executive may either certify that the proposed solution meets the requirements of this condition, request amendments and / or advise the Consent Holder of~~request~~ a timeframe extension for further evaluation of the assessment including possible assessment by an appropriately qualified and experienced external reviewer; and

(d) subject to receiving certification from the Chief Executive to proceed with the proposed solution, the Consent Holder must ensure that if an adaptive management approach is to be implemented, it must be implemented in accordance with the timeframe identified in the assessment required by part (c) of this condition.

Advice Note:

(i) If the proposed adaptive management approach entails modifications to any of the key elements of the mining vessel or associated components, such as the drag-head,

separation plant or the material return, then it is acknowledged that it may take some time to implement the proposed management approach.

(ii) If an adaptive management solution is not identified by part (c) of this condition, Condition 74 provides the Chief Executive with the opportunity to review the term of the marine consent and / or the conditions of this consent.

Environmental Incidents

~~41.~~42. The Consent Holder must maintain and keep a register of all environmental incidents, including but not limited to exceedances of the environmental thresholds identified in Schedule 1, that are associated with activities authorised by this consent. Upon becoming aware of any environmental incident, the Consent Holder must record:

(a) the date, time and duration of incident and / or when the incident was identified;

(b) the location of the mining vessel, and the nature of mining operations taking place, at the time that the incident occurred;

(c) the cause or likely cause of the incident and any factors, such as weather conditions, that may have influenced its severity;

(d) the nature and timing of any measures implemented by the Consent Holder to remedy or mitigate any adverse effects, if any, associated with the event or incident;

(e) the steps to be taken in future to prevent the recurrence of similar events or incidents; and

(f) any other relevant information.

All of the above actions are to be recorded on the register. A copy of this register must be held on the mining vessel at all times and is to be provided to the Chief Executive upon request. If the incident relates to an exceedance of the environmental thresholds identified in Schedule 1, then the Consent Holder must follow the process outlined in Condition 41 of this consent while also ensuring that the register and associated records required by this condition are maintained in relation to the incident.

~~42.~~43. In circumstances where an incident, other than an incident associated with an exceedance of environmental threshold, has or is likely to result in a non-compliance with the conditions of this consent, then the Consent Holder must advise the Chief Executive, as soon as practicable and no later than 5 working days after the Consent Holder becomes aware of the incident. In circumstances where the Chief Executive has been advised of an environment incident under this condition then the Consent Holder must, within 5 working days of completing the investigation required by Conditions 42(c) to (f), provide a copy of the investigation to the Chief Executive.

Complaints

~~43.~~44. The Consent Holder must establish and publicise its dedicated communication methods, which provides for 24 hours a day coverage, for receipt of environmental complaints arising from the Consent Holder's mining operations. The dedicated communication methods must also be advised, in writing, to the Chief Executive and the ERG.

~~44.~~45. The Consent Holder must maintain and keep a register of all environmental complaints, as part of its environmental incident register required by Condition 42, associated with activities authorised by this consent. Upon becoming aware of any environmental complaint, the Consent Holder must record:

(a) the date, time and duration of the event associated with the complaint;

(b) the nature of the complaint, the time at which it was received, and if the complainant is willing to provide the information, the complainant's name, contact details and their location and the time of the event or incident;

(c) the location of the mining vessel, and the nature of mining operations taking place, at the time that the event occurred;

(d) the cause or likely cause of the event and any factors, such as weather conditions, that may have influenced its severity;

(e) the nature and timing of any measures implemented by the Consent Holder to remedy or mitigate any adverse effects, if any, associated with the event;

(f) the steps to be taken in future to prevent the recurrence of similar events; and

(g) any other relevant information.

All of the above actions are to be recorded on the register. A copy of this register must be held on the mining vessel at all times and is to be provided to the Chief Executive upon request.

~~45.~~46. In circumstances where a complaint is associated with an event that has or is likel~~t~~y to result in a non-compliance with the conditions of this consent, then the Consent Holder must advise the Chief Executive, as soon as practicable and no later 5 working days after the complaint is received. In circumstances where the Chief Executive has been advised of a complaint under this condition then the Consent Holder must, within 5 working days of completing the investigation required by Conditions 42(c) to (f), provide a copy of the investigation to the Chief Executive.

Environmental Reference Group (ERG)

~~46.~~47. At least three calendar months prior to mining activities commencing in accordance with this consent, the Consent Holder must establish an ERG. The brief for the ERG must include, but not be limited to:

(a) receive all data and reports, including but not limited to the monitoring outlined in Schedule 2, prepared in accordance with this consent, as well as other relevant research that is part of the adaptive management approach described within the conditions of this consent;

(b) consider the impacts on the Chatham Rise marine environment of the Consent Holder's mining activities;

(c) identify and discuss appropriate measures, or management actions, to address issues identified or to remedy or mitigate unexpected adverse impacts for the Consent Holder to consider, including consideration of proposed adaptive management approaches; and

(d) other matters relevant to the environmental management and performance of the Consent Holder's mining activities.

The ERG are to consider these matters at regular meetings, as required by the Condition 50 of this consent.

~~47.~~48. In establishing the ERG in accordance with Condition 47, the Consent Holder must invite representatives from the following organisations and experts with appropriate qualifications or experience or both to join the ERG. The organisations and experts include, but are not limited to:

(a) one representative from CRP, as the Consent Holder;

(b) a suitably qualified technical specialist in the field of deep-water marine ecology;

(c) a suitably qualified specialist in the field of marine sediments and sediment plume dispersion;

(d) a ~~nominated~~ representative ~~from~~ nominated by the Department of Conservation;

(e) a representative nominated by the deep-water fishing industry;

(f) a representative from the Chatham Islands community;

(g) a representative from an environmental non-government organisation with an interest in the marine ecosystems of the EEZ; and

(h) an Iwi / Imi representative from the collective of Ngati Mutunga o Wharekauri, Moriori, and Te Runanga o Ngai Tahu.

Additional members may also be co-opted onto the ERG, either temporarily or permanently, to ensure that the ERG has the requisite skills to deliver on the brief described in Condition 47.

Advice Note: To provide for an ERG that is both effective and efficient, it is acknowledged that the Consent Holder may generally seek to restrict the ERG membership to no more than 12 individuals.

~~48.~~49. Without limiting the ability of the ERG to set its own procedures, including meetings as and when considered necessary by the ERG, the Consent Holder must provide reasonable administrative, logistical and financial support to facilitate the function of the ERG, including the provision of an independent facilitator to chair ERG meetings.

~~49.~~50. The Consent Holder must provide for meetings of the ERG to occur at the following frequency:

(a) at least twice a year during the first two years of mining operations; and

(b) after the first two years of mining, at least annually.

~~50.~~51. The Consent Holder must ensure that all ERG members are advised of meeting dates and location in a timely manner, and no later than one calendar month in advance of the meeting.

~~51.~~52. The Consent Holder must ensure that all information, including data and reports, that are to be discussed at ERG meetings are provided in a timely manner, and no later than 10 working days in advance of the meeting.

~~52.~~53. The Consent Holder must ensure that a record of the ERG meetings is forwarded to the Chief Executive within one month of meetings being held.

Environmental Compensation Trust

~~53.~~54. The Consent Holder, through the establishment of a Trust, must provide environmental compensation for those areas of its environmental impacts that cannot be avoided, remedied or mitigated. The Trust is to be established before the commencement of mining. Trustees are to be appointed at the Consent Holder's discretion but must include:

(a) one representative from CRP, as the Consent Holder;

(b) one ~~nominated~~ representative nominated by~~from~~ the Department of Conservation;

(c) a suitably qualified deep-water marine scientist;

(d) one representative from Iwi / Imi from the collective of Ngati Mutunga o Wharekauri, Moriori, and Te Runanga o Ngai Tahu; and

(e) one representative from an environmental non-government organisation with an interest in the marine ecosystems of the EEZ.

~~54.~~55. The purpose of the Trust is to administer annual funding, to be settled on the Trust by the Consent Holder, of $350,000 per annum (annually adjusted for inflation). The first annual settlement must occur on or before the first day that mining takes place and subsequent annual settlements must occur on the anniversary of the first settlement for each year that mining takes place.

~~55.~~56. The objectives of the Trust, with priority for funding allocation given to objective (a), are:

(a) to advance environmental and biodiversity enhancement in the marine environment of the Chatham Rise, and on or around the Chatham Islands; and

(b) to support scientific research of the Chatham Rise, in particular geographic areas and biological communities relevant to the Consent Holder’s mining operations.

Chatham Islands Trust

~~56.~~57. The Consent Holder, through the establishment of a Trust, will support initiatives designed to benefit the Chatham Islands and Chatham Islands community, Ngāti Mutunga o Wharekauri and Moriori. The Trust is to be established before the commencement of mining. Trustees are to be appointed at the Consent Holder's discretion but must include:

(a) one representative from CRP, as the Consent Holder;

(b) at least one representatives from Hokotehi Moriori and at least one representative from Ngati Mutunga o Wharekauri; and

(c) at least two representatives from the Chatham Islands community.

~~57.~~58. The purpose of the Trust is to administer annual funding, to be settled on the Trust by the Consent Holder, of $280,000 per annum (annually adjusted for inflation). The first annual settlement must occur on or before the first day that mining takes place and subsequent annual

settlements must occur on the anniversary of the first settlement for each year that mining takes place.

~~58.~~59. Priorities for funding, and the objectives of the Trust, are:

(a) Annually, the Trustees are to allocate up to $200,000 (annually adjusted for inflation) to the following objectives, with priority for funding allocation given to objective (i). The objectives are:

(i) to provide for, initially through investigation and then through implementation, maintenance and enhancement of Chatham Islands farming activities; and

(ii) to provide for the enhancement of economic development opportunities on the Chatham Islands.

(b) Annually, the Trustees are to allocate the remainder of the funds held by the Trust (less the costs of administering the Trust) to the following objectives, with priority for funding allocation given to objective (i). The objectives are:

(i) to support education opportunities, through grants or scholarships, for Chatham Islanders, with a particular focus, where possible, on education related to the marine environment, offshore mining operations and vessel operations;

(ii) to support cultural development initiatives, through education grants and scholarships or through other means, that support the unique cultural needs of Ngati Mutunga o Wharekauri and Moriori, including any initiatives relating to Ngati Mutanga o Wharekauri and Moriori cultural relationship with the marine environment; and

(iii) to support other community activities on the Chatham Islands.

Protection of Mining Exclusion Areas

~~59.~~60. Prior to undertaking and if necessary following commencement of mining operations under this consent, the Consent Holder must:

(a) In consultation with the Ministry of Business, Innovation and Employment – NZ Petroleum & Minerals, the Department of Conservation, the Ministry for Primary Industries and other interested parties, use best endeavours to establish a legal mechanism to protect the areas referred to in Condition 14(a) and (b), and other areas outside of the marine consent area but identified from the marine spatial planning exercise undertaken by the Consent Holder, from future mining operations and any other activities that would disturb the seabed ; and

(b) Upon either:

(i) the legal mechanism being established; or

(ii) best endeavours being exhausted,

the Consent Holder must provide evidence to the Chief Executive, for the purposes of certification in accordance with the requirements of this condition, of a satisfactory legal mechanism being established or best endeavours discussions being exhausted.

Advice Note: This condition is a proffered condition intended to further protect the mining exclusion areas. It is in addition to the legal protection that is to be sought under Condition 14(a) and (b).

Bond

~~60.~~61. Pursuant to section 65 of the EEZ Act, prior to mining activities commencing on the Chatham Rise, the Consent Holder must make provision for the maintenance of a bond in favour of the EPA for the purposes of:

(a) remediating any long-term unexpected adverse impacts that might arise as the result of the Consent Holder's mining operations; and

(b) monitoring the long-term adverse impacts associated with:

(i) the loss of benthic habitat as a result of seabed removal as part of the mining operations, including but not limited to the effectiveness of hard-substrate recolonisation areas established by the Consent Holder;

(ii) the extent of sedimentation deposition, and associated impacts on the benthic environment, as a result of the return of processed material to the seabed from the mining vessel;

~~61.~~62. The quantum of the bond must be sufficient to cover the estimated costs (including any contingency necessary), and any further sum the Chief Executive considers necessary, associated with the activities outlined in Condition 61 above.

~~62.~~63. The bond must be in a form certified by the Chief Executive in accordance with the requirements of these bond conditions, and be on the terms and conditions required by the Chief Executive.

~~63.~~64. The bond must be guaranteed by a guarantor acceptable to the Chief Executive. The guarantor must bind itself to pay for the carrying out and completion of any bond in the event of any default of the Consent Holder, or any occurrence of adverse impact requiring remedy.

~~64.~~65. Subject to the Chief Executive receiving notice of the Consent Holder's intention to commence mining in accordance with Condition 5, the amount of the bond must be fixed by the the Chief Executive 3 months prior to mining activities commencing on the Chatham Rise and every fifth anniversary thereafter by the Chief Executive. The amount of the bond must be advised in writing to the Consent holder at least one month prior to the review date.

~~65.~~66. Should the Consent Holder not agree with the amount of the bond fixed by the the Chief Executive, then the matter must be referred to arbitration in accordance with the provisions of the Arbitration Act 1996. Arbitration must be commenced by written notices by the Consent Holder to the Chief Executive advising that the amount of the bond is disputed, such notice to be given by the Consent Holder within two weeks of notification of the bond. If parties cannot agree upon an arbitrator within a week of receiving the notice from the Consent Holder, then an arbitrator must be appointed by the Arbitrators' and Mediators' Institute of New Zealand Incorporated. Such arbitrator must give an award in writing within 30 days after his or her appointment, unless the Consent Holder and the Chief Executive agree that time may be extended. The parties must bear their own costs in connection with the arbitration. In all other

respects, the provisions of the Arbitration Act 1996 apply. Pending the outcome of that arbitration, the existing bond, if in place, must continue in force.

~~66.~~67. If the amount of the bond to be provided by the Consent Holder is greater than the sum secured by the current bond, then within one month of the Consent Holder being given written notice of the new amount to be secured by the bond, the Consent Holder and the guarantor must execute and lodge with the Chief Executive a variation of the existing bond or a new bond for the amount fixed on review by the Chief Executive. Activities authorised by this consent may not be undertaken if the variation of the existing bond or new bond is not provided in accordance with this condition.

~~67.~~68. The bond is to be released no more than 10 years after:

(a) the expiry, surrender, lapsing or cancellation of this consent; or

(b) the Consent Holder has advised the Chief Executive that all mining activities authorised by this consent have ceased and will not be resumed.

~~Dispute Resolution~~Mediation

~~68.~~69. In the event of any dispute, disagreement or inaction arising from any Chief Executive certification / approvals required by the conditions of this consent, or the implementation of monitoring required by the conditions, that cannot be resolved by the Consent Holder and the Chief Executive within a timeframe of not more than three months, either party may give notice of the intention to engage an independent and appropriately qualified ~~dispute resolution~~mediation expert to ~~determine~~ mediate the matter. The notice must be in writing and must identify the matter to be ~~determined~~ mediated and reasons that the parties do not agree.

~~69.~~70. Within one week of giving notice, if the parties cannot agree on a mutually acceptable ~~dispute resolution~~mediation expert to determine the matter, then an expert is to be appointed by the Arbitrators' and Mediators' Institute of New Zealand Incorporated.

~~70.~~71. The appointed ~~dispute resolution~~mediation expert is to ~~determine~~facilitate the mediation of the matter before him or her within 30 days of being appointed, unless the Consent Holder and the Chief Executive agree that time may be extended~~. In determining the matter, the appointed dispute resolution expert is entitled to seek further information and hear from the parties as he or she sees fit.~~

Advice Note: The dispute resolution process provided for in this condition does not prejudice any party's rights to take enforcement action in relation to the conditions of this consent.

Non-lapsing and Non-cancellation of Marine Consent

~~71.~~72. This consent will not lapse until a date 10 years from the grant of the consent. For the avoidance of doubt, during the first 10 years following the grant of this consent, this consent is not liable to cancellation pursuant to section 86 of the EEZ Act.

Marine Consent Review

~~72.~~73. The Chief Executive may, within two months of the second anniversary of the grant of this marine consent, and every five years thereafter, serve notice to the Consent Holder, in accordance with sections 76 and 77 of the EEZ Act, of its intention to review either the duration

and / or the conditions of this marine consent for the purposes described in section 76(1) of the EEZ Act.

~~73.~~74. At any time, if an adaptive management approach, in accordance with Condition 41, has not been considered to be achievable by the Consent Holder following completion of an assessment carried out in accordance with these conditions, the Chief Executive may serve notice to the Consent Holder, in accordance sections 76 and 77 of the EEZ Act, of its intention to review either the duration and / or the conditions of this marine consent.

Schedule 1 – Environmental Thresholds

If the following environmental thresholds are exceeded the Consent Holder is then required to follow the process provided for by the 'Adaptive Management Approach – Unexpected Adverse Impacts' condition (Condition 41).

Ref.	Parameter / Impact	Purpose	Trigger	Determined by / at	Confirmation mechanism (if applicable)
1A	Total suspended solids (TSS)	To confirm that the TSS levels of the plume generated by the mining operations are in accord with those predicted by the numerical models and to ensure that the impacts on ecological values in the water column, beyond the area of predicted adverse impact from the plume, are no greater than predicted.	50 mg/L (Note: The verification of this trigger will be determined based on turbidity. The correlation between turbidity and total suspended solids will be determined through monitoring to be carried out prior to mining commencing – refer to Schedule 2).	At a point 5 km or greater away from the edge of the mining block being mined OR at a point 50 m or greater above the seabed at any location	If the results of monitoring, as described in Schedule 2, exceeds the threshold on any occasion, the Consent Holder must: (a) within no more than 48 hours carry out an additional round of monitoring while mining operations are occurring; and (b) if the results of the second round of monitoring exceeds the threshold, carry out two further rounds of monitoring, no more than 48 hours apart, when mining operations next occur; and (c) if the results of additional rounds of monitoring also exceed the threshold, then the adaptive management process outlined in Condition 41 is to be followed.
1B	Seabirds	To ensure that adverse impacts on seabirds as a result of contact with equipment on the mining vessel are	Injury or killing of any Chatham Island taiko (*Pterodroma magenta*) or Chatham petrel (*Pterodroma axillaris*) by mining	As required by Condition 23, the Consent Holder must ensure that all bird strike events are logged and other specific activities followed.	Not applicable.

Ref.	Parameter / Impact	Purpose	Trigger	Determined by / at	Confirmation mechanism (if applicable)
		avoided.	operations. In any calendar month, injury or killing of more than 2 other seabirds.		
1C	Sedimentation	To confirm that the extent of sediment deposition generated by the mining operations is in accord with that predicted by the numerical models and to ensure that the impacts on ecological values on the seabed, beyond the area of predicted adverse impact from sedimentation, are no greater than expected.	No observed adverse impacts on benthic organisms beyond the distance predicted for 1 mm sedimentation from the mining of one mining block.	At a point no more than 7 km from the edge of a mined mining block.	As determined by examination and assessment of the qualitative seabed images and seabed samples by an appropriately qualified expert, and as collected in accordance with the 'ecological impacts outside of the mining area' as described in Schedule 2.

The environmental thresholds identified in the above table may be amended (reduced or increased), removed or new thresholds added through a replacement Schedule. This reflects an adaptive management approach in terms of the utilisation of environmental thresholds throughout the term of the marine consent. At all times the environmental thresholds are to be set at a level that is consistent with ensuring

the extent of adverse impacts recognised by this consent are not exceeded and / or continuing to minimise adverse impacts associated with mining.

The process to be followed before a replacement Schedule forms part of this consent is:

(a) The Consent Holder is to prepare a proposed replacement Schedule and an associated report, supported by relevant scientific and / or operational evidence, outlining the reasons for the proposed amendments.

(b) The Consent Holder is to provide the ERG with an opportunity to review and comment on the proposed replacement Schedule.

(c) ~~Once t~~The Consent Holder ~~and ERG have agreed that replacement Schedule is appropriate, the replacement Schedule~~ is to ~~be~~ provide~~d~~ the proposed replacement Schedule to the Chief Executive for certification~~review~~.

(d) Within one month of receiving the replacement Schedule, the Chief Executive must either certify that the replacement Schedule contains environmental thresholds that continue to reflect appropriate thresholds that reflect the nature of the Consent Holder's ongoing mining operations, ~~request~~ require amendments and / or ~~request~~ advise the Consent Holder of a timeframe extension for further evaluation. At any time prior to making a decision about whether or not to certify a proposed replacement Schedule, the Chief Executive may request an assessment by an appropriately qualified ~~which may include possible assessment by an~~ external reviewer.

(e) Within five working days of certifying the replacement Schedule, the Chief Executive must ensure that the consent contains the replacement Schedule (including the date at which the Schedule comes into effect).

Schedule 2 - Monitoring

Advice Note: The following schedule described the monitoring required by Conditions 34 and 40. There are also a range of conditions that specifically describe additional monitoring requirements that have not been included in this schedule (Conditions 12, 13, 23 and 24) as this monitoring is required to continue, with any possible amendment, while mining is taking place in accordance with this marine consent.

Ref.	Parameter	Objective/s	Requirement	Timing and Frequency	Reporting
2A - Prior to commencement of any mining operations					
i	Water quality	To obtain and analyse water samples to determine the near seabed water quality.	Collection of water samples from 10 m above the seabed from three locations, one in MP 55549 and two non-mining locations at least 50 km away from MP 55549. At each location, on the occasion that the sample is being collected, measurements of salinity, temperature and dissolved oxygen will be collected from the surface to the seabed at appropriate intervals to identify vertical variation within the water column for these parameters. Five samples, collected every 500 m along a 2 km long transect, will be collected at each location. Total of 15 samples. Samples will be analysed for the following parameters: - total suspended solids and turbidity; - particulate and dissolved organic carbon;	Two rounds of monitoring, at least six months apart, are to be carried out prior to mining commencing, within sufficient time to meet the identified reporting requirements.	As part of a pre-mining report to be provided to the Chief Executive at least three months before mining commences.

Ref.	Parameter	Objective/s	Requirement	Timing and Frequency	Reporting
			- ammoniacal nitrogen; - dissolved reactive phosphorus; and - arsenic, chromium, copper, lead, mercury, nickel, uranium, vanadium and zinc. Three samples from each sampling location (9 samples in total) will be collected an analysed to determine polonium 210 content.		
ii	Water quality and oceanographic (fixed landers) (Note – as described in Schedule 2B below, this monitoring will be continued once mining commences)	To continuously measure seabed turbidity and other physical properties of the marine environment at selected fixed sites in the marine consent area.	Monitoring to be carried out using fixed landers with appropriate monitoring equipment. Up to 4 landers are to be deployed at any one time, with 3 located adjacent to area to be mined in the first year and 1 located in an area unaffected by mining (i.e., the latter is to be an area utilised as a reference for mining ecological or water quality impact assessment). The lander at the reference site and one of the other landers will include instruments to monitor turbidity, current speed and direction. The other 2 landers will monitor turbidity only. The monitoring instruments will be capable of providing detailed information about the lower 50 m of the water column.	Monitoring to commence at least 18 months before mining commences. This provides for at least 12 months of data to be assessed within the pre-mining report. Data will be downloaded at least every 6 months.	As part of a pre-mining report to be provided to the Chief Executive at least three months before mining commences.
iii	Bathymetry in MP	To complete the basemap	To undertake a survey that will	To be completed at least	As part of a pre-

Ref.	Parameter	Objective/s	Requirement	Timing and Frequency	Reporting
	55549 - completion	for resource development and environmental assessment by ensuring that the bathymetry for the whole of the mining permit area is collected.	complete the multi-beam swath bathymetry mapping of MP 55549. Bathymetry survey margin of error must not exceed ±5 m vertically and ±10 m horizontally.	three months before mining commences and in sufficient time to meet the identified reporting requirements.	mining report to be provided to the Chief Executive at least three months before mining commences.
iv	Benthic community modelling ground-truthing (Zonation)	To collect seabed images and samples to confirm the modelling of benthic habitats and communities that underlies the identification of areas with high biodiversity.	Surveys will use AUVs or similar technology to collect photographs of the seabed and corers to collect samples of the seabed sediments that will be analysed to determine benthic habitats and communities in the same manner as previous surveys. The results will be integrated with existing data to update the predicted distribution of areas with high biodiversity value, especially those containing stony corals.	The survey and analysis is to be completed at least three months before mining commences.	A report to be provided to Chief Executive at least three months before mining commences. The report is to recommend any amended or additional mining exclusions areas that meet the purpose of Condition 14(b), and which require certification in accordance with that condition.
v	Elutriate testing	To repeat the elutriate testing previously carried out using fresh sediment samples.	Elutriate testing of three sediment samples collected from MP 55549.	One testing round only. Testing to be completed at least 6 months before mining commences.	A report to be provided to the Chief Executive at least three months before mining

Ref.	Parameter	Objective/s	Requirement	Timing and Frequency	Reporting
					commences. Report is to compare results to those reported in Appendix 11 of the application.
vi	Toxicity testing	To repeat the toxicity testing previously carried out using fresh sediment samples.	From sediment samples collected from MP 55549, repeat the toxicity testing on the same organisms utilised in the 2014 toxicity testing carried out by NIWA. In addition, if practical, also include testing on appropriate organisms representative of Chatham Rise species.	One testing round only. Testing to be completed at least 6 months before mining commences.	A report to be provided to the Chief Executive at least three months before mining commences. Report is to compare results to those reported by NIWA in 2014.
vii	Turbidity profile / equipment trial	To measure the turbidity, and other physical parameters of the marine environment, using the equipment to be used in subsequent plume monitoring.	Within and adjacent to the proposed first mining block to be mined, survey the water column using an AUV, or similar equipment. The principle purpose of this monitoring is to determine the effectiveness of the equipment to gather turbidity data (and other data) within the plume once mining commences. Determine the turbidity profile within and adjacent to the area surveyed.	One successful monitoring round only. This monitoring / testing round to be completed at least 6 months before mining commences.	As part of a pre-mining report to be provided to the Chief Executive at least three months before mining commences.
viii	Trace elements in	To determine the	Species to be monitored are ling and	At least two rounds of	As part of a pre-

Ref.	Parameter	Objective/s	Requirement	Timing and Frequency	Reporting
	key commercial fish on the Chatham Rise.	concentrations of trace elements and key radionuclides in fish muscle tissue (i.e., the edible flesh) on the Chatham Rise before mining commences.	hoki. Fish are to be obtained from commercial long-line or trawl operations that have caught fish from areas: - 3 'mining locations' which are located within 50 km of MP 55549; and - 3 reference locations which are located more than 100 km from MP 55549. Eight fish, of each species, are to be collected from each site. The length and weight of each fish is to be recorded. Muscle tissue from each individual fish is to be removed and homogenised for laboratory analysis. Analysis of the muscle tissue must include: - from all fish at each site, trace elements, including arsenic, nickel, uranium and vanadium; and - from five fish collected from each site, polonium 210.	monitoring are to be carried out prior to mining commencing, within sufficient time to meet the identified reporting requirements.	mining report to be provided to the Chief Executive at least three months before mining commences.
ix	Ambient sedimentation rates (fixed landers)	To determine the natural sedimentation rate in the marine consent area.	Install a sediment trap on ~~the~~ at least one lander established at ~~the~~ a reference site as part of the water quality and oceanographic monitoring described above.	Monitoring to commence at least 18 months before mining commences. This provides for at least 12 months of data to be	As part of a pre-mining report to be provided to the Chief Executive at least three months

Ref.	Parameter	Objective/s	Requirement	Timing and Frequency	Reporting
				assessed within the baseline report. The sediment in the sediment trap is to be recorded at least every 6 months (at the same time that the data is downloaded from the lander).	before mining commences.
2B - During mining operations					
i	Sound from the mining vessel and equipment	To measure the sound of the mining vessel and mining equipment, in both the near field and far field, to verify the acoustic modelling results (McPherson et. al 2014 – refer to Condition 18).	Monitoring to be carried out using at least one lander equipped with instruments capable of recording sound levels in the appropriate frequency range at distances necessary to measure the near and far field sound levels of the vessel and mining equipment.	Monitoring is to commence no later than one month after mining commences. Monitoring data is to be collected for up to two months while mining is occurring.	A separate report is to be provided to the Chief Executive within two months of all of the monitoring data having been collected. The report is to assess whether the actual sound generated by the activity is within the range predicted in the acoustic modelling carried out prior to mining commencing.
ii	Water quality and oceanographic	To continuously measure seabed turbidity and other	Monitoring to be carried out using fixed landers with appropriate	Continuously while	Summary to be provided in

Ref.	Parameter	Objective/s	Requirement	Timing and Frequency	Reporting
	(fixed landers) (Note – continuation of the pre-mining monitoring described in Schedule 2A above)	physical properties of the marine environment at selected fixed sites in the marine consent area.	monitoring equipment. ~~Up to~~At least 4 landers are to be deployed at any one time, with at least 3 located adjacent to mining blocks and at least 1 located in an area unaffected by mining (i.e., the latter is to be an area utilised as a reference for mining ecological or water quality impact assessment). These landers may be relocated as mining progresses. The lander/s at the reference site and at least one of the other landers will include instruments to monitor turbidity, current speed and direction. ~~The other two landers will monitor turbidity only.~~ The monitoring instruments will be capable of providing detailed information about the lower 50 m of the water column.	mining is occurring. Data will be downloaded at least every 6 months.	report required by Conditions 38 and 39.
iii	Plume extent	To confirm that the turbidity levels of the plume generated by the mining operations are in accord with those predicted by the numerical models and to ensure that the impacts on ecological values in the water column, beyond the area of predicted adverse	Profile (track and map) the sediment plume, while mining is occurring, using an AUV or similar equipment, within and adjacent to the mining block being mined. The AUV, or similar equipment, will measure turbidity levels continuously during its surveys.	Profiling must occur on at least two occasions while the first mining block is being mined, and on at least one occasion for each of the mining blocks mined during the remainder of the first 12 months. After the first 12 months of mining, and	Summary to be provided in report required by Conditions 38 and 39.

Ref.	Parameter	Objective/s	Requirement	Timing and Frequency	Reporting
		impact from the plume, are no greater than predicted.		dependent on the results of the first 12 months of monitoring, the frequency of this monitoring can be reduced to up to two occasions each year during the second through to the fifth years of mining, and thereafter to at least one occasion each year while mining continues.	
iv	Sediment composition and chemistry	To routinely determine the composition of the seabed material to confirm that seabed chemistry is with the bounds described in Appendix 11 of the marine consent application.	Analysis of cores collected as part of monitoring programme to include: where visual redox differences are observed, Eh readings every 10 cm up to at least 30 cm; and, vertical cross-sections to be photographed immediately. At least five samples are to be collected for each mining block from the samples collected in accordance with Condition 13. Sample analysis must include: - particle size distribution; - examination for total organic carbon and carbonate; and - trace element analysis for arsenic, cadmium, chromium, copper, lead, mercury, nickel, uranium, vanadium and zinc.	Core and sample analysis to be ongoing while mining is occurring. Polonium 210 analysis to occur no later than during the first 6 months of monitoring.	Summary to be provided in report required by Conditions 38 and 39. Reporting to include comparison with the range described in Appendix 11 of the marine consent application, including identification of samples that fall outside of that range.

