ASSESSMENT OF THE CONSERVATION STATUS OF THE HAWKSBILL TURTLE IN THE WESTERN PACIFIC OCEAN REGION

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Assessment of the Conservation Status of the Hawksbill Turtle in the Western Pacific Ocean Region

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1. Preface

The western Pacific Ocean region (Fig. 1) is home to six out of seven marine turtle species. There are several regional agreements and action plans relevant to the long-term conservation and management of marine turtles and their habitats in the region, including a newly revised *Regional Marine Turtle Action Plan 2021-2025* (that came into effect in 2022) developed by the Secretariat of the Pacific Regional Environment Programme (SPREP). SPREP is a regional organisation established and mandated by the governments and administrations of the Pacific to promote cooperation and provide assistance in order to protect and manage the environment and its natural resources. It is non-binding and supported by 21 Pacific Island member countries and territories, but unlike the *Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia* (IOSEA Marine Turtle MOU[1]) it is not embedded under the auspices and the frameworks of other legally binding instruments. There is some overlap in western Pacific Ocean country membership between the SPREP and IOSEA Marine Turtle MOU, and considerable overlap in the geographic distribution and habitat use of the region's shared marine turtle populations.

Aware of the importance of compiling and making available up-to-date information on the status of marine turtle species, particularly in order to identify and address gaps in basic knowledge and necessary conservation actions, the IOSEA Signatory States commissioned a series of region-wide marine turtle species assessments. Following assessments for leatherback (*Dermochelys coriacea*) and loggerhead (*Caretta caretta*) turtles (Hamann et al. 2006 and Hamann et al. 2013, respectively), the Signatory States Advisory Committee determined the need for a comprehensive assessment of the hawksbill turtle (*Eretmochelys imbricata*). The assessment was completed in March 2022 and reflects the current state of knowledge on the species, albeit geographically limited to the IOSEA region (Hamann et al., 2022).

Parallel to the development of IOSEA's hawksbill assessment, the Convention on Migratory Species (CMS) adopted the development of Single Species Action Plan (SSAP) to specifically address the use and trade of hawksbill turtles in South-East Asia and the adjacent western Pacific Ocean region (Decision 13.70c). IOSEA Signatory States agreed to cooperate with CMS to jointly develop the draft SSAP (refer Work Programme 2020-2024, Action 63). However, much of the western Pacific is outside of IOSEA's geographic scope.

To inform the SSAP's full geographic scope, the CMS Secretariat engaged a team of experts to review the status of hawksbill turtles in the western Pacific Ocean region, led by the World Wide Fund for Nature (WWF) and the University of the Sunshine Coast. This information will also support Pacific countries and territories to implement objectives in the updated *Regional Marine Species Action Plans 2022-2026* (SPREP, 2022), specifically the Marine Turtle Action Plan.

This document presents a synopsis of the current state of knowledge for hawksbill turtles in the western Pacific Ocean region, including biological and ecological knowledge of nesting and foraging populations, legislative provisions, and detailed recommendations and proposals for addressing identified deficiencies. We collated and synthesised information from scientific and grey literature, reports from the Turtle Research and Monitoring Database System (TREDS[2]) hosted by the SPREP, the new (2021) online marine turtle breeding and migration atlas "TurtleNet"[3] developed by Queensland's Department of Environment and Science (DES) in collaboration with the CMS, and turtle experts within the western Pacific Ocean region. The format follows the IOSEA hawksbill turtle assessment (Hamann et al., 2022) for consistency and ease of reference, and complements that report. The assessments for IOSEA member countries that fall within the boundaries of the western Pacific Ocean (e.g. Australia, Philippines) are not repeated herein. In this document, we review the remaining 22 countries and territories that, for the purposes of this review, make up the western Pacific Ocean region (including IOSEA non-members), namely: American Samoa, Commonwealth of the Northern Mariana Islands, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Kiribati, Nauru, New Caledonia, New Zealand, Niue, Palau, Papua New Guinea, Republic of the Marshall Islands, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, and Wallis and Futuna (Figure 1).

In compiling our assessment of hawksbill turtles in the western Pacific Ocean region, we used the genetic stocks approach as per the loggerhead (Hamann et al., 2013) and hawksbill (Hamann et al., 2022) IOSEA assessments, and as identified by FitzSimmons and Limpus (2014) and Vargas et al. (2015). Where no genetic stock is assigned, we include a summary of published information and reports for countries for which biological data are available.

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[1] The IOSEA Marine Turtle MOU, with its associated Conservation and Management Plan (CMP), is a non-binding framework under the Convention on the Conservation of Migratory Species of Wild Animals (Convention on Migratory Species, CMS). Through the MOU, States of the Indian Ocean, and South-East Asia (IOSEA) region work together to conserve and replenish depleted marine turtle populations for which they share responsibility. The IOSEA Marine Turtle MOU took effect in September 2001 and as of March 2022 has 35 Signatory States. Supported by an Advisory Committee (AC) of eminent scientists and complemented by the efforts of numerous citizens' groups, nongovernmental, and intergovernmental organisations, Signatory States are working towards the implementation of a comprehensive Conservation and Management Plan (CMP). The CMP is an integral part of the MOU.

[2] https://www.sprep.org/thetreds Please note, there are several unquantified hawkbill records in TREDS, caution should be taken when interpreting the results presented in this assessment.

[3] https://apps.information.qld.gov.au/TurtleDistribution/

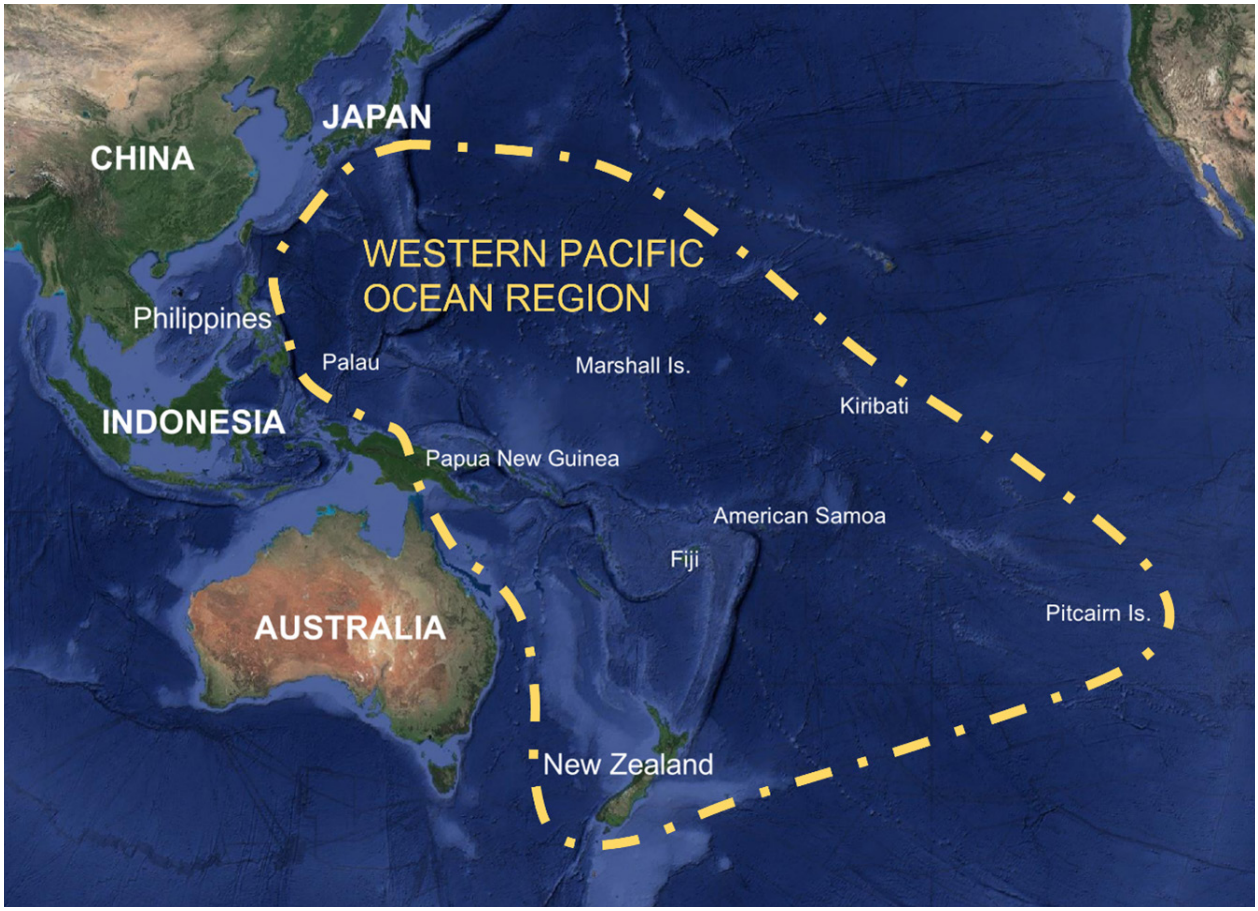

Figure 1. Indicative boundary of western Pacific Ocean region used in this assessment. For a list of countries included within this boundary, see Table 3 (highlighted countries).

2. Introduction

The hawksbill turtle (*Eretmochelys imbricata* (Linnaeus, 1766)) occurs in tropical and sub-tropical regions across the globe. Hawksbill turtles have significant ecological, economic, and cultural value and play an important role in coral reef health, culture, and tourism (Brander et al., 2021). Hawksbill turtles are listed globally as "Critically Endangered" (IUCN Red List, 2022), as some populations around the world are at very high risk of extinction due to continued pressures resulting from combinations of past and continued human activities. Faced with multiple, cumulative threats, and despite international protection, the major contributing factors preventing recovery and/or driving hawksbill turtle populations to lower levels in the western Pacific Ocean region likely include over-exploitation from unsustainable legal and illegal take, including to supply the tortoiseshell trade, fisheries bycatch, ghost nets, coastal development, and climate change (Mortimer and Donnelly, 2008; Wallace et al., 2010; Lam et al., 2012; Humber et al., 2014; SPREP, 2022). Many dedicated organisations, individuals, communities, and governments have achieved conservation gains, but much more work is to be done to prevent further declines.

Given the wide variety of threats and management measures in place across the hawksbill's ecological range, efforts to determine conservation status at the global level (e.g., IUCN Red List framework) have proven challenging and occasionally provoked debate within the scientific community (Godfrey and Godley, 2008; Campbell, 2012). The most comprehensive assessment estimated the Pacific Ocean hawksbill populations to be at least 75% lower than historical levels, and in the Pacific Ocean basin, an estimated 4,800 nesting females remained in 2008 (Mortimer and Donnelly, 2008). While this number does not include male turtles nor the multiple cohorts of non-breeding turtles in the population, the trend in number of nesting females is a useful way of monitoring population status as female turtles emerge on beaches to lay eggs, whereupon they can be counted. It is also the basis upon which the IUCN Marine Turtle Specialist Group based the 2008 global status assessment for hawksbill turtles. This assessment reported hawksbill populations in many countries were depleted and/or declining (e.g., most of Micronesia, Papua New Guinea, Fiji, Guam, American Samoa, and Palau, among others). A more recent peer-reviewed assessment revealed that the number of hawksbill nests laid within the Arnavons Community Marine Park in Solomon Islands was increasing (Hamilton et al., 2015), but examples of such success are limited. Within its remit, SPREP is currently (2023) undertaking an extinction risk assessment which may further inform decision makers of trends in annual nesting patterns for hawksbill populations in this region, but in the absence of recent quantified nesting census figures across most of the region, and a lack of data on the stability of foraging area populations, the 2008 declining trends for hawksbill populations across the entire western Pacific Ocean region is of significant concern.

As with other long-lived, widely distributed species, it is often difficult to determine the hawksbill's conservation status at the scales required for management (Meylan and Donnelly, 1999; Mortimer and Donnelly, 2008; Wallace et al., 2011; FitzSimmons and Limpus, 2014). Hawksbill turtle nesting is widespread and, in some areas, considered abundant within the western Pacific Ocean region (e.g., Arnavon Islands, Solomon Islands). There are numerous hawksbill populations nesting in discrete locations that often display distinct life cycle characteristics (FitzSimmons and Limpus, 2014; Gaos et al. 2012). Confounding our ability to quantify and evaluate populations, hawksbill turtles are migratory and individuals from different nesting populations may overlap in their use of foraging areas (Vargas et al., 2015; Bell and Jensen, 2018), adding to the complexity of understanding the dynamics of each population.

Genetic research techniques can be used to identify distinct hawksbill populations, which may then be grouped into stocks or management units (MUs). Delineating these groups below the species level allows for a more detailed, location-specific assessment of threats and implementation of conservation strategies. Unfortunately, genetic studies to identify appropriate management units across the western Pacific Ocean region are considerably lacking. In the western Pacific Ocean region, only three MUs have been identified (refer below), but the geographical boundaries of each MU remain unresolved due to limited sampling (in large because of a deficiency of nest monitoring programs that can collect samples from nesting females). To specifically address the knowledge gaps in the genetic structure of hawksbill turtle rookeries throughout the region, the Indo-Pacific Hawksbill Genetic Working Group (IPHGWG) was established in 2018. The working group aims to identify sampling gaps, coordinate genetic sampling, share unpublished datasets, and collaborate on data analysis and publication. Supported by WWF, these efforts connect researchers and help fund data collection and analysis to identify the genetic population structure of hawksbills in the Asia-Pacific region, through the ShellBank project (www.shellbankproject.org.au).

Similarly, the Asia-Pacific Marine Turtle Genetic Working Group was established in 2020 (supported by a multi-organization steering committee) to connect researchers across the region and to provide capacity building and training in marine turtle genetics (for all species).

The knowledge gaps in hawksbill genetic structure also affect the designation of regional management units (RMUs[4]) across this region (Wallace et al., 2010). This

[4] RMUs group populations into regional constructs, largely based upon the sharing of foraging areas and were assessed in terms of population risk level (population size, recent trend, long-term trend, rookery vulnerability and genetic diversity) and existing threats (fisheries bycatch, take, coastal development, pollution and pathogens, and climate change).

assessment lists information by RMU and management units (when known), noting however, that these RMUs are currently under review on a global scale (IUCN Marine Turtle Specialist Group). Countries and territories are either categorised under their currently assigned RMU designation, or under the heading of 'Other'.

To date, four broad RMUs for hawksbill turtles have been described for the western Pacific region:

1. **Southwest Pacific, 2. West Central Pacific, 3. West Pacific/Southeast Asia, and 4. South Central Pacific** (Figure 2). Of the four RMUs for hawksbill turtles in the western Pacific Ocean, three appear in this report. The West Pacific/Southeast Asia RMU is included in Hamann et al. (2022) and is not repeated here. For the Southwest Pacific RMU, two management units (North Queensland, Northeast Arnhem Land) are included in Hamann et al. (2022) and therefore not included here, while the third–the Solomon Islands management unit–is reviewed in this document.

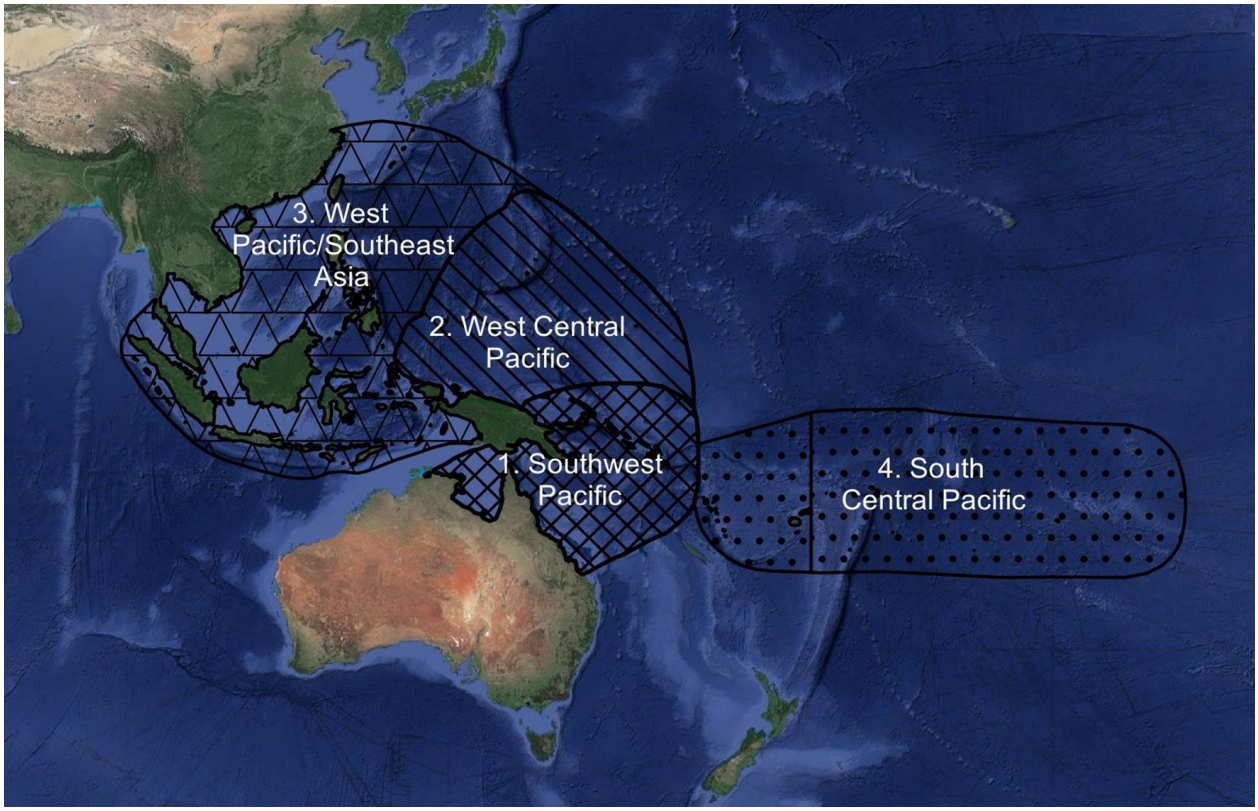

Figure 2. Hawksbill turtle RMUs in the Western Pacific Ocean. Adapted from Wallace et al., 2010.