Ref.	Parameter	Objective/s	Requirement	Timing and Frequency	Reporting
			Analysis of three sediment samples, collected from within MP 55549 and the reference locations, to be analysed for polonium 210.		
v	Disposal of processed material from the mining vessel	To routinely estimate the composition of the material disposed from the mining vessel.	Samples to be collected on the mining vessel at a location where processing has been completed. 24 hour composite samples to be collected. All samples are to be analysed for the following parameters: - total suspended solids and turbidity; - particulate and dissolved organic carbon; - ammoniacal nitrogen; - dissolved reactive phosphorus; and - dissolved and total metals / metalloids for arsenic, chromium, copper, lead, mercury, nickel, uranium, vanadium and zinc.	During the first 12 months of mining, a sample is to be collected during every 24 hour period that mining occurs. After the first 12 months of mining, the frequency of this monitoring shall be reduced to at least once during each mining cycle.	Annual summary to be provided in report required by Conditions 38 and 39.
vi	Ecological impacts outside of mining area	To confirm that the extent of sediment deposition generated by the mining operations is in accord with that predicted by the numerical models and to ensure that the impacts on ecological values on the seabed, beyond the area of predicted adverse	Monitoring locations must include 3 regional reference sites that will not be impacted by mining within MP 55549 or by other activities. The other monitoring locations are from blocks 1 and 2 mined in the first year of mining, and blocks 4 and 5 in the second year of mining. Monitoring transects, at least 8 km in length, will be established at each	The monitoring of the reference sites and block 1 transects must take place within 3 months of completion of mining block 1. Subsequent monitoring must take place as follows: - within 9 months of	Annual summary to be provided in report required by Conditions 38 and 39.

Ref.	Parameter	Objective/s	Requirement	Timing and Frequency	Reporting
		impact from sedimentation are no greater than predicted.	monitoring location. At each monitoring location, one transect will be aligned with the predicted plume direction and another transect perpendicular to the predicted plume direction. Photograph of the seabed will be taken at regular intervals along each transects. These images will be analysed to provide quantitative information on the distribution and condition of benthic epifauna. At points 1,000, 3,000, 5,000, 7,000 m and at the end of each transect, sufficient images and seabed samples will be collected to enable an assessment (qualitative) of the nature and condition of benthic epifaunal and infaunal communities.	the completion of block 1. This monitoring round will include the transects from block 2. - within 15 months of the completion of block 1. In addition, the same monitoring frequency as that applied to blocks 1 and 2 is to be applied to blocks 4 and 5. The survey plan to be followed after the first two years of mining will be determined following an assessment of the monitoring carried out on blocks 1, 2, 4 and 5.	
vii	Trace elements in key commercial fish on the Chatham Rise	To determine the concentrations of trace elements and key radionuclides in fish muscle tissue (i.e., the edible flesh) on the Chatham Rise after mining commences.	Species to be monitored are ling and hoki. Fish are to be obtained from commercial long-line or trawl operations that have caught fish from areas: - 3 'mining locations' which are located within 50 km of MP 55549; and - 3 reference locations which are located more than 100 km from MP 55549. Eight fish, of each species, are to be	A round of monitoring is to be undertaken after the first, second and fourth year that mining has occurred. The timing of this monitoring is to be consistent with the timing of the rounds of 'trace elements in key commercial fish on the Chatham Rise'	Summary, including comparison with the data collected prior to mining commencing, to be provided in report required by Conditions 38 and 39 in the years that

Ref.	Parameter	Objective/s	Requirement	Timing and Frequency	Reporting
			collected from each site. The length and weight of each fish is to be recorded. Muscle tissue from each individual fish is to be removed and homogenised for laboratory analysis. Analysis of the muscle tissue must include: - from all fish at each site, trace elements, including arsenic, nickel, uranium and vanadium; and - from five fish collected from each site, polonium 210.	monitoring that took place prior to mining commencing.	monitoring has occurred.
viii	Recolonisation	To provide long term information on the recolonisation of the mined blocks.	The transects established for monitoring of the 'ecological impacts outside of mining area' will be extended into and across blocks 1, 2, 4 and 5. Photographs of the seabed will be taken at regular intervals along each transect. These images will be analysed to provide quantitative information on the distribution and condition of epifauna. At points 200 and 500 m inside the edge of the mining block, sufficient images and seabed samples will be collected to enable an assessment (qualitative) of the nature and condition of the epifaunal and	The same as monitoring of the 'ecological impacts outside of mining area'	The same as monitoring of the 'ecological impacts outside of mining area'

Ref.	Parameter	Objective/s	Requirement	Timing and Frequency	Reporting
			infaunal communities present.		
ix	Hard substrate trials	To assess the viability and value of the placement of hard material to provide added hard substrate habitat, thereby possibly enhancing biodiversity value within and adjacent to the mined areas.	Initial trials are to be carried out in the following areas: - in an area close to coral-dominated communities and predicted to be suitable habitat for coral-dominated communities but where no such communities have developed due to a lack of hard substrate; and, - within an area that has been mined, but only once deposited sediment has consolidated. Hard substrate is to be placed on the seabed at the above areas in discrete patches, at increasing distances from potential colonising sources. Once in place, sufficient photographs (using an AUV or similar equipmen) are to be taken of the trial areas to enable a record of the change in the epifauna community to be determined.	Monitoring to occur within 12 months, and thereafter at 2, 3, 5 and 10 years of the hard substrate being placed on the seabed.	Summary, including assessment of effectiveness of the trial, to be provided in report required by Conditions 38 and 39 in the years that monitoring has occurred.
x	Sedimentation rates (fixed landers)	To determine the ongoing sedimentation rate in the marine consent area once mining operations commence.	Maintenance of the sediment trap already installed on the lander, as part of the monitoring programme carried out prior to mining commencing, established at the reference site as part of the water quality and oceanographic monitoring described above.	Continuously while mining is occurring. The sediment in the sediment trap is to be recorded at least every 6 months (at the same time that the data is downloaded from the	Annual summary to be provided in report required by Conditions 38 and 39.

Ref.	Parameter	Objective/s	Requirement	Timing and Frequency	Reporting
				lander).	
xi	Organic matter retains on mining vessel	To provide ongoing information about the amount and composition of organic material retained on the 80 mm screens within the on-board sediment processing system (and thus not returned to the seabed).	Maintenance of a log recording the nature of material held on the 80 mm screen storage bin. A digital photographic record of the storage bin is to be taken at the same time.	For the first 12 months of mining, this monitoring is to be carried out daily during mining operations. After the first 12 months of mining, the frequency of this monitoring shall reduced to at least once during each mining cycle.	Annual summary to be provided in report required by Conditions 38 and 39.
xii	Phosphorite nodule composition	To routinely determine the composition of the mined phosphorite nodules to provide information on the resource / chemical composition in relation to its use as a fertiliser.	Statistically representative sample to be collected from each shipload of nodules. Nodule analysis must include major oxides (iron, calcium, potassium, sulfur, phosphorus, silicon, aluminium, magnesium and sodium) and trace elements (arsenic, chromium, copper, lead, nickel, uranium, vanadium and zinc).	Sample collected from each shipload. Ongoing while mining is occurring.	Annual summary of nodule composition to be provided in report required by Conditions 38 and 39.
2C - To meet surveying requirements of the staged adaptive management approach (Condition 40)					
i	Bathymetry	To complete the basemap for resource development and environmental assessment by ensuring that the bathymetry is collected in the areas that the Consent Holder is proposing to carry out	To undertake surveys, that will complete the multi-beam swath bathymetry mapping of the proposed additional mining area (i.e., outside of MP 55549). Bathymetry survey margin of error must not exceed ±5 m vertically and ±10 m horizontally.	To be completed in sufficient time such that relevant information can be provided in the report to be prepared in accordance with Condition 40(e).	A report prepared in accordance with Condition 40(e). The reporting requirements in relation to the

Ref.	Parameter	Objective/s	Requirement	Timing and Frequency	Reporting
		mining, outside of MP 55549, in accordance with Condition 40.			Schedule 2C(ii) monitoring is to include comparison with the range described in Appendix 11 of the marine consent application, including identification of samples that fall outside of that range. Where concentrations fall outside of that range, that reporting is to include measures by which mining will be adjusted (as appropriate) in reflection of those concentrations.
ii	Seabed composition	To collect regionally representative seabed samples to identify sediment physical properties and chemistry in the areas that the Consent Holder is proposing to carry out mining, outside of MP 55549, in accordance with Condition 40.	Analyse the seabed samples to determine particle size distribution, and their major oxide and trace element chemistry.		
iii	Benthic ecology	To collect representative seabed images and samples to confirm the nature and character of benthic habitats and communities in the areas that the Consent Holder is proposing to carry out mining, outside of MP 55549, in accordance with Condition 40.	Surveys will use AUVs or similar technology to collect photographs of the seabed and corers to collect samples of the seabed sediments that will be analysed to determine benthic habitats and communities in the same manner as the previous surveys carried out within MP 55549.		
iv	Oceanographic	To collect physical oceanographic information to enable the calibration and validation of the plume modelling within the area that the Consent Holder is	At least one lander equipped with instruments comparable with those at the regional reference site will be required within the area that the Consent Holder is proposing to undertake mining.	At least 12 months of oceanographic data are to be collected. Data are to be collected in sufficient time such that it can be utilised in the calibration and	

Ref.	Parameter	Objective/s	Requirement	Timing and Frequency	Reporting
		proposing to carry out mining, outside of MP 55549, in accordance with Condition 40.		validation of the plume modelling, as it applies to the new area of mining, and the results be provided in the report to be prepared in accordance with Condition 40(e).	

The monitoring identified in the above table may be amended (reduced or increased), removed or new monitoring requirements added through a replacement Schedule. This reflects an adaptive management approach in terms of the role that monitoring will play throughout the term of the marine consent.

The process to be followed before a replacement Schedule forms part of this consent is:

(a) The Consent Holder is to prepare a proposed replacement Schedule and an associated report, supported by relevant scientific and / or operational evidence, outlining the reasons for the proposed amendments.

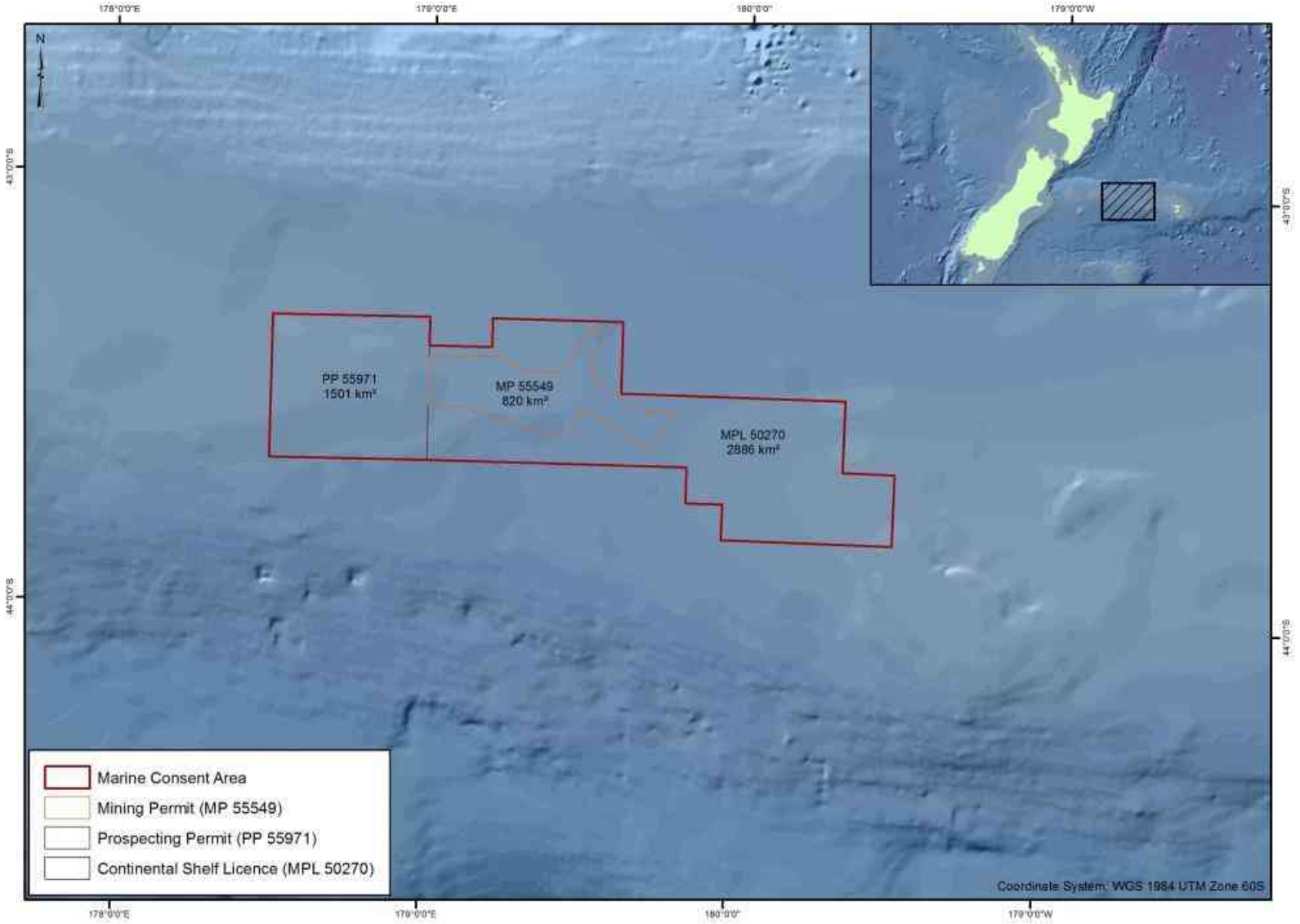
(b) The Consent Holder is to provide the ERG with an opportunity to review and comment on the proposed replacement Schedule.

(c) ~~Once~~ T~~t~~he Consent Holder ~~and ERG have agreed that replacement Schedule is appropriate, the replacement Schedule~~ is to ~~be~~ provide~~d~~ the proposed replacement Schedule to the Chief Executive for certification~~review~~.

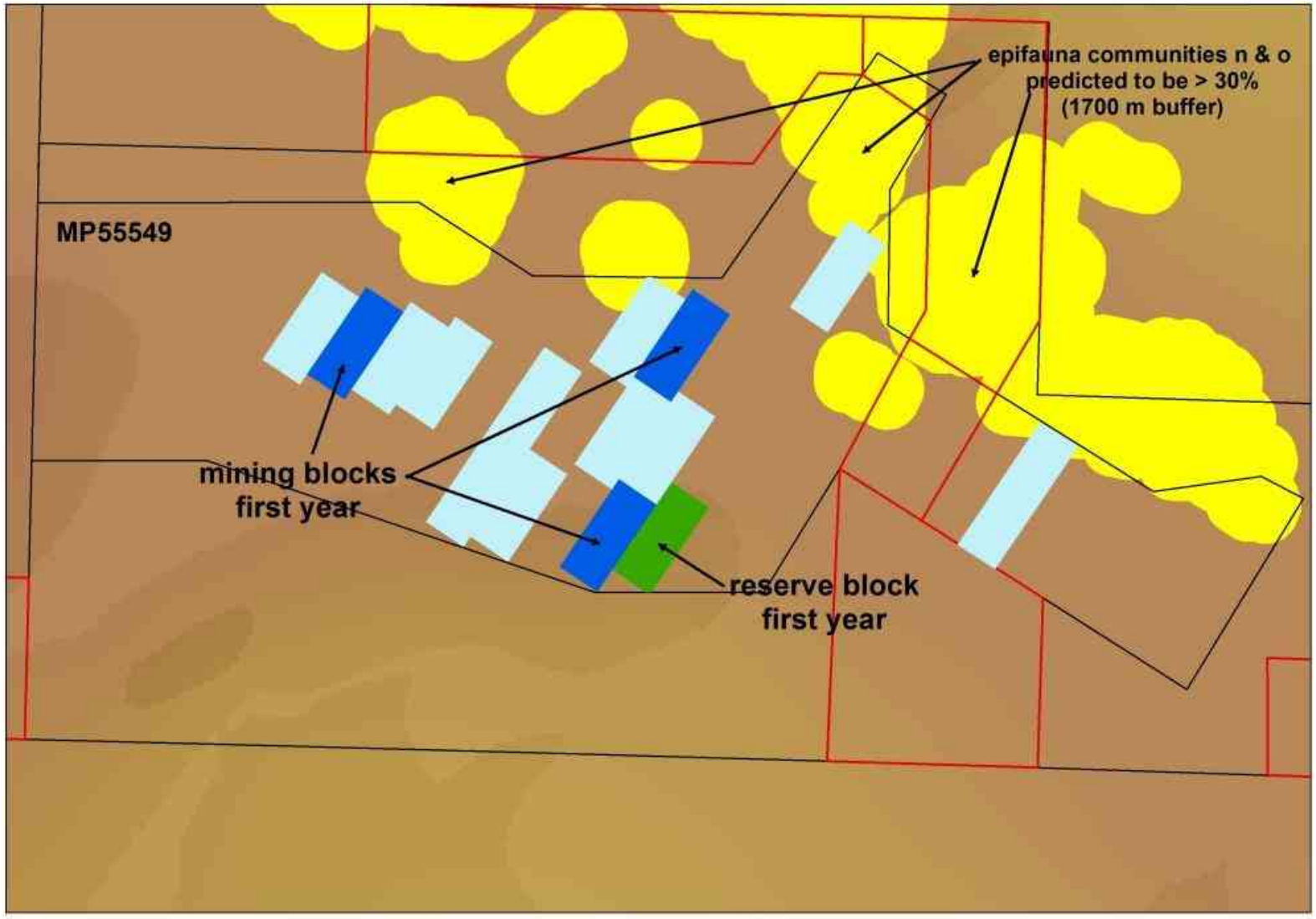
(d) Within one month of receiving the replacement Schedule, the Chief Executive must either certify that the replacement Schedule contains a monitoring programme that will ~~continue to~~ identify the nature of the actual impacts on the environment associated with the Consent Holder's mining operations, ~~request~~ require amendments and / or ~~request~~ advise the Consent Holder of a timeframe extension for further evaluation. At any time prior to making a decision about whether or not to certify a proposed replacement, the Chief Executive may request an assessment by an appropriately qualified ~~which may include possible assessment by an~~ external reviewer.

(e) Within five working days of certifying the replacement Schedule, the Chief Executive must ensure that the consent contains the replacement Schedule (including the date at which the Schedule comes into effect).

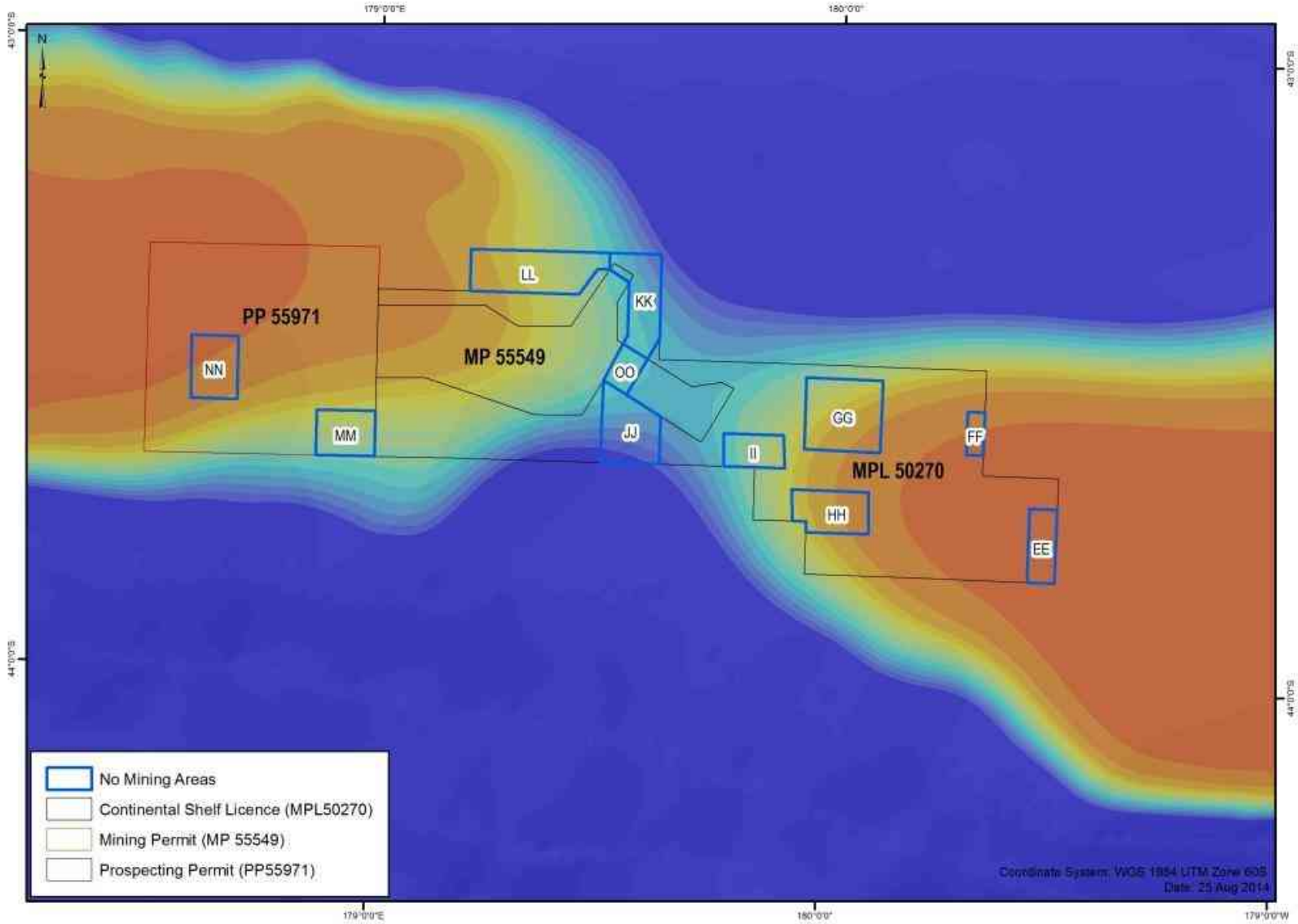
Attachment A – Marine Consent Area



Attachment B – Mining blocks during the first three years of mining



Attachment C – Mining Exclusion Areas



Appendix 4: Expert Conference Participants

Commercial fishing – 19 September 2014

Dr Richard O'Driscoll

Dr David Middleton

Dr Jeremy Helson

Dr Johanna Pierre

Mr Alistair Dunn

Radioactivity – 18 September 2014

Dr Nikolaus Hermanspahn

Dr Ross Jeffree

Dr David Bull

Dr Alec McKay

Dr Barrie Peake

Rock Lobsters – 16 September 2014

Dr Alison MacDiarmid

Mr Daryl Sykes

Economics – 18 September 2014

Mr Peter Clough

Dr Ganesh Nana

Mr Kieran Murray

Mr Alex Sundakov

Dr Johanna Pierre (attended for Issue 4A-C)

Sediment modelling – 26 September 2014

Ms Jamie Lescinski

Dr Jeremy Spearman

Dr Scott Nodder

Dr Peter Longdill

Mr Dougal Greer

Benthic Ecology and Spatial Planning – 16 and 27 September 2014

Dr Judith Hewitt

Dr Les Watling

Dr Thomas Hourigan

Mr Dan Govier

Dr Katrin Berkenbusch

Dr Carolyn Lundquist

Dr John Leathwick

Dr Ashley Rowden (did not attend the second meeting on 27 September 2014 and therefore did not sign the Joint Statement of Experts)

Toxicology and Water Quality – 19 September 2014

Dr Ngaire Phillips

Dr Louis Tremblay

Dr Barrie Peake

Mr Paul Kennedy

Seabirds – 23 September 2014

Dr David Thompson

Mr Graeme Taylor

Dr Leigh Bull

Mr Sandy Bartle

Impacts on Fish – 18 September 2014

Dr Ian Tuck

Dr Mike Huber

Dr Paul R. Krause

Dr Diane Jones

Dr Ian Tuck

Emeritus Professor Arthur N. Popper

Mr Michael Page

Mr Paul Kennedy

Ecosystem Effects – 17 September 2014

Dr Matt Pinkerton

Dr Beth Fulton

Mr Sandy Bartle

Mr Paul Kennedy

Marine Mammals – 15 October 2014

Associate Professor Liz Slooten

Dr Simon Childerhouse

Dr Michael Huber

Mr Darran Humpheson

Dr Darlene Ketten

Mr Tara Ross-Watt

Mr Martin Cawthorn

Conditions – 3 and 24 October 2014

Dr Marie Brown

Ms Andrea Rickard

Ms Carmen Taylor

Mr Chris Rendall

Mr Tara Ross-Watt

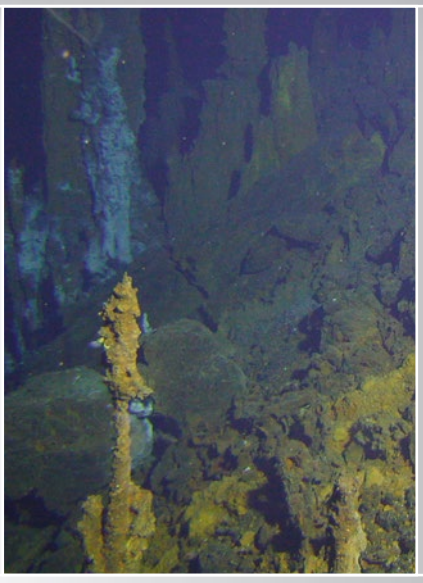
Mr Sam Du Fresne (Observer EPA)

Ms Gemma Couzens (Observer EPA)





NIWA
Taihoro Nukurangi



Preparation of Environmental Impact Assessments: General guidelines for offshore mining and drilling with particular reference to New Zealand



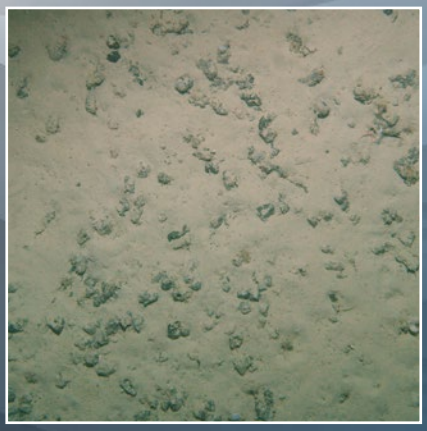
Malcolm R. Clark

Helen L. Rouse

Geoffroy Lamarche

Joanne I. Ellis

Chris W. Hickey





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Executive summary

Interest in offshore hydrocarbon and minerals exploration is growing rapidly as investors identify the potential economic returns from New Zealand's rich marine resources. The challenge for management agencies is how to facilitate development of these natural resources while ensuring environmental sustainability is not compromised. In 2012 the Ministry for Business, Innovation and Employment funded NIWA to lead a research project entitled "*Enabling management of offshore mining through improved understanding of environmental impacts*". This research programme aimed to develop, validate and implement science-based guidelines for effective environmental management of offshore mineral and hydrocarbon extraction, as well as address some critical gaps in our understanding of the environmental impacts of mining operations on New Zealand's marine estate.

The first research aim of the project included the development of a generic template for Environmental Impact Assessment (EIA), and guidelines for its use that could be used by any offshore mining or drilling company to guide the preparation of an assessment of the environmental impacts of the proposed operation. These were initially produced in 2014, but have been revised and updated for this guidance document that accompanies the generic EIA template for offshore mining and drilling activities. It is important to note that the template and guidance have been prepared in the joint context of New Zealand's Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (the EEZ Act) and the broader Pacific context where activities in 'The Area' are managed. An international need for a consistent approach to assessment of environmental impacts has been identified and addressed by the International Seabed Authority (ISA) and the Pacific Community (SPC) in their own developing EIA templates. The template and guidance presented here draws lessons from that international best practice but provides direct reference to New Zealand's own legislation.

The guidance is not intended to be exhaustive or prescriptive. Each resource and each location will have its own set of circumstances that are best described and assessed in a particular way. However, the document covers aspects that should be in every EIA, and provides general guidance to the content in each section of the template. It includes a background to the project and the purpose of this guidance document; outlines (and appends in full) the EIA template; provides general advice on how to prepare an EIA; and then details specific guidance on template sections. The report also contains a list of references cited in various sections to help the reader access important sources of information, a glossary of key terms and abbreviations, and a table containing useful websites for further information.

The document focusses on guidance for **environmental and ecological** assessment of impacts**.** The template includes sections and subsections on social, economic, and cultural issues, and in doing so follows the recent production of an EIA template by the ISA. These issues are often treated separately, and how that is addressed can be evaluated for each specific case. Their inclusion here attempts to progress the concept of a more integrated impacts assessment, even though provision of advice on them was beyond the scope of the existing study.

A related report covering the scientific research requirements for baseline surveys and monitoring programmes has been developed between NIWA and the SPC, and provides more specific detail than given in this higher-level document.

1 Introduction

New Zealand's marine estate contains extensive, largely untapped natural mineral, oil, and gas resources (Figure 1-1) that comprise a major source of potential wealth for New Zealand. However, the region also supports a unique and diverse biota that contributes important ecosystem services. The Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (EEZ Act) and the Crown Minerals Act 1991 (CM Act) provide the framework for environmentally sustainable exploration and exploitation of offshore oil, gas, and mineral resources, but there is currently no consistent process to evaluate the effects of these activities.