3. Hawksbill turtle synthesis

In 1996 and again in 2008, the species was assessed at the global level as Critically Endangered by the IUCN Species Survival Commission. Meylan and Donnelly (1999) and Mortimer and Donnelly (2008) provide the supporting information for the 1996 and 2008 assessments, respectively.

Summary – population identification

Three out of the four western Pacific Ocean region hawksbill RMUs are solely in the Pacific Ocean, while one encompasses the waters of the eastern Indian Ocean, South-East Asia, and the western tropical Pacific (Wallace et al. 2010) (Figure 2). All except the Southwest Pacific RMU are considered putative due to a lack of data demonstrating connectivity through genetics or distribution. The Southwest Pacific RMU has been assessed for distinct populations/management units, of which it has three: the North Queensland management unit (that is based on sampling at Milman Island in Queensland, Australia), the Northeast Arnhem Land MU (in Northern Territory, Australia distinguished from the first by a shift in nesting timing), and the Solomon Islands MU (based on sampling at the Arnavon Islands, Solomon Islands) (FitzSimmons and Limpus, 2014; Vargas et al., 2015; LaCasella et al., 2021). The majority of hawksbill RMUs in the western Pacific have not yet been assessed for genetic population structure, although efforts to collect and analyse samples to do so are underway in several countries. Through the work of the IPHGWG, the genetic sampling of the western Pacific now includes

Table 1. Outputs from the Wallace et al. (2010) RMU designations, management units based on genetic stock designations by FitzSimmons and Limpus (2014) and Vargas et al. (2015), and current sampling/analysis status identified under the IPHGWG. *Denotes inclusion in Hamann et al. (2022).

Regional Management Unit	Western Pacific countries with documented hawksbill turtle nesting	Management Units based on genetic stocks determined by FitzSimmons and Limpus (2014) and Vargas et al. (2015)	Current sampling/analysis status (based on IPHGWG)
Southwest Pacific Ocean (including Australia [Northern Territory and Queensland], Papua New Guinea and Solomon Islands)	Australia (Northern Territory and Queensland), Papua New Guinea and Solomon Islands	North Queensland MU*, Northeast Arnhem Land MU*, and Solomon Islands MU have been assessed	Analysis for genetic-population structure is underway for Torres Strait (Australia) and Conflict Islands and New Ireland (Papua New Guinea). Additional genetic sample collection and analysis is underway across Papua New Guinea (nesting, foraging, bycatch) and Australia (confiscated stockpiles).
West Central Pacific Ocean (including waters surrounding Micronesia, FSM, Palau, the Marshall Islands, Guam, Kiribati, and Commonwealth of Northern Mariana Islands)	Palau Marshall Islands CNMI	Not defined	Efforts to collect samples from countries within this RMU are needed.
South Central Pacific Ocean (including Vanuatu up to the Eastern Solomon Islands, across the Pacific to include Tonga, Samoa, American Samoa, and French Polynesia [equator to 25 South])	Samoa, Vanuatu, American Samoa, Fiji, French Polynesia, Tonga	Not defined	Genetic sample collection and analysis is underway for Vanuatu (nesting), American Samoa, Tonga (nesting, foraging, bycatch), and Fiji (nesting, foraging, bycatch).
West Pacific/Southeast Asia*	Thailand, Malaysia, Indonesia, Philippines, Viet Nam, plus Singapore (not an IOSEA MOU signatory state)	Sulu Sea (Malaysia) MU, Gulf of Thailand (Kho Kram) (possible MU) and western Peninsular Malaysia MU have been assessed. Rookeries in Indonesia, Singapore, Viet Nam, and Philippines have not been assessed for genetic population structure.	Genetic sample collection and analysis is underway for Thailand (nesting), Philippines (nesting, stranded, confiscated stockpiles), and Indonesia (nesting).

data from several rookeries in Vanuatu, American Samoa, Fiji, and Papua New Guinea (Table 1). While these data are currently unpublished, they are expected to become publicly available in the foreseeable future.

Summary – nesting

Hawksbill turtles have been recorded nesting in at least 16 countries in the western Pacific Ocean region (including six nations in the West Pacific/Southeast Asia RMU; see Hamann et al., 2022). Many of these are not Signatory States to the IOSEA Marine Turtle MOU as they lie outside the IOSEA region, seven are Parties to the CMS, and all are members of SPREP. There are no recent records to indicate if hawksbills nest in the Commonwealth of the Northern Mariana Islands (CNMI), Cook Islands, Guam, Kiribati, Nauru, New Caledonia, New Zealand, Niue, Tokelau, Tonga, Tuvalu, or Wallis and Futuna. A summary of known hawksbill annual nester abundance is provided in Table 2 (adapted from Pilcher, 2021).

Summary – foraging

Data from tag recoveries, satellite telemetry, fisheries bycatch, in-water surveys, and anecdotal reports indicate that foraging hawksbill turtles occur and some cases migrate between almost every country in the western Pacific Ocean region. Population and biological studies on foraging hawksbills are limited overall, although some studies have been conducted in Australia, American Samoa, Fiji, Guam, Papua New Guinea, Solomon Islands, and Vanuatu.

Table 2. Summary of the estimated number of female hawksbill turtles breeding per year. Adapted from Pilcher (2021).

Country	RMU	Estimate	Bin category (adapted by Seminoff et al., 2015)
American Samoa	SC	<10-15	11-50
Fiji	SC	20-30	11-50
French Polynesia	SC	n/a	n/a
Samoa	SC	<5-15	1-10
Guam	WC	5-10*	1-10
FSM	WC	10-20	11-50
PNG	SW	<500	101-500
Marshall Islands	WC	n/a	n/a
Palau	WC	20-50	11-50
Solomon Islands	SW	200-300	101-500
Vanuatu	SC	300	101-500

* Indicates no monitored nesting records since 2008

4. Areas within the western Pacific region of known importance for hawksbill turtles

Important nesting sites

There are a number of identified nesting sites within the western Pacific Ocean region, some of which are monitored by local communities, NGOs, and government agencies (Figure 3). However, there are many knowledge gaps regarding distribution and abundance (Table 1).

Index nesting beaches

An index beach is one at which monitoring is sufficiently robust and consistent through time and from which population trends may be used to infer trends at other, less frequently surveyed, locations (refer also definition provided in Hamann et al. 2022, p.12). There are only two recognised index nesting beaches for hawksbill turtles in the western Pacific Ocean region (as geographically defined by this assessment): Namena Lala Island in Fiji and the Arnavon Community Marine Park (ACMP) in the Solomon Islands. While a small number of countries have nesting beach monitoring programmes for hawksbill turtles, these have not been running long enough or with a consistent level of effort needed to gather robust long-term monitoring data and establish these areas as index nesting beaches (Pilcher, 2021). Monitoring efforts are hampered by the difficulty of accessing remote islands and atolls, and providing staff and essential equipment for the duration of monitoring periods. It is possible that some hawksbill turtle nesting sites have not yet been detected in the western Pacific, particularly for the many archipelagic nations in the region, or that nesting reports have not been documented or shared. There are no trends in hawksbill nesting abundance (nests and females) available for any western Pacific countries, except for the Solomon Islands (Hamilton et al., 2015).

Important non-nesting sites

Migration

Hawksbill turtles in the western Pacific Ocean are known to travel up to ~1,500 km between nesting and foraging sites, and this is potentially a reflection of the vast distances between landmasses. Limited tag recoveries of hawksbill turtles from foraging sites in northeastern Australia have been recorded nesting in Vanuatu, Solomon Islands, Papua New Guinea, and

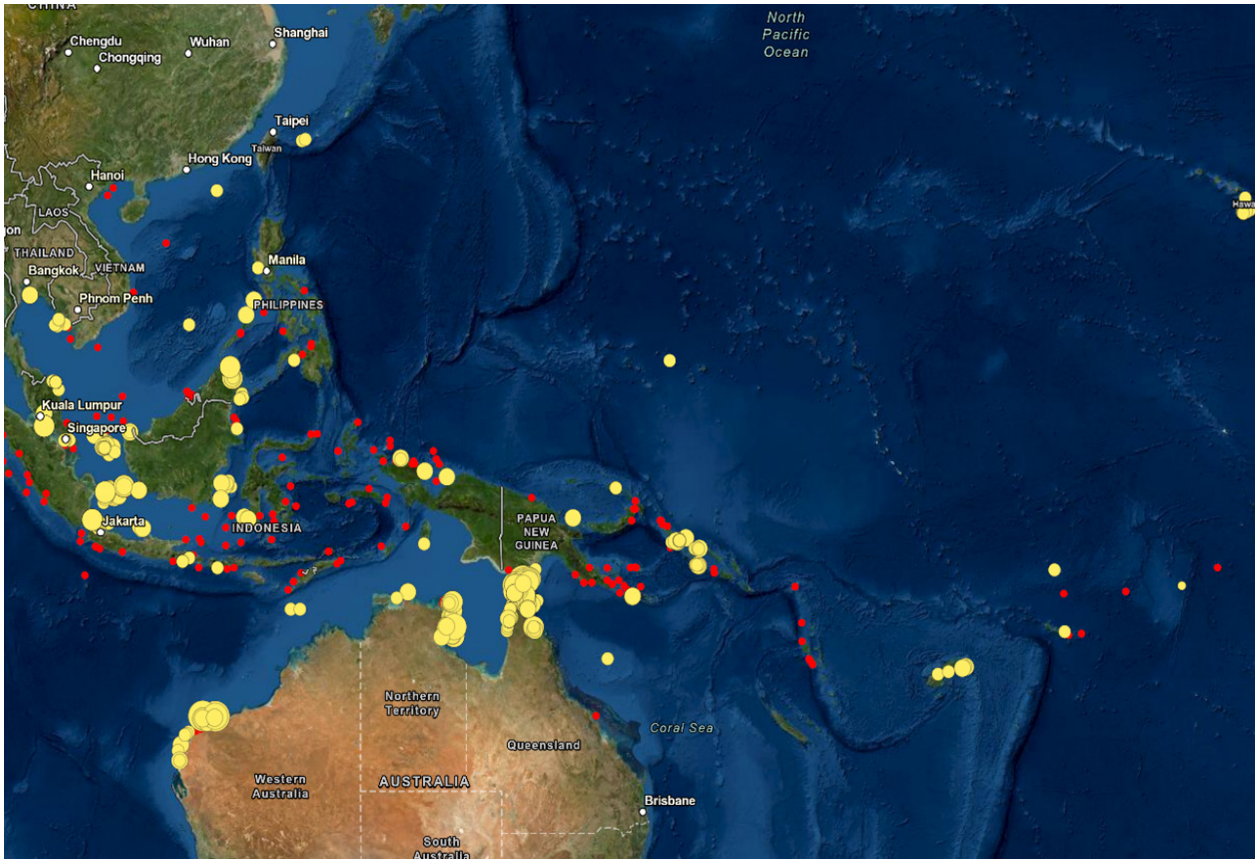

Figure 3. Map of known (yellow dots) and unquantified (red dots) hawksbill turtle nesting areas in the broader Asia-Pacific region. Yellow dot sizes reflect the relative nesting abundance. Red dots denote beaches where unquantified nesting has been recorded (TurtleNet, Accessed 20 April, 2022: https://apps.information.qld.gov.au/TurtleDistribution)

various sites in the Great Barrier Reef (Miller et al., 1998). Linkages of similar distances are demonstrated between American Samoa and the Cook Islands (Tagarino et al., 2008), the Conflict Islands (Papua New Guinea) and northern Queensland (CICI, 2018; Madden Hof et al., in prep), Arnavons (Solomon Islands) and Queensland (Hamilton et al., 2015; Hamilton et al., 2021), and Tinian (CNMI) and Pohnpei (Federated States of Micronesia; Gaos et al., 2020). Genetics and tag returns have also shown links between hawksbills foraging on the nGBR and nesting beaches in the wider Bismarck–Solomon Sea region (Bell and Jensen, 2018).

Important foraging and refuge sites

Migratory connectivity for hawksbill turtles in the western Pacific Ocean is poorly understood. However, satellite telemetry and tag recoveries have revealed the Coral Sea as a key foraging area for hawksbill turtles in the western Pacific (Limpus, 2008; Pilcher, 2021).

Hawksbills have been reported foraging throughout the Coral Sea after post-nesting migrations from the Conflict Islands in Papua New Guinea (CICI, 2018; Madden Hof et al., in prep), the Arnavons in Solomon Islands (Hamilton et al., 2015; Hamilton et al., 2021), and Vanuatu (Jim et al., 2022; Miller et al., 1998). There is no known officially designated index foraging site for hawksbill turtles in the western Pacific Ocean region. Although not included in this assessment, genetic studies from the Great Barrier Reef (Howick Group) in north-eastern Australia show it may be a major foraging site for the Solomon Islands MU (Bell and Jensen, 2018). Some other western Pacific hawksbill populations' migratory routes to the Queensland coast of Australia are becoming more apparent, where other major foraging sites are likely to be identified along north-eastern Australia.

Picture 1. A hawksbill turtle nests on Milman Island, Australia © Black Castle/WWF-Australia

5. Gaps in the biological information

Population structure

The vast majority of western Pacific Ocean countries lack information on hawksbill population structure (i.e. age class distribution, sex ratios and/or genetic composition). The Solomon Islands is the only country in this assessment where hawksbill populations have been genetically assigned to management units. Genetic research is underway in American Samoa, Guam, CNMI, Fiji, Papua New Guinea, Tonga, and Vanuatu. Many western Pacific Ocean countries are archipelagic nations consisting of numerous islands and atolls separated by vast distances. Following genetic research, these countries may be found to host one or more MUs, indicating they warrant independent management approaches. In addition to genetic structure, other population variables such as the proportion of sex ratios at different life stages, growth rates and survivorship remain unknown. Given the hawksbill's current global status of Critically Endangered (Mortimer and Donnelly, 2008), and future plans likely to evaluate the species at the subpopulation level, such knowledge is vital to provide future status assessments and conservation activities.

Life history attributes

A. Nesting populations

There are substantial gaps in our knowledge of life history attributes for most hawksbill turtle nesting sites in the western Pacific Ocean region. The specific gaps vary among locations, as described in each of the country sections of this report. Data on life history attributes are necessary for the development of accurate population models used in designing and implementing effective management plans. Life history parameters should ideally be collected from at least one rookery for each management unit. Where management units have not yet been defined, efforts to do so through genetic research and consistent nesting beach monitoring should be prioritised. Common gaps in life history attributes are attributable to missing or limited data on the following, as identified by Hamann et al. (2022):

- Sampling for genetic mtDNA profiles
- Annual census figures at representative nesting beaches to quantify the number of females nesting per season, or the number of clutches laid per season, or the number of tracks (nesting attempts) made per season
- Quantified mortality estimates from anthropogenic and non-anthropogenic sources across all life history stages
- Quantified key demographic parameters including:
  - the average number of clutches laid per female per year/nesting season
  - the average number of years between breeding/nesting seasons for individual turtles
  - the rate of female and male recruitment into the breeding population
  - survivorship of adult females
  - incubation success and hatchling recruitment
- Temperature profiles for incubation, hatchling, and operational sex ratios
- Information on habitat use during migration and inter-nesting periods

B. Non-reproductive populations

There are also substantial gaps in our knowledge of hawksbill turtle foraging areas, habitat use (oceanic and coastal), diet, growth, age, survivorship, levels of direct harvest, and threats. Although satellite tracking and foraging area studies have been undertaken in a small number of countries (i.e. Australia, American Samoa, Fiji, Guam, Papua New Guinea, Solomon Islands, and Vanuatu), these have generally been extremely limited in sample sizes, and few published data on migration and home range exist for the majority of nations in the western Pacific Ocean.

C. Oceanic post-hatchling populations

There is no knowledge of the distribution or abundance of hawksbill turtle hatchlings in the western Pacific Ocean, nor the threats associated with this life history phase. Larger post-hatchling hawksbill turtles are at risk of interacting with pelagic longline and purse seine fisheries operating in EEZs and oceanic areas, as well as ingestion of plastic and entanglement in marine debris, as documented in other regions or oceanic basins (refer Hamann et al., 2022). Further research is needed to identify distribution, abundance, and threats concerning hawksbill post-hatchlings.