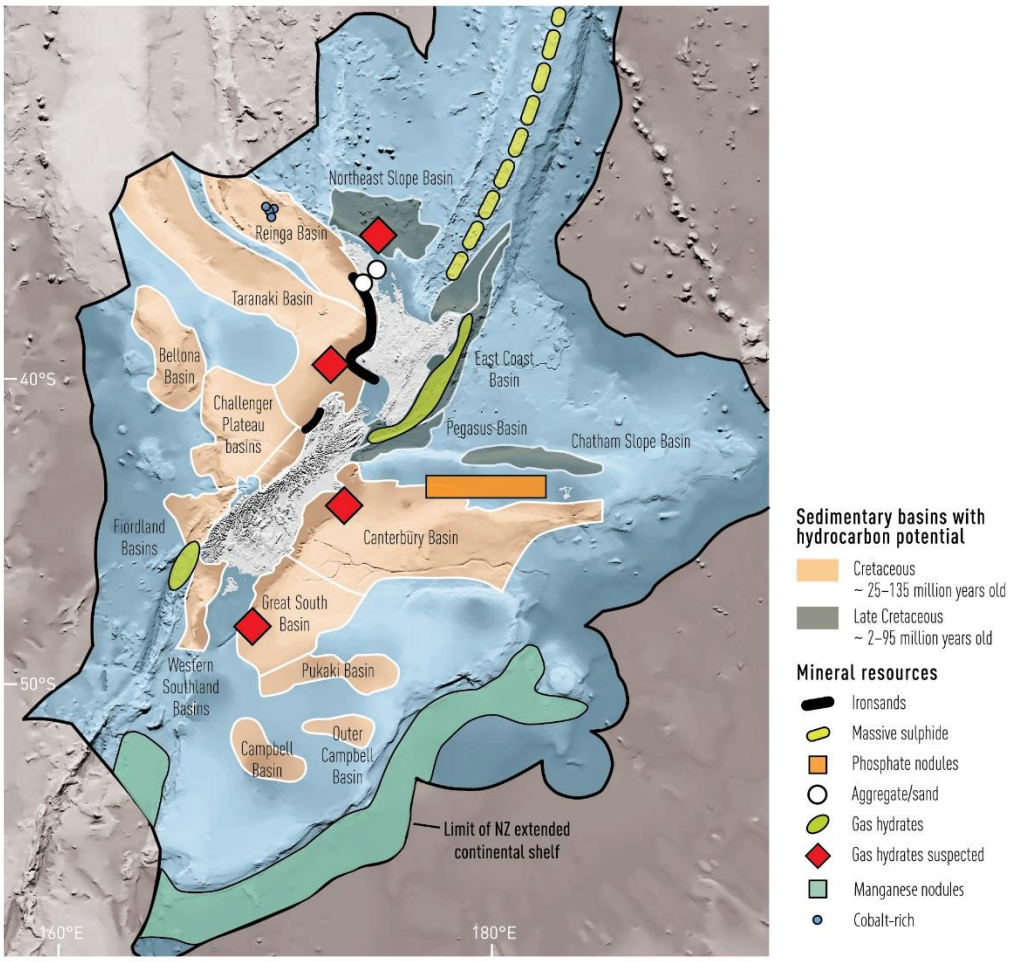


Figure 1-1: The New Zealand region, and distribution of hydrocarbon and mineral resources in the EEZ and ECS (source NIWA).

The EEZ Act requires an assessment of environmental impacts to accompany consent applications for exploration or exploitation of offshore hydrocarbon and mineral resources. There is an extensive international literature on environmental impact assessments, but there has been limited specific guidance about the content and format of EIAs in relation to the New Zealand legal framework and natural environment.

In this report we present a template and guidance for an Environmental Impact Assessment that can be used to assist assessments of proposed offshore hydrocarbon and mineral operations in New Zealand. The intention is for it to apply to both sectors, although we acknowledge some focus on the

deep-sea mineral resources, as they have few established EIA processes. Hence when the term "mining" is used, it applies more widely to extractive activities, including drilling operations.

The template and guidance are designed to support the EEZ Act in the New Zealand context, but also link to assessments in the broader Pacific Ocean where a template has been developed by the ISA to apply in areas beyond national jurisdiction ("the Area") (ISA 2012) and an adaptation of this for Pacific Island States (Swaddling 2016). We draw lessons from this international experience, but note that the specific terminology and requirements of the EEZ Act take precedence for activities within the New Zealand EEZ.

1.1 Project background

The NIWA-led project *Enabling management of offshore mining through improved understanding of environmental impacts* aimed to address these issues through three main research aims:

1. To develop science-based guidelines for management of offshore environmental impacts
2. To identify critical research needs to understand environmental impacts of offshore mining
3. To develop environmental baseline surveys and monitoring plans for exploration and exploitation

This Ministry of Business Employment and Innovation (MBIE) funded project started in 2012 and ran for four years. Because of the high level of demand from resource users for access to offshore mineral resources, and the very recent advent of legislation to manage the environmental effects of such activities, two immediate tasks for the project under research aim 1 were:

- To carry out a review of existing national and international environmental management frameworks, standards and guides (Ellis et al. 2014);
- To develop a generic template for Environmental Impact Assessment (EIA), and associated guidelines that can assist any offshore hydrocarbon or mining company wishing to undertake an assessment of the environmental impacts of the proposed operation, as well as help government agencies to review the assessment.

This report builds on a previous version of the template and guidance report (Clark et al. 2014), as well as incorporates comments and suggestions from several agencies, and aligns with developments in assessment advice for Pacific Island countries and the Area.

1.2 What is an Environmental Impact Assessment?

There are many definitions of an Environmental Impact Assessment or EIA. The International Association for Impact Assessment (IAIA) (Senécal et al. 1999) defines an environmental impact assessment as "the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made." Following on from this, the IAIA describes four key objectives of an EIA:

- To ensure that environmental considerations are explicitly addressed and incorporated into the development decision-making process;

- To anticipate and avoid, minimize or offset the adverse significant biophysical, social and other relevant effects of development proposals;
- To protect the productivity and capacity of natural systems and the ecological processes which maintain their functions; and
- To promote development that is sustainable and optimizes resource use and management opportunities.

EIAs are required for a wide range of activities, including offshore mining activities. There is a wealth of international experience in these activities and reports carrying out EIAs. Ellis et al. (2014, 2017) provides a useful international background to EIAs for offshore mining and drilling activities, and other related environmental management tools such as risk assessments and environmental management plans (which we discuss further below in part 1.2.2). This guidance document takes lessons learned from this international experience and applies them for the New Zealand context.

1.2.1 New Zealand legislative context

In New Zealand, management of offshore mining falls under a number of pieces of legislation, but there are two key acts:

- The Crown Minerals Act 1991 manages the mineral resource, and the purpose of the Act (section 1A) is to promote prospecting for, exploration for, and mining of, Crown owned minerals for the benefit of New Zealand.
- The Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 manages the environmental effects of activities in the Exclusive Economic Zone (EEZ) and Extended Continental Shelf (ECS). The purpose of the EEZ Act (section 10) is to promote the sustainable management of the natural resources of the EEZ.

Many other articles of legislation may be relevant to offshore mining or drilling activities, including the Resource Management Act (RMA) 1991 (where activities overlap into the Coastal Marine Area up to 12 nautical miles (nm) offshore). Other relevant pieces of legislation, defined in the EEZ Act as 'marine management regimes', are listed in Appendix A.

Under the EEZ Act, requirements for EIAs are specified in section 39 (hereafter s39) where they are called Impact Assessments (IA). Strictly speaking, IAs are broader than EIAs, as they encompass aspects of risk assessment and environmental management plans, as well as non-environmental assessment components. However, the trend in the international literature is for EIAs to include elements of social, economic and cultural fields, and so the terms are somewhat interchangeable. We use EIA, as well as separate terms for environmental risk assessment (ERA) and environmental management planning (EMP), as this gives the guidance a wider international meaning (see 1.2.2). We provide a copy of s39 in full in Appendix B. In summary, an IA under the EEZ Act will need to include:

- Describe the proposed activity and the current state of the area where the proposed activity will be undertaken and its surrounds
- Identify people whose existing interests might be affected by the proposed activity, and describe any consultation with those parties (and attach written approval for the proposed activities where this has been given)

- Identify potential effects on both the environment and on existing interests (including cumulative effects and those in EEZ and ECS)
- Specify alternative locations or methods that would avoid remedy or mitigate any potential effects, as well as the measures intended to avoid, remedy or mitigate the potential adverse effects identified
- Contain enough detail that both corresponds to the scale and significance of the proposed activity on the environment and on existing interests and allows the Environmental Protection Authority and people whose interests may be affected to understand the nature of the proposed activity and its effects.

The term 'effects' is defined in the EEZ Act (see Glossary). The IA under the EEZ Act is equivalent to an Assessment of Environmental Effects (AEE) under the Resource Management Act (RMA).

1.2.2 International legislative context

The Law of the Sea Convention (LOSC) is the principal legislation governing environmental requirements associated with deep-sea mining. Under the LOSC, states are given rights to exploit resources of their continental shelf, as well as to seek rights from the International Seabed Authority to undertake or sponsor DSM activities within the Area. However, the LOSC (Article 192) also creates a general obligation for States to protect and preserve the marine environment from activities both within and outside areas of national jurisdiction. It also stipulates that State laws and regulations must be "no less effective than international rules, regulations and procedures". Obligations under international law in respect of DSM include applying the precautionary approach, employing best environmental practice, and conducting prior environmental impact assessment.

The "Mining Code" is a comprehensive set of rules, regulations and procedures based on the LOSC issued by the ISA to regulate prospecting, exploration and exploitation of marine minerals in the international seabed Area (defined as the seabed and subsoil beyond the limits of national jurisdiction). To date, the ISA has issued Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area (2000) which was later updated (2013); Regulations on Prospecting and Exploration for Polymetallic Sulphides in the Area (2010) and Regulations on Prospecting and Exploration for Cobalt-Rich Crusts (adopted 2012). These regulations include the forms necessary to apply for exploration rights as well as standard terms of exploration contracts (see https://www.isa.org.jm/mining-code). The ISAs Legal and Technical Commission has produced additional guidance for the assessment of the environmental impacts of exploration for polymetallic nodules (ISA 2013)) although environmental regulations related to exploitation have not yet been fully developed.

The international legislation, and recommendations for Pacific Island Countries and Territories, are well set out in a report produced as part of a major SPC-EU project on deep-sea minerals ("SPC-EU DSM project"): the "Pacific-ACP states regional legislative and regulatory framework for deep sea minerals exploration and exploitation" (SPC 2012). This has supported the development of national legislation by some countries. It recommends a specific EIA requirement in the legislation to identify potential adverse environmental (including social and economic) impacts and to develop tailored mitigation strategies. It recommends an 'Ecosystem Services' approach to evaluating impacts, as well as an effects-based or impact-specific approach (rather than an activity-specific approach). Assessment requirements would need to be relative to scale and effect; for example, requiring an EIA in some circumstances and no EIA in others. This report further suggested that regulations should

ensure the content of the EIA and the resulting statement must be sufficient to enable informed consideration of the actual or potential effect on the environment and other interests, such as social and human health conditions. Such an EIA could include:

- a description of the project including information on its site, design and size;
- an assessment of the likely effects and impacts of the project;
- an explanation as to how that assessment has been reached;
- details of any consultation undertaken;
- a description of the measures envisaged to avoid, reduce or remedy anticipated adverse effects;
- data required to identify and assess the main effects which the project is likely to have on the environment;
- an outline of the main alternatives studied by the operator (and the no-action option – for comparison) and an indication of the main reasons for the choice(s) made.

The SPC (2012) report also noted the LOSC requirement of States involved with DSM activities to ensure the employment of 'best environmental practice', which can be summarised as "the application of the most appropriate combination of environmental control measures and strategies" (adopting wording used in the 1992 Convention for the Protection of the Marine Environment of the North-East Atlantic). It generally refers to widely accepted norms or customs of environmental and risk management. Since that report, work has been carried out collaboratively by SPC and NIWA and a report produced ("Pacific-ACP states regional scientific research guidelines for deep sea minerals") that provides information and recommendations for baseline and monitoring surveys associated with exploration and exploitation of deep-sea minerals (Swaddling et al. 2016).

There is a suite of additional relevant international legislation (see Appendix 4 of Swaddling 2016) that include the Madang Guidelines (SOPAC 1999) which relates specifically to deep-sea minerals, and includes general principles for environmental impact assessments. The 1992 Convention on Biological Diversity (CBD) aims to conserve biological diversity and species in natural surroundings, and to rehabilitate degraded ecosystems. It requires Convention Parties to protect in situ ecosystems and habitats within national jurisdiction areas, and to (i) identify and monitor impacts (Article 7); (ii) establish a system of marine protected areas (Article 8); (iii) conduct EIA (Article 14a); and promote consultation (Article 14c) regarding processes and activities that may adversely affect biodiversity.

1.2.3 Deep-sea minerals EIA templates

The ISA hosted a workshop in 2012 in Fiji that addressed issues around environmental management needs, and a sub-group at this meeting developed an EIA template (ISA 2012) which was based on the Environmental Impact Statement developed by Nautilus Minerals when applying for a mining licence for Seafloor Massive Sulphides in Papua New Guinea (Coffey/Nautilus 2008).

As mentioned above, this report was an important consideration in the structure of the template developed by NIWA for New Zealand use. The first draft of this template and the inclusion of guidance text to flesh out the expected content of each heading (Clark et al 2014), has been evaluated at a workshop of the SPC-EU DSM project, and was subsequently slightly modified.

The SPC-EU DSM project also further refined the ISA template, in its "Pacific-ACP states regional environmental management framework for deep sea minerals exploration and exploitation (Swaddling 2016). This template aligns closely with the updated NIWA template, and both were evaluated and partially blended at a workshop in 2016 ("Griffith Law School and the International Seabed Authority Workshop on environmental assessment and management for exploitation of minerals in the Area") (ISA 2017).

1.2.4 EIAs as part of a broader process

The EIA process is well developed in many terrestrial and coastal marine situations (e.g., Petts 1999, Glasson et al. 2012). Although it can be tailored to specific national legislation (e.g., US Department of Energy 2004, CEAA 2012), a number of operating principles have been defined by the IAIA (Senécal et al., 1999), which specify that an EIA process should provide for:

- Screening: to determine if an EIA is required
- Scoping: identify the issues and impacts for an EIA
- Examination of alternatives: look at several options to achieve project objectives
- Impact analysis: identify and predict effects of the proposal
- Mitigation and impact management: establish measures to manage impacts
- Evaluation of significance: what are the residual impacts?
- Preparation of report: document all the issues and measures
- Review of the assessment: whether the EIA meets the criteria (see section 1.2)
- Decision making: approve, reject, or modify proposal
- Follow-up: if approved, ensure compliance and monitoring of conditions and impacts.

EIA, environmental risk assessment (ERA) and environmental management plans (EMP) are closely linked, and all are relevant to a broader impact assessment under the EEZ Act. ERAs usually focus on ecological aspects, and are typically carried out to assess the risks of both natural hazards and human-induced effects on the wider environment. Hence, ERAs should be an integral part of the process, whereby they are used to screen and scope important causes of risk that will need further analysis (Suter 2006). One of the key tasks of an EIA is to describe the major impacts of any activity on the environment (in particular ecological systems), and provide information on their nature and extent as the basis for then developing plans to mitigate such impacts (the environmental management plan (EMP) process). Hence an ERA, either as a precursor to, or part of, the EIA highlights the main elements at risk from the activity, and identifies the key aspects that the EIA should focus on (Figure 1.2).

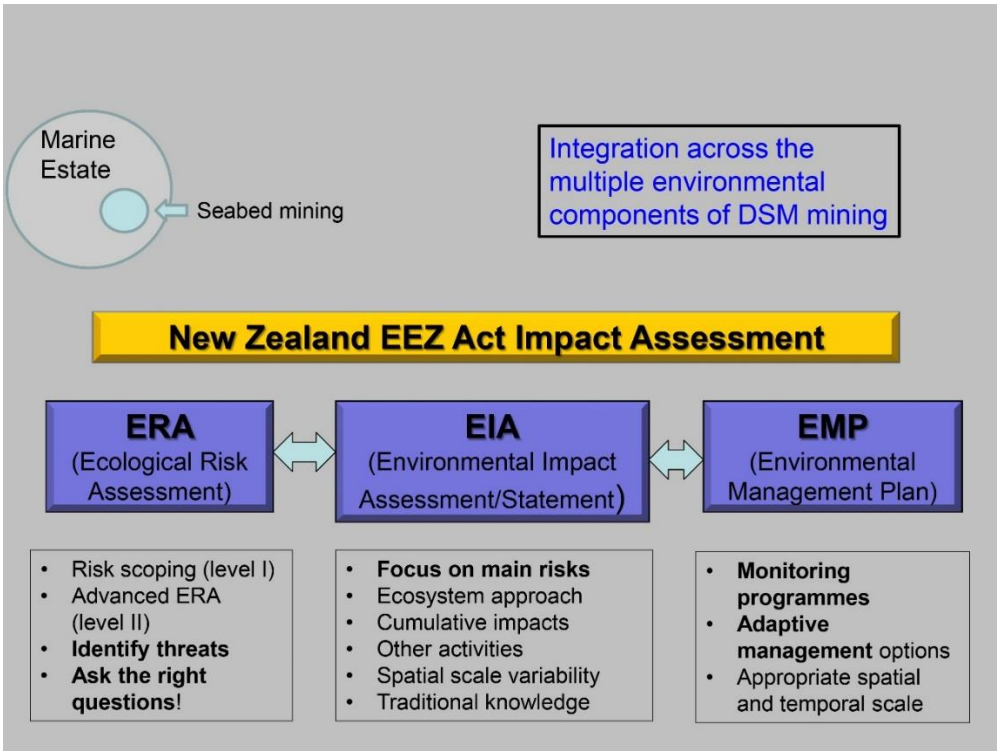


Figure 1-2: A schematic drawing of elements of an environmental management system, showing the relationship between ERA, EIA and EMP (based on Ellis et al. 2017).

An EIA is itself part of a larger scheme. Seabed mining is one of many activities that occur in the marine estate. Other uses, values, and processes will all impact on exploitation of any hydrocarbon or mineral resource, and so there is a wider context to consider. However, within a particular minerals or hydrocarbon operation, there should be a well-structured Environmental Mining Management System (EMMS) (Ellis et al. 2017). This includes the key elements of an ERA, which informs the EIA, in terms of focussing on the main risks. Part of the EIA involves identifying measures to reduce or mitigate impacts, and so there is feedback with risk assessment as the EIA develops. The EIA then enables a management plan to be formulated that covers the progression from exploration to exploitation, and includes detailed descriptions of how the operation is to be managed to ensure environmental objectives are met.

Specifically under the EEZ Act, an IA includes elements of all three stages outlined in Figure 1.2. The ERA acts firstly as a scoping stage to highlight the main elements at risk from the activity, and helps structure data collection during exploration that identifies and informs the key aspects that the EIA should focus on. A key task of the EIA is to describe the major impacts of an activity on the environment and provide information on their nature and extent as the basis for developing plans to mitigate such impacts. The EIA enables a management plan to be formulated that covers the progression from exploration to exploitation, and includes detailed descriptions of how the operation is to be managed to ensure environmental objectives are met. The EMP then monitors the scale of effects to ensure management objectives are met. This process is expanded on by Ellis et al. (2017) who advocate that such an environmental management framework is necessary for deep-sea mining. These linkages are more sequential in an ISA type of scheme than in an Impact Assessment (IA) under the EEZ Act, where in the latter the expectation is that elements of management planning are included rather than an EMP being developed subsequent to the EIA. Hence a reminder that when this document is used in applying for activities under the EEZ Act, that Act's terminology and specific

requirement take precedent-call the EIA an IA, and ensure it addresses the requirements of the EEZ Act.

Terminology can get very confusing in the EIA "space". An additional term (also see Glossary) that is frequently encountered is Environmental Impact Statement (EIS), which is used at times interchangeably with EIA. However, an EIS goes further than an EIA, and incorporates an overall assessment of the proposed project including the effects of proposed activities and any mitigation strategies.

In the context of this guidelines document, we use "EIA" terminology, with a focus on "environmental" components. However, the latter term is widely used to mean much more than just ecological conditions, and often includes human elements (and hence social, cultural and economic aspects). It is important to stress that in this report we focus primarily on the natural environment, although note where social, economic, and cultural aspects need to be developed as part of, or complementary to, the EIA.

1.3 How to use this document

The world of impact assessments is broad and potentially complex, and the scope of this research project provided some boundaries as to what topics to focus on. At a very broad level:

What this guidance is/contains:

- Generic to different resources and mining activities relating to offshore minerals and hydrocarbons
- Assessment of physical, chemical and biological impacts in particular
- Advice on activities that are generic across locations and resource types
- It has a scientifically technical focus to guide environmental research

What this guidance isn't/ doesn't contain:

- Detailed advice on how to do social, cultural or economic impact assessments
- Detailed advice on assessing the effects on existing interests
- Detailed advice on developing monitoring plans
- Advice on site specific issues
- The only advice to be found – there are plenty of alternate sources of info which we refer to where appropriate

1.3.1 How is the document structured?

This document contains the following sections:

- Introduction - a background to the project and the purpose of this guidance document
- The EIA template – outlines the high-level headings for the EIA template document
- General advice – on how to prepare an EIA
- Specific guidance on template sections.

The document also contains a list of references cited and a Glossary of key terms and abbreviations. Appendices A and B provide more detail regarding the EEZ Act requirements, the full EIA template is provided in Appendix C, Appendix D contains a bibliography of useful reading and websites, and Appendix E summarises key research aspects of monitoring surveys.

2 The template

We have prepared a generic EIA template, learning lessons from key international documents and guidance (e.g., US Department of Energy 2004), especially the structure developed by the ISA (2012), NIWA (Clark et al. 2014), Swaddling (2016), and ISA (2017) for minerals mining, but also the hydrocarbon examples of Petro-Canada (1997) and Husky Oil (2001), and making it relevant for the New Zealand legislative context discussed in the Introduction above. The latter includes consideration of advice on preparation of an AEE (MfE 2006) and an EIA for the Department of Conservation (DOC 2012). The full template is given in Appendix C, and the key headings provided here in Box 1

Box 1 – First level headings from the EIA template

Contents page

Executive summary

Non-technical summary

1. Introduction

2. Policy, legal and administrative context

3. Project description

4. Description of the existing physico-chemical environment

5. Description of the existing biological environment

6. Description of the existing onshore environment

7. Description of the existing socio-economic environment

8. Assessment of impacts on the physico-chemical environment and proposed mitigation

9. Assessment of impacts on the biological environment and proposed mitigation

10. Assessment of impacts on the onshore environment and proposed mitigation

11. Assessment of impacts on the socio-economic environment and proposed mitigation

12. Environmental management, monitoring and reporting

13. Consultation

14. Glossary

15. Study team

16. References

17. Appendices

3 General advice

This section of our guidance document is intended to provide generic advice on how to put together an EIA.

3.1 Writing style

The aim of your EIA is to help decision makers, as well as other affected or interested parties, fully understand the impacts of the proposed activity, both positive and negative. There is a wide-ranging audience for EIAs in New Zealand, from the public through scientists and regulatory authorities. Whoever is reading the EIA must be able to identify and understand the key information and messages in the assessment. There are some simple steps to help writing clearly that include:

- Making sure your document has a logical flow (our EIA template should help but amend it if you need to so that it works for your particular circumstances)
- Using plain English and defining any technical terminology that you use, adding a glossary if needed
- Including a 'key messages' introduction section in each chapter can help the reader see what is coming up; using a summary section at the end makes sure that major points are flagged again in the readers mind. This may seem like repetition but the summary section will generally be more detailed, and if you phrase things differently it should work to emphasise the key points on the readers' mind
- Making sure the details you provide are appropriate for the scale and significance of your proposed activity.

Other generic advice on good writing applies too, such as:

- Keep your sentences short and containing one key point
- Use paragraphs to separate topics
- Get a third person to review or edit the document.

Another key element of getting the important messages across is to achieve a balance between the amount of content that is in the main body of text, and that which is placed in appendices. There are no hard and fast rules about this, but the text should contain the **key** results and any information on methods that is important to know to have confidence in those results. The detail that is required by specialists who might review the EIA should be in appendices. Typically the EIA will be easier to digest if as much technical detail as possible is placed in appendices and the main text is a condensed version of the large amounts of supporting information and reports that may be required as appendices. Care must be taken not to oversimplify or misinterpret the technical details, which can be a real challenge in finding a balance between a concise summary for readability and providing sufficient detail for readers to understand conclusions. The relevant experts that contributed to the detailed studies in appendices should check the executive summary and key result sections to ensure their findings are accurately interpreted. The third person mentioned above, who ideally has not been intimately associated with the EIA formulation, should review it, and have as part of their brief whether too much information is in the text, or more is needed to justify and explain certain points.

These guidelines have been compiled to apply generally to an international EIA process, and we have used definitions and phrases in a certain way (see the glossary). Where an application in being made under the EEZ Act, it is very important to ensure the language and terminology used is consistent with the legislation.

3.2 EIA principles

It is important to bear in mind the objectives of an EIA (as covered under section 1.2), as well as check that the EIA meets a number of basic and operating principles (the latter in section 1.2.4). These have been defined by the IAIA (Senécal et al. 1999), and are important to ensure that the EIA is robust to review, and provides environmental managers with the required information. An EIA should be:

- Purposive: be informative for decision-making
- Rigorous: apply best practicable science
- Practical: result in useful information and outputs
- Relevant: provide useable information
- Cost-effective: achieve EIA objectives within acceptable resource and time limits
- Efficient: process should minimise cost burdens
- Focused: concentrate on significant issues
- Adaptive: adjustable to the specific situation but not compromise the process
- Participative: inform and involve interested and affected parties
- Interdisciplinary: involve multiple techniques and experts across a range of fields
- Credible: a professional process, subject to independent checks/verification
- Integrated: interrelationships of social, economic and biophysical aspects
- Transparent: an open and informative process
- Systematic: consider all relevant information and options

These are largely self-evident, but are included here so people preparing EIAs can evaluate whether the information provided under template headings meet these principles and criteria.

3.3 Understanding the decision-making process

It may help during drafting of the EIA to bear in mind the process that the decision makers will need to go through in considering your application. Section 59 of the EEZ Act outlines how an application will be considered and what the decision makers must take into account.

One of the information principles of the EEZ Act (s61) is that any uncertainty or inadequacy in the information is taken into account, along with a requirement to make decisions based on the best available information. Further, in the face of uncertain or inadequate information the decision maker must favour caution and environmental protection, and in doing so, the decision maker must first consider whether an adaptive management approach would allow the activity to go ahead.

Section 63 outlines the ability of the decision maker to impose conditions if it considers these are appropriate to deal with adverse effects. These conditions include bonds (further details in s65), insurance, monitoring (further details in s66), appointing an observer (further details in s67), and record-keeping, and it is noted that this may amount to an adaptive management approach.

Section 64 outlines how an adaptive management approach may be incorporated in granting a marine consent. Section 64(2) provides that an adaptive management approach includes:

- allowing an activity to commence on a small scale or for a short period so that its effects on the environment and existing interests can be monitored.
- any other approach that allows an activity to be undertaken so that its effects can be assessed and the activity discontinued, or continued with or without amendment, on the basis of those effects.

Section 64 goes on to explain that to incorporate an adaptive management approach into a marine consent the EPA may impose conditions whereby the activity is to be undertaken in stages, with a requirement for regular monitoring and reporting before the next stage of the activity may be undertaken or the activity continued for the next period. A stage is defined to say it may relate to the duration of the consent, the area over which the consent is granted, the scale or intensity of the activity, or the nature of the activity. Some advice on adaptive management is given here in section 3.10.

Consultation between the regulatory bodies and the applicant is a key issue in developing an EIA. Most agencies are willing to see a draft copy well in advance and can provide feedback on its general structure and content.

Given these decision making and information principles, we outline below some simple points about inadequate information, uncertainty, use of models, conditions, and adaptive management. This discussion is by no means exhaustive, and readers are also referred to recent decisions such as the one for Trans-Tasman Resources' (TTR) application to extract iron ore from the EEZ in the South Taranaki Bight[1] for early indications about the types of matters that may be considered by decision makers. As this document goes to press, information from a second application in 2016 is available on the EPA website.

3.4 Engagement

Consultation and engagement with stakeholders is an important consideration to keep in mind. Pre-lodgement engagement can be critical for a successful EIA, and should involve discussions with the EPA, other government agencies, existing interest stakeholders, tangata whenua and relevant local communities early in the process. The key to this is "engagement" and not just communication. A good engagement process should involve a two-way exchange of information, ideas, and comments which ultimately will improve the EIA itself, as well as satisfy the necessity of the wider community feeling informed and involved. It should be stressed that this process must start early on, and not be an afterthought to satisfy ticking the "consultation box".

It would be useful for applicants to provide a draft of the EIA to persons and organisations identified during the engagement phase as existing interests or potentially affected by the proposal. This can avoid unforeseen issues arising during the consenting process. This must allow sufficient time for

[1] http://www.epa.govt.nz/EEZ/trans_tasman/decision/Pages/default.aspx viewed 27 August 2014

review and modification of the draft EIA before submission, as once an EIA is lodged, there may be tight timeframes and limited opportunity for further modifications.

Associated with engagement, is the need for transparency of the process. This is ensured in the New Zealand process by all documents and submissions being made available on the Environmental Protection Authority (EPA) website. Commercially-sensitive information can be withheld, but most information related to environmental impacts and assessment can be made publically available. This was also the case in Papua New Guinea with the Nautilus EIS, and is something the ISA will need to address as contractors move in future from exploration to exploitation.

3.5 Completeness of information

The template and guidance in this document will help applicants to meet requirements for carrying out an adequate EIA. However, the EPA has prepared some advice on "best practice impact assessment" (EPA 2013), and this includes the following checklist for information that the assessment must have to comply with s 39 of the EEZ Act:

a) describe the activity for which consent is sought; and

b) describe the current state of the area where it is proposed that the activity will be undertaken and the environment surrounding the area; and

c) identify the effects of the activity on the environment and existing interests (including cumulative effects) and effects that may occur in New Zealand or in the sea above or beyond the continental shelf beyond the outer limits of the exclusive economic zone; and

d) identify persons whose existing interests are likely to be adversely affected by the activity; and

e) describe any consultation undertaken with persons described in paragraph (d) and specify those who have given written approval to the activity; and

f) include copies of any written approvals to the activity; and

g) specify any possible alternative locations for, or methods for undertaking, the activity that may avoid, remedy, or mitigate any adverse effects; and

h) specify the measures that the applicant intends to take to avoid, remedy, or mitigate the adverse effects identified.

A simple "completeness check" should be carried out to ensure that the EIA covers these elements. The amount of detail should correspond to the scale and significance of the effects.

An Impact Assessment (s39) should be in such detail as corresponds to the scale and significance of the effects that the activity may have on the environment and existing interests, as well as sufficient detail to enable the EPA and persons whose existing interests are or may be affected to understand the nature of the activity and its effects on the environment and existing interests. So it is not unreasonable to assume that an EIA will be inadequate if it doesn't contain sufficient detail that corresponds to the potential effects the activity will have, if it is missing any information required by s39, or if the EPA or a stakeholder with a potentially affected existing interest can't understand those effects. Recent decisions by the EPA in regard to Trans-Tasman Resources and Chatham Rock

Phosphate emphasise the importance of documenting uncertainty around information, as well as early and thorough engagement of stakeholders, particularly those with existing interests, to help in scoping and understanding the effects of the proposed activity.

3.6 Expressing uncertainty and confidence

There are many kinds of uncertainty, and even within the narrower range of scientific uncertainty there can be many sources. It can be helpful to define different types of uncertainty so that they can be better understood and managed. Uncertainties can be defined in several groups:

- Knowledge uncertainty arises where there is incomplete understanding of processes, interactions or system behaviours
- Unpredictability arises from chaotic (often random) components of complex systems or of human behaviour
- Structural uncertainty arises from inadequate models, ambiguous system boundaries, or over simplification or omission of processes from models
- Value uncertainty arises from missing or inaccurate data, inappropriate spatial or temporal resolution, or poorly known model parameters
- Uncertain interpretations, arise when values or terms are interpreted differently by different user groups.

These types of uncertainties may all be relevant to assessing whether something will happen, or what effect it may have if it does happen. Many of the techniques used in preparing an EIA, such as models used to make predictions of impacts (see section 3.6 below), will therefore have the potential for the 'answers' they produce to have associated uncertainty. Monitoring programme measurements and information may also have uncertainties due to precision of instruments used, or if new and less proven technologies are used.

Rouse & Norton (2010) proposed three broad steps in managing scientific uncertainty, which may be useful in this context:

1. identify sources of uncertainty
2. reduce uncertainty where possible
3. acknowledge and manage the residual (unavoidable) uncertainty.

Rouse and Norton (2010) state that generally scientists conduct the first two steps in the context of their disciplines using a variety of techniques. Acknowledging, stating and quantifying residual uncertainty is required, before managing it. This may be done in a number of ways, such as:

- Statistically – using statistics such as mean with a standard error, or a minimum-maximum range of estimates
- Probabilistically – estimating the likelihood of the predicted outcome happening.

3.7 General approaches to managing uncertainty

Managing residual uncertainty can be undertaken using general risk-management or adaptive management approaches (e.g., Rouse & Norton 2010; PCE 2003). In a New Zealand context, the best

practice approach to risk management would be to use the appropriate national standard (AS/NZS ISO 31000:2009) which requires risks to be identified, analysed, evaluated and ranked for management, as part of a process that includes ongoing communication with any stakeholders and monitoring and review of management actions and re-evaluation of risks as required. As stated in Rouse and Norton (2010), adaptive management (e.g., Holling 1978) has been loosely defined as 'management with a plan for learning' (Wintle 2007). Where there is uncertainty, adaptive management allows for a structured process to test competing hypotheses of system behaviour and the testing of alternative management actions (Gunderson & Light 2006), resulting in improved understanding and management of the resource (see also section 3.10).

Rouse and Norton (2010) highlighted how the RMA incorporates aspects of these approaches and thus provides a pathway to manage uncertainty. Some of these approaches are also reflected in the EEZ Act; as stated in Ellis et al. (2014), the EEZ Act is at least implicitly risk-based. For example, the definition of effect (s6) includes potential effects with potential high impact (i.e. likelihood and consequences are considered). In addition to the s61 and 39 requirements above, there is a reference to using adaptive management (s64) to allow staged approaches to activities whose environmental effects may be uncertain at the time of decision making. The use of bonds (s65) to insure adherence to conditions, particularly for ongoing effects, is also a risk-based provision that could be used to cover off some uncertainties, for example around adverse effects that become apparent during or after the expiry of the consent.

3.8 A comment on the use of models

In understanding the existing environments that you are proposing to work in, and particularly in predicting potential impacts of your activity on the environment (be it physical, biological, or social), you may need to use models. If you have used modelling in preparing your EIA, the report should include:

- A description of the model used (is it an off-the-shelf readily available model that meets industry standards or some purpose built one-off? Where has it been used before?)
- An outline of underlying assumptions in the model (and how these may influence the model outcomes)
- An outline of the key model input parameters, and their justification
- A description of how it has been tested, validated and/or calibrated; including "ground-truthing" and model sensitivity analyses
- A comment as to whether the model and/or its outputs have been independently peer reviewed
- Comments regarding the level of confidence in the model predictions (and the input data).

This list is by no means exhaustive, and you should provide whatever information is required to make sure the structure and workings of the model are clear, and all uncertainties are fully documented.

3.9 A comment on the provision of proposed conditions

The EEZ Act definition of an Impact Assessment does not include the provision of suggested monitoring regimes or consent conditions. However, bearing in mind the decision-making framework outlined above, it will be important to include mitigation and monitoring conditions as part of the EIA. We do not provide specific guidance on permitting topics, as they are complex, and specific to the nature of the resource and the mining operation characteristics at a certain location. There are existing guidelines for resource consent conditions under the RMA (Quality Planning Organisation 2013) which includes advice on aspects of management plans, and general issues of environmental standards and adverse impact assessment. A key aspect is addressing whether all the significant adverse effects that may result from the exercise of the consent can be effectively managed by consent conditions. This may involve an environmental management plan, or consent conditions that provide clear performance or environmental standards that are to be certified by an appropriately qualified and experienced person as being achieved. The guidance advises that under the RMA "Critical actual or potential adverse effects need to be identified, appropriately avoided, remedied or mitigated with conditions before a decision to grant is made and not left to be addressed via a future management plan". However, the applicant will have the best information about the proposed activity and the intended location, and hence can propose realistic conditions that ensure the identified potential impacts are avoided, remedied or mitigated. Any proposed conditions should be detailed and preferably SMART (Specific, Measurable, Achievable, Relevant and Time-bound). The EPA's 2014 TTR decision indicates that decision-makers will place significant weight on the conditions proposed with the application and EIA (paragraph 781), and that sufficient baseline survey work should have been undertaken prior to lodgement of an application to help increase the decision-makers certainty regarding assessments of effects (paragraphs 788, 831-837). Similarly, the EPA's 2015 decision on the CRP application reviewed the proposed conditions as an integral part of the decision-making process (e.g. paragraph xviii)[2].

Monitoring and reporting conditions are likely to be very specific to the nature of the resource, the site characteristics, and the requirements for what needs to be monitored in that particular situation. We do not provide detailed guidance in this document, but cover some general aspects under section 12 of the template.

3.10 A comment on adaptive management

Given the EEZ Act's stated approach to adaptive management, it makes sense that in preparing an EIA, thought should be given as to areas of the assessment that have uncertainties associated with them such that an adaptive management approach might be considered. Adaptive management is an established tool for managing environmental effects where there are uncertainties about the potential impacts of a proposed activity and is allowed for in the EEZ Act. We make some comments here and in section 4.15, as part of the EIA that deals with environmental management, monitoring and reporting.

Adaptive management is a widely-used term, but is often misinterpreted. It is flexible decision-making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood (National Research Council 2004). However, it is not a "trial and error" approach that involves doing something, seeing what happens, and then trying something else. It is a structured decision making process (Figure 3-1).

[2] Readers are referred to these EPA decisions for further detail, at http://www.epa.govt.nz/EEZ/Pages/default.aspx

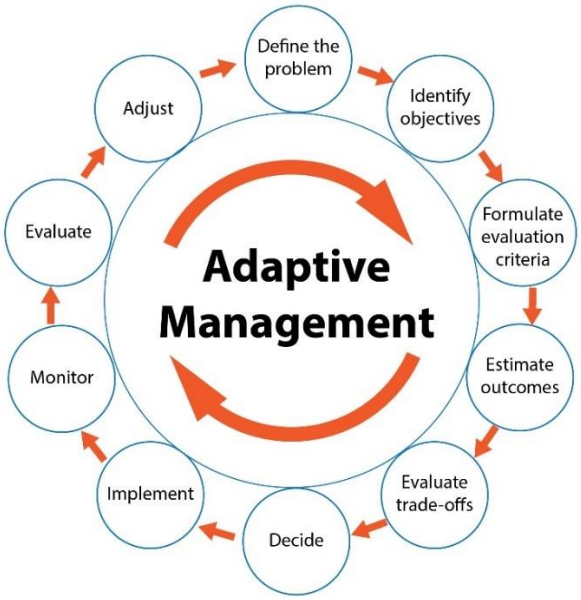


Figure 3-1: The Adaptive Management cycle (modified from Allen et al. 2011).

It is important to recognise that it is only one of a suite of available management tools, and should not be seen as a silver bullet to coping with uncertainty. It is best suited to situations where there is high uncertainty, but also high controllability of management factors and actions. There are two slightly different forms of adaptive management; Passive, where management accounts for anticipated changes in resource status, but is not designed for learning; and Active, where the approach anticipates the effects of management actions on learning. Whether either can be successful depends on a number of conditions ("problem-scoping key") that should be evaluated in proposing such management (Figure 3-2).

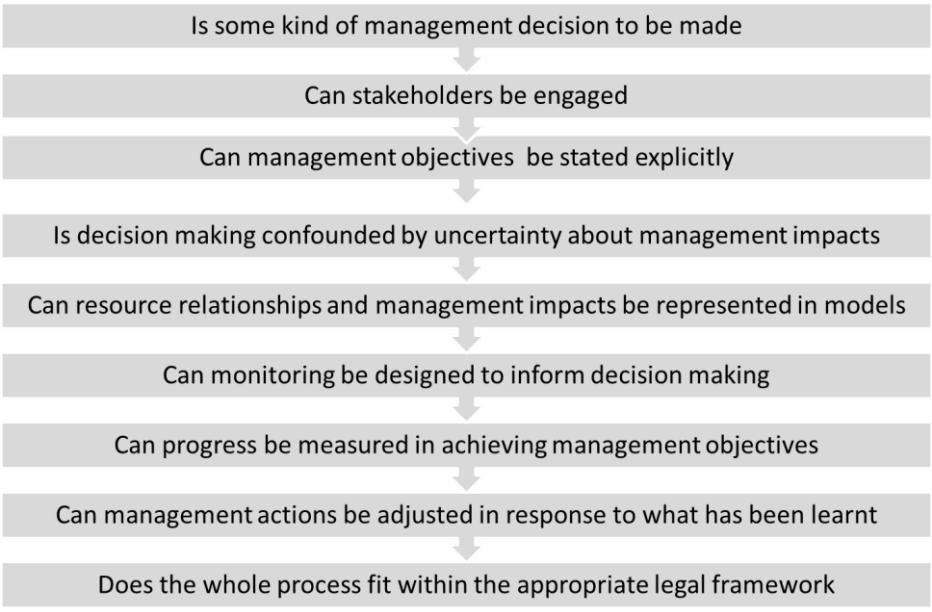


Figure 3-2: The adaptive management problem-scoping key: criteria to evaluate if the process is appropriate (based on Williams et al. 2009).

The scientific requirements behind adaptive management include having clear and measurable management objectives, and the ability to express and evaluate uncertainty through testable models. The latter involve a number of difficult issues to address adequately, including:

- Models need to include key components of the resource system, and quantify critical processes, natural change dynamics, fluctuating environmental conditions, and management inputs
- Models need to incorporate different ideas (alternative hypotheses) about how the system works and how it responds to management. A suite of models may be needed to capture key uncertainties
- Models should be calibrated or validated, so predictions are realistic

The decisions in 2015 by the EPA to decline consent for TTR to mine ironsands in the South Taranaki Bight and CRP to mine phosphate on the Chatham Rise throw light on how to interpret some of these aspects of the EEZ Act for managing uncertainty. One of the EEZ Act s64 definitions of adaptive management is the use of a staged approach (start small and expand). Both TTR and CRP Decision-Making Committees (DMCs) considered potential for a staged approach but in both cases, the applicants said this was not feasible due to investment certainty needed.

The DMCs for both applications quoted from the Supreme Court decision on Sustain Our Sounds v New Zealand King Salmon under the Resource Management Act (RMA) with regard to adaptive management[3], which outlined four factors to assess whether an adaptive management approach is appropriate (TTR decision paragraph 799, CRP decision paragraph 833). These include the extent of environmental risk, the importance of the activity, the degree of uncertainty, and the extent to which risk and uncertainty will be reduced by the adaptive management approach.

In addition, both DMCs considered a further aspect of the King Salmon decision (at TTR decision paragraph 803, CRP paragraph 834) with a further four factors to consider before endorsing an adaptive management approach: good baseline information about the receiving environment, appropriate indicators used as conditions, threshold set to trigger actions before the effect becomes overly damaging, and effects that might arise are able to be remedied before they become irreversible. While both decisions note there are differences between the RMA and the EEZ Act, they consider there is useful guidance from the 'King Salmon decision' in considering an adaptive management approach under the EEZ Act.

3.11 A comment on cumulative effects

Policy and regulatory requirements in many countries include that EIAs identify, analyse and evaluate cumulative effects. The EEZ Act is no different, with section 39 (1c) specifying an assessment must identify the effects of the activity on the environment and existing interests, including cumulative effects. The latter can arise over time, or in combination with other effects (section 6).

There are many stressors caused by anthropogenic activities that can affect the marine environment in a number of ways, and there is a very large body of literature dealing with this field of research (see Glasson et al. 2012, Solan & Whiteley 2016). Results of numerous studies indicate that interactions between stressors can be variable, and hard to predict (e.g., Crain et al. 2008, Darling & Cote 2008). Nevertheless, cumulative effects should be explored as much as possible given available

[3] https://www.courtsofnz.govt.nz/cases/sustain-our-sounds-incorporated-v-the-new-zealand-king-salmon-company-limited-ors

data, and should be thought about early on during the exploration phase so appropriate information can be collected.

The assessment of cumulative impacts in a deep-sea mining EIA needs to consider three key elements:

1. Multiple sources of impact (either different types of mining operation, or different sectors)
2. Additive or interactive processes (repetition leading to accumulation of impacts)
3. Different types of cumulative effects

These elements form the basis of six evaluation criteria (Smit & Spaling 1995):

- Temporal accumulation (consider duration and frequency of perturbation)
- Spatial accumulation (consider geographic scales, boundaries, directional patterns)
- Perturbation type (single, multiple, likely trigger for further effects)
- Processes of accumulation (consider cause and effect, what is additive versus interactive)
- Functional effects (causing changes in ecological processes or controlling properties)
- Structural effects (spatial changes in biological or physical composition)

Historically EIAs have not addressed cumulative impacts well, and have tended to be simply qualitative (Burris & Canter 1997). There are now many methods available to analyse cumulative effects, including expert group opinion, spatial analysis, network analysis, interactive matrix techniques, biogeographic pattern analysis, and ecological/ecosystem modelling (e.g., Smit & Spaling 1995). Ideally there would be sufficient data available to adopt an ecosystem approach, and evaluate the impacts of stressors on ecosystem services (Austin & White 2016). Full ecosystem modelling may be unrealistic, but mapping the extent of various stressors, and evaluating potential interactions on a spatial scale, is a good way to at the very least visualise the likely distribution of cumulative effects which can inform precautionary management (Ban et al. 2010). Ban et al. (2010) also provide a simple method for scoring cumulative impacts, and this can be a useful aid to help design robust monitoring programmes.

Cumulative effects should be separated in the EIA as a readily identifiable section that brings together the single impact descriptions in other sections of the template. Burris & Canter (1997) note that cumulative impacts should be considered for the same set of environmental factors that are analysed for both direct and indirect impacts. That ensures that significant impacts (which can be positive as well as negative) are not overlooked.

Interactions with commercial fisheries are a major aspect that must be covered. Together, mining and bottom trawling activities will have a larger benthic footprint than either by itself, and this needs to be evaluated against the spatial scale of community structure and function. Indirect effects, such as sedimentation plumes and deposition, are also common to both industries, and so need to be considered where the two are close together or overlap.

Climate change (warming waters, expanding Oxygen Minimum Zones, rising sea levels, increasing ocean acidification) may also be relevant, especially in areas where biological communities are predicted to be affected in the future (e.g., the distribution of deep-sea corals may change as ocean acidification will affect the depth of the aragonite saturation horizon). This may seem too long-term an effect, but if a prospective mining site is a feature or habitat that could be a future refuge for rare communities this needs to be considered (e.g., seamounts and corals, Tittensor et al. 2010).

Cumulative effects should also be evaluated at two different spatial and possibly temporal scales: within the scope of the proposed mining operation, which will cover the nature and extent of operations within the physical footprint of mining disturbance, as well as the larger area of potential indirect effects. This scale needs to pay particular attention to the duration and frequency of repetitive activities within the mining site. This was an important aspect of the CRP application, where the cumulative distribution of 15 years of sedimentation was required by the DMC to assess the additive component of the impact.

On a more regional scale, multiple mining operations, and various commercial and recreational/artisanal (if nearshore) fisheries will involve assessing multiple sources of impacts, as well as different types of effects. Displacement of fishing activities from mining blocks, wider environmental effects of mining on fish behaviour, and consumer concerns about seafood quality were considered in the CRP application process, but their significance was uncertain.

4 Specific guidance on template sections

This section works through each part of the EIA template in order, offering additional guidance or reference to other sources of information where relevant. The brief of the project, and expertise of the authors, is primarily bio-physical, and although there are template sections for describing the socio-economic environment and impacts in the template (sections 7 and 11) we offer little guidance beyond what is already contained in the template. Also, it is important to note that sections on existing onshore environment and potential impacts of the proposed activity on the onshore environment may need to vary to complement or replace an AEE completed under the RMA.

The EEZ Act requires that an IA is done with regard to the scale and significance of the proposed project. In this guidance we make suggestions for approximate length, but the overall length - or even if all sections of the EIA template are required – will need to be appropriate to the scale and significance of the proposal. Each part below contains the template text in a blue box, followed by general advice to help at that stage of the EIA.

Note that the detail within, and order of, some sections differs from that of the ISA and SPC templates. Nevertheless, the content of the guidance here is applicable across the various templates.

4.1 Executive summary

A summary of the content of the EIA, including:

- *description of the proposed activity/project and its objectives*
- *the main processing methods of the proposed operation*
- *key potential impacts (physico-chemical, biological, socio-economic)*
- *measures to avoid, remedy or mitigate environmental impacts*
- *end-use plans, including decommissioning*
- *consultation with stakeholders and interested parties.*

The Executive summary is intended to provide a concise overview of the EIA so that the decision makers for the application can form an initial view of the issues involved and also of the quality of the EIA. The five bulleted topics in the template should be covered in as succinct a way as possible. However, it is worth writing this section of the EIA with the intention that this summary could form a stand-alone document; it should contain sufficient detail to allow the reader to appreciate all of the key areas that need to be considered, even though they will need to read parts of the main document to understand the details of those decision points. The length of this section will be variable depending on the scale and significance of the proposed project, but is likely to be 8–10 pages.

4.2 Non-technical summary

A short and "plain language" summary for the public.

The non-technical summary is just as described– it is intended for a public audience. Use clear, jargon-free language to outline the proposal, summarise the potential effects, comment on proposed mitigation and any residual and/or cumulative effects, and any proposed monitoring. This should be no longer than about 5 pages and will provide the opportunity to condense the key points of the proposal into a concise statement that can be used for many purposes in consulting with various people about the proposed work. It can't be over-emphasised that clear communication is essential to help interested members of the public understand the proposed work and the extent of environmental assessment and mitigation. Good information exchange with all parties is an important part of the overall process.

4.3 Template Section 1: Introduction

1.1 Background

- *Introductory background to the application.*

1.2 The proposed activity/project

- *A description of the overall proposed mining or drilling activity*
- *Describe the area of the proposed activity*
- *Include an outline of previous consultation.*

1.3 This report

- *Scope of the Environmental Impact Assessment (EIA) – what is included, what is not based on earlier assessments or work. Link to other supporting documentation.*
- *The format (i.e. structure) of the EIA document – especially for larger projects where there is a lot of detail (in line with EEZ Act requirements for EIAs to be appropriate to scale and significance of the project).*

The purpose of the Introduction section is to set the scene for the EIA. It contains introductory background to the proposal, a summary of the proposed activity (with reference to more detail to come in Template Section 3 Project description, see 4.5 below), and outlines the EIA format so that readers understand where to look for certain information. We suggest that detailed technical reports are summarised within the EIA and the full reports appended, in which case the Introduction should make this clear.

This section should contain enough detail for a reader to form an overall impression of the proposed project and how it has developed, and understand how the EIA is structured. As this section mainly provides a 'roadmap' to more detailed material in the EIA, it should be relatively short (1-2 pages).

4.4 Template Section 2: Policy, legal and administrative context

This section provides information on relevant legislation, agreements or policies that are applicable to the proposed mining or drilling operation.

2.1 Applicable mining and environmental legislation, agreements and policies

- *Outline links to New Zealand's EEZ legislative context, including requirements for consultation*

2.2 Other applicable legislation, agreements and policies

- *Description of other legislation etc that does not necessarily apply specifically to seabed mining*
- *Consider other marine management regimes such as those as defined in s7 of the EEZ Act*

2.3 Relevant international and regional agreements

- *Include relevant international agreements (e.g., UNCLOS, CBD, IMO, SOLAS, MARPOL)*

2.4 Other standards, principles and guidelines

- *Reference any national, regional and international standards, management principles and guidelines not covered above, such as non-binding recommendations from the ISA.*

Make clear the extent of overlap into the Coastal Marine Area under the Resource Management Act 1991

This section of the EIA references the relevant contextual and legal frameworks under which the mining or drilling is proposed. This is relatively straight-forward, but at the same time it is important to make sure this section is clear and complete. The EIA should demonstrate that the applicant is aware of the key legislative requirements under the EEZ Act but also other relevant international requirements and other New Zealand marine management regimes. Most of these are outlined in section 7 of the EEZ Act but there are also some other acts (e.g. Sugar Loaf Islands Marine Protected Area Act 1991) to be aware of. This section should make it clear if any additional permits are required for the proposed project under these other legislative frameworks, and whether these have been applied for or granted.

In particular, if the proposed activity will overlap into the Coastal Marine Area or include onshore support activities managed under the RMA, the EIA will need to make this clear so that decision makers can consider how to handle the application, in line with sections 88-100 of the EEZ Act. Any relevant regional provisions (objectives or policies from regional policy statement or regional plans under the RMA) or territorial provisions (from district or city plans) to manage the coastal marine environment should be identified. These provisions should make it clear whether a consent is required for any activities that the proposed project will undertake within the Coastal Marine Area or onshore. This will include activities subject to restrictions under the RMA such as:

- The use of land (RMA s9)
- The use of the coastal marine area (s12)
- Certain uses of the beds of lakes and rivers (s13)

- Taking, using, damming or diverting water (s14)
- Discharges of contaminants to air, water or land (s15)
- Avoidance of unreasonable noise (s16).

If both EEZ Act and RMA consents are required, a joint application can be made in which case the EIA must include an assessment of effects that comply with both section 88(2)(b) of the RMA and section 39 of the EEZ Act. Guidance on preparing AEEs under the RMA can be found on Ministry for the Environment (e.g. http://www.mfe.govt.nz/publications/rma/aee-guide-aug06/index.html) and Quality Planning websites (http://www.qualityplanning.org.nz/index.php/consents).

Under the LOSC, all states are required to take appropriate steps to ensure that seabed exploration and exploitation activities under their jurisdiction or control are appropriately managed, in accordance with international standards and best practice. Compliance with the EEZ Act should meet most of these international standards, but we refer the reader to knowledge of a number of conventions and agreements to be aware of. These include (based on Swaddling 2016, Appendix 4): the United Nations Convention on the Law of the Sea, International Maritime Organization (IMO) conventions (e.g., MARPOL), The Madang Guidelines, ISA Mining Code, Nouméa Convention, London Convention, United Nations sustainable development goals, Rio declaration on the environment and development, Convention on Biological Diversity, United Nations Agenda 21, International Marine Minerals Society code for environmental management of marine mining, Convention on the Conservation of Migratory Species of Wild Animals (CMS), OSPAR Convention.

This section may be several pages in length and will obviously be longer where there is overlap with multiple regulatory regimes.

4.5 Template Section 3: Activity/Project description

3.1 Purpose and need of the proposed activity/project

- *Type of mineral or hydrocarbon resources*
- *Why the operation is proposed*
- *Background to the project, including aspects of the discovery of resources, development of techniques etc.*

3.2 Proposed project location

- *Coordinates of proposed project area*
- *Map and boundaries of footprint (total area, and certain phases, see 3.3.2)*
- *Include any closed/exclusion areas.*

3.3 Description of the proposed development

3.3.1 Project duration and phasing

- *Overall life of project*
- *Duration of different operational phases (timeline) from mobilisation to decommissioning*

- *Development timetable should be detailed, and perhaps outline here but include an appendix covering:*
  - *Pre-construction tasks*
  - *Construction schedule, staging of activities*
  - *Commissioning and operational schedules*
  - *Infrastructure development*
  - *Closure schedule.*

3.3.2 Proposed project scale

- *Spatial scale of the proposed operation, including how it is proposed to evolve through time.*
- *Include indicative rates of extraction, total extraction, depths of extraction (both below sea level and depth of seabed) overburden estimates, discharge rates etc.*

3.3.3 Mining or drilling methodologies

- *Proposed methods of extraction (dredging, coring, etc.).*
- *Describe technical specifications of equipment, including construction and operating standards for design of gear.*
- *Include details of the operation throughout the water column, from seabed to surface.*

3.3.4 Support equipment

- *Describes any equipment needed for support (e.g., tender, supply vessels, barges), includes handling of hazardous materials.*
- *Describe frequency of vessel movements for support, supply, barge removal etc.*

3.3.5 Proposed processing operation

- *Includes:*
  - *Commissioning*
  - *On-site operations (including how onsite operations will be powered)*
  - *Off-site operations*
  - *Transport of material off-site*
  - *Disposal of waste (including hazardous waste).*
  - *Decommissioning*
- *A schematic diagram should be included of the key components of the operation.*

3.3.6 Other alternatives considered

- *What other locations, methods etc. were considered, and rejected in favour of what is proposed.*

The Project Description section of the EIA template is fairly self-explanatory, with the headings of most sections or sub-sections clear as to their intent. The purpose and need is essentially background to the project, but sets the scene for why the extractive operation is needed. The project location should have a series of maps that demonstrate the regional location, as well as the more detailed locality. It will link in with a further description, and perhaps more detailed maps again, under part 3.3.2 which describe spatial and temporal changes in the sequence of activities.

A key aspect of this section is the description of mining methodologies. Most oil and gas operations utilise well known techniques, equipment and overall operating procedures, whereas mining of seabed minerals is new, and there is no standard methodology. Methodologies will vary with mineral type and depth. Where the technology is new or untested, this section needs to be very detailed, as it is fundamental to understanding what the impacts are likely to be. This should include the operation at the seafloor, as well as water column activities (e.g. riser pipe transfer) as well as the methods of disposal of processing water, fine sediment, and other by-products. If there are national or international "best practices" that are relevant, it is useful to include an assessment of how the proposed operation will align with them (see Appendices D and E).

Description of the overall timetable, from construction through to decommissioning and closure of operations, is important to scope the nature and extent of various environmental impacts. The description should include the major phases of the operation, as well as the milestone dates on which relevant tasks and activities are expected to be completed. Information on the development timetable provided under this section should clearly communicate the different phases in the development proposal. For reasons of clarity, a flow chart or Gantt chart should be used where appropriate.

Section 20 of the EEZ Act outlines restrictions on activities, and it is important that the project description includes a clear summary of what activities may require consent under this section. This refers to deployment of structures, pipelines and cables, as well as disturbance to the seafloor environment by removal or addition of material, and any activity that could have an adverse impact on marine species (including vibrations and explosions). A table is a useful way of displaying each of the restricted activities, and whether the project will affect any of the conditions. It also provides a clear signal to managers of the activities that will need to be addressed in the EIA for consent to be granted.

The final section covers alternative methodologies and locations, and it is essential to give an account of the pros and cons of methods and sites that were evaluated before deciding on undertaking the activity in this particular area, and the justification for use of the particular equipment and methodologies chosen. This is a legal requirement under the EEZ Act.

This section may be relatively long, as it will include some technical detail of equipment and mining methodologies, as well as a full account of the overall mining and drilling sequence. Some parts may be best suited as Appendices (especially those where there is a lot of technical detail that is not needed in the main text), but is important to describe fully the proposed operational plan.

4.6 Template Section 4: Description of the existing physico-chemical environment

4.1 Key messages

- *Overview of key content covered in this section (this is a box with up to 6 bullet points of the main aspects covered, or the main findings).*

4.2 Regional Overview

- *General regional context (includes map, covers wider area around proposed activity area).*
- *Include site-specific issues and characteristics, particularly sensitive environments.*
- *Reference to relevant technical data/previous studies will be required.*
- *The regional overview is a brief section, but provides the broader scale context for the more detailed site-specific description below.*

4.3 Meteorology and Air Quality

- *General overview of climatology e.g. wind directions and speeds, seasonal patterns, cyclones.*
- *Description of air quality, including chemical characteristics*

4.4 Geological setting

- *Describe the general geological landscape and topographic features of the site.*
- *Describe in detail the nature and extent of the resource (including aspects such as thickness, depth below seabed, horizontal extent for crusts or nodules).*

4.5 Physical oceanographic setting

- *Describe oceanographic aspects such as currents, waves, vertical stratification, sedimentation rates.*
- *Describe notable characteristics of the site, such as hydrothermal vents, seamounts, canyons.*
- *Detail is required on the regional setting as well as the specific site, and include changes with depth, and horizontal distance (near-field, far-field).*

4.6 Water quality

- *Describe water mass characteristics at the site at various depths, including salinity, nutrients, particle concentrations, temperature, geochemistry, chemical composition, dissolved gas profiles, etc.*

4.7 Seabed substrate characteristics

- *Substrate composition with special reference to sediment composition, sediment chemistry, nutrient characteristics, pore water profiles, and grain size.*

4.8 Natural hazards

- *Volcanism, seismic activity, tsunami etc.*

4.9 Noise and light

- *Ambient noise if any, influence of existing exploration and maritime activity.*

4.10 Gas and chemical emissions

- *Describe the level of gas and chemical emissions from both natural and anthropogenic activities, as well as those affecting seafloor or water column chemistry (e.g., acidity).*

4.11 Summary of existing physico-chemical environment

- *Bring together key findings e.g. any sensitive environments or highly valued areas.*
- *This will be up to a page, and more extensive than the Key messages in the first section.*

This section provides regional and site-specific information on the physical environmental conditions at the activity site(s). The term "physical environment" is generally interpreted here in the widest sense, and this section may be reasonably large. The section should not include however, biogenic habitat (corals) or structures directly related to living or dead biological matter – unless specifically mentioned. The aim is to provide a robust environmental assessment against which impacts will be assessed. As a general guideline, the level of detail should be commiserate with the scale and intensity of the proposed activity. It should provide ample information on material collected by the applicant specifically for the purpose of the document.

This section should be illustrated using maps, diagrams and photos. Particular attention should be made to using adequate spheroid and projections for the maps. The EPA as the primary decision maker does not recommend a particular projection for applications under the EEZ Act, but marine charts have traditionally been generated using Mercator projections, such as Mercator 41/WGS84 spheroid. This projection was submitted to EPSG (European Projection Survey Group) and accepted as EPSG code 3994. New Zealand Petroleum and Minerals traditionally uses the LINZ New Zealand Transverse Mercator (NZTM, EPSG code 2193) projection. LINZ recommends the NZCS2000 Lambert Conformal projection for spatial data. It is a confusing area, but the important point is that the projection should be appropriate for the particular location/site. If the site extends onshore or inside 12 nm then the Lambert projection should be used, but for general offshore use we recommend Mercator 41/WGS84. A number of web sites are listed in Appendix D which can help.

Notable physical characteristics at the site should be clearly identified in the relevant sub-sections. These can include sensitive physical environments, but not strictly biologically or ecologically sensitive environment (covered in part 4.11). Such physical environments include sites of hydrothermal venting, seamounts, areas of high surface productivity, carbonate concretions, pockmarks, sandwaves, and oceanic eddies.

A number of physical environment datasets, databases and data portals are available from New Zealand government and research organisations and should be used and referenced whenever necessary. Such platforms provide either metadata or specific and detailed data for the New Zealand region. The Department of Internal Affairs hosts the "all Government datasets online" portal, which provides a directory of publicly-available, non-personal, New Zealand government held datasets (https://data.govt.nz).