6. Key pressures on hawksbill turtles of the western Pacific region

The tortoiseshell trade – a summary

The historical global trade and its impact on hawksbill turtle populations has been well summarised by Milliken and Tokunaga (1987), Groombridge and Luxmoore (1989), Meylan and Donnelly (1999), NMFS and USFWS (1998), and Mortimer and Donnelly (2008). While it is recognised that the international and domestic commercial trade of hawksbill turtles and/or their eggs dates back to the 9th century, demand for hawksbill turtle shell (scutes) to make tortoiseshell products rapidly expanded in the 17th century. Historically, between 1950 and 1992, trade networks concentrated in Southeast Asia harvested between 1.3 million turtles (Mortimer and Donnelly, 2008). Trade figures were recalculated by Miller et al. (2019) with a possible nine million turtles re-estimated to be harvested over a 150 year period (1844-1992). The trade was only managed internationally through the global Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) trade bans starting in 1977, with all trade reservations lifted by 1992. The consequence of this historical trade is that many hawksbill turtle populations are at, or recovering from, low baselines. Yet, recent research indicates there is still an active, underground illegal trade network concentrated in Southeast Asia creating a renewed demand for turtles and turtle products (Gomez and Krishnasamy, 2019). The Miller et al. (2019) study also noted the trade's likely overlap and links to illegal fishing and small-scale fisheries (see also Riskas et al., 2018; Vuto et al., 2019). Indeed, foreign turtle poachers have been reported encroaching on the national waters of the Coral Triangle and western Pacific countries (IOSEA, 2014; Lam et al., 2012; Gomez and Krishnasamy, 2019).

The tortoiseshell trade continues to be an issue in multiple western Pacific Ocean countries. Recently in the Solomon Islands, Vuto et al. (2019) reported the local sale of hawksbill shell in three of the 10 communities surveyed, with evidence of sales to local carvers and other buyers in Honiara that were presumed to be exporting shell out of the country. In this study, hawksbill turtle products were far more likely to be illegally sold (32%) than green turtle products (12%) because of the domestic and international market for tortoiseshell. In the past, the export of tortoiseshell from the Solomon Islands was among the ten highest globally (Groombridge and Luxmoore, 1989). In Papua New Guinea, Kinch and Burgess (2009) noted that the trade in hawksbill turtles was ongoing in coastal towns, mainly in the form of tortoiseshell items for domestic buyers, and potentially targeting international tourists. Also in Papua New Guinea, Opu (2018) found that turtle harvest was concentrated in Manus, Milne Bay, and Western

Picture 2. Turtleshell products for sale © Hal Brindley/TravelforWildlife.com

Provinces. Media reports and anecdotal reports from government stakeholders suggest the tortoiseshell trade is still active in Palau despite a 2018 ban (Reklani, 2021). Recently in Australia, as part of a ShellBank - Surrender Your Shell project, several tortoiseshell products donated from Australians were either bought and/or genetically assessed to have originated from hawksbill populations harvested from within the southwest Pacific (Madden Hof et al., 2022). While attempts to estimate current trade and the resultant mortalities of hawksbills are limited due to a lack of data, the reports (quantified and unquantified) of illegal trade in hawksbill shells occurring in multiple western Pacific Ocean countries warrant further study and action. These estimates may then also be able to be used in models to assess the extinction risk of hawksbills in the Pacific.

Bycatch in legal fisheries

Incidental capture (bycatch) in legal fisheries is globally recognised as a significant threat to marine turtle populations (Alverson et al., 1994; Lewison et al., 2004; Bourjea et al., 2008; Wallace et al., 2011). Broadly, the three major gear types shown to have the highest impact on marine turtles are gillnets, bottom trawls, and longlines. In the western Pacific Ocean region, commercial fisheries are dominated by longline and purse seine fisheries for tuna and tuna-like species. Monitoring of these fisheries in high seas areas is the responsibility of the Western and Central Pacific Fisheries Commission (WCPFC), a regional fisheries management organization (RFMO). Peatman et al. (2018a) estimated that hawksbill turtles accounted for 16% of turtle bycatch in purse seine fisheries in the WCPFC area from 2003 to 2017, with a mean of 36 hawksbills per year (range 15-75). Hawksbill bycatch is recorded in longline fisheries, with a mean of 1,126 individuals (range 534-1,598) caught per year in WCPFC longline fleets (Peatman et al., 2018b). Yet, because not all bycatch incidences result in mortalities, and observer coverage is not sufficiently uniform nor normally distributed across the fishery (Peatman et al., 2018b), these figures should be used as indicative of the magnitude of the threat, not the precise quantities. Furthermore, discards of turtles are rarely recorded in log books, the main method of assessing catch of target and nontarget species in the Western Pacific longline fisheries (Brown et al., 2021). Yet, observer data from Fiji's national longline fleet indicate that hawksbill bycatch has slightly decreased since 2017 (see Fiji's annual report to the WCPFC scientific committee, July 2021). Similarly, Peatman et al. (2018a) report that hawksbill turtle bycatch by longline fisheries in the WCPFC area occurs at lower rates compared to other species (accounting for 4.9% of all interactions), likely due to their utilization of shallow and nearshore foraging habitats (e.g. coral reefs). Nevertheless, given the multiple threats facing hawksbills in the western Pacific, the interaction of hawksbills with pelagic longline fisheries underscores the need for further investigation into pelagic habitat utilization during other life history stages, such as migration.

In 2018, the WCPFC updated the 2008 Conservation and Management Measures (CMM) to reduce the impact of tuna fisheries on marine turtles by requiring fleets to implement additional gear changes, operational controls, mandatory reporting of interactions, and other measures. Other regional bodies, such as the Pacific Islands Fisheries Forum Agency (FFA) and the Secretariat of the Pacific Community (SPC), are leading ongoing efforts to improve the transparency of fisheries activities, including electronic monitoring (EM) to detect and quantify bycatch. In their analysis of EM trials in RMI, FSM, and Palau, Brown et al. (2021) reported that “discards of tuna, billfish and turtles were almost never reported in logbooks, though EM and human observers did observe discards for these taxa”. Observer coverage is very high in purse seine fleets (mandated target is 100% since 2010), but rarely meets the target of 5% in the longline fleets (MRAG Asia Pacific, 2021).

Small-scale fisheries largely operate in nearshore or coastal waters using a variety of gears, including set and drift nets, trawls, seines, longlines, traps, and others (Lewison, 2013). Recent research has shown that small-scale fisheries can have high levels of turtle bycatch that directly cause population declines (Lewison and Crowder, 2007; Peckham et al., 2007; Alfaro-Shigueto et al., 2011; Liles et al., 2017). In the western Pacific Ocean region, small-scale fisheries are widespread, often operating in remote areas and at levels that have not been quantified. Because hawksbill turtles inhabit coral reef habitats and shallow coastal waters, they are highly vulnerable to bycatch and mortality in small-scale fisheries in almost every country in the western Pacific Ocean region. There are only two published examples of small-scale fishery assessments in the western Pacific, one in Malaysia which estimated 988 hawksbill turtles were taken in small-scale fisheries in a single year (extracted from data in Pilcher et al. (2009)) and the other in the Solomon Islands, which estimated small-scale fisheries harvest approximately 10,000 turtles per year (of which almost 1/3 were hawksbill turtles; (Vuto et al., 2019)). Although a commissioned study by the CITES Secretariat (2022) surmised that bycatch and active targeting of marine turtles in small-scale fisheries is unlikely to contribute to the international trade of hawksbills, Vuto et al. (2019) provides evidence to the contrary from the Solomon Islands. Vuto et al. (2019) reported that hawksbill turtle products are far more likely to be sold illegally than green turtle products, and that the shells of 87.5% of hawksbill turtles harvested were sold to local buyers, who then on-sold to Asian buyers in Honiara. With growing evidence of the role of small-scale fisheries in facilitating the turtle trade (IOSEA, 2014), an understanding of hawksbill interactions with small-scale fisheries across a much larger region is urgently needed.

Illegal use and Illegal, Unreported and Unregulated (IUU) Fishing

Illegal, unreported and unregulated (IUU) fishing is a pervasive issue for fisheries management in every ocean basin (Agnew et al., 2009). Vessels engaged in IUU fishing are less likely to comply with conservation mandates intended to reduce bycatch and mortality of non-target, vulnerable species, including marine turtles (MRAG, 2005). Riskas et al. (2018) found that IUU fishing poses a threat to marine turtle populations in the IOSEA region, and that in certain regions IUU fishing is associated with poor fisheries management and wildlife trafficking. Similarly, Lam et al. (2012) notes the potential involvement of small-scale fishing vessels in the trafficking of hawksbill turtles and products. In the western Pacific Ocean, commercial IUU fishing incidence is estimated to be lower than in many other seafood-sourcing regions globally and has decreased in the Pacific Islands region relative to a 2016 assessment of data from 2010-2015 (MRAG Asia Pacific, 2021). This is attributable to the concerted and ongoing cooperative efforts by Pacific countries and partner organisations (e.g. FFA, SPC, WCPFC) to increase the monitoring, control and surveillance (MCS) of fleets operating in the region.

There is little documented information however, on hawksbill turtle interactions with illegal commercial fisheries in the western Pacific Ocean. Where turtle take is prohibited by law, the take of hawksbills in small-scale fisheries would also be considered illegal and, hence, be considered IUU fishing. From that perspective, the illegal take of hawksbill turtles by coastal fisheries recorded throughout the western Pacific Ocean (i.e. CNMI, Fiji, Guam, Palau, Solomon Islands, and Vanuatu) constitutes IUU fishing. More information regarding take levels and size classes is needed to inform risk assessments and mitigation measures.

Human use of turtles and their products

Hawksbill turtles have a high level of cultural significance in many countries across the IOSEA and western Pacific Ocean region and are a traditional food with eggs and meat consumed, and shells used in customary practice and in trade.

Hawksbill turtles and their eggs are harvested in every RMU in the western Pacific Ocean, despite laws banning these practices in many countries. Particularly in the west and south central Pacific, data is sparse on legal and illegal turtle and egg harvests, as documentation of these is inconsistent or unrecorded. Monitoring turtle harvest over vast distances between atolls and islands is logistically challenging.

Harvest by humans is a serious concern, particularly for green turtles that have predominantly been used for food (NMFS and USFWS 1998 in Pilcher et al., 2021) and hawksbills also used for trade (Miller et al., 2019). Nonetheless, there often isn't a clear distinction between species, nor harvest levels. Unless otherwise indicated, the studies mentioned below refer to the take of all marine turtles. Maison et al. (2010) indicate that there have been uncontrolled, long-term harvests of turtle eggs and females in FSM that are likely to have had an impact on current population numbers. In RMI, turtles have historically been a food source and played an important cultural role. Egg collecting and harvest of turtles while they are onshore is prohibited at all times, but current levels of exploitation are unknown (Maison et al., 2010). In Palau, hawksbill turtles are taken to support a tradition of gift exchanges of toluk (tortoiseshell currency) (Pilcher, pers. obs.), despite traditional closures and a current moratorium banning the take of turtles or eggs. While many pieces of toluk are heirloom artefacts, it is unknown what proportion of new pieces are added to the tradition each year. In the Cook Islands, turtles are occasionally killed and eaten at Tongareva, Rakahanga, Manihiki, and Palmerston, and probably at other atolls, but the true level of direct take remains unclear (White, 2012). There are no estimates or reports of adult or egg harvests for Kiribati, Nauru, Niue, the Pitcairn Islands, Tokelau, Tuvalu, or Wallis and Futuna.

In Papua New Guinea, Opu (2018) found that the highest catches of turtles occurred in Manus, Milne Bay, and Western Provinces. Although the report estimates 4,760 turtles (all species) in 2016 and 5,320 turtles (all species) in 2017 were landed in various Papua New Guinea markets over the survey period, these numbers are likely an underestimate of the true degree of turtle harvest in Papua New Guinea, given the limitations of the survey method (37 stakeholders interviewed over 15 maritime provinces) and that many landed turtles were likely used for personal consumption, cash sales or in the barter trade or in the barter trade were not reported. However, it remains unquantified how many were hawksbills.

Vuto et al. (2019) provides a recent update on turtle harvests in the Solomon Islands. Modelled data (based on coastal community location, footprint of fisheries and existing average catch rates per hectare of reef in localities with both typical and high levels of turtle harvesting) estimated that 9,473 (95% CI: 5,063 to 22,423) turtles were harvested each year with hawksbill turtles accounting for 2,435 turtles (26%) of the estimated total harvest. Over 90% these turtles were harvested by free divers (The Nature Conservancy unpublished data) and juvenile turtles comprised 1,860 (76%) of hawksbill captures; the remaining were adult-sized turtles (equating to 575; >75cm in carapace length, sex unknown, but likely caught near nesting localities). Hawksbill turtle meat was most commonly used for subsistence purposes (82%) and were most likely to be consumed by the family of the fisher that captured the turtles. However, the shells of 88% of hawksbill turtles harvested were sold to local buyers, who frequently on-sold to Asian buyers in Honiara.

Picture 3. Climate change leads to higher incubation temperatures and to changes in sex ratios © Veronica Joseph/ WWF-Australia

In Vanuatu, there is a strong programme of local turtle monitors that aids in protecting turtles and convincing local communities to participate in turtle conservation efforts (Hickey and Petro, 2005). Past estimates suggest turtle harvest may have been in the region of 1,500 turtles per year, although Hickey and Petro (2005) suggest that much of this harvest has since ceased. However, a recent survey found that people still catch some turtles intentionally to eat and sell (Shaw, unpublished data). While Shaw's study site was not representative of the island chain as a whole, it does indicate that turtle captures continue to this day, and that updated estimates of take and trade are needed.

Collaborative efforts to understand the drivers and annual levels of hawksbill turtle harvest and trade are underway. In collaboration with governments, WWF and SPREP are supporting the delivery of a sociocultural survey in Papua New Guinea, Fiji, and Tonga. The project is part of WWF's broader Cracking the Code for Recovery - Protecting Turtles for Tomorrow Strategy, which will collect and synthesise data on turtle use, trade, and genetics to advocate for targeted policy action to recover Asia-Pacific hawksbill turtle populations.

Climate change

Countries in the western Pacific are highly vulnerable to the effects of global climate change. A recent study (Patrício et al., 2021) reviewed the impacts of climate change to marine turtles globally and highlighted that, even if marine turtles survive as a group, species with restricted distribution ranges and depleted populations are likely to be most vulnerable.

Changes in sex ratios due to higher incubation temperatures are likely to affect the population dynamics of hawksbill turtles. Rising sand temperatures can negatively impact marine turtle population function by producing clutches that are extremely female-biased (i.e. feminizing the population) and by causing excessive mortality of eggs and/or hatchlings. Feminization of turtle populations is already occurring in the Pacific at Australia's largest green turtle rookery (Jensen et al., 2018; Booth et al., 2021). However, of note are the marine turtle populations in the Arabian Gulf, where temperatures have long remained high, but do not seem to produce feminised stocks (Pilcher et al., 2015). Whereas Chatting et al. (2021) future forecast of hawksbill turtle hatchlings sex ratios from rookeries in Qatar predicted female bias in current and 2100 populations to be around 75% and >85%, respectively. Hence, the situation is not clear (historically or in the future), and there are likely to be different thermal thresholds for each species and population. In the central west Pacific, Summers et al. (2017) reported reduced hatching success and embryonic death above 34 °C for green turtles in CNMI, and that these impacts, combined with egg poaching, could decrease the abundance of nesting females.

There is a high risk of loss of nesting habitat due to sea level rise, which is projected to reach one metre in the Pacific by 2100 (IPCC, 2019). Most of the volcanic islands in the western Pacific are barely a few metres above sea level (Oppenheimer et al., 2019). However, recent studies have suggested that some atolls and islands are actually growing (Hollingsworth, 2020) and may be less vulnerable than expected to the impacts of sea level rise. Jeh Island, in the Marshall Islands, has increased in size by 13% since the 1940s (Ford et al., 2020). Thus, estimates of nesting habitat loss due to rising seas should be made at scales that can be supplemented with location-specific data, rather than basin-wide estimates (Pilcher, 2021).

Possibly of greater consequence, projected increases in the severity of tropical cyclones and hurricanes (IPCC, 2007) could cause accelerated erosion of nesting beaches and degradation of foraging habitats (coral reefs and seagrass meadows) (Work et al., 2020). Hawksbills are also likely to be impacted by loss of coral reef habitat through bleaching caused by marine heat waves.

Marine debris and plastic pollution

Marine debris, and plastic pollution in particular, has been increasingly recognised as a serious and widespread threat to marine turtle populations globally (Schuyler et al., 2014; Schuyler et al., 2015; Wilcox et al., 2013; Duncan et al., 2019; Duncan et al., 2021), and especially to hawksbill turtles (see Lynch, 2018).