The New Zealand National Aquatic Biodiversity Information System (NABIS - http://www.nabis.govt.nz) also provides information on bathymetry, topography, and oceanography in the New Zealand region, as well as information on the distribution of marine species.

EcoConnect is an environmental forecasting and information service (http://ecoconnect.niwa.co.nz) that enables real time weather observations and forecasts at a specific site. The portal provides information and map generating tools for weather, sea state (wave and wind hindcast models); sea level (tides and storm surge); and climate analyses.

Reference can be made to international databases such as the Australian Ocean Data Network Portal (AODN - http://portal.aodn.org.au/aodn/) or ARGO Data set (http://www.usgodae.org/argo/argo.html and http://www.coriolis.eu.org/) for physical oceanography considerations.

Other databases of relevance to physical environment are provided in Appendix D.

Because distant natural events could have an impact, even minor, on the operations (see Template Section 8), it is recommended that any natural hazardous or catastrophic events that would have an impact on the operations be described in this section (e.g., distant tsunami, earthquakes).

Some template sections here, such as 4.3 - "Meteorology and Air Quality", 4.5 “Physical oceanographic setting” and 4.6- "Water quality" may require the inclusion of results from numerical models – whether developed purposefully to describe the existing environmental conditions, or readily available. If so, uncertainty and model protocols should be discussed (also see report section 3.7). Various characteristic and frequency statistics can be derived from such models: for example wind speed and direction, and wave conditions (such as height, mean and peak wave period, direction) (e.g., Tolman 2009; Tolman et al. 2002; Uppala et al. 2005).

The description of the geological setting in Template Section 4.4 should be reasonably detailed because of its direct relevance to the proposed exploration and exploitation of mineral and oil and gas resources. The reader should be able to understand the general nature, structure and dynamics of the seafloor and its processes at and near the proposed site/s. This will include description of the regional and local geology, geomorphology and tectonic environment. A brief geological history of the region is needed, including specific information on the origin of the relevant resources at the site. This section should synthesise, in plain language, the up-to-date knowledge available in the scientific literature. The literature should be referred to appropriately.

Seafloor information may be illustrated using bathymetry, backscatter, sediment or predictive maps at a scale relevant to the region and the site. An account of the sub-seafloor will usually require this information to be illustrated using seismic reflection data, with suitable scale, vertical exaggeration and labelling of key reflectors and events. Seismic sections should be presented with a clear interpretation. Indicative vertical scales in metres should be added on two-way travel time sections. Technical terms should be listed in the Glossary.

Template section 4.7 on sediment characteristics may include a variety of information. It will need to cover the results from actual sampling and cover the type of sediment, particle size distribution, chemical composition, pore water characteristics, and nutrient composition and levels. Existing “contaminant” presence should also be noted, such as naturally accumulated heavy metals and radioactive compounds.

The description of natural hazards in Section 4.8 should focus on the relevant hazards likely to affect the site, although also mention hazards that are unlikely to occur. The main natural geological hazards include, but are not necessarily limited to, active faults capable of generating earthquakes (Litchfield et al. 2013; Stirling et al. 2012), active submarine volcanic edifices (Carey et al. 2014), potential slope instabilities and landslides (Vanneste et al., 2013). Although tsunami usually have little to no impact on offshore structures they may be of relevance to coastal regions and ports and should be mentioned if such issues are of relevance. Probability of occurrences could be presented from published data (Stirling et al. 2012).

Information on noise and light should include both aerial and underwater ambient (or background) levels from natural and anthropogenic origin. The origins of the anthropogenic noise and light should be detailed if possible (ship traffic, timing, period of the year etc.). Noise levels are commonly expressed in decibels (dB), referred to a conventional reference value. Underwater, the reference is usually re. 1µPa at 1 m, and in the aerial environment the reference is usually re. 20µPa. Noise frequencies should be clearly indicated, and background noise should be measured or assessed at a wide range of frequencies.

This section does not need to present and discuss the measures that will be implemented to avoid, remedy or mitigate adverse impacts to the surrounding environment and existing interests. Mitigation measures should be addressed as appropriate in sections 8, 9, 10, and 11 of the EIA and there needs to be good cross referencing throughout the EIA so that a reader can easily see how an identified effect is to be avoided, remedied or mitigated.

4.7 Template Section 5: Description of the existing biological environment

- *This section is divided by depth regime for the site into a description of the various biological components and communities that are present or utilise the area.*
- *The format of this could be handled in many different ways. However, it is useful to structure it by depth as this reflects the likely division of impacts in the 3 main areas of the water column. It is the approach taken by the International Seabed Authority (2012).*

5.1 Key messages

- *Overview of key content covered in this section (this is a box with up to 6 bullet points of the main aspects covered, or the main findings).*

5.2 Regional Overview

- *General regional context*
- *Include site-specific issues and characteristics, particularly sensitive environments*
- *Existing conservation areas, protected species etc.*
- *Reference to relevant technical data/previous studies will be required*
- *The regional overview is a brief section, but provides the broader scale context for the more detailed site-specific description below.*

5.3 Biological communities

5.3.1 Surface

- *From the surface down to 200 m - this includes plankton (phytoplankton and zooplankton), surface/near surface fish such as tunas, also seabirds, turtles, marine mammals.*

5.3.2 Midwater

- *Open water from a depth of 200 m down to within 50 m of the seafloor and includes zooplankton, mesopelagic and bathypelagic fishes, deep-diving mammals.*

5.3.3 Seafloor

- *Benthic invertebrate and fish communities, including infauna to an appropriate depth of sediment, and demersal fish up to a distance of 50 m from the seafloor.*

5.3.4 Ecosystem/Community level description

- *Summary of ecosystem studies, where elements of the above components are integrated*

5.4 Summary of existing biological environment

- *Bring together key findings such as any sensitive environments or highly valued areas.*
- *This will be up to a page, and more extensive than the Key messages in section 5.1.*

The depth ranges given above apply to deep-sea resources. In shallow areas (e.g., ironsand deposits) the depth ranges to describe the surface-seabed characteristics would be different.

This section gives a detailed account of the state of information on biological communities. It starts with a general regional overview, which covers broad-scale characteristics such as biogeographic provinces, particular topographic features that may have a certain type of fauna (e.g., hydrothermal vent sites, seamounts, canyons), as well as any existing areas or species subject to management. Template section 5.2 is relatively high level, but sets the scene for a more in-depth description in section 5.3.

There are several recent biogeographical accounts that applicants may find useful, including global epipelagic (Spalding et al. 2012), mesopelagic (Sutton et al. 2017) and benthic (Watling et al. 2013) classifications. There are also a number of more regional or New Zealand accounts, including Rowden et al. (2005) for seamounts, Francis et al. (2002) for demersal fishes, and two recent generic environmental classifications of the EEZ, the Marine Environment Classification (MEC) (Snelder et al. 2006), and a Benthic Optimised MEC (Leathwick et al. 2012).

A comprehensive species list should be provided for the area. This can be compiled from a number of sources, including:

- a literature review to uncover all published records. A good place to start is the summary by Gordon et al. (2010) and the 3 volume series on New Zealand's biodiversity (Gordon, 2009, 2010, 2012).
- museum, university or research institute collection specimen records (e.g., National Fish Collection at Te Papa, NIWA Invertebrate Collection,)

- research databases available from national institutes (e.g., NIWA, Te Papa, Auckland Museum) or government agencies. The New Zealand National Aquatic Biodiversity Information System (NABIS - www.nabis.govt.nz) provides information on the distribution of marine species (in particular fishes) in the New Zealand region
- global biodiversity databases, available online (e.g. www.iobis.org, www.fishbase.org for invertebrates and fishes respectively).

There should also be notes provided on particular characteristics of the species, especially if they may be endemic (restricted in their distribution to just the site, resource substrate, or localised region) or known to be rare, threatened or endangered. The IUCN redlist of endangered species (www.iucnredlist.org) with additional data provided by national lists (Freeman et al., 2010 for New Zealand species) can then be linked with species lists from the area to know if they are present.

The description of species composition and abundance needs to include all size and age ranges of fauna, from microfauna and infaunal meiofauna (e.g., nematodes which are very important in soft sediment environments such as nodule habitat) through macrofauna to epifaunal megafauna. Life history stages also need to be considered, such as larval and juvenile stages with different ecological characteristics from adults.

Existing data (as well as new data collected during exploration activities) should be analysed to be more than a simple list of animals found, but indicate how species and faunal assemblages use habitats in the area. This needs to include use by different life history stages of fauna, such as spawning sites, nursery areas, feeding grounds etc. This can highlight key linkages between faunal groups and their environmental context. This should include multivariate analysis of community structure, at appropriate scales where there has been sample replication. This type of analysis should evaluate whether particular faunal communities are common or rare throughout the site of interest, as well as distributed outside the licence area. Faunal descriptions should include accounts of genetic diversity and trophic relationships, and an assessment of community function and their role in provision of ecosystem goods and services. This type of analysis needs to be planned during the exploration phases of the project to produce data that enable robust analyses to be carried out for the EIA. Useful sources of guidance are ISA reports on environmental guidelines for polymetallic nodules, and polymetallic sulphides and crusts (ISA 1999, 2007), as well as a recent report by SPC-NIWA (Swaddling et al. 2016).

Given the emphasis by many agencies on the ecosystem approach to management, it is important to consider wider community relationships where information exists (section 5.3.4). This enables assessments to move beyond community descriptions to incorporate potential changes in ecosystem function (e.g., Armstrong et al. 2012, Tuck et al. 2014, Thurber et al. 2015).

Community-level analyses may be carried out for different faunal groups under the three depth bands above. It is common to have multivariate grouping/clustering type analyses for benthic invertebrate fauna in particular. However, where analyses may span the depth-based habitats, they should be included in the ecosystem/community section. There should, at the least, be a description and assessment of information on trophic interactions and the linkages of both food energy, and contaminants, in the food chain. Emphasis might be placed on knowledge of trophic levels, the degree of interaction between benthic and pelagic communities, whether there are specialised predators that could be more vulnerable than generalists, and how complex the food web and species interactions are to give an idea of resilience of the system to disturbances. Scientific interests

may also look at going further and developing models to quantify the trophic structure, and energy flows through the ecosystem. There are a number of ecosystem models that could be considered, as data are collected during exploration phases. Such data can begin to support a trophic model structure that quantifies the transfer of organic material through a food web, such as that based on the widely used mass-balance Ecopath trophic model (Christensen and Walters, 2004). Modelling is likely to become a more common feature of EIAs, whereby mining-like perturbations to the system can be modelled and assessed (e.g., Chatham Rock Phosphate Ltd, 2014).

This description of the biological environment (and subsequent assessment of impacts in Template Section 9) can also be structured by "receptor" rather than by the depth range. This approach is based on the main biological groups, such as:

- Primary producers
  - Phytoplankton
  - Algae (if sufficiently shallow)
  - zooplankton
- Mesopelagic fauna
  - fish
  - squids
  - macrozooplankton
- Fish
  - assemblages
  - pelagic species
  - demersal species
- Marine mammals
  - cetaceans
  - pinnipeds
- Seabirds
- Other rare or endangered species
  - e.g., turtles
- Benthic invertebrates
  - Meiofauna, macrofauna, megafauna
  - Microbes and protists
  - Assemblages
- Ecosystem/Community level descriptions
- Sensitive habitats (as defined by the EPA in the EEZ Act regulations)

Sensitive Habitats warrant a separate heading, whether the structure is by depth zone (in this case template section 5.3.3 “Seafloor”, or by receptor. The EPA Permitted Activities Regulations (Schedule 6) define 13 sensitive habitat types, and provide indicative criteria and thresholds as to whether they are potentially sensitive:

- Stony coral thickets or reefs
- Xenophyophore beds
- Bryozoan thickets
- Calcareous tube worm thickets
- Chaetopteridae worm fields
- Seapen fields
- Rhodolith beds
- Sponge gardens
- Beds of large bivalve molluscs
- Macroalgae beds
- Brachiopods
- Deep-sea hydrothermal vents
- Methane or cold seeps.

Components of “Vulnerable Marine Ecosystems” (VME) should also be considered, as defined by the Food and Agriculture Organisation (FAO) (FAO 2009). Taxa that have been identified as VME indicators for the high seas region around New Zealand managed by the South Pacific Regional Fisheries Management Organisation are described by Parker et al. (2007).

The format of the biological description does not really matter, and should suit the particular area, resource, and the report authors’ preference for structure. However, the depth component should be retained in the description of the range of taxa, as that can then guide the evaluation of the sensitivity and vulnerability of fauna to different stages or parts of the extractive operation. Hence depth zone can be a sub-section structure under each of the faunal groups, or conversely the faunal groups become sub-sections of the depth zones.

4.8 Template Section 6: Description of the existing onshore environment

This section should describe the conditions of the area where onshore processing operations will be located, as well as any relevant environmental information on transit lanes/areas.

Although other legislation may apply onshore, there are advantages to having the entire operation and chain of processing and potential impacts covered in a single EIA.

The level of detail provided in this section will depend on the extent of onshore activities and any overlap with the RMA management regime to 12 nm offshore.

6.1 Key messages

- *Overview of key content covered in this section (this is a box with up to 6 bullet points of the main aspects covered, or the main findings).*

6.2 Overview

- *General context for the onshore area*
- *Include site specific issues and characteristics*
- *Existing conservation areas, protected species etc.*
- *Reference to relevant technical data/previous studies will be required*
- *The overview is a brief section, but provides the broader scale context for the more detailed site-specific description below.*

6.3 Physico-chemical environment

- *Land and any waterbodies that may be affected. Air quality issues.*

6.4 Biological environment

- *Terrestrial or aquatic communities in the area.*

6.5 Summary of existing onshore environment

- *Bring together key findings.*
- *This will be up to a page, and more extensive than the Key messages in section 6.1.*

The length and detail of this section, and the corresponding assessment of impacts (Template section 10, see 4.12 below), will obviously depend on the proposed activity. If the activity is in the middle of the EEZ, with no shore-based support activities, this section would either not be required or would be a very short statement to that effect. However, if there is either a potential cross-boundary impact and/or associated shore-based support activities this section will be required. It may also be a briefer description for operations beyond EEZs in the Area under the jurisdiction of the ISA.

As per the three introductory bullets to this topic in the template, this section should describe the conditions of the area where onshore processing operations will be located, as well as any relevant environmental information on transit lanes/areas. In Template Section 2 (the Policy, legal and

administrative context; see 4.4 above) your EIA will have outlined the extent of overlap into the Coastal Marine Area under the RMA management regime to 12 nm offshore, and any relevant regional or local management provisions. This would include an assessment of whether a resource consent under the RMA was required for the Coastal Marine Area or onshore activities, for which an assessment of environmental effects (AEE) would be required. Sections 88-100 of the EEZ Act outline the potential for joint applications if both EEZ Act marine consents and RMA resource consents are required. If this is the case, the EIA must include an assessment of effects that complies with section 88(2)(b) of the RMA and section 39 of the EEZ Act. It should be remembered that section 59 of the EEZ Act requires applicants to take into account the nature and effect of other marine management regimes, plus relevant regulations and any other applicable law.

Regardless of whether a joint application is made, there may be advantages to having the entire operation and chain of processing and potential impacts covered in a single EIA, and so this section allows for that. The level of detail provided will depend on the extent of onshore activities. Guidance for preparing an AEE under the RMA can be found elsewhere (e.g. www.mfe.govt.nz/publications/rma/ or www.qualityplanning.org.nz/index.php/consents), and the suggested headings provided here are just one way of organising this section and are not exhaustive.

An overview should provide general context for the onshore area, in particular identifying any site-specific issues and characteristics, such as existing conservation areas, or habitat for rare or protected species. Reference to any relevant technical data/previous studies will be helpful. The overview is a brief section, but provides the broader scale context for more detailed site-specific descriptions below.

In line with the EIA template as a whole, it will be useful to include physical, chemical and biological aspects in your assessment of the existing environment. The physico-chemical environment would include comment on any particular features of the land, water or air. The biological environment would include any terrestrial or freshwater aquatic ecosystems. It will be helpful to organise these sections to make it clear whether the planned activities will breach the relevant restrictions under RMA sections 9-16 (see 4.4 above) such as whether discharges to land, water or air may have potential impacts on physical, chemical or biological aspects of the environment (which would be discussed in Template Section 10 of the EIA).

In line with other sections establishing environmental baselines, this section should start with Key messages and end with a summary of key findings.

4.9 Template Section 7: Description of the existing socio-economic environment

7.1 Key messages

- *Overview of key content covered in this section.*

7.2 Existing Interests

7.2.1 Fisheries

- *If the project area occurs within an area used by fisheries, then this needs to be described here.*

7.2.2 Marine Traffic

- *This section describes the non-project related marine traffic occurring within the project area.*

7.2.3 Tourism

- *This section describes areas used by cruise-liners, game fishing, sightseeing, marine mammal watching, other tourism activities.*

7.2.4 Marine Scientific Research

- *Outline the current scientific research programmes that are taking place in the area.*

7.2.5 Conservation areas

- *Describe any Marine Protected Areas or Marine Reserves, Marine Mammal sanctuaries etc.*

7.2.6 Other

- *Other uses of the project area not related to fisheries, marine traffic, tourism, scientific research or conservation (e.g., recreational activities (sailing, diving), telecommunications cables, other hydrocarbon or mineral exploration or mining projects etc.).*

7.3 Cultural environment

- *Cultural significance of the proposed project area (including specific sites).*
- *Iwi authorities, customary marine title groups, customary rights groups who may be directly affected by the application*

7.4 Historic heritage

- *Historic significance of the proposed project area (e.g., shipwrecks).*

7.5 Socio-economic and socio-cultural aspects

- *Adjacent coastal communities' regional demographic and economies, including local port information if relevant.*
- *Emphasise existing coastal uses by communities that could be affected.*
- *Existing economic conditions and issues must be described*

7.6 Summary of existing socio-cultural environment

- *Bring together key findings e.g. any existing interests.*
- *This will be up to a page, and more extensive than the Key messages in section 7.1.*

This section of the EIA provides a detailed account of existing interests and values and the wider socio-economic environment. This baseline information is then used to assess economic and social impacts of the proposed development, which are reported in template section 11 of the EIA (see 4.13). Social impact assessment can be defined as an effort to assess or estimate, in advance, the social consequences that are likely to follow from a proposed activity (NOAA, 1994). The term

includes social, cultural and economic components, conditions and factors which interactively determine the state, condition, and quality of living conditions, employment, health and well-being of those people and communities affected directly or indirectly by the project.

When describing socio-economic and socio-cultural conditions, this section should focus on components that may be affected by the proposed activity. In addition to the interests and uses outlined below, relevant components often include:

- Population characteristics including the demographics of relevant groups and trends (including ethnicity and sensitive populations and groups); major economic activities; available work force, unemployment and underemployment; availability of housing, infrastructure and services (e.g. roads, education facilities); and seasonal migration patterns where relevant.
- People's relationships with the biophysical environment, including areas having economic, recreational, aesthetic, cultural or symbolic significance to specific people.
- Historical heritage of the area, especially any features that may be affected by the proposed activity.

Socio-economic assessments must determine existing interests that may be affected by the proposed project. The EEZ Act lists activities and rights that are considered existing interests. Within the New Zealand context, iwi authorities, customary marine title groups and protected customary rights groups that may be affected by the proposed project would need to be consulted so that these interests can be described (and effects then assessed for template section 11 of the EIA). This may require a cultural impact assessment to be undertaken. Existing interests that may be affected by a proposed marine activity can also include fisheries (commercial, recreational and customary (i.e., indigenous)), marine transport, tourism, scientific research, marine protected areas and other conservation areas, historic heritage, as well as adjacent coastal communities. Any other interests in or uses of the area, such as sailing or telecommunications cables, must also be identified.

Multiple use of offshore areas subject to minerals or hydrocarbon interest is most likely to involve fisheries. There is a large literature resource available for fisheries around New Zealand, and it can be a complex picture to unravel. In the first instance, applicants can learn a lot from NABIS (www.nabis.govt.nz) which can plot the distribution of many marine species, including all of New Zealand's commercial fishery species, as well as conservation areas and regions subject to fishing restrictions (such as Benthic Protection Areas). Annual stock assessment plenary reports published by the Ministry for Primary Industries (http://fs.fish.govt.nz/Page.aspx?pk=61&tk=212) are also a good resource to gain an understanding of the importance of commercial fisheries in the region.

There are a number of offshore areas that are protected from bottom trawling and dredging operations, under the Fisheries Act. There are also seasonal closures in some areas, as well as vessel size and fishing gear restrictions. These may have no direct bearing on potential mining or drilling operations, but need to be described within the area of interest. Of particular importance offshore are seamount closures (dating from 2001) (Brodie & Clark 2003) and Benthic Protection Areas (BPAs) declared in 2007 (Helson et al. 2010). The location of these is shown in Figure 4-1.

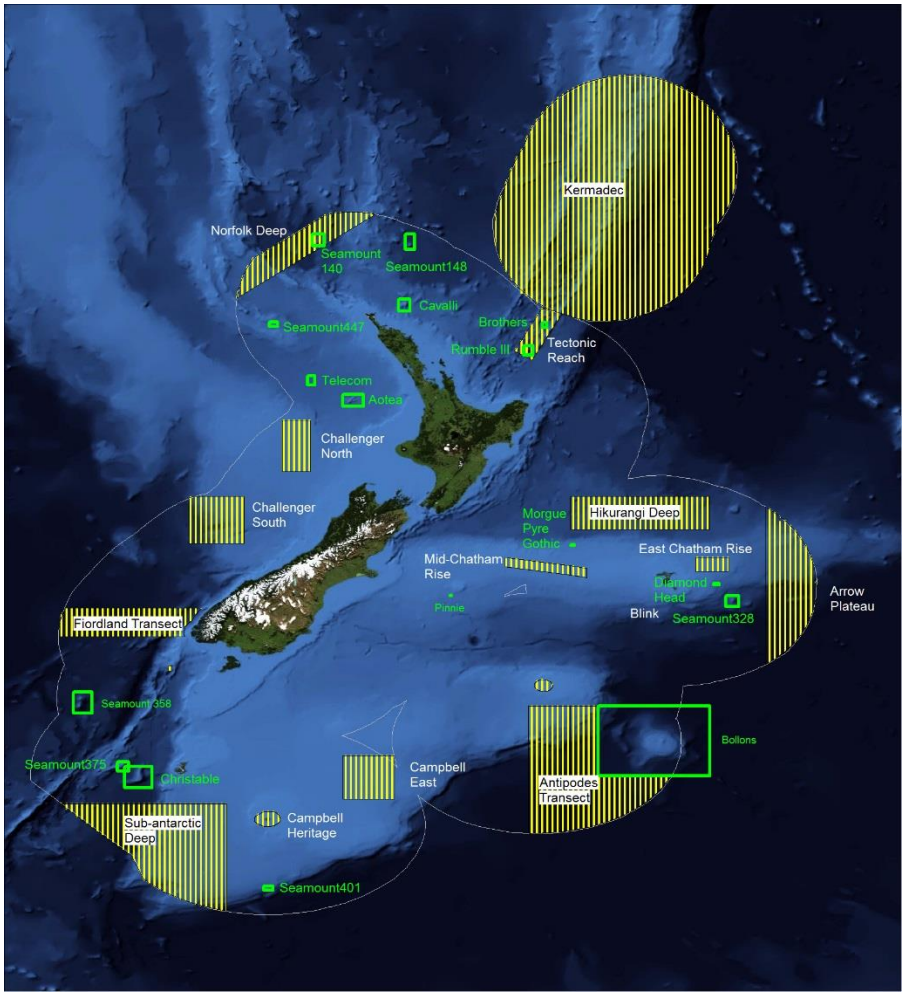


Figure 4-1: The New Zealand EEZ showing the location of Benthic Protection Areas (yellow striped) and seamount closures (green polygons), where no bottom trawling or dredging is permitted.

Marine Mammal Sanctuaries are also important conservation areas to be aware of. These are areas designed to protect marine mammals from harmful human impacts, particularly in vulnerable areas such as breeding grounds and on migratory routes. They occur off the Auckland Islands, Banks Peninsula, Catlins coast, Clifford and Cloudy Bay, Te Waewae Bay, and off the west coast of the North Island (see http://www.doc.govt.nz/nature/habitats/marine/other-marine-protection/).

Identification of, and working with, all potentially affected groups at the very beginning of planning for the proposed project is best practice. An overview should provide general context of the existing interests, and then give more detailed description of these interests, in particular identifying any site specific issues and characteristics, such as existing conservation areas, historic heritage sites or overlap of the project with key fisheries.

In line with other sections establishing environmental baselines, this section should start with key messages and end with a summary of key findings. The level of effort that is devoted to the description of the human environment should be commensurate with the size, cost, and degree of expected impacts of the proposed activity.

4.10 Template Section 8: Assessment of impacts on the physico-chemical environment and proposed mitigation

This section should provide a detailed description and evaluation of potential impacts of the operation to the physical environment components identified in section 4. This may need to consider effects that may happen during construction/development (pre-commissioning), operational, and decommissioning phases, as well as the potential for accidental events. The preferred approach in this template is that for each component there is a description of:

(i) the nature and extent of any actual or potential impact, including cumulative impacts;

(ii) measures that will be taken to avoid, remedy or mitigate such impacts; and

(iii) what unavoidable (residual) impacts will remain.

It is also important for these sections to make clear the expected time to recover following disturbance, the longevity of residual effects, and if possible an indication of potential state shifts, so that the duration of residual effects is clear.

Note: This section (and section 9) will focus on aspects of greatest risks to the environment. Before an EIA is written, an environmental risk assessment (ERA) should be carried out which will evaluate the likelihood, scale, intensity and consequences of the mining or drilling operations having an impact on the physical, chemical and biological environment. This means the EIA can describe in greater detail the main impacts on the environment and not expand elements of minor risk. The methods and results of the ERA should be provided as an appendix to the EIA, or as a separate report.

8.1 Key messages

- *Overview of key content covered in this section.*

8.2 Identification of threats

- *Summarise the results of a previous ERA (undertaken as part of the initial scoping stage of the EIA process). This is expected to be a separate report, with only the summary provided here to highlight the major issues of concern.*
- *This ERA identifies the key parts of the project which have potential to impact the existing environment.*
- *The detail is in the associated ERA, and so this frees the EIA to focus on the main impacts, not have a lot of detailed description of minor effects.*

8.3 Meteorology and Air Quality

8.3.1 Potential impacts and issues to be addressed

8.3.2 Environmental management measures

8.3.3 Residual impacts

8.4 Geological setting

8.4.1 Potential impacts and issues to be addressed

8.4.2 Environmental management measures

8.4.3 Residual impacts

8.5 Physical oceanographic setting

8.5.1 Potential impacts and issues to be addressed

8.5.2 Environmental management measures

8.5.3 Residual impacts

8.6 Water quality

8.6.1 Potential impacts and issues to be addressed

8.6.2 Environmental management measures

8.6.3 Residual impacts

8.7 Seabed substrate characteristics

8.7.1 Potential impacts and issues to be addressed

8.7.2 Environmental management measures

8.7.3 Residual impacts

8.8 Natural hazards

8.8.1 Potential impacts and issues to be addressed

8.8.2 Environmental management measures

8.8.3 Residual impacts

8.9 Noise and light

8.9.1 Potential impacts and issues to be addressed

8.9.2 Environmental management measures

8.9.3 Residual impacts

8.10 Gas and chemical emissions

8.10.1 Potential impacts and issues to be addressed

8.10.2 Environmental management measures

8.10.3 Residual impacts

8.11 Vessel waste management

8.11.1 Potential impacts and issues to be addressed

8.11.2 Environmental management measures

8.11.3 Residual impacts

8.12 Cumulative impacts

The nature and extent of interactions should be considered. This is at both local, and regional scales.

8.13 Summary of residual effects

- *A table may be a useful summary format*

The aim here is to provide a description and evaluation of potential impacts of the mining or drilling operations on the physical environment components identified in Template Section 4 (see 4.8 above) from the activity described in Template Section 3 (see 4.6 above). It therefore links closely with Section 4 of the template, and uses a similar format to enable a reader to learn about the physical characteristics of the area, and directly relate them to the description of impacts. It emphasises the importance of a detailed description of methods under Section 3, as that enables an understanding of the source and nature of impacts caused directly by the operation.

The section should start with a revision of the methods, and a description of the source of impact. This typically comprises physical disturbance of the seabed, and an associated sediment plume that will disperse beyond the footprint of the direct mining or drilling operation. There is potential impact from leakage of material through riser pipes, or semi-enclosed collection methods (e.g., grab), as well as discharges of processing waters and fines after sorting on the surface platform (Figure 4-2).

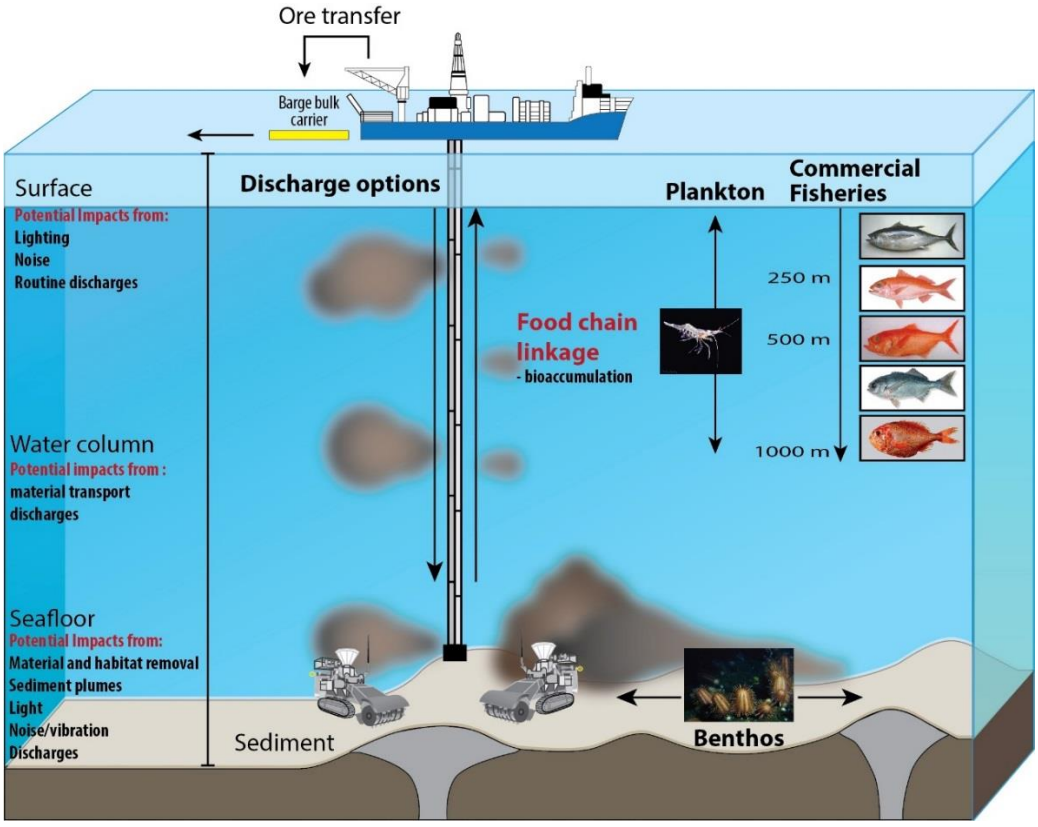


Figure 4-2: Schematic of deep-sea mining or drilling impacts. (from NIWA/IUCN)

The description of the potential physical impacts of the proposed activity can be divided into three types:

1. **Direct physical impact** of equipment and machineries on the seafloor, such as:

    - the removal or displacement of material,
    - the alteration of landforms (e.g., sandwaves, scours, pockmarks, mud volcanoes, carbonated concretions etc.), and other physical and chemical characteristics of the seafloor,
    - the radical changes or creation of small-scale topography (scarps, channels, pockmarks, mounds, etc.).

Alteration of habitat by installation of infrastructure (pipelines, platforms, anchors etc.) also needs to be considered

2. **Indirect physico-chemical impacts**.

    - Generation of sediment plumes. The formation of sediment plumes, their displacement and redeposition of sediment, and their potential impact on substrate composition and biology, is very complex and will generally require specific research including observations and numerical modelling.
    - The discharge or release of fluid or solid materials. This could be the result of drilling, dredging, transporting slurry to the surface, or rejection of unwanted residual products. This should address the contaminants of potential concern relating to the proposed operation. Estimates of volume rejected should be given. Changes in the water chemistry and assessment of potential ecotoxicity effects associated with extractive activity and potential discharges from support vessels or operational processes (e.g., drilling muds, antifouling release from structures) need to be estimated. This will require provision of data on background physico-chemical conditions and seasonal variability of these parameters. Such studies may need to be undertaken for the seabed and benthic environment as well as the water column.

3. **Surface effects**. Release of gas or solid particles in the atmosphere should be estimated. These may result from increases in natural emissions triggered by the activity or directly generated by equipment and machineries, usually onboard support and transport vessels. Generation of combusted exhaust gases (usually in the form of CO_2, CO, and NOx) potentially released to the atmosphere should be estimated.

The descriptions should consider effects that may happen during construction/development (pre-commissioning), operational (including maintenance), and decommissioning phases, as well as the potential for accidental events. The preferred approach in this template is that for each component there is a description of:

1. the nature and extent of any actual or potential impact, including cumulative impacts;
2. measures that will be taken to avoid, remedy or mitigate such impacts; and
3. what residual impacts will remain and the rationale for why these cannot be reduced.

This approach should also apply to sections 4.11, 4.12, and 4.13.

Although the details of the ERA should be provided in a separate report, a summary of risk information should be presented in the EIA (see discussion about this in section 4.11 below).

In evaluating the nature and extent of impacts, it is important to consider what type of activity is restricted under legislation. For these there must be a detailed account of impacts and mitigation options, as these will need specific EPA consent whereas permitted activities are already able to be undertaken (depending on their scale).

The impact of natural hazards is clearly different from any treatment of human-generated impacts. This part (8.8) could be divided in two parts:

- Any potential trigger of natural event directly or indirectly associated to the activity, i.e., is there any possibility that the activity would increase the likelihood of occurrence of an event (e.g., underwater landslide)?
- Any impacts of natural events – recurrent or rare - on the operation and infrastructures. Such events include extreme weather. However, some may originate from distant locations, well outside the EEZ, but with an impact, even minor, on the operations (distant tsunami, earthquakes). A management plan should be developed for such events.

This particular section may be fairly brief where the magnitude or frequency of any event is low. However, if potentially large or regular, then mitigation of impacts will be an important aspect to consider.

Where any noise and light effects resulting from the activity (e.g., vessels, ROVs, seafloor mining tools) are going to have a biological, rather than physical impact, cross-referencing between sections should enable the reader to link the cause and effect. Hence this section should relate to, and be closely integrated with, Template Section 9. Note potential adverse effects from noise and lights resulting from activities were identified in both TTR and CRP applications, and that conditions to avoid remedy and mitigate such impacts were proposed.

In line with other assessment of impact sections of the EIA, this section should start with Key messages and end with a Summary of key findings. The overall impact from the various sources need to be summarised to give an holistic view of the effects of the entire operation.

4.11 Template Section 9: Assessment of impacts on the biological environment and proposed mitigation

In this section, we provide a detailed description and evaluation of potential impacts of the mining or drilling operation to the biological environment components identified in section 5. This may need to consider effects that may happen during construction/development (pre-commissioning), operational, and decommissioning phases, as well as the potential for accidental events. The preferred approach in this template is that for each component there is a description of:

(i) the nature and extent of any actual or potential impact, including cumulative impacts;

(ii) measures that will be taken to avoid, remedy or mitigate such impacts; and

(iii) what unavoidable (residual) impacts will remain.

It is also important for these sections to make clear the expected time to recover following disturbance, the longevity of residual effects, and if possible an indication of potential state shifts, so that the duration of residual effects is clear.

Note: This section (as for section 10) will focus on aspects of greatest risks to the environment. Before an EIA is written, an ecological risk assessment (ERA) should be carried out which will evaluate the likelihood and consequences of the operation having an impact on the biological environment. This means the EIA can describe in greater detail the main impacts on the physical and biological environment and not elements of minor risk. The methods and results of the ERA should be provided as an appendix to the EIA, or as a separate report.

9.1 Key messages

- Overview of key content covered in this section.

9.2 Identification of threats

- Summarise the results of a previous ERA. This is expected to be a separate report, with only the summary provided here to highlight the major issues of concern.
- This ERA identifies the key parts of the project which have potential to impact the existing environment.
- The detail is in the associated ERA, and so this frees the EIA to focus on the main impacts, not have a lot of detailed description of minor effects.
- Include the results of any test mining (if applicable) that is relevant to identifying impacts.

9.3 Biological environment

9.3.1 Surface

9.3.1.1 Potential impacts and issues to be addressed

9.3.1.2 Environmental management measures

9.3.1.3 Residual impacts

9.3.2 Midwater

9.3.2.1 Potential impacts and issues to be addressed

9.3.2.2 Environmental management measures

9.3.2.3 Residual impacts

9.3.3 Seafloor

9.3.3.1 Potential impacts and issues to be addressed

9.3.3.2 Environmental management measures

9.3.3.3 Residual impacts

9.3.4 Ecosystem/community level

9.3.4.1 Potential impacts and issues to be addressed

9.3.4.2 Environmental management measures

9.3.4.3 Residual impacts

9.3.5 Cumulative and cross-boundary effects

9.3.5.1 Potential impacts and issues to be addressed

9.3.5.2 Environmental management measures

9.3.5.3 Residual impacts

NOTE: As in section 5.3, this assessment of impacts can also be structured by "receptor" rather than by the depth range. The format does not matter, as long as the depth component is retained in the description of the range of taxa that need to be included.

9.4 Other issues

- Outline where there are other more general issues or overlap with other marine management regimes or regulations such as maritime safety, biosecurity, waste management etc.
- Aspects of existing conservation areas, management plans etc.

9.5 Summary of residual effects

- A table may be a useful summary format

This section links closely to Template Section 5 (see 4.7 above), in that the format is similar to enable a reader to learn about the biological communities and their characteristics in the area, and then directly relate the description of impacts to them. It emphasises the importance of a detailed 0description of methods under template section 3 (see 4.5 above), as that enables an understanding of the source and nature of impacts caused directly by the mining operation. This section should also link with the Ecological Risk Assessment that was performed as part of, or a separate exercise to, the preparation of this EIA. The ERA will have examined sources of impact in detail, and identified the main sources of risk, and their likely severity. ERAs, in the context of deep sea mining and drilling, have been reviewed by Ellis et al. (2014).

There are many approaches and methods to Ecological Risk Assessment (ERA). A realistic approach at the beginning of the exploration phase, given the amount of information available, is to conduct at least a Level 1 assessment in line with accepted New Zealand and Australian risk assessment standards (AS/NZS ISO 31000 2009). This assessment is based on knowledge of the activities likely to occur within the region, and their nature and extent. Likely environmental threats arising from these activities to the local habitats can be identified, and then evaluated for the likely level of risk. There are two common approaches to a Level 1 assessment: the likelihood – consequence risk assessment method (Fletcher 2005), and a more exposure-effects approach such as applied in a Scale-Intensity-

Consequence analysis (SICA, Hobday et al. 2007). These are both largely expert-opinion methods that involves convening a group of experts with knowledge of a range of biological aspects, who then progress through 3 main steps:

1. examination of sources of risk, their magnitudes, scales, frequencies and intensities;
2. assessment of the potential consequences of those risks; and
3. likelihood of a particular level of consequence occurring from the various activities.

Scores are given to the potential consequence of each identified activity that results in an assessment of the **relative** significance of the likely impact.

A likelihood-consequence analysis was carried out by MacDiarmid et al. (2012) to give managers an indication of what sort of activities were likely to cause most impact across a range of resource and mining operations. The results of this type of assessment are given for a New Zealand example in Table 4-1 (Table 4.8 in MacDiarmid et al. 2012).

Table 4-1: Example risk assessment. This is a subset of the activity-threat combinations that result in a relative score and hence enables a ranking of the impact of activities. From MacDiarmid et al. (2012).

Table 4-8: Expert Panel Assessment: Polymetalic crust mining. Levels of consequence, likelihood, risk and confidence associated with this activity in the EEZ and ECS. Activities are listed (a, b, c, etc) after each threat to which they contribute. The maximum possible level of environmental risk is 30. Extreme environmental risks are highlighted in red, high in yellow, and moderate in green. Low risk activities are not highlighted. *Threats managed under the Maritime Transport Act (1994). NA = not applicable as species assessed are all protected.

Expert Panel Assessment: Polymetalic crusts		Recovery period				Key species				Protected species				Ecosystem functional impact				Proportion of habitat affected			
Activity	**Threat**	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence
Prospecting a) Surface flood lights and noise b) ROV and other imaging surveys c) Acoustic swath mapping d) Sub-bottom profiling using CHIRPS, boomers and sparkers e) Spot sampling using ROV, submersible, or rock dredge f) Survey vessel activities	*Seabird attraction, disturbance, collision (a)	1	6	6	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	3	6	18	2b
	Acoustic impact from multi-beam echo sounders on marine mammals, reptiles, fish and invertebrates (c)	0	5	0	2a	0	6	0	2a	1	5	0	2a	0	6	0	2a	0	6	0	2a
	Acoustic impact of high resolution seismics on marine mammals, reptiles, fish and invertebrates (d)	1	6	6	2a	2	6	12	1c	2	6	12	2a	0	6	0	2b	2	6	12	2b
	*Ship strikes on marine mammals, fish, and reptiles (f)	3	6	18	2b	2	2	4	2b	2	2	4	1c	0	6	0	2b	0	6	0	2b
	Impact on benthos (b, e)	4	3	12	1c	1	4	4	2a	1	4	4	2a	2	5	10	1c	1	6	6	2a
Exploration g) Surface flood lights and noise h) Test extraction methods i) Bulk sampling j) Sediment plume k) Underwater noise l) Sub-bottom profiling using CHIRPS,	*Seabird attraction, disturbance, collision (g)	0	6	0	2b	NA	NA	NA	NA	2	5	10	2b	0	6	0	2b	0	6	0	2b
	Impact on benthos (h, i)	4	6	24	1c	2	4	8	2a	1	4	4	2a	2	5	10	2a	1	4	4	2b
	Acoustic impact on marine mammals, reptiles, fish and invertebrates (l, m)	1	6	6	2a	2	6	12	1c	2	6	12	2a	0	6	0	2b	2	6	12	2b
	Entanglement of megafauna (h, i)	3	5	15	2b	1	3	3	2b	1	3	3	2b	0	6	0	2b	0	6	0	2b

Where the nature of the resource, site, and technology specific characteristics are known, an exposure-effects approach may be more appropriate. The "likelihood" component of an assessment is then less relevant than assessing the nature and extent of impacts that will definitely occur.

The level 1 SICA analysis assesses the impact of each of 32 potential impact activities on 5 ecological components (target, bycatch and byproducts, Endangered, Threatened and Protected species, habitats, communities/ecosystem). Expert judgement classifies each on a 6-point scale from negligible to catastrophic. Activity/component combinations for which the risk score is greater than a certain level (moderate or above has been adopted in many cases) are taken through to level 2 analysis. There are 10 principal steps in a SICA analysis, which correspond to columns in a summary table:

1) Record the hazard identification score (absence, presence)
2) Score spatial scale of the activity
3) Score temporal scale of the activity
4) Choose the sub-component most likely to be affected by activity
5) Choose the most vulnerable unit of analysis for the component
6) Select the most appropriate operational objective
7) Score the intensity of the activity for that sub-component
8) Score the consequence resulting from the intensity for that subcomponent
9) Record confidence/uncertainty for the consequence scores
10) Document rationale for each of the above steps

The SICA method and tables described by Hobday et al. (2007) are designed for fisheries, and so need to be made more specific to a seabed mining or drilling operation, although the activity of bottom trawling covers many of the relevant impacts.

The results of this level 1 qualitative risk assessment should guide data collection during exploration activities, as a more quantitative assessment is likely to be required before progressing to a mining licence application stage. So a level 1 assessment identifies the main issues, and a level 2 assessment applies a more rigorous evaluation of risk to those factors/effects that are identified as high risk. In addition to a standard ecological set of conditions to be assessed, a chemical risk assessment process relative to water, sediment and tissue body-burden is an important component of the EIA.

As stated above, the method used for an ERA may vary, but any assessment should be transparent, and rank activities in such a way as to highlight those that have a high risk of causing an impact. These should be emphasised in the EIA. Even low risk activities are included, but do not need to be described in as much detail.

The details of the ERA should be provided in a separate report (as an appendix), but summary information presented in the EIA.

Impacts of the mining or drilling operations will be resource, site, and method dependent. There are many potential impacts, but some of the key effects on biological structure and function that this section should always consider include:

- **Potential surface impacts (0–200 m)**
  - increased vessel activities and potential pollution (from vessel discharges and wastes) of the surrounding area
  - reduction in primary production (e.g., through shading by discharges) (in shallow or clear deeper water this may affect macroalgae or microalgae on the seafloor)
  - stimulation of primary production by increased nutrient release (e.g., nitrogen, iron in discharges) in photic depths

- reduction in the availability of prey (through either changes in abundance, displacement, or visibility)effects (e.g. displacement) on surface/deep-diving mammals and birds, fish and mobile pelagic invertebrates(e.g., through changes in water composition and clarity or noise/lights)
- this includes vessel-based effects above the actual sea surface

- **Potential water column impacts (200–50 m above seafloor)**
  - plankton/mesopelagic fish mortality
  - toxic effects with metal and other contaminants (e.g., ammonia, sulphides, pH reduction) release
  - bioaccumulation of toxic metals though the midwater food chain
  - sediment plume effects through water column (e.g., visual clarity reduction for feeding)
  - potential oxygen depletion at depth
  - effects on deep-diving marine mammals
  - potential noise effects (direct avoidance, masking faunal communication, feeding disruption)
- **Potential benthic impacts (seafloor to 50 m above)**
  - direct physical impact of mining/sampling gear
  - smothering/burying of animals by sediment
  - clogging of suspension feeding structures
  - toxic effects with metal and other contaminants (e.g., ammonia, sulphides) release
  - loss of essential habitat (e.g., spawning/nursery, feeding grounds)
  - loss of other habitats and/or communities of particular biological importance

As in template section 5, this assessment of impacts can also be structured by “receptor” rather than by the depth range. With this approach, the description is based on the main biological groups:

- Primary producers
  - Phytoplankton

    Impacts and issues to be addressed

    Environmental management measures

    Residual impacts
  - Micro- and macro-algae

    Impacts and issues to be addressed

    Environmental management measures

    Residual impacts

- Zooplankton
    - Impacts and issues to be addressed
    - Environmental management measures
    - Residual impacts
- Mesopelagic fauna
    - Fish [Impacts, Management measures, Residual subheadings]
    - Squids [Impacts, Management measures, Residual subheadings]
    - Macrozooplankton [Impacts, Management measures, Residual subheadings]
- Fish [Impacts, Management measures, Residual subheadings]
    - assemblages
    - pelagic species
    - demersal species
- Marine mammals [Impacts, Management measures, Residual subheadings]
    - cetaceans
    - pinnipeds
- Seabirds [Impacts, Management measures, Residual subheadings]
- Other rare or endangered species [Impacts, Management measures, residual subheadings]
    - e.g., turtles
- Benthic invertebrates [Impacts, Management measures, Residual subheadings]
    - Microfauna, meiofauna, macrofauna, megafauna
    - Microbes and protists
    - Assemblages
- Sensitive habitats [Impacts, Management measures, Residual subheadings]

The Sensitive Habitats section is very important here. The EPA Permitted Activities Regulations (Schedule 6) define 13 sensitive habitat types (see Template Section 5), and provide indicative criteria and thresholds as to whether they are potentially sensitive:

The likelihood of encountering some of these habitats depends on the environment of the resource type being considered, yet even where it is highly unlikely to occur (e.g., seapen fields on a seamount with SMS potential) it is suggested that each habitat type is considered so that it is clear which habitats require detailed attention in the EIA.

The effects of noise/vibrations are poorly understood for many marine species. There are guidelines for assessing effects of sound on marine mammals (NMFS 2016), and for New Zealand the potential impact of noise on marine mammals from seismic reflection, and the required mitigating actions are addressed in the 2013 Code of conduct for minimising acoustic disturbance to marine mammals from seismic survey operations (New Zealand Department of Conservation), but data on thresholds of noise that cause physiological impacts (such as hearing damage, barotrauma, stress) on fishes are less developed (Popper & Hastings 2009, Hawkins et al. 2014). Natural sources of noise in the marine environment are important for sensing the environment, and for communication by animals. Behavioural responses include fish avoiding large approaching vessels; disruption of spawning sites in shallow coastal waters; and altered predator-prey detection responses (see review by Stanley & Jeffs 2016).

Masking of animal communication vocalisations may also be a serious and long lasting issue of mining operations rather than seismic operations which may only be used extensively during exploration phases. If the sound to be produced by the mining operation is known then effects on marine mammals and fish (such as blue whales and gurnard with documented vocalisations and sensitivities) can be modelled.

This section, with description of impacts, management measures, and residual impacts is clearly a critical one to enable the EPA and other management agencies to assess the nature and extent of impacts, what can be reduced by various operating measures, and what impacts remain that then need to be considered. When there are impacts that cannot be avoided, it is important to describe both the spatial and temporal extent of these.

Temporal considerations:

This should include an assessment of the relative impacts on different components of the ecosystem, as some will be affected more than others (e.g., sessile species versus mobile ones that have an ability to move), and whether this could lead to a change in the structure of the system, or any regime shift over time if mortality rates on key taxa are very high. The timing of impacts relative to important biological events (e.g., spawning, migration) needs to be assessed. There should also be consideration of the likely recovery potential of various faunal components of the ecosystem, and hence the duration of any disturbance effects.

Spatial considerations:

Ecological: A key component of any management plan will be how any damage to ecosystem structure or function can be conserved elsewhere. If residual effects are severe, then the broader impact of these on representative, abundant, or rare communities will need to be evaluated. The practicality and effectiveness of spatial management options will likely be a major aspect of how residual impacts can be managed. There are numerous types of spatial management areas that could be mentioned in this section, but they should be developed further in Template section 12, with much more detail in the subsequent Environmental Management Plan. Some options include:

- closed areas within the mining or drilling region to protect particularly rare or vulnerable communities
- preservation reference (or “control”) sites to enable monitoring of changes of representative faunal communities in mined versus non-mined areas of the region, and

- protected areas outside the affected region that replicate faunal communities within the mined area, and allow for conservation of the ecosystem structure of the broader area, and perhaps recolonisation of the impacted sites.

There is an extensive literature on the design of spatial management zones and Marine Protected Areas. Papers that give a good introduction to the concepts that need to be considered are Botsford et al. (2003), Crowder & Norse (2008), Ehler & Douvere (2009), and Wedding et al. (2013).

Operational. The process of seabed mining or drilling will of necessity require some consideration of mixing and dispersion associated with the return of seabed-derived contaminants in the water column at some height above the ocean floor. This continuous mining process will discharge wastes and generate a plume of sediment-laden material with associated chemical contaminants. The characteristics of this plume and its dispersion requires a consideration of the extent of mixing in the water column, where contaminant concentrations may be elevated.

The use of mathematical models is generally required to provide predictions of the mixing of discharges from the end of a pipe. A commonly used model is CORMIX developed by the US EPA for discharge simulations (Jirka et al. 1996), although more sophisticated models are available which provide predictions of concentrations in the near-field and far-field areas of the plume. The key information required from such models include the size of the plume and concentrations of contaminants with distance away from the discharge point.

Tiered assessment approaches covering a range of different methods at different scales are often employed for chemical contaminant assessment. These include elutriation testing and longer-term assessments relating to potential whole sediment toxicity. Guidance on these assessments are provided in various dredge disposal guidance documents from various jurisdictions (e.g., NZGSDW 1999, US EPA 1991) and see section 3.2 of Ellis et al. (2014).

EIA risk assessments for potential discharges from oil drilling operations (e.g., Husky Oil 2001) may differ from seabed mining. For these operations potential hazards include (i) chemicals discharged from surface operations; (ii) discharge of drilling muds; (iii) oil residues during exploration and production activities; and (iv) chemicals used to treat oil spillages (e.g., dispersants). While the likelihood of oil spillages may be considered low, the consequences of oil spillages may be very high because of threats to surface-dwelling species (e.g., birds, mammals) and wind-driven transport processes.

In line with other assessment of impact sections of the EIA, this section should start with Key messages and end with a Summary of key findings.

4.12 Template Section 10: Assessment of impacts on the onshore environment and proposed mitigation

In this section, provide a detailed description and evaluation of potential impacts of the mining or drilling operation to the onshore environment components identified in section 6. This may need to consider effects that may happen during construction/development (pre-commissioning), operational, and decommissioning phases, as well as the potential for accidents. The preferred approach in this template is that for each component there is a description of:

(i) the nature and extent of any actual or potential impact, including cumulative impacts;

(ii) measures that will be taken to avoid, remedy or mitigate such impacts; and

(iii) what unavoidable (residual) impacts will remain.

It is also important for these sections to make clear the expected time to recover following disturbance, the longevity of residual effects, and if possible an indication of potential state shifts, so that the duration of residual effects is clear.

10.1 Key messages

- *Overview of key content covered in this section.*

10.2 Identification of threats

- *Summarise the results of a previous Ecological Risk Assessment. This is expected to be a separate report, with only the summary provided here to highlight the major issues of concern.*
- *This ERA identifies the key parts of the project which have potential to impact the existing environment.*
- *The detail is in the associated ERA, and so this frees the EIA to focus on the main impacts, not have a lot of detailed description of minor effects.*

10.3 Physico-chemical environment

10.3.1 Potential impacts and issues to be addressed

10.3.2 Environmental management measures

10.3.3 Residual impacts

10.4 Biological environment

10.4.1 Potential impacts and issues to be addressed

10.4.2 Environmental management measures

10.4.3 Residual impacts

10.5 Summary of residual effects

- *A table may be a useful summary format*
- *Potential cumulative effects should also be included.*

The aim of this section of the EIA is to provide a detailed description and evaluation of potential impacts of the operation to the onshore environment components identified in Template Section 6 (see 4.8 above). This will vary with national legislative requirements, and whether the activity is contained entirely within the EEZ or includes activities that span national or jurisdictional boundaries (e.g., High Seas/National waters, EEZ/Territorial Seas, EEZ Act/RMA). The overall length of this section will depend on the extent of cross-boundary and onshore activity.

We recommend that an ERA (see 4.12 above) is carried out to identify the key threats, which are summarised in this section of the EIA. The potential impacts of these threats on the existing onshore environment is then assessed, management measures explored, and any residual effects identified. As in Template Section 6 of the EIA (see 4.8 above), it may be useful to organise these sections according to the relevant restrictions under the RMA sections 9-16 (outlined in 4.4 above); e.g. discharges to land, water or air and potential impacts on physical and biological aspects of the environment. It is also important for these sections to make clear the expected time for the respective systems to recover following disturbance, the longevity of residual effects, and if possible an indication of potential state shifts, so that the duration of residual effects is clear.

In line with other assessment of impact sections of the EIA, this section should start with Key messages and end with a Summary of key findings.

4.13 Template Section 11: Assessment of impacts on the socio-economic environment and proposed mitigation

As per preceding sections, provide a detailed description and evaluation of potential impacts of the mining or drilling operation to the socio-economic components identified in section 7. This may need to consider effects that may happen during construction/development (pre-commissioning), operational, and decommissioning phases, as well as potential for accidental events. The preferred approach in this template is that for each component there is a description of:

(i) the nature and extent of any actual or potential impact, including cumulative impacts;

(ii) measures that will be taken to avoid, remedy or mitigate such impact; and

(iii) what unavoidable (residual) impacts will remain.

It is also important for these sections to make clear the expected time to recover following disturbance, the longevity of residual effects, and if possible an indication of potential state shifts, so that the duration of residual effects is clear.

11.1 Key messages

- *Overview of key content covered in this section.*

11.2 Existing Uses

11.2.1 Fisheries

11.2.1.1 Potential impacts and issues to be addressed

11.2.1.2 Environmental management measures

11.2.1.3 Residual impacts

11.2.2 Marine Traffic

11.2.2.1 Potential impacts and issues to be addressed

11.2.2.2 Environmental management measures

11.2.2.3 Residual impacts

11.2.3 Tourism

11.2.3.1 Potential impacts and issues to be addressed

11.2.3.2 Environmental management measures

11.2.3.3 Residual impacts

11.2.4 Marine Scientific Research

11.2.4.1 Potential impacts and issues to be addressed

11.2.4.2 Environmental management measures

11.2.4.3 Residual impacts

11.2.5 Conservation Areas

11.2.5.1 Potential impacts and issues to be addressed

11.2.5.2 Environmental management measures

11.2.5.3 Residual impacts

11.2.6 Other

11.2.6.1 Potential impacts and issues to be addressed

11.2.6.2 Environmental management measures

11.2.6.3 Residual impacts

11.3 Cultural environment

11.3.1 Potential impacts and issues to be addressed

11.3.2 Environmental management measures

11.3.3 Residual impacts

11.4 Historic heritage

11.4.1 Potential impacts and issues to be addressed

11.4.2 Environmental management measures

11.4.3 Residual impacts

11.5 Socio-economic and socio-cultural aspects

11.5.1 Potential impacts and issues to be addressed

11.5.2 Environmental management measures

11.5.3 Residual impacts

11.6 Summary of residual effects

- *A table may be a useful summary format.*
- *Potential cumulative effects should also be included.*

The aim of this section of the EIA is to provide a detailed description and evaluation of potential impacts of the operation on the socio-economic environment, especially those components identified in Template Section 7 (see section 4.9 above). It relates primarily to other uses and the offshore marine environment rather than the onshore situation.

Socio-economic impact assessment can include consideration of the desirability of outcomes (from beneficial to adverse), the scale of effects (e.g. creation of jobs, estimates of risk of environmental impacts), extent of duration of impacts in time and space, intensity or severity of social impacts and an assessment of whether impacts are likely to be cumulative. It is important to consider the social equity or distribution of impacts across different populations, i.e. which groups are likely to be affected in which ways. In the case of proposed projects that involve controversy, attitudes and perceptions towards the proposed project are one of the variables that must be considered in determining the significance of impacts.

There are a number of steps that can help with constructing the likely nature and extent of potential impacts on existing interests. The steps identified below are recommended by NOAA (1994) and are still current as best practice for social impact assessments. Firstly, scoping and identification of the probable social impacts for each of the existing interests can be based on the consultation process or interviews. Consideration needs to be devoted to the impacts perceived by affected groups and communities. Principal methods can include public meetings, interviews, workshops, surveys, and reviews of the existing social science literature.

Secondly the likely and possible effects must be estimated. The probable social impacts can be formulated in terms of predicted conditions without the proposed activity (baseline projection, from template section 7); predicted conditions with the proposed activity; and predicted impacts, which can be interpreted as the differences between the future with and without the proposed activity.

After direct impacts have been estimated, the assessment should consider how affected people will respond in terms of attitude and actions. The assessment should also consider cumulative impacts which are those impacts which result from the incremental impacts of an action added to other past, present, and reasonably foreseeable future actions.

Economic benefit should be described in terms of profit (net of costs) and new jobs created, including the location of those jobs and the persons to whom the profits will accrue. Indirect economic effects, i.e. additional jobs, revenue or economic activity in related or secondary sectors, should only be included if there is significant under-employment or under-capacity in relevant sectors of the economy, and these should be identified separately from direct employment and revenue from the proposed activity.

A social impact assessment not only forecasts impacts, it should identify means to mitigate adverse impacts. Mitigation includes avoiding the impact by not taking or modifying an action; minimising, rectifying, or reducing the impacts through the design or operation of the project; or compensating for the impact by providing substitute facilities or resources.

Cultural impact assessment

A Cultural Impact Assessment (CIA) is a report documenting Māori cultural values (including both iwi Māori and imi Moriori), interests and associations with an area or a resource, and the potential impacts of a proposed activity on these. CIAs are a tool to facilitate meaningful and effective participation of Māori in impact assessment. Some iwi/hapū use the terms 'Tangata Whenua Impact Assessment', or 'Tangata Whenua Effects Assessment', to describe the impact assessment process and report.

The content and structure of a CIA may differ between iwi/hapū groups and with the nature and scale of the proposed activity. However, a CIA generally includes:

- Information on the relevant cultural values associated with the site or area (noting that iwi/hapū may choose not to fully disclose information about some sites);
- The effects on those values, and the relationship of tangata whenua to them, as a result of the proposed activity; and
- Recommendations to avoid, remedy or mitigate adverse effects, including but not limited to recommended conditions of consent should the application be granted.

A CIA report will also include the methodology or description of the consultative processes used in preparing the report (site visit, hui, tangata whenua presentations, reviews of draft and sign off), as well as a brief overview of the relevant planning framework and iwi/hapū expectations for the process following the CIA.

The Quality Planning website provides further information on preparing CIA's (see www.qualityplanning.org.nz for further information), and the EPA website hosts a report by Repo Consultancy (2010), as well as general advice (see http://www.epa.govt.nz/EEZ/working_eez/Pages/engaging_with_maori.aspx). Additional resources include Te Puni Kōkiri which has developed a national web-based database that provides information on the iwi authorities within each region and district and the areas over which one or more iwi exercise kaitiakitanga.

In line with other assessment of impact sections of the EIA, this section should start with key messages and end with a summary of key findings.

4.14 Template Section 12: Environmental management, monitoring and reporting

Sufficient information should be provided to enable regulatory agencies to anticipate possible environmental management, monitoring and reporting requirements for an environmental permit. Information listed should reflect the proponent's environmental policy (Environment Management System (EMS)) during different stages in the project life, i.e. from construction to decommissioning and closure. Information detailed in this section should include, but not be limited to, the headings below:

12.1 Organizational structure and responsibilities

This section should show how the Contractor's environmental management team fits into its overall organizational structure. Responsibilities of key personnel should be outlined.