The main threats that plastics pose to turtles are ingestion of plastic fragments and plastic bags, entanglement in abandoned, lost or discarded fishing gear (ALDFG) (also called ghost gear), and contamination of nesting and foraging habitat. Ingestion of plastics can be directly life threatening through intestinal blockage (Kühn and Van Franeker, 2020), as well as through introduction of toxic substances (either accumulated on the plastic surface (Rochman et al., 2013) or from the plastic itself). The population level impacts of plastic ingestion are still unknown. Entanglement in ALDFG can result in damaged limbs and drowning (Stelfox et al., 2016). The mechanisms enabling accumulation of heavy metals and chemical contaminants in turtles have been studied (Kittle et al., 2018; Leusch et al., 2020), but little is known about the effects of plastic pollution on turtle health.

More research on the impacts of marine debris and plastic pollution is needed for the western Pacific region. Hamann et al. (2022) note six key areas requiring investigation: 1) quantification of health impacts across populations and life stages; 2) toxicological impacts on turtle health; 3) the role of debris particles as vectors for heavy metal and chemical contamination (see Clukey et al., 2018); 4) identification of the oceanographic forces that disperse pollution; 5) understanding the social and economic drivers contributing to the creation of pollution; and 6) the barriers and opportunities for improved management of marine debris and plastic pollution (see Vegter et al., 2014; Nelms et al., 2015; Duncan et al., 2017).

7. Management and protection

Countries in the western Pacific Ocean have adopted a variety of regional international agreements aimed at protecting hawksbill turtles and their habitats or to mitigate threats that may directly or indirectly affect hawksbills (Table 3). On a national scale, hawksbill management and protection vary from country to country. For example, in Papua New Guinea, hawksbill turtles remain unprotected, whereas in Fiji there is currently a total ban on all take, sale, possession and transport. Whilst a marine species legislative review was conducted for Asian countries (Ezekiel, 2018), no comprehensive marine turtle policy and legislative review has been undertaken in the western Pacific Ocean region, but is urgently required to understand gaps and inconsistencies.

A coordinated regional effort towards the conservation of hawksbill turtles through collaborative efforts, linkages between countries, and the exchange of information at the national, regional, and global levels is needed if hawksbill populations are to recover. Such an effort is constrained by limited resources, both financially and in terms of capacity to implement many management actions in the western Pacific Ocean region. However, SPREP's Regional Marine Turtle Action Plan 2021-2025 (that came into effect in 2022) will help provide direction and support.

Picture 4. Researcher catching a hawksbill turtle for monitoring, Papua New Guinea © Christine Hof/WWF-Australia

Table 3. Selection of regional and international Legally and Non-legally Binding Instruments and Relevant Bodies.
Tick mark (✓) indicates adoption, ratification, or membership. For more detail, please refer to CMS/IOSEA/Hawksbill-SSAP/Inf.5.

Asia-Pacific Signatories and Parties	CITES	CBD	CMS	UNCLOS	RFMOs	PSMA	Ramsar Convention	IOSEA Marine Turtle MOU	MOU ASEAN Sea Turtle Conservation and Protection	CTI-CFF	London Declaration (IWT)	SSME Regional Action Plan	SPREP
American Samoa (USA)	✓			✓	✓	✓	✓	✓		✓	✓		✓
Australia	✓	✓	✓	✓	✓	✓	✓	✓			✓		✓
Brunei Darussalam	✓			✓					✓				
Cambodia	✓	✓				✓	✓	✓			✓		
China	✓	✓		✓	✓		✓				✓		✓
Cook Islands		✓	✓	✓	✓	✓	✓						✓
Federated States of Micronesia		✓		✓	✓								✓
Fiji	✓	✓	✓	✓	✓	✓	✓						✓
French Polynesia (France)	✓	✓	✓	✓	✓	✓	✓				✓		✓
Guam (USA)	✓				✓	✓	✓	✓			✓		✓
Hawaii (USA)	✓				✓	✓	✓	✓			✓		
Hong Kong (China)	✓	✓	✓	✓			✓						
Indonesia	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	
Japan	✓	✓		✓	✓	✓	✓				✓		
Kiribati		✓		✓	✓		✓						✓
Lao People's Democratic Republic	✓	✓		✓			✓		✓		✓		
Malaysia	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	

Asia-Pacific Signatories and Parties	CITES	CBD	CMS	UNCLOS	RFMOs	PSMA	Ramsar Convention	IOSEA Marine Turtle MOU	MOU ASEAN Sea Turtle Conservation and Protection	CTI-CFF	London Declaration (IWT)	SSME Regional Action Plan	SPREP
Marshall Islands		✓		✓	✓		✓						✓
Myanmar	✓	✓		✓		✓	✓	✓	✓		✓		
Nauru		✓		✓	✓								✓
New Caledonia (France)	✓	✓	✓	✓	✓	✓	✓				✓		✓
New Zealand	✓	✓	✓	✓	✓	✓	✓				✓		✓
Niue		✓		✓	✓		✓						✓
Northern Marianas (USA)	✓					✓	✓	✓			✓		✓
Palau	✓	✓	✓	✓	✓	✓	✓						✓
Papua New Guinea	✓	✓		✓	✓		✓	✓		✓			✓
Philippines	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Republic of Korea	✓	✓		✓	✓	✓							
Samoa	✓	✓	✓	✓	✓		✓						✓
Singapore	✓	✓		✓					✓		✓		
Solomon Islands	✓	✓		✓	✓					✓			✓
Taiwan (China)				✓	✓								
Thailand	✓	✓		✓		✓	✓	✓	✓		✓		
Timor-Leste		✓		✓						✓			
Tokelau				✓			✓						✓

Asia-Pacific Signatories and Parties	CITES	CBD	CMS	UNCLOS	RFMOs	PSMA	Ramsar Convention	IOSEA Marine Turtle MOU	MOU ASEAN Sea Turtle Conservation and Protection	CTI-CFF	London Declaration (IWT)	SSME Regional Action Plan	SPREP
Tonga	✓	✓		✓	✓	✓							✓
Tuvalu		✓		✓	✓								✓
United States of America	✓				✓	✓	✓	✓			✓		✓
Vanuatu	✓	✓		✓	✓	✓	✓						✓
Viet Nam	✓	✓		✓		✓	✓	✓	✓		✓		
Wallis and Futuna (France)	✓	✓	✓	✓	✓	✓	✓						✓

Blue: Countries within the range of the IOSEA Marine Turtle MOU, and adjacent areas
Orange: Western Pacific countries and territories

8. Southwest Pacific Ocean

Solomon Island management unit

The nesting hawksbill population in the Solomon Islands MU is considered genetically distinct (Vargas et al. 2015). These samples were only collected from hawksbills nesting in the ACMP. There are unsampled rookeries throughout the Solomon Islands and other countries in close proximity, for example Papua New Guinea, meaning hawksbills from this management unit may occur throughout the western Pacific; however, this remains to be determined.

Ecological range

The ACMP in the western Solomon Islands supports the largest rookery for hawksbill turtles in the oceanic South Pacific (Hamilton et al., 2021; Pilcher, 2021). Hawksbill turtles nest throughout the year in the ACMP, with peak nesting activity occurring from approximately May to July, with a second shorter nesting peak occurring from December to January. In peak periods, the number of nests laid per month are approximately double those laid in quieter nesting periods. During the May to July nesting peak, approximately 3-4 hawksbill turtle clutches are laid within the ACMP each night (Hamilton et al., 2015). In the past 15 years, it is estimated that between 1000-1500 nests have been laid in the ACMP each year, representing 200-300 breeding turtles annually. Initial beach surveys that were conducted in the ACMP from the mid-1970s to 1995 revealed that the island of Kerehikapa accounted for 51–65% of all clutches laid in the ACMP, however by 2000, greater nesting activity was occurring on Sikopo Island (Mortimer, 2002). The increasing nesting activity on Sikopo has coincided with conservation efforts and the chronic erosion of low-profile nesting beaches on Kerehikapa between 1991 and 2020 (Hamilton et al., 2021). The ACMP is an important hawksbill turtle breeding site, with mating hawksbill turtles observed on numerous occasions over the past 30 years at five locations within the ACMP (Hamilton et al., 2021). The genetic characterisation of this management unit is based solely on samples from the ACMP, and the geographical boundaries of the management unit remain unknown but are likely to extend across the Bismarck-Solomon Sea area, including rookeries in Papua New Guinea (Bell and Jensen, 2018).

Geographic spread of foraging sites and migration

Hawksbill turtles from this management unit forage across the southwest Pacific region. Genetics studies from the Great Barrier Reef (Howick Group) show that the majority of turtles foraging at this nGBR foraging site (83%) originated from the Solomon Island management unit (Bell and Jensen, 2018). Flipper and satellite tagging studies show that many hawksbills that nest at the ACMP make long distance migrations to foraging grounds in Australia, Papua New Guinea and New Caledonia (Vaughan and Spring, 1980; Parmenter, 1983; Mortimer, 2002; Limpus et al., 2008; Hamilton et al., 2015; Bell and Jensen, 2018; Hamilton et al., 2021), while a small proportion of ACMP nesters travelled to nearby foraging grounds in Solomon Islands. Hamilton et al. (2021) satellite tracked 30 female hawksbill turtles that were nesting in the ACMP, and these turtles had a mean migration distance between nesting and foraging grounds of 2028 km ± 222 km, much further than the mean migration distance reported for any other nesting hawksbill turtle population (e.g. Parker et al., 2009; Gaos et al., 2012; Hart et al., 2019).

Satellite tracking has revealed that many of the turtles that nest in the ACMP follow a common post nesting migratory corridor before dispersing across the Solomon and Coral Sea (Hamilton et al., 2021). Sixteen of the ACMP nesters that were tracked to their foraging grounds by Hamilton et al. (2021) displayed short-term fidelity to specific sites (mean 50% utilisation density (UD) 1.1 km^2 ± 0.3 km^2), with one individual demonstrating foraging site fidelity over multiple post-nesting migrations. Many of these 16 hawksbills established foraging sites on outer barrier reefs, with several turtles also foraging on inshore reefs close to the Queensland mainland.

Juvenile foraging hawksbill turtles comprise a small portion of total catch in multispecies coral reef fisheries throughout Solomon Islands (i.e. Hamilton et al., 2012; Vuto et al., 2019). Juveniles and some adults have been observed foraging on coral reefs in multiple locations in Solomon Islands including Kolombangara (Argument et al. 2009) and Marovo Lagoon in New Georgia (Green et al. 2006). Howard (2022) reported 105 juveniles were tagged foraging in Kolombangara between 2013-14 (cited in Esbach et al. (2014)), and 12 tagged while foraging in Tetepare between 2004-2008 (cited as unpublished data, Tetepare Descendants Association).

The TREDS database contains over 140 records of foraging hawksbill encounters from Wagina Island (Choiseul Province), Santa Isabel (Arnavons, Kia Village, Sire Bay), and Tetepare Island.

Geographic spread of nesting

Index nesting beaches: Nesting is concentrated in the ACMP, and the islands of Sikopo and Kerehikapa are designated as the index nesting beaches for this management unit.

The TurtleNet records approximately 25 localities and the TREDS database contains over 1,200 records of

Table 4. Historical and current hawksbill turtle nesting sites and estimated number of nests (not always taking into account re-nesting) in Solomon Islands (Adapted from Howard, 2022).

Site/Island	Estimated numbers of nests/year	Source
Arnavon Islands	1000-1500 nests	Hamilton et al. (2015)
Shortland Islands	400-500 nests	Vaughan (1981)
	Bagora/Obeani Is.: 50-100 nests Balaka Is.: 50-100 nests	Wilson et al. (2004)
Ramos Islands	50-100 nests (combined with green turtles)	Vaughan (1981); Wilson et al. (2004)
Choiseul Islands	230-450 nests (mostly on Haycock and Wagina Islands)	Vaughan (1981)
Tetepare Island	5 nested between 2005-2007	TDA, unpublished data
Makira	~50-100 nests (combined with green turtles)	Vaughan (1981)
Russell Islands	50-100 nests	Wilson et al. (2004)
Hele Bar islands (Marovo)	50 nests	Wilson et al. (2004)
Santa Cruz	50-200 nests	Wilson et al. (2004)
Kolombangara	Nesting recorded but no data	Esbach et al. (2014)
Ngalo Island	Nesting recorded but no data	Ceccarelli (2018)
Munda/Gizo barrier islands	Nesting recorded but no data	Dr. Alec Hughes, pers comm (2022)
Ontong Java Island	Nesting recorded but no data	Ceccarelli (2018)
Cross Island (Gizo)	Nesting recorded but no data	Vaughan (1981)

'nesting' hawksbill encounters, overwhelmingly from the Isabel Province (Kerehikapa Island in the Arnavons), and the Obeani Group in Western Province. A list of historical and current hawksbill nesting sites in the Solomon Islands with an estimated number of nests was recently published in Howard (2022) and can be found in Table 4.

Trends in nesting data

Nesting numbers are increasing in the ACMP, with the number of nests laid at the ACMP islands of Big Maleivona, Kerehikapa, Sikopo, and Small Maleivona combined doubling since its establishment in 1995 (Hamilton et al., 2015). No other long-term data is available to assess trends at other nesting sites.

Threats to the population

Quantitative information on the impact of threats in Solomon Islands is limited, except in the case of use and trade, and some data on climate change impacts (i.e. nest inundation from flooding (Howard, 2022)).

Hawksbill turtles and eggs are harvested in the Solomon Islands, mainly for subsistence purposes. Some historically important hawksbill nesting beaches now appear to be functionally extinct. For example, historically >100 hawksbill nests were laid annually at Haycock Island, Wagina, Choiseul (Vaughan, 1981). But since the early 1990s, permanent Gilbertese communities have been established on Haycock Island, and any turtles that still return here to nest face a very high probability of being killed for food (John Pita, personal communications). Vuto et al. (2019) more recently calculated that hawksbill turtles comprised 2,435 (26%) of all turtle captures (in an annual country survey) of which 575 (or 24%) are adult-sized (sex unknown) reported to be likely caught near nesting localities (beaches and breeding grounds) despite Solomon Island legislation banning the harvesting of turtle eggs or a nesting turtle (Fisheries Management Prohibited Activities Regulations, 2018). Based on all available data, Pilcher (2021) estimated that between 2,500 and 5,000 hawksbill turtles are likely taken each year in the Solomon Islands, though these figures require further investigation.

Despite legislation in 1993 banning the trade in turtle products, the tortoiseshell trade remains active in the Solomon Islands. Vuto et al. (2019) reported the sale of hawksbill shell in three of the 10 communities surveyed, but was only a common practice in one (Wagina). In the Wagina community, Vuto et al. (2019) found that the shells of 87.5% of hawksbill turtles harvested were sold to local buyers, who then on-sold to Asian buyers in Honiara. LaCasella et al. (2021) used mtDNA extracted from tortoiseshell products for sale at local markets in Papua New Guinea and Solomon Islands (Honiara) and demonstrated that nine of the 13 tortoiseshell products were from turtles with haplotypes found primarily at the Solomon Islands management unit. In the past, the export of tortoiseshell from the Solomon Islands was ranked among the ten highest globally (NMFS and USFWS, 1998; Miller et al., 2019), peaking at around 4,000 kg of hawksbill shell exported per year in the late 1980s (Limpus and Miller, 2008).

Nesting beach erosion, and compromised or lost hawksbill clutches due to climate change, remain a key and ongoing threat to many hawksbill nesting sites (Foale et al., 2017). Since 1993, sea levels have risen by approximately 8mm per year (more than the global average of 2.8-3.6mm per year) and are expected to continue to rise 4-15cm by 2030 (Anon, 2011).

Similarly, annual maximum air temperatures have increased (in Honiara by 0.15˚C per decade since 1951; Howard, 2022). Although hatchling survival in the nest and sex-determination is governed by sand temperature, there is limited nest temperature monitoring on any nesting beach in the Solomon Islands. Where there are known hatcheries (for other species than hawksbills), there is concern hatcheries are not being monitored, as high temperatures potentially feminize the incubating clutches within the hatcheries. Sand temperature monitoring within the nest chamber to gauge the effect of rising global temperatures on embryonic development in the Solomon Islands is needed (Howard, 2022).

Whilst predation of nests by crabs, megapodes, rats and iguanas (Wilson et al., 2004) remains a problem at some hawksbill nesting beaches in the Solomon Islands, there appears to be no quantitative or qualitative reporting on the impact of other known marine turtle threats, including light pollution, plastic pollution, ghost nets, unsustainable coastal development, boat strikes and fibropapilloma disease within Solomon Island (Howard, 2022).