12.2 Environmental Management System (EMS)

Although a full EMS may not exist at the time the EIA is submitted, this section should outline the standards that will be considered and/or aligned with developing the EMS for the project.

12.3 Environmental Management Plan (EMP)

This differs in detail between what is needed at the time of the EIA for a New Zealand assessment, and the EMP subsequently needed under the ISA and SPC processes. Irrespective of position in the sequence, an EMP will be submitted as a separate document for approval prior to exploitation operations commencing. This section should provide an overview of what an EMP would entail. This section shall include, as a minimum, the following headings:

12.3.1 Mitigation and Management

This section should summarize the actions and commitments that have arisen from the impact minimisation and mitigation strategies. There may be different rehabilitation strategies and activities for operations during mining, and those for closure.

12.3.2 Monitoring plan

This section should summarize the monitoring plan approach and specific detail of the monitoring programme.

12.3.3 Closure plan

It is expected that a closure plan will be submitted as a separate document for the Regulatory Authority's approval. However, this section should provide an overview of what the closure plan will entail, including decommissioning, continued monitoring and rehabilitation measures, if applicable.

12.4 Reporting

12.4.1Monitoring

This section should outline how results of monitoring studies will be reported to the Regulatory Authority.

12.4.2 Incident Reporting

This section should outline how incidents will be reported.

Details about environmental management issues and procedures are often developed in international assessment processes beyond the EIA, at the stage of an Environmental Impact Statement (EIS), and an Environmental Management Plan (EMP). There is often considerable confusion about what goes where in various Assessment/Statement/Report formats. In this EIA template we have largely limited scope to the assessment of environmental impacts, although recent EPA decisions under the EEZ Act highlight the importance of including EMP and/or adaptive management plans in conjunction with the EIA to aid decision-makers. Hence this section of the template is an opportunity to highlight the main aspects of monitoring and reporting procedures that will be central to environmental management planning.

An EMP defines and describes the measures to prevent and/or minimise impacts identified in the EIA. It lays out procedures showing how the mining company manages the implementation of mitigation measures, how it will monitor their effectiveness, how it will act in response to the monitoring, and what reporting systems will be followed. There is a large body of literature available describing EMP structure and content, and most are generically similar despite application to different industries and resource types. General guideline documents that are useful include Auckland Council (2014) and Australian Department of the Environment (2014). Swaddling (2016) also gives a good overview of the EMP process, and suggests a number of sub-plans that include for each aspect covered measurable objectives, targets, frequency and timeframe, responsible personnel, measures of success, procedures for dealing with non-conformance, and corrective action. These sub-plans include:

- Environmental monitoring
- Training and awareness
- Water use management
- Materials handling and storage
- Leak and spillage management
- Waste management
- Dust management
- Noise management
- Decommissioning and closure
- Stakeholder engagement (internal and external communication)
- Socio-economic impacts management
- Emergency preparedness and response
- Occupational health and safety

Environmental monitoring is the main aspect of EMPs that concern us here, as monitoring programmes are critical to confirm that the effects of the proposed project are as predicted in

template sections 8, 9, 10, and 11. In the following we focus our discussion on monitoring for physical, chemical and biological effects.

The design of a monitoring programme will be based on results of an environmental baseline survey/s. Baseline studies must occur prior to submission of an EIA and before any operation can start. Data need to represent the undisturbed environment as much as possible, and hence need to be included in plans for the exploration phase from the outset. These data form the benchmark against which conditions during development and commencement of the project can be measured.

The nature and level of monitoring should be proportional to the expected or potential impact identified in the main body of the EIA, especially where the residual effects are large, or there is considerable uncertainty. Aspects to consider when evaluating monitoring priorities include whether an impact is persistent, toxic or noxious, can bio-accumulate, is radioactive, is widely spread (transboundary significance), could cause undesirable changes in ecosystems, is irreversible, or can interfere with other marine uses (e.g., fishing, food production) (OSPAR Convention 1992). The main components of the impact monitoring process are given in Figure 4-3.



Figure 4-3: Components of the environmental monitoring process (from Swaddling 2016).

There are two "categories" of monitoring

- Operational monitoring: including mining or drilling location and rate, volumes discharged, hazardous discharge events and quantity of mined material removed.
- Effects monitoring: including physical (e.g., clarity, sediment deposition), chemical (e.g., analytical suite of contaminants, zone of initial mixing for guideline comparisons, relevant water and sediment quality guidelines, bioaccumulation assessment) and biological monitoring (e.g., sentinel species, survey approaches).

The main aspects to be included, and parameters to be measured, for both baseline and monitoring survey programmes are described in the guidelines on scientific research developed by the SPC-EU DSM project and NIWA (Swaddling et al. 2016). This report covers survey design, sampling equipment, and "best scientific practices" for deep-sea sampling relevant to marine minerals. A summary table from that report on recommended scientific studies, their rationale, and methods, is reproduced as Appendix E, which provides a starting point for determining the studies that need to be conducted for monitoring changes over time and space.

Table 13.1 in the Nautilus EIS (Coffey Natural Systems/Nautilus Minerals, 2008) is a helpful reference, even though specific to Seafloor Massive Sulphide (SMS) resources. It covers several ecological aspects that should be considered, and summarises the proposed (or existing) baseline studies, as well as methods for validation and monitoring to ensure mitigation is appropriate. These aspects include:

- Geological processes (e.g., venting dynamics with SMS)
- Topography changes
- Plume formation over time from re-suspended sediment
- Sediment deposition effects
- Genetic structure of the population/s
- Faunal abundance changes
- Larval recruitment and settlement patterns
- Effects of lights, noise, vibration, etc.
- Animal recolonisation
- Recovery of trophic structure
- Concentration of contaminants in discharges.

Baseline studies

Baseline data collection, and short-term monitoring studies, are important aspects of prospecting and exploration activities, as they underpin the preparation of an EIA, prior to any application for a full mining permit. It is expected that some information will be available from an area before any exploration occurs, and desk-top studies will form the basis of initial scoping of the activity/project. However, available data will invariably be inadequate to describe and characterise the receiving environment of any likely mining site. Hence baseline surveys and targeted scientific studies will be needed to provide the pre-mining state of the environment, as well as some monitoring of conditions over time to understand temporal variability of some key environmental factors. Such studies will need to cover a wide range of research aspects (Figure 4-4).

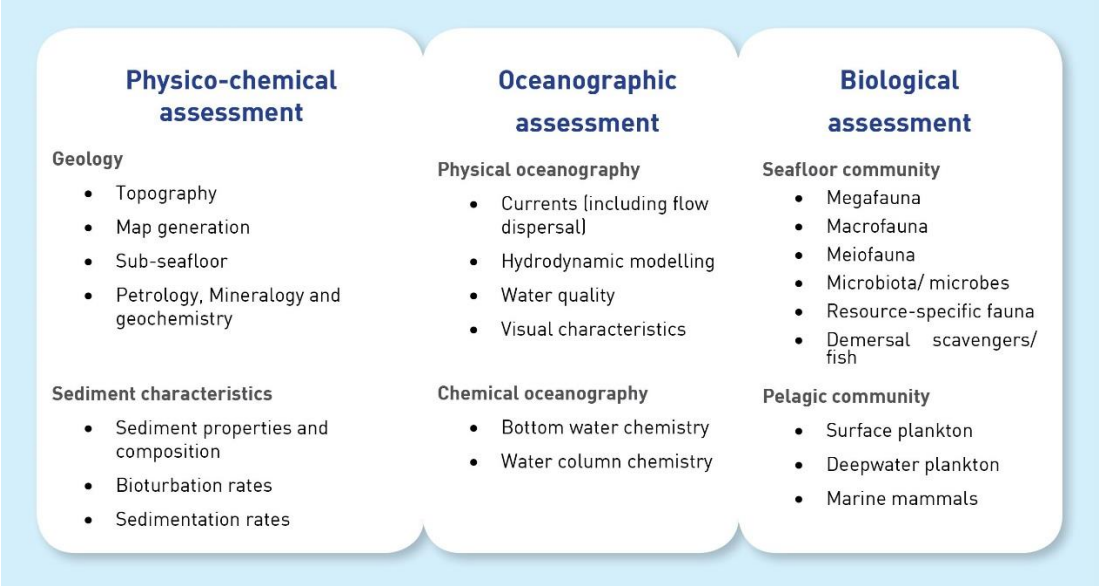


Figure 4-4: The types of scientific studies required for initial baseline (and subsequent monitoring) surveys. (from Swaddling et al. 2016)

Details are not repeated here, and we refer applicants to the detailed SPC-EU-NIWA report (Swaddling et al. 2016). In addition to that resource, the ISA has published two reports that describe and give some advice on the sorts of studies, type of data, and nature of sampling (physico-chemical and biological) required for both baseline measurements and ongoing monitoring. These cover manganese nodule (ISA 1999), seafloor massive sulphide, and cobalt-rich crust resources (ISA 2007). However, the type of information provided can apply much more generically to other mineral resources. Wherever appropriate, the recommendations from the ISA reports have been incorporated into Swaddling et al (2016).

Monitoring

Validation and monitoring studies should start as soon as possible after operations commence. They may be specified in consent conditions, although the level of detail may be left to the separate EMP. Monitoring studies are expected to be a combination of short-term validation studies that can confirm predicted project impacts (e.g., plume modelling versus empirical observations of sedimentation) and longer-term monitoring studies that provide regular updates on environmental conditions.

Monitoring is an integral part of any marine consent, and hence there should be a well thought out and justified explanation of what, how, and why monitoring is occurring. It is easy to put down a long list of environmental parameters that can be measured, but there are several key points to consider beyond this:

- describe why these particular variables are being assessed (i.e., what the information will tell the company and managers).
- explain how the parameters are measured. The metrics used for the particular variables must be reliable, and an indication of measurement accuracy and precision given.

- ensure that any measurements taken are done so in a standardised way, that equipment is adequate, and as comparable with other gear used for similar studies in the region (enabling some integration to benefit regional knowledge).

The purpose and content of a proposed Monitoring Plan should provide clear and specific statements of objectives and criteria for actions. It should not merely include monitoring for trends which are not linked to triggering thresholds for management responses. There must be an assessment of what level of change constitutes an adverse effect, when the expected limits of change as outlined in the EIA are exceeded. This must accompany some decision rules about what will then happen. It is inadequate to just monitor, and then think about what the changes mean afterwards. This should be discussed with the regulatory authority, as acceptable levels of environmental change as a consequence of the activity (environmental performance standards) will influence the type and level of monitoring, and the plan may be modified based on consent conditions assessed and imposed by managers.

Monitoring studies, including their rationale, and methodologies, are covered by Swaddling et al (2016). A major section of the report describes aspects of fundamental survey design, emphasising the need to have clear objectives, which then dictate aspects such as sampling scale, spatial design, sampling unit size, sample number, and sampling gear. Annex 4 then goes on to provide current best practice methodology for conducting this research.

The EEZ Act requires the EPA to consider an adaptive management approach to address lack of information, and hence a monitoring programme should ensure that an adaptive management concept is supported by appropriate data. Adaptive management can be a complicated area of science and management (see section 3.10), and it is important that in developing such an approach, and an associated monitoring programme, that there is consultation with the EPA to ascertain their detailed requirements about an acceptable level of environmental risk.

4.15 Template Section 13: Consultation

This describes the nature and extent of consultation with parties identified to have existing interests in the proposed project area, as well as relevant Iwi Māori and other stakeholders

This can be considered earlier in the document in some situations where knowledge of the extent of consultation is critical to progressing further. It may aid gaining confidence in the information to be provided in the body of the EIA.

13.1 Consultation methods

- *Describe how you have consulted with different groups.*

13.2 Existing interests

- *Identify any parties with potential existing interests in the area that may be impacted by the proposed activity.*

13.3 Tangata whenua

- *Any iwi, hapū, customary marine title group, and protected customary rights group that have been notified and consulted.*

- *This should include both iwi Māori and imi Moriori*

13.4 Other stakeholders

- *Include other stakeholders that have been consulted.*

13.5 Public consultation

- *Describe the goals and approach to methods and workshops that have occurred with the general public.*

13.6 Ongoing consultation plans

- *What further consultation with stakeholders is planned, or needed?*

Consultation involves talking with people who may be interested in, or affected by, a proposed activity. It is an opportunity to inform people about the proposed project and an invitation for those affected to contribute to the project design/issue identification and resolution process. Consultation needs to be done early in the process and as often as required. While consultation about resource consents is not mandatory under the RMA, it is good practice and can reduce costs and delays later in the process. Under the EEZ Act, applicants for a marine consent must describe any consultation undertaken with existing interests potentially affected by their proposed activity. Early and full consultation can identify and resolve issues and reduce affected parties' concerns and opposition to proposed projects.

Under RMA consultation requirements, applicants should:

- provide enough time and information to the consulted party so they can make intelligent and informed decisions
- provide enough time for the consulted party to participate and for their advice to be considered
- genuinely consider that advice, including keeping an open mind and having a willingness to change. The detail of a proposed project should not be pre-determined.

Consultation involves talking with parties including relevant iwi, hapū, customary marine title groups and other stakeholders. Section 4.9 of this guidance (EIA template section 7) provides guidance on identifying existing interests.

As well as describing the consultation methods, a summary of key findings and whether further consultation with stakeholders is required should be included in this section.

4.16 Template Section 14: Glossary

This section is self-explanatory. It includes:

- *Relevant terms are explained (e.g. terms under different legislation, technical terms).*
- *List of acronyms.*

If your EIA has introduced particular terms relevant to legislation or technical disciplines, a glossary should be included. This recognises the fact that different terms may mean different things to potential readers of the EIA (decision makers, technical consultants undertaking reviews, members of the public) and so a clear definition will be essential. It is also important to ensure, when your EIA is being edited before submission, that you have been consistent with your use of these terms. If a glossary is included, it may be useful to state that in the Introduction section where the EIA format is outlined (see 4.3).

4.17 Template Section 15: Study team

This comprises a list and description of the main people involved in the EIA, their areas of skill and technical expertise, and institute/consultancy/company affiliations.

Include a list and summary biography (1-2 paragraphs) for key people involved in the preparation of the EIA, including their qualifications, professional area of expertise and years of experience. This can allow the decision maker to have confidence in the EIA work. This may be especially important in EIAs for large, complex proposals, or proposals in sensitive areas. Full CVs could be made available on request.

4.18 Section 16: References

References are provided for:

- *Citations from the EIA.*
- *Technical reports, previous studies.*

Any evidence provided in the EIA from other sources should be clearly referenced, and this list at the end of the EIA document should state the full details of any documents cited in the text. This should include clear links (e.g. website urls with date of access) to where the cited references can be obtained, so that the decision makers can access this information readily.

4.19 Template Section 17: Appendices

Include technical reports carried out for parts of EIA (e.g., the ERA, other important studies such as sediment plume modelling, ecotoxicity research).

In preparing the EIA, thought should be given early on to the level of technical detail included in the main body of the EIA and what can be appended. We suggest that technical reports referred to throughout the EIA are appended, and summarised in the main body of the EIA. This approach will make the main EIA easier for decision makers to navigate and understand, but ensures appropriate technical detail is available where required. The appendices may therefore form many hundreds of pages for complex proposals.

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6 Glossary of abbreviations and terms

Adaptive management	An experimental approach to management, or structured “learning by doing”, based on developing dynamic models that attempt to make predictions or hypotheses about the impacts of alternative management policies. Management learning proceeds by systematic testing of models rather than by random trial and error.
AEE	Assessment of Environmental Effects
Benthic	Associated with the seafloor
Biotope	Both the abiotic and biotic elements of habitats. Usually applies to physical habitats and their associated faunal communities
Coastal Marine Area	As defined under the Resource Management Act 1991, the area between mean high water springs (HWMS) and 12 nm, managed by regional or unitary authorities.
Contaminant	Includes any substance (including gases, [odorous compounds,] liquids, solids, and micro-organisms) or energy (excluding noise) or heat, that either by itself or in combination with the same, similar, or other substances, energy, or heat— (a)When discharged into water, changes or is likely to change the physical, chemical, or biological condition of water; or (b)When discharged onto or into land or into air, changes or is likely to change the physical, chemical, or biological condition of the land or air onto or into which it is discharged (Resource Management Act)

Demersal	An animal that lives on or near the seafloor
DOC	NZ Department of Conservation
ECS	Extended Continental Shelf: this applies to the seabed and subsoil of submarine areas extending out to the continental margin-in many cases it extends further than the EEZ.
EEZ	Exclusive Economic Zone: this extends from the territorial sea (12 nautical miles) to 200 nautical miles off the coast and offshore islands of New Zealand.
EEZ Act	The Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012
Effect	Under the EEZ Act, effect includes— (a) any positive or adverse effect; and (b) any temporary or permanent effect; and (c) any past, present, or future effect; and (d) any cumulative effect that arises over time or in combination with other effects; and (e) any potential effect of high probability; and (f) any potential effect of low probability that has a high potential impact. (2) Subsection (1)(a) to (d) apply regardless of the scale, intensity, duration, or frequency of the effect.
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
Elutriate	Process of elutriating fine particles and pore water from sediments
EMP	Environmental Management Plan
EMMS	Environmental Mining and Management System
EPA	New Zealand Environmental Protection Authority
Epifauna	(also called epibenthos) aquatic animals that live on the bottom substratum as opposed to within it, that is, the benthic fauna that live on top of the sediment surface at the seafloor
ERA	Environmental or Ecological Risk Assessment
Hapu	The most significant political unit in pre-European Māori society (clans or descent groups). Hapū ranged in size from one hundred to several hundred people, and consist of a number of whānau (extended families). Hapū controlled a defined portion of tribal territory, which may provide access to sea fisheries, shellfish beds, cultivations, forest resources, lakes, rivers and streams.
IA	Impact Assessment
IAIA	International Association for Impact Assessment
imi	The largest socio-political grouping in pre-European Moriori society

Impact	Equates to effect as defined in the EEZ Act (s6) as: 1(a) any positive or adverse effect; and (b) any temporary or permanent effect; and (c) any past, present, or future effect; and (d) any cumulative effect that arises over time or in combination with other effects; and (e) any potential effect of high probability; and (f) any potential effect of low probability that has a high potential impact. (2) Subsection (1)(a) to (d) apply regardless of the scale, intensity, duration, or frequency of the effect.
Infauna	Benthic organisms that live within the bottom substratum of a body of water, especially within the bottom-most oceanic sediments, rather than on its surface. Bacteria and microalgae may also live in the interstices of bottom sediments.
ISA	International Seabed Authority
Iwi	The largest socio-political grouping in pre-European Māori society (Tribe).
Hindcast	Is a way of testing a mathematical model. Known or closely estimated inputs for past events are entered into the model to see how well the output matches the known results. Hindcasting is also known as backtesting.
MBIE	New Zealand Ministry of Business Employment and Innovation
Macrofauna	Benthic or soil organisms which are retained on a 0.5mm sieve
Megafauna	Large animals of any particular region or time, generally >2 cm.
Meiofauna	Small benthic invertebrates that live in both marine and fresh water environments, loosely defined by their size, larger than microfauna but smaller than macrofauna, rather than a taxonomic grouping.
Mesofauna	Macroscopic soil invertebrate
Microfauna	Microscopic or very small animals
MfE	New Zealand Ministry for the Environment
nm	Nautical Miles = 1.852 km
Pelagic	Any body of water that is neither close to the bottom nor near the shore
Precautionary Approach	This is a management rule whereby if a threat of serious or irreversible damage to the environment exists, uncertainty or a lack of information should not delay management action, and that action should be 'precautionary' with the burden of proof on those proposing the activity
RMA	Resource Management Act 1991
SICA	Scale Intensity Consequence Analysis. A level 1 risk assessment method.
SEA	Strategic Environmental Assessment
SMS	Seafloor Massive Sulfide (also written as sulphide)

Territorial Sea	Limited within the 12 nm inshore
Toxicant	A chemical capable of producing an adverse response (effect) in a biological system, seriously injuring structure or function or producing death.

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Appendix A Other marine management regimes

EEZ Act section 7: Meaning of marine management regime

(1) In this Act, unless the context otherwise requires, marine management regime includes the regulations, rules, and policies made and the functions, duties, and powers conferred under an Act that applies to any one or more of the following:

(a) territorial sea:

(b) exclusive economic zone:

(c) continental shelf.

(2) The marine management regimes referred to in this section include those established under the following Acts:

(a) Biosecurity Act 1993:

(b) Continental Shelf Act 1964:

(c) Crown Minerals Act 1991:

(d) Defence Act 1990:

(e) Fiordland (Te Moana o Atawhenua) Marine Management Act 2005:

(f) Fisheries Act 1996:

(g) Hauraki Gulf Marine Park Act 2000:

(h) Marine and Coastal Area (Takutai Moana) Act 2011:

(i) Marine Mammals Protection Act 1978:

(j) Marine Reserves Act 1971:

(k) Maritime Transport Act 1994:

(l) Resource Management Act 1991:

(m) Submarine Cables and Pipelines Protection Act 1996:

(n) Wildlife Act 1953.

Appendix B EEZ Act section 39 Impact Assessment

(1) An impact assessment must—

(a) describe the activity for which consent is sought; and

(b) describe the current state of the area where it is proposed that the activity will be undertaken and the environment surrounding the area; and

(c) identify the effects of the activity on the environment and existing interests (including cumulative effects and effects that may occur in New Zealand or in the sea above or beyond the continental shelf beyond the outer limits of the exclusive economic zone; and

(d) identify persons whose existing interests are likely to be adversely affected by the activity; and

(e) describe any consultation undertaken with persons described in paragraph (d) and specify those who have given written approval to the activity; and

(f) include copies of any written approvals to the activity; and

(g) specify any possible alternative locations for, or methods for undertaking, the activity that may avoid, remedy, or mitigate any adverse effects; and

(h) specify the measures that the applicant intends to take to avoid, remedy, or mitigate the adverse effects identified.

(2) An impact assessment must contain the information required by subsection (1) in—

(a) such detail as corresponds to the scale and significance of the effects that the activity may have on the environment and existing interests; and

(b) sufficient detail to enable the Environmental Protection Authority and persons whose existing interests are or may be affected to understand the nature of the activity and its effects on the environment and existing interests.

(3) The impact assessment complies with subsection (1)(c) and (d) if the Environmental Protection Authority is satisfied that the applicant has made a reasonable effort to identify the matters described in those paragraphs.

(4) The measures that must be specified under subsection (1)(h) include any measures required by another marine management regime and any measures required by or under the Health and Safety in Employment Act 1992 that may have the effect of avoiding, remedying, or mitigating the adverse effects of the activity on the environment or existing interests.

Appendix C Environmental Impact Assessment template

Table of Contents

Executive Summary

A summary of the content of the EIA, including:

- description of the proposed activity/project and its objectives
- the main processing methods of the proposed operation
- key potential impacts (physico-chemical, biological, socio-economic including existing interests)
- measures to avoid, remedy, or mitigate environmental impacts
- end-use plans, including decommissioning
- consultation with stakeholders and interested parties.

Non-technical Summary

A short and "plain language" summary for the public.

1. Introduction

1.1 Background

- Introductory background to the application.

1.2 The proposed activity/project

- A description of the overall proposed mining or drilling activity
- Describe the area of the proposed activity
- Include an outline of previous consultation.

1.3 This report

- Scope of the Environmental Impact Assessment (EIA) – what is included, what is not based on earlier assessments or work. Link to other supporting documentation.
- The format (i.e., structure) of the EIA document – especially for larger projects where there is a lot of detail (in line with EEZ Act requirements for EIAs to be appropriate to scale and significance of the project).

2. Policy, legal and administrative context

This section provides information on relevant legislation, agreements or policies that are applicable to the proposed mining or drilling operation.

2.1 Applicable mining and environmental legislation, agreements and policies

- Outline links to New Zealand's EEZ legislative context, including requirements for consultation

2.2 Other applicable legislation, agreements and policies

- Description of other legislation etc that does not necessarily apply specifically to seabed mining
- Consider other marine management regimes such as those as defined in s7 of the EEZ Act

2.3 Relevant international and regional agreements

- Include relevant international agreements (e.g., UNCLOS, CBD, IMO, SOLAS, MARPOL)

2.4 Other standards, principles and guidelines

- Reference any national, regional and international standards, management principles and guidelines not covered above, such as non-binding recommendations from the ISA.

Make clear the extent of overlap into the Coastal Marine Area under the Resource Management Act 1991.

3. Activity/Project description

3.1 Purpose and need of the proposed activity/project

- Type of mineral or hydrocarbon resources
- Why the operation is proposed
- Background to the project, including aspects of the discovery of resources, development of techniques etc.

3.2 Proposed project location

- Co-ordinates of proposed project area
- Map and boundaries of footprint (total area, and certain phases, see 3.3.2)
- Include any closed/exclusion areas.

3.3 Description of the proposed development

3.3.1 Project duration and phasing

- Overall life of project
- Duration of different operational phases (timeline) from mobilisation to decommissioning
- Development timetable should be detailed, and perhaps outline here but include an appendix covering:
  - Pre-construction tasks
  - Construction schedule, staging of activities
  - Commissioning and operational schedules
  - Infrastructure development
  - Closure schedule.

3.3.2 Proposed project scale

- Spatial scale of the proposed operation, including how it is proposed to evolve through time.
- Include indicative rates of extraction, total extraction, depths of extraction (both below sea level and depth of seabed) overburden estimates, discharge rates etc.

3.3.3 Mining or drilling methodologies

- Proposed methods of extraction (dredging, coring, etc.).
- Describe technical specifications of equipment, including construction and operating standards for design of gear.
- Include details of the operation throughout the water column, from seabed to surface.

3.3.4 Support equipment

- Describes any equipment needed for support (e.g., tender, supply vessels, barges), includes handling of hazardous materials.
- Describe frequency of vessel movements for support, supply, barge removal etc.

3.3.5 Proposed processing operation

- Includes:
  - Commissioning
  - On-site operations (including how onsite operations will be powered)
  - Off-site operations
  - Transport of material off-site
  - Disposal of waste (including hazardous waste)
  - Decommissioning
- A schematic diagram should be included of the key components of the operation.

3.3.6 Other alternatives considered

- What other locations, methods etc. were considered, and rejected in favour of what is proposed.

4. Description of the existing physico-chemical environment

4.1 Key messages

- Overview of key content covered in this section (this is a box with up to 6 bullet points of the main aspects covered, or the main findings).

4.2 Regional Overview

- General regional context (includes map, covers wider area around proposed activity area)
- Include site-specific issues and characteristics, particularly sensitive environments

- Reference to relevant technical data/previous studies will be required
- The regional overview is a brief section, but provides the broader scale context for the more detailed site-specific description below.

4.3 Meteorology and Air Quality

- General overview of climatology e.g., wind directions and speeds, seasonal patterns, cyclones
- Description of air quality, including chemical characteristics

4.4 Geological setting

- Describe the general geological landscape and topographic features of the site
- Include notable characteristics of the site, such as hydrothermal vents, seamounts, canyons
- Describe in detail the nature and extent of the resource (including aspects such as thickness, horizontal extent for crusts or nodules).

4.5 Physical oceanographic setting

- Describe oceanographic aspects such as currents, waves, vertical stratification, sedimentation rates.
- Detail is required on the regional setting as well as the specific site, and include changes with depth, and horizontal distance (near-field, far-field).

4.6 Water quality

- Describe water mass characteristics at the site at various depths, including salinity, nutrients, particle concentrations, temperature, geochemistry, chemical composition, dissolved gas profiles, etc.

4.7 Seabed substrate characteristics

- Substrate composition with special reference to sediment composition, sediment chemistry, nutrient characteristics, pore water profiles, and grain size.

4.8 Natural hazards

- Volcanism, seismic activity, tsunami etc.

4.9 Noise and light

- Ambient noise if any, influence of existing exploration and maritime activity.

4.10 Gas and chemical emissions

- Describe the level of gas and chemical emissions from both natural and anthropogenic activities, as well as those affecting seafloor or water column chemistry (e.g., acidity).

4.11 Summary of existing physical environment

- Bring together key findings e.g. any sensitive environments or highly valued areas.
- This will be up to a page, and more extensive than the Key messages in the first section.

5. Description of existing biological environment

- This section is divided by depth regime for the site into a description of the various biological components and communities that are present or utilise the area
- The format of this could be handled in many different ways. However, it is useful to structure it by depth as this reflects the likely division of impacts in the 3 main areas of the water column. It is the approach taken by the International Seabed Authority (2012).

5.1 Key messages

- Overview of key content covered in this section (this is a box with up to 6 bullet points of the main aspects covered, or the main findings).

5.2 Regional Overview

- General regional context
- Include site specific issues and characteristics, particularly sensitive environments
- Existing conservation areas, protected species etc.
- Reference to relevant technical data/previous studies will be required
- The regional overview is a brief section, but provides the broader scale context for the more detailed site-specific description below.

5.3 Biological communities

5.3.1 Surface

- From the surface down to 200 m - this includes plankton (phytoplankton and zooplankton), surface/near surface fish such as tunas, also seabirds, turtles, marine mammals.

5.3.2 Midwater

- Open water from a depth of 200 m down to within 50 m of the seafloor and includes zooplankton, mesopelagic and bathypelagic fishes, deep-diving mammals.

5.3.3 Seafloor

- Benthic invertebrate and fish communities, including infauna to an appropriate depth of sediment, and demersal fish up to a distance of 50 m from the seafloor.

5.3.4 Ecosystem/Community level description

- Summary of ecosystem studies, where elements of the above components are integrated

Existing data should be analysed if possible to be more than a simple list of animals found. This could include multivariate analysis of community structure, at appropriate scales with replication, as well as genetic diversity and trophic relationships. The section should span the size ranges from megafauna through to microfauna.

5.4 Summary of existing biological environment

- Bring together key findings e.g. any sensitive environments or highly valued areas.
- This will be up to a page, and more extensive than the Key messages in section 5.1.

6. Description of the existing onshore environment

- This section should describe the conditions of the area where onshore processing operations will be located, as well as any relevant environmental information on transit lanes/areas.
- Although other legislation may apply onshore, there are advantages to having the entire operation and chain of processing and potential impacts covered in a single EIA.
- The level of detail provided in this section will depend on the extent of onshore activities and any overlap with the RMA management regime to 12 nm offshore.

6.1 Key messages

- Overview of key content covered in this section (this is a box with up to 6 bullet points of the main aspects covered, or the main findings).

6.2 Overview

- General context for the onshore area
- Include site specific issues and characteristics
- Existing conservation areas, protected species etc.
- Reference to relevant technical data/previous studies will be required
- The overview is a brief section, but provides the broader scale context for the more detailed site-specific description below.

6.3 Physico-chemical environment

- Land and any waterbodies that may be affected. Air quality issues.

6.4 Biological environment

- Terrestrial or aquatic communities in the area.

6.5 Summary of existing onshore environment

- Bring together key findings.
- This will be up to a page, and more extensive than the Key messages in section 6.1.

7. Description of existing socio-economic environment

7.1 Key messages

- Overview of key content covered in this section.

7.2 Existing Interests

7.2.1 Fisheries

- If the project area occurs within an area used by fisheries, then this needs to be described here.

7.2.2 Marine Traffic

- This section describes the non-project related marine traffic occurring within the project area.

7.2.3 Tourism

- This section describes areas used by cruise-liners, game fishing, sightseeing, marine mammal watching, other tourism activities.

7.2.4 Marine Scientific Research

- Outline the current scientific research programmes that are taking place in the area.

7.2.5 Conservation areas

- Describe any Marine Protected Areas or Marine Reserves, Marine Mammal sanctuaries etc.

7.2.6 Other

- Other uses of the project area not related to fisheries, marine traffic, tourism, scientific research or conservation (e.g. recreational activities (sailing, diving), telecommunications cables, other hydrocarbon or mineral exploration or mining projects etc.).

7.3 Cultural environment

- Cultural significance of the proposed project area (including specific sites).
- Iwi authorities, customary marine title groups, customary rights groups who may be directly affected by the application

7.4 Historic heritage

- Historic significance of the proposed project area (e.g. shipwrecks).

7.5 Socio-economic and socio-cultural aspects

- Adjacent coastal communities' regional demographic and economies, including local port information if relevant
- Emphasise existing coastal uses by communities that could be affected.
- Existing economic conditions and issues must be described

7.6 Summary of existing socio-cultural environment

- Bring together key findings e.g. any existing interests.
- This will be up to a page, and more extensive than the Key messages in section 7.1.

8. Assessment of impacts on physico-chemical environment and proposed mitigation

Provide a detailed description and evaluation of potential impacts of the operation to the physical environment components identified in section 4. This may need to consider effects that may happen during construction/development (pre-commissioning), operational, and decommissioning phases, as well as the potential for accidental events. The preferred approach in this template is that for each component there is a description of:

(i) the nature and extent of any actual or potential impact, including cumulative impacts;

(ii) measures that will be taken to avoid, remedy or mitigate such impacts; and

(iii) what unavoidable (residual) impacts will remain.

It is also important for these sections to make clear the expected time to recover following disturbance, the longevity of residual effects, and if possible an indication of potential state shifts, so that the duration of residual effects is clear.

Note: This section (and section 10) will focus on aspects of greatest risks to the environment. Before an EIA is written, an environmental risk assessment (ERA) should be carried out which will evaluate the likelihood and consequences of the operation having an impact on the physical and biological environment. This means the EIA can describe in greater detail the main impacts on the environment and not elements of minor risk. The methods and results of the ERA should be provided as an appendix to the EIA, or as a separate report.

8.1 Key messages

- Overview of key content covered in this section.

8.2 Identification of threats

- Summarise the results of a previous ERA (done as part of the initial scoping stage of the EIA process). This is expected to be a separate report, with only the summary provided here to highlight the major issues of concern.
- This ERA identifies the key parts of the project which have potential to impact the existing environment.
- The detail is in the associated ERA, and so this frees the EIA to focus on the main impacts, not have a lot of detailed description of minor effects.
- Include the results of any test mining (if applicable) that is relevant to identifying impacts.

8.3 Meteorology and Air Quality

8.3.1 Potential impacts and issues to be addressed
8.3.2 Environmental management measures
8.3.3 Residual impacts

8.4 Geological setting
8.4.1 Potential impacts and issues to be addressed
8.4.2 Environmental management measures
8.4.3 Residual impacts

8.5 Physical oceanographic setting
8.5.1 Potential impacts and issues to be addressed
8.5.2 Environmental management measures
8.5.3 Residual impacts

8.6 Water quality
8.6.1 Potential impacts and issues to be addressed
8.6.2 Environmental management measures
8.6.3 Residual impacts

8.7 Seabed substrate characteristics
8.7.1 Potential impacts and issues to be addressed
8.7.2 Environmental management measures
8.7.3 Residual impacts

8.8 Natural hazards

8.8.1 Potential impacts and issues to be addressed
8.8.2 Environmental management measures
8.8.3 Residual impacts

8.9 Noise and light
8.9.1 Potential impacts and issues to be addressed
8.9.2 Environmental management measures
8.9.3 Residual impacts

8.10 Gas and chemical emissions/climate change issues
8.10.1 Potential impacts and issues to be addressed
8.10.2 Environmental management measures
8.10.3 Residual impacts

8.11 Vessel waste management
8.11.1 Potential impacts and issues to be addressed
8.11.2 Environmental management measures
8.11.3 Residual impacts

8.12 Cumulative impacts
The nature and extent of interactions should be considered. This is at both local and regional scales.

8.12.1 Potential impacts and issues to be addressed
8.12.2 Environmental management measures
8.12.3 Residual impacts

8.13 Summary of residual effects
- A table may be a useful summary format

9. Assessment of impacts on biological environment and proposed mitigation
Provide a detailed description and evaluation of potential impacts of the operation to the biological environment components identified in section 5. This may need to consider effects that may happen during construction/development (pre-commissioning), operational, and decommissioning phases, as well as the potential for accidental events. The preferred approach in this template is that for each component there is a description of:

(i) the nature and extent of any actual or potential impact, including cumulative impacts;

(ii) measures that will be taken to avoid, remedy or mitigate such impacts; and

(iii) what unavoidable (residual) impacts will remain.

It is also important for these sections to make clear the expected time to recover following disturbance, the longevity of residual effects, and if possible an indication of potential state shifts, so that the duration of residual effects is clear.

Note: This section (as for section 9) will focus on aspects of greatest risks to the environment. Before an EIA is written, an ecological risk assessment (ERA) should be carried out which will evaluate the likelihood and consequences of the operation having an impact on the biological environment. This

means the EIA can describe in greater detail the main impacts on the physical and biological environment and not elements of minor risk. The methods and results of the ERA should be provided as an appendix to the EIA, or as a separate report.

9.1 Key messages

- Overview of key content covered in this section.

9.2 Identification of threats

- Summarise the results of a previous ERA. This is expected to be a separate report, with only the summary provided here to highlight the major issues of concern.
- This ERA identifies the key parts of the project which have potential to impact the existing environment.
- The detail is in the associated ERA, and so this frees the EIA to focus on the main impacts, not have a lot of detailed description of minor effects.
- Include the results of any test mining (if applicable) that is relevant to identifying impacts.
- Include description of baseline survey work undertaken relevant to future monitoring.

9.3 Biological environment

9.3.1 Surface
9.3.1.1 Potential impacts and issues to be addressed
9.3.1.2 Environmental management measures
9.3.1.3 Residual impacts

9.3.2 Midwater
9.3.2.1 Potential impacts and issues to be addressed
9.3.2.2 Environmental management measures
9.3.2.3 Residual impacts

9.3.3 Seafloor
9.3.3.1 Potential impacts and issues to be addressed
9.3.3.2 Environmental management measures
9.3.3.3 Residual impacts

9.3.4 Ecosystem/community level
9.3.4.1 Potential impacts and issues to be addressed
9.3.4.2 Environmental management measures
9.3.4.3 Residual impacts

9.3.5 Cumulative and cross-boundary effects
9.3.5.1 Potential impacts and issues to be addressed
9.3.5.2 Environmental management measures
9.3.5.3 Residual impacts

NOTE: As in section 5.3, this assessment of impacts can also be structured by "receptor" rather than by the depth range. The format does not matter, as long as the depth component is retained in the description of the range of taxa that need to be included.

9.4 Other issues

- Outline where there are other more general issues or overlap with other marine management regimes or regulations such as maritime safety, biosecurity, waste management etc.
- Aspects of existing conservation areas, management plans etc.

9.5 Summary of residual effects

- A table may be a useful summary format
- Potential cumulative effects should also be included.

10. Assessment of impacts on the onshore environment and proposed mitigation

Provide a detailed description and evaluation of potential impacts of the operation to the onshore environment components identified in section 6. This may need to consider effects that may happen during construction/development (pre-commissioning), operational, and decommissioning phases, as well as the potential for accidents. The preferred approach in this template is that for each component there is a description of:

(i) the nature and extent of any actual or potential impact, including cumulative impacts;

(ii) measures that will be taken to avoid, remedy or mitigate such impacts; and

(iii) what unavoidable (residual) impacts will remain.

It is also important for these sections to make clear the expected time to recover following disturbance, the longevity of residual effects, and if possible an indication of potential state shifts, so that the duration of residual effects is clear.

10.1 Key messages

- Overview of key content covered in this section.

10.2 Identification of threats

- Summarise the results of a previous Ecological Risk Assessment. This is expected to be a separate report, with only the summary provided here to highlight the major issues of concern.
- This ERA identifies the key parts of the project which have potential to impact the existing environment.
- The detail is in the associated ERA, and so this frees the EIA to focus on the main impacts, not have a lot of detailed description of minor effects.

10.3 Physico-chemical environment

10.3.1 Potential impacts and issues to be addressed

10.3.2 Environmental management measures

10.3.3 Residual impacts

10.4 Biological environment
10.4.1 Potential impacts and issues to be addressed
10.4.2 Environmental management measures
10.4.3 Residual impacts

10.5 Summary of residual effects

- A table may be a useful summary format
- Potential cumulative effects should also be included.

11. Assessment of impacts on socio-economic environment and proposed mitigation

As per preceding sections, provide a detailed description and evaluation of potential impacts of the operation to the socio-economic components identified in section 7. This may need to consider effects that may happen during construction/development (pre-commissioning), operational (including maintenance), and decommissioning phases, as well as potential for accidental events. The preferred approach in this template is that for each component there is a description of:

(i) the nature and extent of any actual or potential impact, including cumulative impacts;

(ii) measures that will be taken to avoid, remedy or mitigate such impact; and

(iii) what unavoidable (residual) impacts will remain.

It is also important for these sections to make clear the expected time to recover following disturbance, the longevity of residual effects, and if possible an indication of potential state shifts, so that the duration of residual effects is clear.

11.1 Key messages

- Overview of key content covered in this section.

11.2 Identification of threats

- This identifies the key parts and activities of the project which have potential to impact the existing social or economic environment.

11.3 Existing Uses

11.3.1 Fisheries
11.3.1.1 Potential impacts and issues to be addressed
11.3.1.2 Environmental management measures
11.3.1.3 Residual impacts

11.3.2 Marine Traffic
11.3.2.1 Potential impacts and issues to be addressed
11.3.2.2 Environmental management measures
11.3.2.3 Residual impacts

11.3.3 Tourism
11.3.3.1 Potential impacts and issues to be addressed
11.3.3.2 Environmental management measures
11.3.3.3 Residual impacts

11.3.4 Marine Scientific Research
11.3.4.1 Potential impacts and issues to be addressed
11.3.4.2 Environmental management measures
11.3.4.3 Residual impacts

11.3.5 Conservation Areas
11.3.5.1 Potential impacts and issues to be addressed
11.3.5.2 Environmental management measures
11.3.5.3 Residual impacts

11.3.6 Other
11.3.6.1 Potential impacts and issues to be addressed
11.3.6.2 Environmental management measures
11.3.6.3 Residual impacts

11.4 Cultural environment
11.4.1 Potential impacts and issues to be addressed
11.4.2 Environmental management measures
11.4.3 Residual impacts

11.5 Historic heritage
11.5.1 Potential impacts and issues to be addressed
11.5.2 Environmental management measures
11.5.3 Residual impacts

11.6 Socio-economic and socio-cultural aspects
11.6.1 Potential impacts and issues to be addressed
11.6.2 Environmental management measures
11.6.3 Residual impacts

11.7 Summary of residual effects
- A table may be a useful summary format.
- Potential cumulative effects should also be included.

12. Environmental management, monitoring and reporting
Sufficient information should be provided to enable regulatory agencies to anticipate possible environmental management, monitoring and reporting requirements for an environmental permit. Information listed should reflect the proponent's environmental policy (Environment Management System) and the translation of that policy to meet the requirements under this section and previous sections during different stages in the project life, i.e. from construction to decommissioning and closure. Information detailed in this section should include, but not be limited to, the headings below:

12.1 Organizational structure and responsibilities
This section should show how the Contractor's environmental management team fits into its overall organizational structure. Responsibilities of key personnel should be outlined.

12.2 Environmental Management System (EMS)
Although a full EMS may not exist at the time the EIA is submitted, this section should outline the standards that will be considered and/or aligned with in developing the EMS for the project.

12.3 Environmental Management Plan (EMP)

This differs in detail between what is needed for the EMP component of a New Zealand assessment, and the EMP subsequently needed under the ISA and SPC processes. Irrespective of position in the sequence, an EMP will be submitted as a separate document for approval prior to exploitation operations commencing. This section should provide an overview of what an EMP would entail. This section shall include, as a minimum, the following headings:

12.3.1 Mitigation and Management

This section should summarize the actions and commitments that have arisen from the impact minimisation and mitigation strategies. There may be different rehabilitation strategies and activities for operations during mining, and those for closure.

12.3.2 Monitoring plan

This section should summarize the monitoring plan approach and specific detail of the monitoring programme.

12.3.3 Closure plan

It is expected that a closure plan will be submitted as a separate document for the Regulatory Authority's approval. However, this section should provide an overview of what the closure plan will entail, including decommissioning, continued monitoring and rehabilitation measures, if applicable.

12.4 Reporting

12.4.1 Monitoring

This section should outline how results of monitoring studies will be reported to the Regulatory Authority.

12.4.2 Incident Reporting

This section should outline how incidents will be reported.

13 Consultation

- This describes the nature and extent of consultation with parties identified to have existing interests in the proposed project area, as well as relevant Iwi Māori, imi Moriori and other stakeholders
- This can be considered earlier in the document in some situations where knowledge of the extent of consultation is critical to progressing further. It may aid gaining confidence in the information to be provided in the body of the EIA.

13.1 Consultation methods

- Describe how you have consulted with different groups.

13.2 Existing interests

- Identify any parties with potential existing interests in the area that may be impacted by the proposed activity.

13.3 Tangata whenua

- Any iwi, hapū, customary marine title group, and protected customary rights group that have been notified and consulted.
- This should include iwi Māori and imi Moriori

13.4 Other stakeholders

- Include other stakeholders that have been consulted.

13.5 Public consultation

- Describe the goals and approach to methods and workshops that have occurred with the general public.

13.6 Ongoing consultation plans

- What further consultation with stakeholders is planned, or needed?

14. Glossary

- Relevant terms explained (e.g. terms under different legislation, technical terms).
- List of acronyms.

15. Study team

- A list and description of the main people involved in the EIA, their areas of skill and technical expertise, and institute/consultancy/company affiliations.

16. References

- Citations from the EIA.
- Technical reports, previous studies.

17. Appendices

- Include technical reports carried out for parts of EIA (e.g., the ERA, other important studies such as sediment plume modelling, ecotoxicity research).

Appendix D Bibliography of useful reading and websites

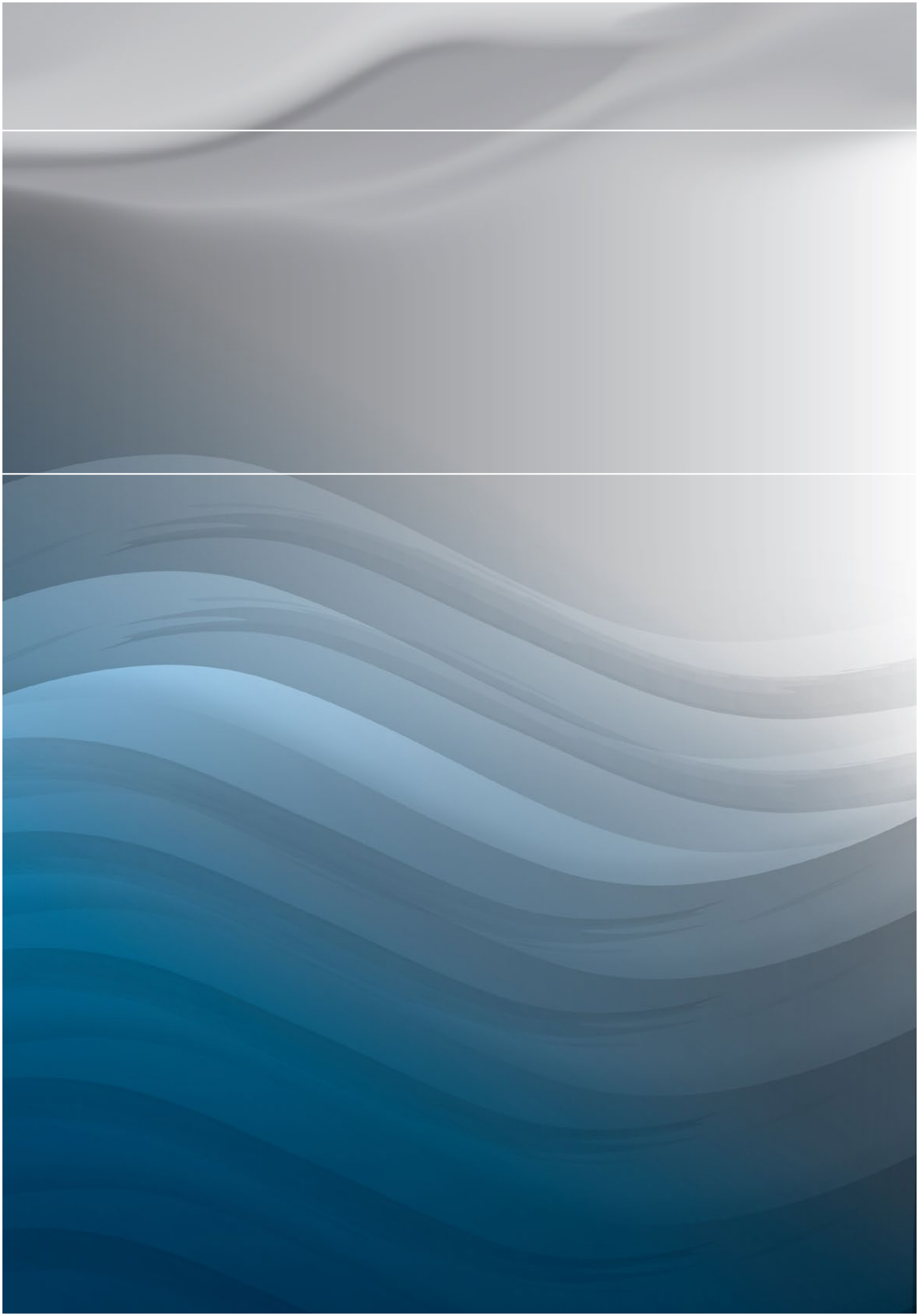
Name	url	Comments
ISA	http://www.isa.org.jm/en/documents	ISA publications
New Zealand Environmental Protection Authority	http://www.epa.govt.nz/Pages/default.aspx	EPA home page
	http://www.epa.govt.nz/EEZ/Pages/default.aspx	EEZ Act pages
New Zealand Ministry for the Environment	http://www.mfe.govt.nz/index.html	MfE home page
	http://www.mfe.govt.nz/publications/rma/	For RMA references such as preparing AEEs
Quality Planning	http://www.qualityplanning.org.nz/index.php/consents	For good practice in implementing the RMA
Biological databases	www.iobis.org	for invertebrates
	www.fishbase.org	for fishes
	www.iucnredlist.org	endangered species
NABIS	http://www.nabis.govt.nz/Pages/default.aspx	NZ's National Aquatic Biodiversity Information System. An interactive web-based mapping tool which provide information relevant to NZ's marine environment
PBE	http://www.gns.cri.nz/Home/Our-Science/Energy-Resources/Oil-and-Gas/Petroleum-Basin-Explorer	Petroleum Basin Explorer
data.govt.nz	https://data.govt.nz	New Zealand government held datasets
AODN	http://portal.aodn.org.au/aodn	the Australian Ocean Data Network Portal (AODN - http://portal.aodn.org.au/aodn/
ARGO	http://www.usgodae.org/argo/argo.html	ARGO Data
CORIOLIS	http://www.coriolis.eu.org/	The Coriolis project provide operational oceanography data to monitor and forecast the ocean behaviour. Includes : Sea-surface observation; In situ measurements; and Assimilation of in-situ and satellite data
Statisphere	http://statisphere.govt.nz/	NZ's official statistics portal to find information about NZ's official statistics system
LINZ Geospatial Office	http://geodata.govt.nz	Land Information New Zealand (LINZ) geospatial office
NZPAM	https://data.nzpam.govt.nz/GOLD	New Zealand Petroleum and Mineral Online exploration database
NIWA Data Catalogue	http://dc.niwa.co.nz	NIWA data catalogue
NZ Bathymetry	www.bathymetry.co.nz	The New Zealand bathymetry, offers dataset for the New Zealand Region (CANZ, 2008).
Ecoconnect	http://ecoconnect.niwa.co.nz/	environmental forecasting and information

Appendix E Summary of recommended scientific studies and methodologies for baseline and monitoring surveys (from Swaddling et al. 2016).

Aspect	Reason	Main Parameters	Sampling
Geology	Topography	Seabed characteristics, classification of habitats for assessment, survey stratification, selection of test and control areas	Bathymetry, morphometry, seafloor type	Shipboard/towed acoustic systems, optical sensors, dredges, box-corer, drilling equipment
	Backscatter	Seabed characteristics, classification of habitats for assessment, survey stratification, selection of test and control areas	Acoustic reflectivity	Shipboard/towed acoustic systems; sidescan sonar, hyperspectral imaging
	Sub-seafloor	Petrology, geochemistry, and mineralogy for resource characterisation	Penetration layers, rock properties, mineral and chemical composition	Seismic, drilling, rock sampling (dredges, coring)
Sediment characteristics	Sediment properties	Sediment plume dynamics, classification of habitats	Substrate type, sediment and pore water measurements: water content, grain size, specific gravity, porosity, depth of oxic layer, carbon content, chemical composition (trace and heavy metals)	Sediment cores (box corer or mulitcorer)
	Bioturbation rates	Natural mixing of sediments	Bioturbation depth, faunal zonation, Pb210 activity	Sediment cores (box corer or mulitcorer)
	Sedimentation rates	Distribution and concentration of natural suspension, settlement rates	Particle flux, suspended particle concentrations, settlement rates	Moorings and sediment traps
Pelagic community	Deepwater pelagic (plankton and nekton)	Impacts of sediment plume and discharges on midwater communities, vertical migrators, and near-bottom hyper-benthos	Species composition, distribution, abundance. Biological characteristics (sensitivity, recoverability parameters)	Opening/closing nets for plankton (Remotely Operated Vehicle (ROV) also possible). Pelagic trawls/commercial records for fish
	Surface fauna	Effects of surface discharges, presence of vessels and equipment	Species composition, distribution, abundance. Biological characteristics (sensitivity, recoverability parameters)	Opening/closing nets, surface plankton nets, remote-sensed data
	Marine mammals/sea birds	Effects of surface discharges, presence of vessels and equipment	Species composition, distribution, abundance. Biological characteristics (sensitivity, recoverability parameters)	Marine Mammal Observer protocols

	Aspect	Reason	Main Parameters	Sampling
Seafloor community	Megafauna	Impacts on benthic communities	Species composition, distribution, abundance. Biological characteristics (sensitivity, recoverability parameters)	Photographic surveys from ROV/towed camera; direct sampling from dredge/sled/trawl/ROV
	Macrofauna	Impacts on benthic communities	Species composition, distribution, abundance. Biological characteristics (sensitivity, recoverability parameters)	Multicorer or box corer, and epibenthic sled; photographic surveys from ROV/towed camera; direct sampling from dredge/sled/trawl/ROV
	Meiofauna	Impacts on benthic communities	Biodiversity, distribution, abundance	Multicorer or box corer; direct sampling from dredge/sled/trawl/ROV
	Microfauna	Impacts on benthic communities	Biodiversity, distribution, abundance	Sediment cores (box corer or mulitcorer)
	Specific resource fauna	Endemic species or communities, sensitive habitats (including biogenic habitats)	Species composition, distribution, abundance	ROV/towed camera, epibenthic sled; direct sampling by ROV, box corer for nodule environments
	Scavenger/demersal fish	Impacts on benthic communities	Species composition, distribution, abundance	Baited lander, fish trawls, traps, ROV observations
	Ecotoxicity	Impacts of heavy metals/contaminants on benthic communities, accumulation through food chain potential	Tissue samples from representative and abundant fauna	Various direct sampling methods (as above)
Physica	Currents	Dispersal of impacts, biological connectivity	Current speed, direction, depth variation, tidal dynamics, Sea Surface Temperature (SST), Sea Surface Height (SSH), ocean colour	Conductivity Temperature Depth profiler (CTD), current meters, Acoustic Doppler Current Profiler (ADCP), remote-sensed data, profiling moorings
	Hydrodynamic modelling	Dispersal of impacts, sediment plume dynamics, biological connectivity	Oceanographic parameters (temperature, salinity, current flow and direction), turbulence, turbidity, bathymetry	Various models applicable: e.g. Regional Ocean Modelling System (ROMS), Hybrid Coordinate Ocean Model (HYCOM), CORMIX (discharges)

	Aspect	Reason	Main Parameters	Sampling
Chemical oceanography	Water quality	Effects of discharges, sediment plume	Chemical composition (including heavy metals and toxic contaminants), turbidity, suspended sediment, dissolved oxygen, pH	Water samples (from CTD), surface remote-sensed data, core samples, nephelometer, transmissiometer, optical backscatter sensors
	Visual characteristics	Effects of discharges, sediment plume	Optical backscatter, light attenuation, black disc distance	Transmissiometer, optical backscatter sensors, remote sensing
	Bottom water chemistry	Effects of sediment/rock disturbance, release of chemicals, effluent discharge	Elutriation for chemical and toxicity testing, pH, trace and heavy metal concentrations, dissolved oxygen	Water samplers (CTD-Niskin bottles), core samples
	Water column chemistry	Effects on chemical characteristics due to sediment plume and discharges	Nutrients (P, N, Si, C), dissolved oxygen, trace and heavy metal concentrations	Water samplers (CTD-Niskin bottles)



From: CMS Secretariat <cms.secretariat@cms.int>
Sent: Friday, 28 June 2024 08:42
To:
Subject: FW: CMS Notification 2024/013 | Notification de la CMS 2024/013 | Notificación de la CMS 2024/013
Attachments: Draft Response Karen.docx

From:
Sent: 27 June 2024 22:41
To: CMS Secretariat <cms.secretariat@cms.int>
Cc:
Subject: FW: CMS Notification 2024/013 | Notification de la CMS 2024/013 | Notificación de la CMS 2024/013

Talofa CMS secretariat,
Please find attached a response to Decision 14.51. Although not a Party SPREP as the environmental IGO which provides environmental advice to Pacific Parties, we felt it would be useful to contribute. I asked our Environmental Monitoring and Governance team to provide some advice on how SPREP supports Parties with EIA guidance relevant to Deep Sea Mining impacts to migratory species. Some gaps have been identified and SPREP will be attempting to provide more specific advice in future updates. We hope this is useful.

Regards

Karen

Karen Baird | Threatened and Migratory Species Adviser
Island and Ocean Ecosystems Programme
www.sprep.org **Check out:** SPREP Annual Report | SPREP-Tok

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From: Ivan Diarra
Sent: Thursday, June 27, 2024 12:34 AM
To: Karen Baird
Cc:
Subject: Re: CMS Notification 2024/013 | Notification de la CMS 2024/013 | Notificación de la CMS 2024/013

Hi Karen,

Please find some consolidated response from EMG on your request below.
Hope you find this useful. In addition, the team is happy to discuss any of these in person if in case you have any questions or requests.

Many thanks,
Ivan

From: Karen Baird
Sent: Tuesday, June 4, 2024 9:13 AM
To: Ivan Diarra
Cc:
Subject: FW: CMS Notification 2024/013 | Notification de la CMS 2024/013 | Notificación de la CMS 2024/013

Talofa again,

Also requesting if you can advise if any of our EIA advice to our Members provides guidance that considers the impacts of deep-seabed mineral exploitation activities on migratory species, their prey and their ecosystems. This is a request that has gone to Parties to CMS, however it would be useful for SPREP as an Observer and adviser to SPREP Members including Parties to the Convention to be able to advise if this is something we do consider in our advice or if it is a gap.

I will need to advise the Secretariat for CMS by the 24th June.

Thank you

Karen

From: CMS Secretariat <cms.secretariat@cms.int>
Sent: Tuesday, June 4, 2024 2:04 AM
To: CMS Secretariat <cms.secretariat@cms.int>
Subject: CMS Notification 2024/013 | Notification de la CMS 2024/013 | Notificación de la CMS 2024/013
Importance: High

Notification to the Parties:

A Notification to all Parties on Deep-Seabed Mineral Exploitation Activities and Migratory Species was posted on 3 June on the CMS webpage.

All CMS Notifications to Parties can be accessed here: Notifications | CMS

Kind regards,

CMS Secretariat

Notification aux Parties:

Une notification à toutes les Parties sur Activité d'exploitation minière des grands fonds marins et espèces migratrices a été publiée le 3 juin sur la page web de la CMS.

Toutes les notifications de la CMS aux Parties sont accessibles sur Notifications | CMS

Meilleures salutations,

1. **SPREP's EIA Guidance and Migratory Species**
   - SPREP recognizes the potential impacts of deep-seabed mineral exploitation activities on migratory species, their prey, and ecosystems. Our regional EIA guidelines, developed to assist Members in strengthening their EIA processes, can be applied to deep-seabed mineral exploitation activities. SPREP is working on incorporating more specific guidance on migratory species and deep-sea ecosystems in future updates.
2. **National EIA Frameworks and Deep-Sea Mining**
   - Most SPREP Members have established EIA regulatory frameworks that can be applied to deep-sea mining activities. For example, Kiribati has enacted the Seabed Minerals Act 2017, which includes specific EIA regulations for seabed mining.
   - Depending on the nature and scope of deep-sea mining activities, EIA can also be tailored through the terms of reference (TOR) to specifically assess the potential impacts on migratory species and their ecosystems, and to propose management measures.

3. **Capacity Building and Support**
   - SPREP is actively building the capacity of Members through:
     a) Training programs on EIA implementation and enforcement
     b) Support for EIA legislative development, review, and updates
     c) Ongoing training on the regional EIA guidelines
   - SPREP is working to enhance the consideration of migratory species in these capacity-building efforts, particularly in relation to deep-sea ecosystems and activities.
4. **International Cooperation and Frameworks**
   - SPREP is supporting Members with the implementation of international EIA regulatory frameworks, particularly the BBNJ Agreement EIA provisions, which address potential impacts of proposed activities in areas beyond national jurisdictions.
   - This support is provided in collaboration with CROP agencies and other regional and international partners, aiming to strengthen the consideration of migratory species in transboundary contexts.
5. **Identified Gaps and Future Actions**
   - SPREP recognizes the need to strengthen the focus on migratory species in both national and regional EIA processes, particularly in relation to deep-seabed mineral exploitation activities.
   - Lack of pool of experts on migratory species in the Pacific region. Experts have important roles in EIA specially for activities that have the potential to impact species and their ecosystems.
   - Future actions and areas of support include:
     a) Developing specific guidance on assessing impacts of deep-seabed mineral exploitation on migratory species.
     b) Enhancing collaboration with international bodies and experts on migratory species and deep-sea ecosystems.
     c) Incorporating lessons learned from other regions dealing with similar challenges.