Picture 5. A critically endangered hawksbill turtle encountered during a dive off northern Kia Island. © Tom Vierus/ WWF-US

Summary of threats to the Sulu Sea MU of hawksbill turtles

Type of threat	Known or likely location of impact 1=nesting beach 2=oceanic/high seas 3=coastal foraging areas	Quantified 1=comprehensive documentation across population 2=comprehensive documentation for some of the population 3=non-published evidence only 4=not quantified
Consumption – nesting beach		
Egg collection	1	2
Commercial use of turtles	1,2,3	2
Non-commercial use of turtles	1,2	1
Predation of eggs by non-native fauna	1	3
Predation of eggs by native fauna	1	2
Consumption – foraging turtles		
Commercial use of turtles	2,3	2
Non-commercial use of turtles	2,3	2
Climate change impacts		
Increasing beach temperature	1	4
Beach erosion	1	2,3
Sea level rise	1	4
Coastal development		
Habitat modification (urban)	1	4
Habitat modification (industrial)	1	4
Light horizon disorientation	1	4
Fisheries impacts		
Bycatch – trawl	2,3	4
Bycatch – longline	2	3
Bycatch – gillnet	3	3
Impact to benthic ecology from fisheries	3	4
IUU fishing	2,3	4
Pollution		
Water quality	3	4
Entanglement in discarded fishing gear	2,3	4
Ingestion of marine debris	2,3	4
Noise pollution	3	3
Disease and pathogens	3	4

Management and protection

Under existing Solomon Islands law, only the leatherback turtle (*Dermochelys coriacea*) is fully protected. Hawksbills can be legally harvested for subsistence purposes, excluding eggs and the harvesting of nesting females. Additional protection is afforded under the ACMP, prohibiting egg and turtle harvesting (since 1995). The sale of any hawksbill product (meat, eggs or shell) is banned (Fisheries Management Prohibited Activities Regulations, 2018). International instruments applicable to hawksbill turtles in Solomon Islands are listed in Table 3.

Biological data – breeding

Parameter	Value	Reference(s)
Pivotal temperature		
Remigration interval	modal inter-nesting interval of 14 days [range 12–19 days]	McKeown 1977; Hamilton et al., 2021 (see SEM data)
Clutches per season	3-6	Mortimer 2002; Hamilton et al., 2021 (max 6)
Mean size of nesting adult (CCL)	88 cm (75.5-93) 84.3 cm (82-90) 86.6 cm (78.4-96.5)	McKeown 1977 Leary 1992 Hamilton et al., 2021
Age at maturity		

Biological data – foraging

Parameter	Value	Reference(s)
Mean size at recruitment (to inshore foraging) (CCL)	69.9 cm	Bell and Pike 2012
Growth rates (from Howick Group, nGBR)	2.5 cm/yr at 60-70 cm 0.5 cm/yr at 70-80 cm 0.6 cm at 80-90 cm	Bell and Pike 2012
Sex ratio – in foraging populations adults	97% female (A)	Bell and Jensen et al. 2018
pubescent immature	85% female (SA)	Bell and Jensen et al. 2018
large pre-pubescent immature		
small pre-pubescent immature	96% female (J)	Bell and Jensen et al. 2018

Papua New Guinea

Geographic spread of foraging sites

There is a lack of data on foraging sites for hawksbill turtles in Papua New Guinea. Tagged hawksbills have been recovered at Fishermen's Island (Central Province), Tagula Island (Milne Bay Province), and other locations within Milne Bay Province. The TREDS database contains records of foraging hawksbill encounters at Tureture reef in Western Province, Fishermen's Island in Central Province, Kavieng in New Ireland Province, and on the northern coast of Papua New Guinea.

Geographic spread of nesting

Hawksbill turtle nesting has been recorded in multiple provinces throughout Papua New Guinea, although population densities are unknown. Surveys in the 1970s found hawksbill nesting in the following locations: East Sepik Province at Laboin Island, Musschu Island, Kairuru Island, Wuvulu Island, and Kaniet Island; Manus Province at Pak Island, Los Reyes Islands, Harengan Island, Paluwak Island, Bipi Island, and the Ninigo Group of Islands; New Ireland Province in the Boloma Group of Islands, Emirau and Mussau Islands, and the Tanga Islands; East New Britain at Nuguria; Madang Province

on the north and south coasts and at Long Island; and in Western Province along the whole coast. More recently, hawksbill nesting has been reported at numerous islands in the Jormad Passage and Conflict Islands groups in Milne Bay Province (Wangunu, 2004). A detailed review of historical records of hawksbill nesting in Papua New Guinea is provided in Kinch (2020) (in Work et al., 2020).

The TREDS database contains 27 records of nesting hawksbills throughout multiple islands of Milne Bay Province (Panarairai, Lunn, Jomard, and Irai), one hawksbill turtle nesting in Wide Bay of East New Britain Province, and one nesting hawksbill turtle on Suau Island on the south coast of Milne Bay Province.

Trends in nesting data

There are no data on long-term trends in nesting hawksbill turtle populations in Papua New Guinea. Mortimer and Donnelly (2008) suggested that 500 to 1,000 females may nest annually in Papua New Guinea. In Milne Bay Province, the Conflict Island Conservation Initiative have now tagged a total of 130 nesting hawksbill turtles between 2017-2020 (CICI, 2021). Kinch (2020, in Work et al., 2020) reports several sites where nesting occurs, but surveys have been inconsistent and thus an updated assessment of nesting at a national level is not possible. Based on all available data, Pilcher (2021) suggests that the total nesting population may be less than 500 turtles per year.

Migration and distribution of foraging areas

Nesting and foraging hawksbill turtles from the northern Great Barrier Reef (Australia) are known to migrate to Papua New Guinea and several other nations (Miller et al., 1998; Hamilton et al., 2015). TREDS records indicate that one hawksbill turtle that was flipper tagged in Samoa was later reported as a tag recovery in Papua New Guinea; similarly, three foraging turtles that were tagged in Australia were later reported as tag recoveries in Papua New Guinea (Trevor, 2010). Other tagging data shows that an adult female hawksbill turtle that was tagged at Kerehikapa in the Arnavon Group of the Solomon Islands in December 1976 was later killed on its foraging grounds at Fisherman's Island, Central Province, Papua New Guinea in February 1979 (Vaughan and Spring, 1980). Similarly, one nesting hawksbill turtle that was satellite tagged at Kerehikapa in July 2001 migrated to its foraging grounds at Tagula Island in the far south-eastern end of the Milne Bay Province (Hamilton et al., 2015). Many turtles that were satellite tracked in the ACMP made post-nesting migrations through Milne Bay en route to Torres Strait Islands and GBR foraging grounds, with several ACMP nesters also returning to foraging grounds in Milne Bay (Hamilton et al., 2021).

Threats to the population

Papua New Guinea is identified as having the highest legal harvest of marine turtles globally (all species combined) and subsistence harvest of hawksbill turtles for meat, eggs, carapace and other products is widespread throughout the country (Humber et al., 2014). Coastal communities use turtles and turtle parts for a variety of reasons, including food, barter, selling for cash, and as part of cultural activities and celebrations (Opu, 2018). Opu (2018) estimated an annual turtle harvest of around 5,000 turtles (all species), with the highest take occurring in Manus Province, Milne Bay Province, and Western Province. It is currently not known what proportion of these are hawksbills. However, given the lack of data and the remoteness of many coastal villages where turtle harvest takes place, accurate figures for annual harvest – and the proportion of hawksbills – may be different across sites. Further research is needed to better understand this specific impact.

Hawksbills are widely targeted to produce tortoiseshell items, such as jewellery and other trinkets, mainly for international tourists (Kinch and Burgess, 2009). Decorative tortoiseshell items (e.g., jewellery, ornaments) are sold in major provincial centres (i.e. Port Moresby) as well as areas popular with tourism (Opu, 2018).

Other threats include bycatch and retention of hawksbills in coastal fisheries, and bycatch in commercial fisheries (Papua New Guinea's tuna fleet in the WCPFC area recorded 506 hawksbills caught as bycatch in 2017; see Annual Report to WCPFC, 2020).

Management and protection

Hawksbill turtles are not protected in Papua New Guinea. Even in Australia, the taking of hawksbill turtles by Papua New Guineans within Australia's EEZ (i.e. the Torres Strait Protected Zone) is allowed under the 1985 Torres Strait Treaty as long as they are traditional inhabitants of 'Treaty' Villages (Kinch, 2020 in Work et al., 2020). International instruments applicable to hawksbill turtles in Papua New Guinea are listed in Table 3.

Biological data on breeding and foraging

The Conflict Islands Conservation Initiative (CICI) initiated a nesting beach monitoring program in 2017, which includes quantification of nesting, flipper and satellite tagging, and the collection of morphometric data from nesting and foraging hawksbills. Scientific publication of 2017-2021 data is expected by the end of 2023. Prior to this, there have been limited quantitative studies on the nesting and foraging hawksbill turtles in Papua New Guinea.

9. West Central Pacific

Federated States of Micronesia (FSM)

Geographic spread of foraging sites

Hawksbill turtles are known to forage on nearshore reefs of FSM, but there is little documented information on the abundance or location of foraging activities (McCoy, 2020 in Work et al., 2020). The TREDS database contains 12 records of foraging hawksbill encountered at various sites across FSM from 1991 to 2018.

Geographic spread of nesting

Nesting by hawksbill turtles in FSM is believed to be rare. Buden and Edward (2001) indicate that nesting was infrequent in Pohnpei, although they were unable to provide a figure for annual nesting females. A single hawksbill was reported nesting on Losiep and Gielop islands in Ulithi from 2005-2008 (Yap Marine Resources Management Division 2005-2008, in Work et al., 2020). No hawksbill nesting has been reported for Yap (Buden, 2000). In December 2017, hawksbill turtle hatchlings were photographed emerging from a nest at Ant Atoll. Local Chief William "Willie" Hawley Sr. reported that a handful of hawksbill clutches are deposited each year, but limited funding to support patrols of the lagoon and islets of the atoll has prohibited accurate estimates (PIFSC unpublished data). Based on all available data, Pilcher (2021) estimated it is likely that less than 10 to 20 females per year nest at FSM. The TREDS database contains eight records of nesting hawksbills from 1990 to 2009.

Trends in nesting data

There is no information on nesting trends for hawksbill turtles in FSM.

Migration and distribution of foraging areas

No systematic monitoring has been carried out to document the abundance and distribution of hawksbill turtles in FSM waters. A large adult female hawksbill measuring 72.3 cm straight carapace length was captured by staff of the National Oceanic and Atmospheric Administration (NOAA) in the nearshore waters off of Tinian Island, in the Commonwealth of Northern Marianas Islands (CNMI), in July of 2014, and was fitted with a satellite transmitter. In April of the following year (2015), the turtle migrated towards Pohnpei, arriving at Ant Atoll on 01 July 2015, where it continued to transmit locations until April of 2016 (Gaos et al., 2020). Although it is unclear whether the hawksbill nested at either site, given the duration of stay at Ant Atoll, it is likely this area was a foraging / residential area for this turtle. Whatever the case, the migration demonstrates adult hawksbill connectivity between CNMI and Pohnpei.

Threats to the population

Hawksbill turtles in FSM are threatened by illegal harvest of nests, bycatch, and hawksbills are killed for their carapace (McCoy 2020 in Work et al., 2020). Nest depredation by ghost crabs, monitor lizards, and wild pigs have been documented for green turtle nests in FSM (see Pilcher, 2021), may potentially affect hawksbill turtle nests where they occur. Given the low numbers of turtles nesting in FSM it is unknown what proportion of turtles are impacted by these threats.

Management and protection

The harvest of hawksbill turtles is allowed in FSM, with provisions for minimum size limits for hawksbills (27 inches=~68.5 cm curved in front of carapace length (CCL)) and closed seasons (June 1 to August 31 and December 1 to January 31). Harvesting of eggs is not allowed for any species. National jurisdiction covering marine turtles applies only beyond 12 miles in the Exclusive Economic Zone, and thus does not apply in practice to most of the turtle-related activities occurring in FSM. States of Yap, Kosrae, and Pohnpei match national regulations concerning minimum size and closed seasons for hawksbill turtle harvest. In 2014, the Yap State Environmental Protection Agency (EPA) banned the shipment of any seafood – including turtles – from the Yap outer islands to Yap mainland. The ban also restricts turtle catch to one turtle per vessel per week and prohibits catch between March and August, inclusive (cited in Balk, 2016). The municipality of Sapwuahfik, an atoll about 90 miles southwest of Pohnpei Island, banned the hunting of turtles following two incidents of chelonitoxication from hawksbill turtles that caused the deaths of several people on the island (Buden, 1999). Further details on turtle protection in FSM are provided in Hickey (2020) (in Work et al., 2020). International instruments applicable to hawksbill turtles in FSM are listed in Table 3.

Biological data on breeding and foraging

There is no biological information on hawksbill turtle breeding and foraging in FSM.

Guam

Geographic spread of foraging sites

Hawksbill turtles have been recorded foraging and residing in the nearshore waters of Guam during NOAA in-water surveys (Martin et al. 2016,2018; Gaos et al. 2020). The coral reefs along north-western Guam (Double Reef) and near the mouth of Apra Harbor may be particularly important for hawksbill turtles as relatively high densities were observed in these areas during these surveys. The TREDS database has 5 records of encounters with non-nesting hawksbills, including mortality in fishing gear and stranded turtles.

Geographic spread of nesting

No hawksbill turtle nesting has been recorded in Guam since 2008, during which four hawksbill nesting attempts were recorded at Dakiki Beach (Grimm and Farley, 2008; Kelly, 2020 in Work et al.; 2020). The TREDS database contains 11 records from 1991 to 1995 of hawksbill nesting encounters at Sumay Marina, Cetti Bay, Sella Bay, and Tarague Beach.

Trends in nesting data

There are no consistent records of nesting hawksbill turtles in Guam that would allow for an evaluation of nesting trends, however reports suggest extirpation may have already occurred (Eldredge, 2003, in Work et al. 2020).

Migration and distribution of foraging areas

Aerial turtle surveys found that 15% of turtles in marine habitats of Guam are hawksbills, with mean abundance estimates of 101 to 196 hawksbills found between 2008 and 2012 (Martin et al., 2016). Between 2013 and 2019, of the 357 non-capture turtle observations in Guam, 258 (72.3%) were identified as green turtles, 19 (5.3%) as hawksbill turtles, and 80 (22.4%) as "unknown" species (but either green or hawksbill turtles) (Gaos et al., 2020).

Preliminary assessment from 14 satellite tagged and tracked hawksbill turtles in nearshore foraging habitats around Guam, Tinian, and Saipan revealed high foraging site fidelity and limited movements (Martin et al., 2018; Gaos et al., 2020). Gaos et al. (2020) described one sub-adult hawksbill (61.7 cm straight carapace length (SCL)) captured in nearshore waters of Tinian (CNMI) in 2013. It was equipped with a satellite tag and subsequently traveled 233 km south to the Achang Reef, on the southern coast of Guam (Figure 4) where it remained for over 2 years until the tag ceased transmitting. It is possible this turtle underwent some sort of ontogenetic habitat shift as it was getting closer to maturity, or that it reached maturity at a smaller size than expected and moved to breed (Gaos et al., 2020).

Threats to the population

Hawksbill turtles in Guam are threatened by fisheries bycatch, boat strike, foraging habitat degradation, and coastal development, as well as human activities such as intentional take, harvest for the tortoiseshell trade, and plastic pollution. Prior hawksbills nesting in Guam are impacted by predation by monitor lizards, wild pigs, rats, and crabs (Cummings, 2002). The TREDS database contains records of hawksbill turtle strandings at Andersen Air Force Base, Pago Bay, and Jeff's Pirate Cove (Ipan), and one turtle found at Capras with plastic and metal in its intestine.

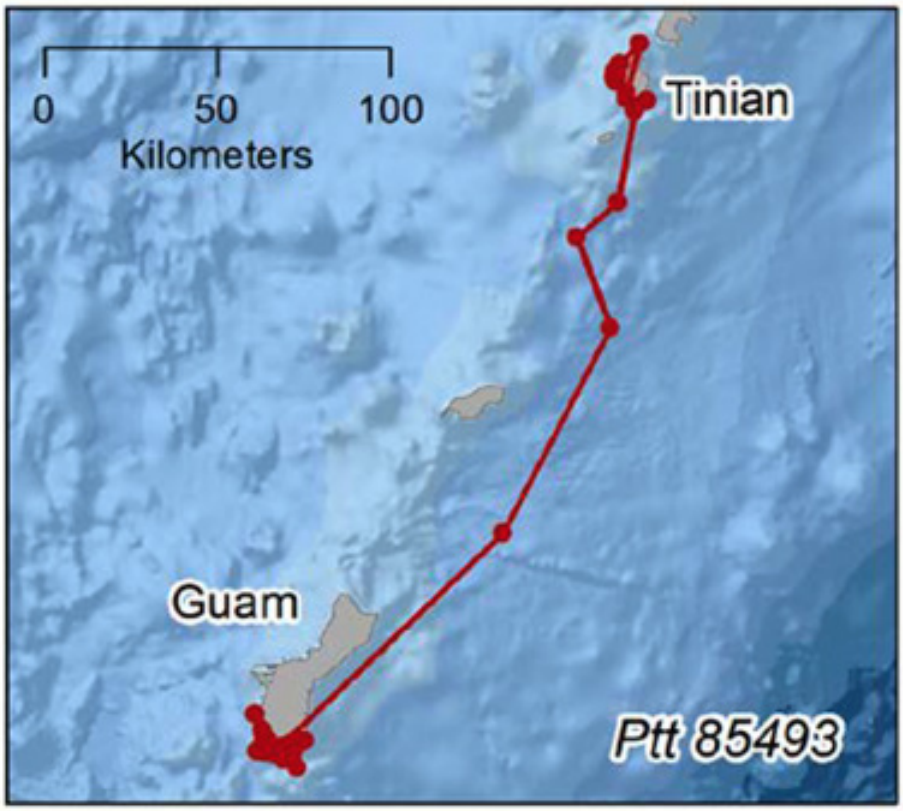

Figure 4. CNMI caught sub-adult hawksbill satellite tracked to Guam (Gaos et al. 2020).

Management and protection

Hawksbill turtles are protected on Guam by the Endangered Species Act (USA) and the Endangered Species Act of Guam. As a US territory, Guam must also uphold its responsibilities under all relevant conservation agreements (e.g. CITES, CMS, CBD). International instruments applicable to hawksbill turtles in Guam are listed in Table 3.

Biological data on breeding and foraging

There is no biological data for breeding hawksbill turtles in Guam. Three juvenile foraging hawksbills were tagged and recaptured between 2014 and 2019 on Guam, including two hawksbills that were captured on a total of three occasions (Gaos et al., 2020). The longest period between original capture and most recent capture for one of the hawksbills was 1,119 days, during which the turtle grew 4.4 cm SCL from 52.9 cm on 12 May 2016, to 60.1 cm on 05 June 2019. The turtle also increased 10.0 kg over that time period. Another hawksbill grew 4.6 cm over a period of 307 days, increasing from 42.3 cm SCL on 17 July 2014, to 46.9 cm on 20 May 2015. It increased 8.1 kg during that time. The third hawksbill grew 2.9 cm over 729 days, increasing from 68.2 cm SCL on 19 May 2015, to 71.1 cm SCL on 11 May 2017. The turtle increased 3.9 kg during that time.

The mean core (50% utilization distribution) and overall (95% utilization distribution) home ranges of three juvenile hawksbills equipped with satellite tags in Guam was 0.15 km^2 (sd = 0.17 km^2; range = 0.01–0.34 km^2) and 4.41 km^2, (sd = 7.07 km^2, range = 0.06–12.57 km^2), respectively (Gaos et al., 2020).

Nine hawksbills captured in Guam and CNMI, and equipped with satellite tags incorporating dive computers, revealed that they spent 93.1% of their time in waters <25 m in depth and used an average depth of 15.3 m (Gaos et al., 2020).

Kiribati

Geographic spread of foraging sites

Hawksbills are less abundant than green turtles in Kiribati. During SCUBA surveys conducted in the Phoenix Islands, three and five hawksbill turtles were observed over 11 days in May 2000 and 21 days in June 2002, respectively (Benson et al., 2007). Hawksbill turtles were not observed during a resource assessment conducted at Kanton Island in June 2017. The TREDS database includes three records of foraging juvenile hawksbill turtle encounters at three separate locations: Beru (Gilbert Group) in 2015, Abemama Island in 2010, and Tabiteuea South in 2014.

Geographic spread of nesting

No nesting records of hawksbill turtles in Kiribati are available. The TREDS database does not contain any records of nesting by hawksbills.

Migration and distribution of foraging areas

No tag recapture or genetic data are available to determine the source beaches of the in-water hawksbill population.

Threats to the population

Putative threats to marine turtles in Kiribati include incidental capture in commercial fisheries, habitat degradation, pollution, marine debris, boat strikes, and climate change (Buden, 1999).

Management and protection

Hawksbill turtles are fully protected in the Phoenix Islands Protected Area (PIPA). Kiribati is not a participating party to CITES. International instruments applicable to hawksbill turtles in Kiribati are listed in Table 3.

Biological data on breeding and foraging

There is minimal biological data on breeding and foraging hawksbills in Kiribati. There are only two records of hawksbill turtle encounters available in TREDS. The CCL measurements of the two hawksbill records are 30.0 cm and 69.9 cm.

Republic of the Marshall Islands (RMI)

Geographic spread of foraging sites

Hawksbill turtles have been reported at nearshore foraging grounds of at least 17 atolls in the RMI, including Majuro and Kwajalein (Parker, 2020 in Work et al., 2020). However, no information is available on pelagic movements or the migration of adult females or hatchlings from nesting beaches within the RMI. The TREDS database contains three records of foraging hawksbill encounters, all at Likiep Island with two in 1992 and one in 1993.

Geographic spread of nesting

Infrequent nesting by hawksbill turtles is reported to occur in the RMI, but no current data on abundance are available (Pilcher, 2021). Locations of reported nesting are spread across the RMI and not concentrated in a specific location (Figure 5). L. Tobin estimated that hawksbill turtles accounted for approximately 30% of total turtle nesting on Rongerik and Ailinginae Atolls (McCoy, 2004). Wotje Atolls has been suggested to possibly be the center of activity for hawksbill turtles (Puleloa and Kilma,

1992), and both Wotje and Erikub atolls have recorded hawksbills nesting, but in lower numbers than green turtles. The TREDS database contains one record of a nesting hawksbill at Wotje Atoll in 1992.

Trends in nesting data

Hawksbill turtle nesting is believed to be decreasing in the RMI (see Parker, 2020, in Work et al., 2020).

Migration and distribution of foraging areas

Hawksbill turtles have been reported foraging around at least 17 atolls throughout the RMI (McCoy, 2004; Rudrud, 2008) and have been photographed resting at atolls (Parker, 2020 in Work et al., 2020). No information is available on pelagic movements or the migration of adult females or hatchlings from nesting beaches within the RMI.

Threats to the population

Nesting hawksbill turtles in the RMI are threatened mainly by harvesting eggs and nesting females (McCoy, 2004; Rudrud, 2008). Other anthropogenic threats include sand mining on inhabited islands such as Majuro (Hay and Sablan-Zabedy, 2005), coastal development, light pollution, contamination from nuclear testing, and marine debris. Natural threats to nesting hawksbills include sea level rise due to climate change, beach erosion from extreme weather events, and predation by rats, sand crabs, and seabirds. Threats to foraging and breeding hawksbill turtles include direct harvest, fisheries bycatch in pelagic and nearshore artisanal fisheries, and degradation of foraging and resting coral reef habitats (Parker, 2020 in Work et al., 2020). Commercial longline fisheries operate in the waters of the RMI, with 190 foreign licensed vessels fishing there in 2020. Mandatory bycatch reporting requirements came into effect on 1 January 2020, but data is not yet available; and collection may have been impeded by the COVID-19 pandemic.

Management and protection

The harvest of hawksbill turtles is permitted in the RMI, with provisions for minimum size limits (27 inches CCL) and closed seasons from June 1 to August 31 and December 1 to January 31 (Kabua and Edwards, 2010). Egg collecting and harvest of turtles at nesting beaches is prohibited at all times. The RMI is not a participating party to CITES. International instruments applicable to hawksbill turtles in the RMI are listed in Table 3.

Biological data on breeding and foraging

No biological information is available for breeding or foraging hawksbill turtles.

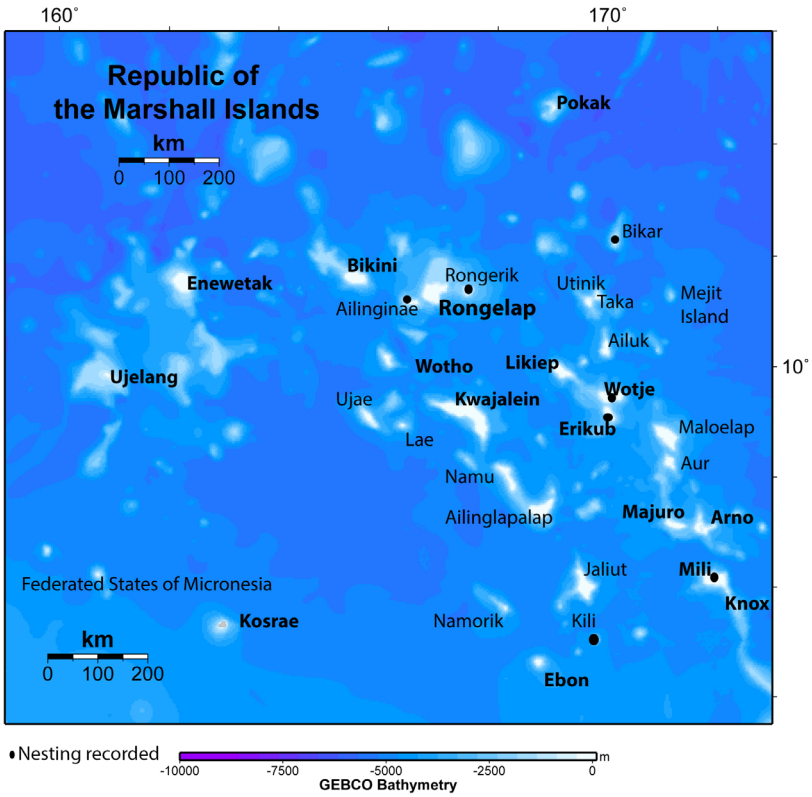

Figure 5. Distribution of reported hawksbill turtle nesting in RMI. From Parker, 2020 in Work et al., 2020.

Commonwealth of the Northern Mariana Islands (CNMI)

Geographic spread of foraging sites

Summers et al. (2017) and Gaos et al. (2020) documented predominantly juvenile and subadult sized hawksbills in the waters of the islands of Saipan and Tinian in CNMI. Of note is that numerous small hawksbills were observed along the northwest coast of Tinian, indicating this area may be of particular importance for small hawksbills that have recently recruited to neritic habitats after spending their first years of life in open-ocean pelagic habitats.

Geographic spread of nesting

There is no reported nesting of hawksbill turtles at CNMI (NMFS, 1998; Mortimer and Donnelly, 2008). Summers et al. (2013) and Summers et al. (2017) refer to hawksbill nesting, but do not provide further data.

Migration and distribution of foraging areas

NOAA staff surveyed the nearshore waters of the islands of Saipan and Tinian in CNMI between 2013 and 2019, during which time they captured 11 juvenile and one adult hawksbill and equipped them with satellite tags (Gaos et al., 2020).

One sub-adult hawksbill equipped with a satellite tag after being captured in the nearshore waters of Tinian, subsequently migrated to Guam (see Guam section). An adult hawksbill (72.3 cm SCL) equipped with a satellite tag after being captured in the nearshore waters of Tinian in 2014, subsequently migrated 2,118 km in 74 days to Ant Atoll, adjacent to Pohnpei, in the FSM (Figure 6). The turtle remained in the nearshore waters of Ant Atoll for 10 months, at which time the tag ceased transmitting. This individual was possibly making a long-distance migration to a known breeding site on Ant Atoll; however, it is also possible that it was concluding a breeding season near Tinian and returning to Ant Atoll to forage. All other juvenile hawksbills remained on the islands where they were originally captured and tagged.

Threats to the population

Hawksbill turtles in CNMI are primarily threatened by illegal harvest, marine debris entanglement, boat strike, and disease (Parker, 2020 in Work et al., 2020).

Management and protection

All marine turtle species occurring in U.S. territorial waters of the Western Pacific region are protected under the U.S. Endangered Species Act (ESA). International instruments applicable to hawksbill turtles in CNMI are listed in Table 3.

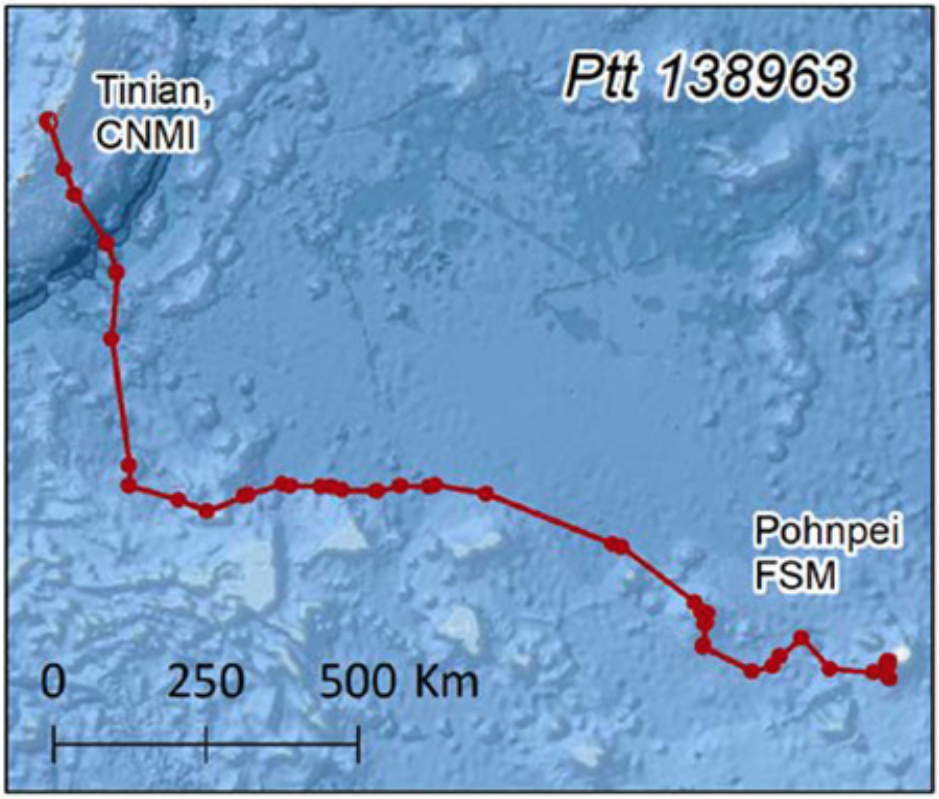

Figure 6. Adult hawksbill caught in Tinian, CNMI and satellite tracked to FSM (Gaos et al., 2020).

Biological data on breeding and foraging

There are no biological data for breeding hawksbill turtles in CNMI. Eleven foraging hawksbills were captured and equipped with satellite tags in the nearshore waters of CNMI between 2013 and 2019, including five on Saipan and six on Tinian. The mean core (50% utilization distribution) and overall (95% utilization distribution) home ranges of hawksbills on Saipan were 0.09 km^2 (sd = 0.13 km^2; range = 0.01–0.24 km^2) and 0.73 km^2 (sd = 1.08 km^2; range = 0.02–1.97 km^2), respectively, while on Tinian they were 0.37 km^2 (sd = 0.13 km^2; range = 0.28–0.46 km^2) and 2.20 km^2 (sd = 1.36 km^2; range = 1.24–3.16 km^2), respectively (Gaos et al. 2020).

Nine hawksbills captured in Guam and CNMI and equipped with satellite tags incorporating dive computers revealed that they spent 93.1% of their time in waters <25 m in depth and used an average depth of 15.3 m (Gaos et al., 2020).

Palau

Geographic spread of foraging sites

Hawksbill turtles are regularly reported foraging at the seagrass beds, lagoons, and extensive shallow coral reef habitat surrounding the islands of Palau. There has been an apparent steady decline in the population over the past 20 years (Rice, 2020 in Work et al., 2020). The highest concentrations of foraging hawksbills were reported from the Helen's Reef lagoon and the lagoon of the Rock Islands (Geermans, 1992). Sub-adult hawksbill turtles have also been observed foraging in the dive areas of Blue Corner and German Channel (Rice, 2000, personal observation). The TREDS database contains 6 records of foraging hawksbill (mostly juvenile) encounters, but some capture and location information is missing.

Geographic spread of nesting

Low level hawksbill turtle nesting is found across Palau, with 5-6 nesting locations reported (Rice, 2020 in Work et al., 2020). Mortimer and Donnelly (2008) and NMFS (1998) reported between 20 and 50 nests per year in Palau. In 2018, approximately 70 hawksbill clutches were reported across 13 beaches on the Rock Islands in Koror State by the Department of Conservation and Law Enforcement (pers comm 25 May 2021). Yalap (2016) also reported that hawksbill turtles' nest in small numbers (<10 clutches) on some of the Rock Islands. The TREDS database contains at least 6 records of nesting turtles, but there are various other records of "nesting" hawksbills which require clarification and confirmation.

Trends in nesting data

No information is available regarding trends in hawksbill turtle nesting numbers although these are believed to be declining.

Migration and distribution of foraging areas

There are no data on migration and distribution of hawksbills from foraging areas in Palau.

Threats to the population

Hawksbill turtles in Palau are threatened at nesting sites by illegal human harvest (eggs and females), predation by wild pigs and monitor lizards, habitat degradation due to tourism development, and increasing frequency of extreme weather events (Eberdong and Klain, 2008; Golbuu et al., 2005). Foraging turtles are threatened by harvest for the tortoiseshell trade (and/or cultural toluk trade), entanglement in marine debris, habitat destruction from sand mining and dredging, and water pollution near urbanised areas (Rice, 2020 in Work et al., 2020).

Management and protection

In 2018, Palau enacted a ten-year moratorium on the harvest and sale of hawksbill turtles or their products in response to concerns that populations were declining. Previously, the harvest of hawksbill turtles was permitted in Palau under domestic fishing laws (24 PNCA 1201), with provisions for minimum size limits (27 inches CCL) and closed seasons from June 1 to August 31 and December 1 to January 31 (Secretariat of the Pacific Community and Bureau of Marine Resources Palau, 2007). Taking of eggs or female turtles while onshore is prohibited at all times. Nesting females, eggs, and habitats are also protected within the Ngerukewid Islands Wildlife Preserve (Guilbeaux, 2002). The Ngeruangel Reserve Management Plan restricts turtle harvest levels and circumstances under which turtles can be harvested from Ngeruangel Atoll in Kayangel State. At the same time, the implementation of no-fishing and limited public access areas in Koror State offers some protection to turtles in the water, as well as nesting turtles and eggs. However, enforcement of these regulations is weak (Seminoff et al. 2015).

International instruments applicable to hawksbill turtles in Palau are listed in Table 3.

Biological data on breeding and foraging

There are no biological data on breeding and foraging for hawksbill turtles in Palau. Despite the number of agencies, NGOs, and community groups working on turtle conservation in the country, monitoring of hawksbill turtles to ascertain key nesting sites, abundance, and other biological data is limited throughout Palau (Rice, 2020 in Work et al., 2020).

10. South Central Pacific Ocean

American Samoa

Geographic spread of foraging sites

Hawksbill turtles have been reported foraging at Tutuila Island (63 individuals captured between 1995 and 2002) and in small numbers at Rose Atoll (Grant et al., 1997) and Ofu Island (Tagarino et al., 2008). Becker et al. (2019) recorded a relatively high abundance of hawksbills foraging at Tutuila and Tau.

Geographic spread of nesting

Hawksbill turtles nest at the islands of Tutuila, Ofu, and Olosega. A recent survey of Tutuila identified 15 active nesting beaches for hawksbill turtles, with a further 14 described as having high potential for nesting (Tagarino et al., 2008). The TREDS database contains <10 records of hawksbill nesting encounters at multiple locations around Tutuila (Lauli'i Villa, Maloata Village, and Amalau Beach).

Trends in nesting data

NMFS and USFWS (1998) indicated there may be up to 80 nesting females per year in Tutuila and the Manu'a Islands group. However, Mortimer and Donnelly (2008) indicate only 10 to 30 female hawksbill turtles nest per year in American Samoa and Samoa combined. Surveys with locals in 1991 found that an estimated 50 adult females (green and hawksbills combined) used nesting beaches at Tutuila in 1990-1991 (Tuato'o-Bartley, et al. 1993), indicating that present day populations may have declined dramatically (Utzurrum, 2002). More recently, based on all available data, Pilcher (2021) suggests that <10-15 female hawksbill turtles' nest in American Samoa annually. Rapid assessments of three beaches (Mafafa, Toaga, and Airport Beach) over 5-6 weeks in 2017 and 2018 revealed six and seven nests, respectively (Mark MacDonal, pers comm. 13 December 2018). Approximately 10 known nesting beaches are present on Tutuila, but it is uncommon for each site to receive more than one or two nesting females per season and many of these sites may go a season or two with no activity (Mark MacDonal, pers comm. 13 December 2018).

Migration and distribution of foraging areas

Post nesting hawksbill turtles in American Samoa can undertake migrations to other western Pacific countries, including to the neighbouring nation of Samoa, or can remain in local waters. Two hawksbills tracked from American Samoa travelled to the Cook Islands (Tagarino et al., 2008), a straight-line distance of some 1,400 km. Hawksbills tagged at Tutuila and Ofu-Olosega were tracked to the Cook Islands, Samoa, Tonga, and French Polynesia, while others stayed in nearshore waters of Tutuila (Tagarino, 2015). The TREDS database contains over 100 records of foraging hawksbills from numerous locations around Tutuila.

Threats to the population

Turtles have been reported caught in fishing gear, including lines, traps and nets around Tutuila (Utzurrum, 2002). An estimated 14 hawksbill turtles may interact with the American Samoa longline fleet annually (McCracken, 2019). Hawksbill turtles are known to be caught in artisanal fisheries such as gillnets and small numbers have been found stranded with apparent spear holes in the head (Tagarino et al. 2008, 2015).

Impacts on hawksbill turtles due to climate change include sea level rise, increased air temperatures that may change hatchling sex ratio, increased storm severity, and decreased coral reef habitat quality from bleaching and acidification (Score, 2017). Toxins from non-point source (land-based sources) have been detected in coastal streams in American Samoa at levels known to cause toxicity in aquatic animals (Polidoro et al., 2017). Other threats include entanglement in debris such as fishing gear (MacDonald, 2016), erosion of nests from storm surges (Peck, 2016), potential predation from feral pigs and rats (Tagarino et al., 2010), and disorientation of hatchlings and adults from light pollution (Tagarino et al., 2008).

The TREDS database contains 6 records of nesting hawksbill encounters, all from Tutuila (Utumea East Village, Lauli'i Village, Maloata Villa, Tula Village, and Amalau Beach) and 69 records of foraging hawksbills, all from multiple locations at Tutuila.

Management and protection

Hawksbill turtles in American Samoa are protected under the U.S. Endangered Species Act (ESA) of 1973. A Sea Turtle Hotline was implemented in 2007 for emergency responses to strandings and other wildlife emergencies (Tagarino et al., 2008). International instruments applicable to hawksbill turtles in American Samoa are listed in Table 3.

Biological data on breeding and foraging

There is limited biological data on hawksbill turtle breeding and foraging in American Samoa. Growth rates from mark recapture studies suggest a mean growth rate of 4.5 cm/yr (Grant et al., 1997). Becker et al. (2019) summarize the results of marine turtle observations from towed-diver surveys in the U.S. Pacific Islands. American Samoa had the highest densities of hawksbill turtles within these regions; size class distributions (sample size not reported) are depicted in Figure 7.

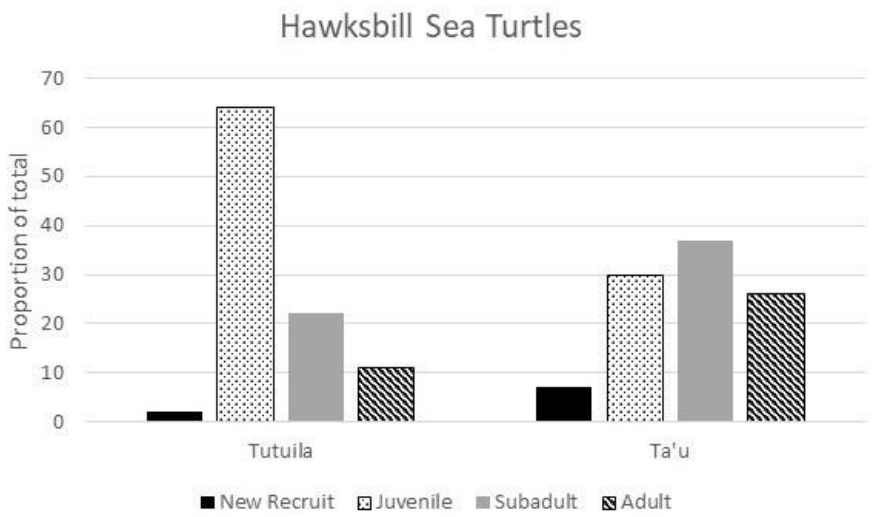

Figure 7. Size distributions of hawksbill turtles in waters around islands and atolls of American Samoa (Becker et al., 2019, in Work et al., 2020).

Fiji

Geographic spread of foraging sites

Hawksbill turtles have been recorded on several Fijian coral reefs, including the Great Sea Reef (Laveti, 2010). However, no survey to collect abundance indices has been performed in the last twenty years. Hawksbill turtles reportedly feed on the seagrass beds off the easternmost point of Vanua Levu (Batibasaga et al., 2006). The TREDS database contains over 500 records of hawksbills foraging at coral reef habitats throughout Fiji.

Geographic spread of nesting

Hawksbill turtles are known to nest on several beaches of the islands of Fiji (Figure 8). Nesting is diffuse and spread across approximately 27 sites; Namena Lala Island is the only index nesting site for hawksbill turtles in Fiji. Data recorded (and made available) over the last 20 years are summarized in Piovano (2020) (in Work et al., 2020). The TREDS database contains records of hawksbill nesting encounters at Treasure Island, Nukuvadra Island, Kavewa Island, Yadua Island, Bounty Island, and Namena Lala Island. The records span from 1997 to 2015.

Trends in nesting data

Batibasaga et al. (2006) reported a severe decline in the number of nests laid at Namena Lala Island and at Makogai Island. The most recent national estimate of the size of the hawksbill turtle nesting population is 150-200 adult females (Batibasaga et al., 2006). Most recently (during 2015-2019) Prakash et al. (2020) reported Yadu and Yadua Taba recorded 35% of all nesting in Fiji, followed by Katawaqa and Nukuvadra (29%).

There are no long-term data on clutch estimates per female per season for hawksbill turtles in Fiji. It is likely that 20 to 30 females nest annually in Fiji (Pilcher, 2021). Mortimer and Donnelly (2008) suggested that 100 to 200 female hawksbill turtles nest per year in Fiji. However, the most recent nesting assessments are presented from 2015 to 2019; Prakash et al. (2020) report only 147 clutches recorded among 27 nesting sites during the study period. As nesting sites are widely distributed and isolated, the number of nesting turtles at each site is likely to be low, although this is probably underestimated due to the logistics of full-time monitoring.

Migration and distribution of foraging areas

Satellite tracking studies have shown that Fiji is a foraging area for hawksbill turtles nesting in American Samoa (Jayne and Solomona 2007).

Threats to the population

Hawksbill turtles in Fiji are particularly threatened by illegal harvest in coastal waters and flooding and erosion of nesting beaches.

Management and protection

Hawksbill turtles are protected in Fiji under national law. Despite the expiry of the Fisheries Moratorium on 31 December 2018, Regulation 5 of the Offshore Fisheries Management Regulations 2014 (OFMR) remains in force which imposes a ban on the harvest, sale, possession and transportation of marine turtle, their eggs or any part or product of all five species of marine turtles found in Fiji. The provisions of the OFMR apply to "all Fiji Fisheries waters," meaning it applies to all internal, inshore and offshore areas of Fiji. The specific ban under the OFMR applies to the killing, taking, landing, selling or offering or exposing for sale, dealing in, transporting, receiving or possessing any marine turtle species. However, the

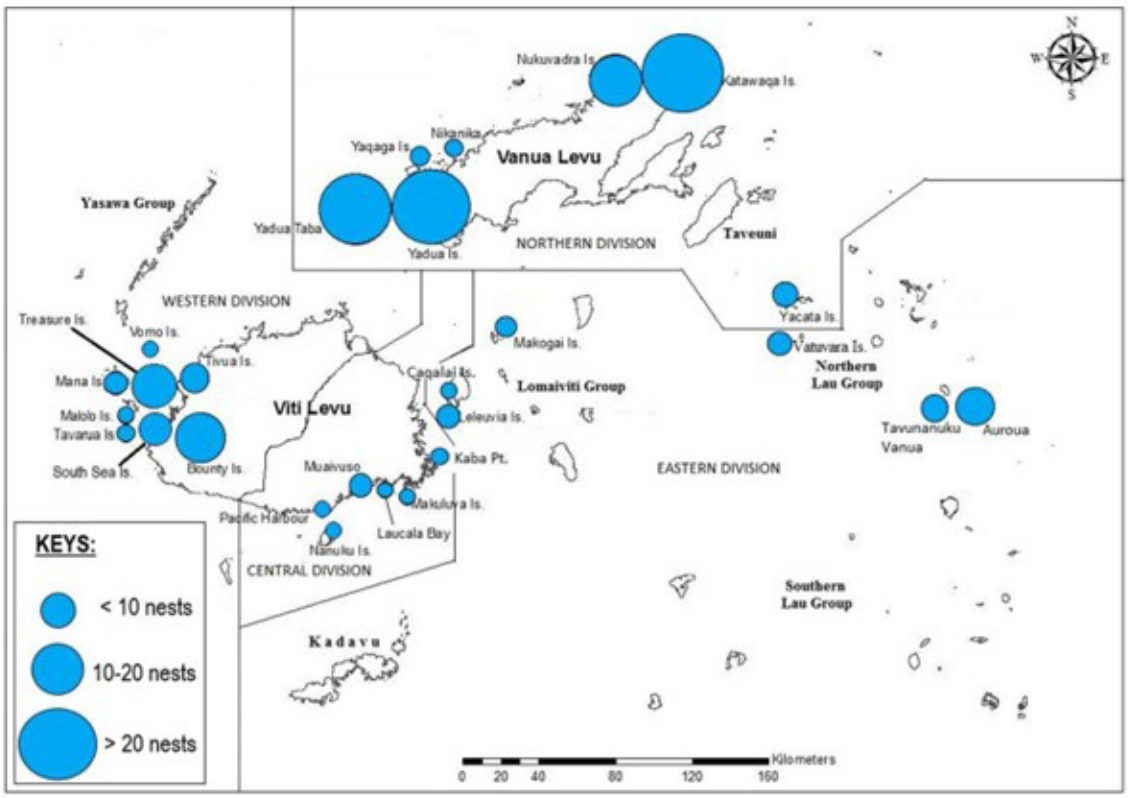

Figure 8. Distribution of hawksbill turtle nesting in Fiji. From Prakash et al. (2020). © 2020 British Chelonia Group

Ministry of Fisheries is currently working to update and amend this legislation to allow for permits to be issued to authorise limited cultural harvest by local i-Taukei communities. International instruments applicable to hawksbill turtles in Fiji are listed in Table 3.

Biological data on breeding and foraging

A recent literature review (Piovano, 2020 in Work et al., 2020) shows missing key information for nesting and foraging hawksbill turtles in Fiji. Upcoming publication of satellite tracking studies will help identify possible migratory routes and benthic foraging areas, and upcoming publication of data collected under the SPREP BIEM project will likely yield a wealth of data on sizes and species of turtles that are captured and traded.

Prior studies recorded minimum CCL of hawksbill turtles nesting in Fiji is 75 cm (Batibasaga et al., 2006). Calculated from available data, average clutch size and average emergence success were 116 eggs and 98.3%, respectively (Piovano, 2020 in Work et al., 2020). In more recent assessments between 2015-2019, Prakash et al. (2020) reported an average CCL of 81.5cm (n = 4 nesting females), average clutch size of 121 (eggs/clutch; n = 71 nests), average hatching success of 89% (n = 71 nests), and a mean egg incubation period of 56 days (range 49 to 69 days). Based on these assessments, Prakash et al. (2020) reported peak nesting in January.

French Polynesia

Geographic spread of foraging sites

Hawksbill turtles are commonly seen foraging and resting throughout French Polynesia (Gaspar, 2020 in Work et al. 2020). An in-water population assessment in 2010-2011 recorded 243 hawksbill turtles at the barrier reefs of six islands: Tetiaroa, Moorea Maiao, Bora Bora, Maupiti, and Tupai (Petit, 2011). The TREDS database contains 46 records of foraging hawksbills at Taha'a, Mataia, Bora Bora, Tiahura Lagoon, and Moorea. The records span from 1993 to 2013.

Geographic spread of nesting

Hawksbill turtles have only been confirmed to nest at one location in French Polynesia: Reao Atoll in Tuamotu archipelago (M. Tatarata, pers. comm, 2020). The TREDS database recorded 28 nesting hawksbill encounters at Taha'a, though these only span from 1995 to 1997.

Trends in nesting data

There are no data on nesting trends for hawksbill turtles in French Polynesia.

Migration and distribution of foraging areas

Limited data is available on the migratory behavior

of hawksbills in French Polynesia. However, two post-nesting female hawksbills equipped with satellite tags on the island of Ofu in American Samoa in 2019 migrated to French Polynesia, a distance of >2,000km (PIFSC unpublished data). The first hawksbill settled in a foraging ground along the eastern coast of Tahiti, while the second settled in a foraging ground in the Palliser Islands.

Threats to the population

There is very limited information available on threats to hawksbill turtles in French Polynesia.

Management and protection

Hawksbill turtles are fully protected in French Polynesia, but laws are difficult to enforce given the distances between islands (Gaspar, 2020 in Work et al., 2020). International instruments applicable to hawksbill turtles in French Polynesia are listed in Table 3.

Biological data on breeding and foraging

There is very limited biological data on breeding and foraging of hawksbill turtles in French Polynesia. Mean hawksbill CCL is 61.74 ± 13.74 cm (n = 243), with a minimum size of 30 cm and maximum of 95 cm (Petit, 2011).

Samoa

Annual nesting for hawksbill turtles is estimated to be between <10 to 30 female hawksbill turtles per year in Samoa and American Samoa combined (Mortimer and Donnelly, 2008). It is likely that <5 to 15 female hawksbill turtles nest in Samoa annually (Pilcher et al., 2021). The TREDS database recorded 34 "nesting" hawksbill encounters on Upolu Island (Vini Beach, Nuulua Island, Nuutele Island, and Lalomanu). All but two of these records are from the 1993-1994 season.

Tonga

There is no reported nesting of hawksbill turtles in Tonga (NMFS, 1998; Mortimer and Donnelly, 2008). The TREDS database contains 11 records of foraging hawksbill encounters, most caught at Tongatapu Island and two from the Haapai Group (Foa Island and Vavau).

Vanuatu

Geographic spread of foraging sites

Hawksbill turtles have been reported foraging at multiple locations throughout Vanuatu. Hickey (2020) identified foraging habitat (mainly coral reefs) at Southeast Vanua-Lava in the Banks Group, Pakea Island, Reef Island (also known as Rowa), Malekula Island, Uripiv and Uri Islands (Port Stanley and south to Crab Bay), Maskelyne Islands, islands to the north of Efate Island (Lelapa, Kagula, Emao, Nguna, Pele, Emau, and Moso), Aneityum Island, Mystery (Inyueg) Island, and Futuna Island.

Geographic spread of nesting

Hawksbill turtles have been reported nesting at multiple locations throughout Vanuatu, including Banks/Torres, Malekula, Epi, Green, and Aneityum. Rice et al. (2018) report that Malekula Island (Bamboo Bay and Wiawi village area) and Moso Island are the most important documented locations for hawksbills in Vanuatu. The TREDS database lists additional hawksbill turtle nesting sites on the islands of Ambrym, Efate, Espiritu Santo, Moso (off north Efate) and Tegua, Torres. The highest numbers of clutches were reported from Moso and Bamboo Bay during the 2006-2007, 2007-2008, 2009-2010, and 2011-2012 nesting seasons. However, these higher figures may be an artifact of greater surveying intensity (Hickey 2020 in Work et al., 2020). More detailed information on hawksbill nesting throughout Vanuatu is summarised in Hickey (2020) (in Work et al., 2020).

Trends in nesting data

Nesting by hawksbill turtles may be declining (Mortimer and Donnelly, 2008), but the lack of long-term monitoring in Vanuatu makes detection of a trend problematic (Hickey, 2020 in Work et al., 2020). During the 2018/2019 nesting season, 170 hawksbills returned to nest at Bamboo Bay (D. Aromalo, pers. comm). Based on all available data, Pilcher (2021) estimated the annual nesting population to be around 300 female hawksbills.

Migration and distribution of foraging areas

Hawksbills nesting in Vanuatu have been documented migrating to overseas foraging grounds, including areas in New Caledonia, Australia, and Samoa (Hickey, 2020 in Work et al. 2020; Jim et al., 2022; Rice et al., 2018). For more information on tagged hawksbill turtles recovered outside Vanuatu, see the TREDS 2015 Report (Siota, 2015). Figure 9 shows a summary of migratory tracks of the seven post-nesting hawksbills satellite tagged on Moso Island, central Vanuatu between 2018 and 2020. The most recent data available from the SPREP TREDS database covers 2017-2018. The 2016 data is currently missing. The 2017-2018 TREDS Report (Ward, 2019) indicates that out of the 15,217 tags issued to Vanuatu since 1991, 4,705 tags have been entered into the TREDS database and the hawksbill turtle (n=1,550) is the species with the most records in TREDS for Vanuatu. Genetic samples have been collected from Malekula and are currently being analyzed.

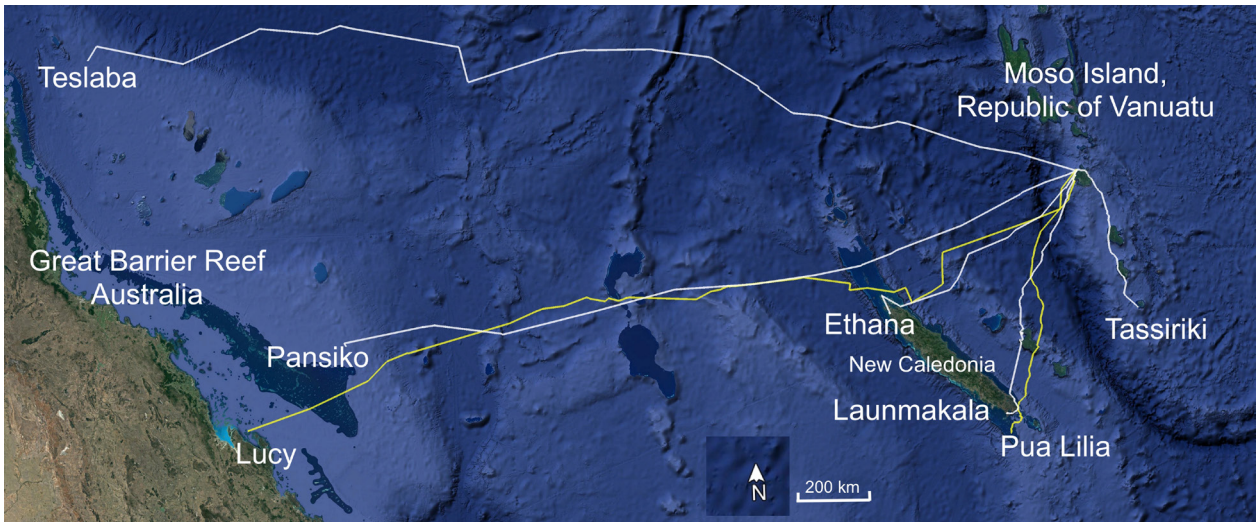

Figure 9. Summary of post-nesting migrations of hawksbill turtles from Moso Island, Vanuatu from 2018 to 2020. From Hickey, 2020 in Work *et al.*, 2020.

Threats to the population

Despite laws prohibiting turtle take in Vanuatu, harvesting of nesting and foraging hawksbill turtles continues (Rice et al., 2018). Other threats include light pollution, domestic dogs, development of nesting beaches, and bycatch in longline and purse seine fisheries (Hickey, 2020 in Work et al., 2020).

Hawksbill turtle hatchlings are caught and retained for headstarting programs on Efate, and adult hawksbills are occasionally kept in tanks for tourism purposes (Hickey, 2020 in Work et al., 2020). Hatchling mortality is reported to be high in these environments due to poor water quality (ibid.).

Management and protection

Take of marine turtles has been prohibited (except for traditional harvests) in Vanuatu since 2005 (Fisheries Act No. 55 of 2005). In 2009, an amendment to the 2005 prohibition was passed, which closed earlier loopholes and prohibited the killing of any marine turtle species. Provisions of the law allow for traditional harvests through application to the Department of Fisheries (Rice et al., 2018). The Vanuatu Fisheries Department has recently begun training community members to monitor fisheries violations at the village level, including for turtle related offenses (Hickey, 2020 in Work et al., 2020).

International instruments applicable to hawksbill turtles in Vanuatu are listed in Table 3.

Biological data on breeding and foraging

The TREDS database contains CCL measurement records of 1,454 hawksbill turtles in Vanuatu. The size frequency graph shows 1,086 turtles with a CCL under 64.9 cm, 23 turtles within the range of 65.0-79.9 cm, and 345 adult-sized turtles within the range of 80.0-109.9 cm (Figure 10). Siota (2015) reported 1,254 hawksbill turtles with CCL measurements in 2013-2014.

Wallis and Futuna

There are no reports of hawksbill turtle nesting for Wallis and Futuna. Some hawksbill turtles have been reported at the reefs of Futuna Island and flipper tagged as a result of recent monitoring (Work et al., 2020).

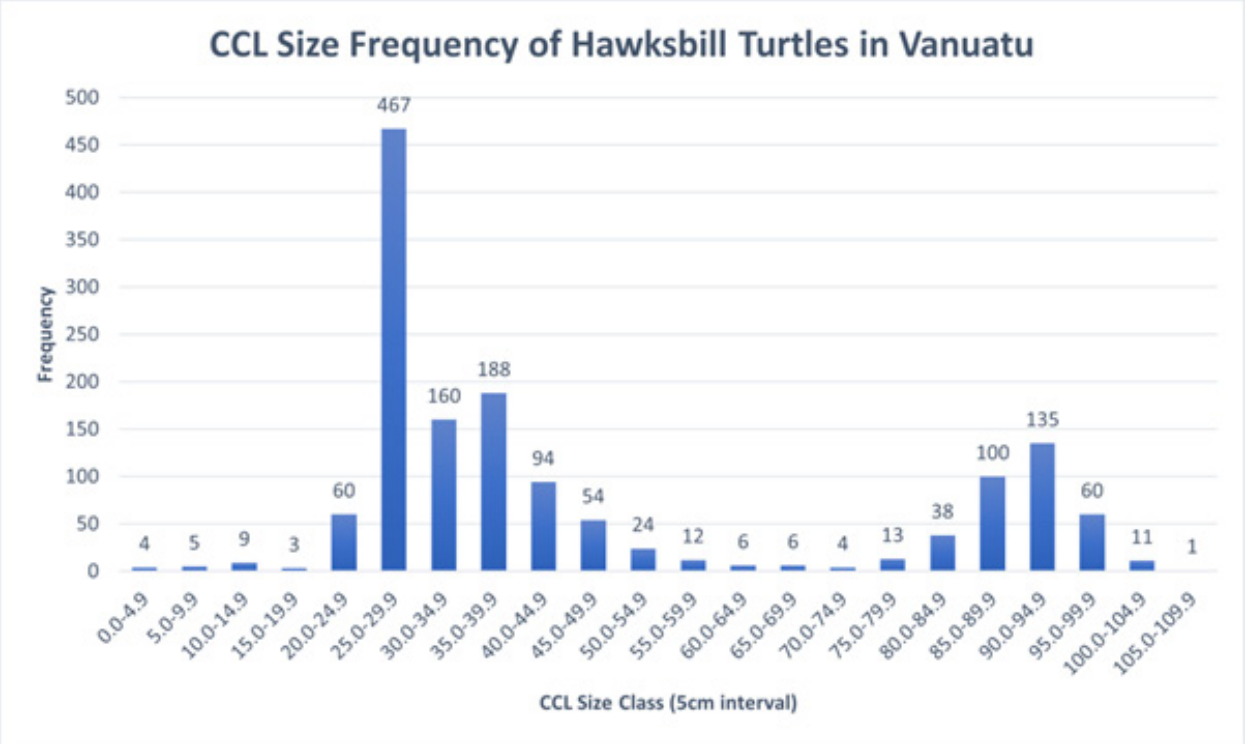

Figure 10. Hawksbill CCL size classes from turtles caught in Vanuatu. From the TREDS database (Siota, 2015).

11. Other

Cook Islands

Geographic spread of foraging sites

Hawksbill turtles are known to forage in the waters of the Cook Islands (Ischer, 2019; White, 2012; White, 2013). Foraging hawksbills can be regularly found on coral reefs around Rarotonga and less frequently in its lagoons. White (2012) recorded three juvenile hawksbills at Palmerston Atoll and one adult female seen at Tongareva Atoll in 2010, although only two juveniles have been seen at Tongareva since 2012. Juvenile hawksbill turtles have also been reported at Suwarrow Atoll (White, 2012) and both juvenile and subadult hawksbill turtles in Papua passage (Ischer, 2019). This later study indicates Papua passage may be an important developmental habitat for hawksbill turtles. The TREDS database contains 29 records of foraging juvenile hawksbill encounters from 2004-2010. Four of these were titanium flipper tagged (R series) during 2004-2005.

Geographic spread of nesting

There are no current reports of nesting by hawksbill turtles in the Cook Islands (Ischer, 2019; White, 2012).

Migration and distribution of foraging areas

There are very limited data on migration and distribution of hawksbill turtles from the Cook Islands. Two hawksbills tracked from American Samoa travelled to the Cook Islands (Tagarino et al., 2008), a straight-line distance of some 1,400 km.

Threats to the population

Hawksbill turtles in the Cook Islands are threatened by entanglement in marine debris and plastic ingestion, foraging habitat destruction though dredging and sand mining, water pollution near urbanised areas (e.g. Rarotonga's Muri Lagoon), and climate change impacts including degraded foraging habitat (e.g. acidification and bleaching of coral reefs) (White, 2020 in Work et al., 2020).

Management and protection

The Marine Resources Act 1989 provides for the protection and management of fishery resources, the definition of which includes marine turtles. It is unknown whether specific regulations exist regarding marine turtle harvest, although Maison et al. (2010) reported that marine turtle eggs were fully protected (Puleloa, 1992). International instruments applicable to hawksbill turtles in the Cook Islands are listed in Table 3.

Biological data on breeding and foraging

There are no biological data on breeding and foraging hawksbills in the Cook Islands. A new organisation, 'Te Ara o te Onu', is to work with the tourism industry to collate data on turtle presence, size, and behaviour (White, 2020 in Work et al., 2020).

Nauru

There is no reported nesting of hawksbill turtles in Nauru (NMFS, 1998; Mortimer and Donnelly, 2008). It is not currently possible to determine if nesting occurs. Nauru's coral reef habitats might be foraging habitat to hawksbill turtles, but further investigation is needed.

New Caledonia (France)

Meylan and Donnelly (1999) indicated that few hawksbills were reported to nest in New Caledonia. d'Auzon (2007) reported that the main population (about 200 individuals) is located on the northeast coast, but it was unclear if this referred to in-water turtles. Recent surveys suggest there is no nesting in New Caledonia (T. Read, pers. comm.). The TREDS database contains three records of foraging hawksbill turtles, one at Sainte Marie Bay in 2011 and two at Anse Vata Beach in 2011 and 2012.

New Zealand

Geographic spread of foraging sites

Almost no local population information exists for this species in New Zealand. However, unpublished diet component analysis shows that hawksbill turtles forage in benthic and pelagic habitats in northern New Zealand, especially around the subtropical Kermadec Islands (Godoy, unpubl. data).

Geographic spread of nesting

There is no nesting of hawksbill turtles in New Zealand, including the sub-tropical Kermadec Islands.

Migration and distribution of foraging areas

There is very limited information on hawksbill migration in New Zealand. Fifty-three sighting, stranding and incidental capture (commercial and recreational fishing bycatch) records have been documented from 1949 to 2015 (WCPFC, 2005; Godoy, 2016; Godoy, unpubl. data). Hawksbill records extend from the Kermadec islands (c. 30^{O} S) south to Palliser Bay, Wellington (c. 41^{O} S), their distribution is mostly concentrated off northeastern North Island, with a significant temporal peak in strandings during winter (July-September) and sightings of free-ranging animals during the warmer summer months (Godoy, unpubl. data).

Threats to the population

There are very little data on threats to hawksbill turtles in New Zealand. Hawksbill stranding and incidental capture in commercial and recreational fisheries is collected as part of the New Zealand marine turtle sighting and stranding database (private database curated by D Godoy).

Management and protection

Hawksbill turtles are fully protected under the Wildlife Act 1953 and have been assessed as Migrant - Threatened Overseas according to the New Zealand Threat Classification System (NZTCS). International instruments applicable to hawksbill turtles in New Zealand are listed in Table 3.

Biological data on breeding and foraging

There is no information on ecology, regional connectivity, or genetic origin of hawksbill turtles in New Zealand. Limited data indicates that hawksbills occurring in New Zealand are juvenile to large sub-adults (μ = 53.2 cm CCL, SD 14.5 cm, range 35.0-90.0 cm, n = 23). Data and samples (including tissue for genetic and isotopic analysis) have been collected since 2007, thus warranting further research initiatives into regional connectivity, migratory corridors, threats, and habitat use.

Niue

There is no reported nesting of hawksbill turtles in Niue (NMFS, 1998; Mortimer and Donnelly, 2008). Hawksbills are reported to frequent marine areas around Niue (Government of Niue, 2001).

Tokelau

Geographic spread of foraging sites

Low numbers of hawksbill turtles have been reported to forage in coastal waters around Tokelau (Balazs, 1983). No further information regarding location or turtle abundance is available.

Geographic spread of nesting

Hawksbill turtles have been recorded nesting at low numbers on Nukunonu Atoll (Balazs, 1983). More recent assessments do not report any hawksbill nesting in Tokelau (Mortimer and Donnelly, 2008; NMFS, 1998).

Trends in nesting data

There is no data on nesting trends for hawksbill turtles in Tokelau, nor is it possible to determine the number of females nesting annually (Pilcher, 2021).

Migration and distribution of foraging areas

There is no data on migration and distribution of hawksbill turtles from foraging areas in Tokelau.

Threats to the population

Hawksbill turtles in Tokelau are threatened by direct harvest of eggs and nesting females, direct take at foraging grounds, fisheries bycatch, predation of nests by crabs and Polynesian rats, and climate change impacts from sea level rise, beach erosion, nest inundation, alteration of sex ratios, and increased frequency of extreme weather events (Ward and Lemalu, 2020 in Work et al., 2020).

Management and protection

There are no national protections for hawksbill turtles in Tokelau. Rules and regulations are determined separately for each atoll and village of Tokelau (Balazs, 1983; Pierce et al., 2012).

International instruments applicable to hawksbill turtles in Tokelau are listed in Table 3.

Biological data on breeding and foraging

There are no biological data on breeding and foraging for hawksbill turtles in Tokelau.

Tuvalu

There is no reported nesting of hawksbill turtles in Tuvalu. Low numbers of nesting hawksbills (tens of individuals) are recorded in adjacent countries, namely Solomon Islands and Vanuatu. The TREDS database contains records of two foraging hawksbill encounters at Funafuti Island, one of which was a tag return from Tuvalu, although Vanuatu and Solomon Islands are potentially important foraging areas.

Threats to hawksbill turtles in Tuvalu include illegal harvest, habitat degradation, and pollution.

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