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CMS

CONVENTION ON MIGRATORY SPECIES

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REVIEW OF THE IPBES GLOBAL ASSESSMENT ON BIODIVERSITY AND ECOSYSTEM SERVICES

(Prepared by the Secretariat)

Summary:

This document presents a review of the six chapters of the IPBES Global Assessment on Biodiversity and Ecosystem Services concerning the findings related to the implementation of CMS and to the topic of connectivity.

REVIEW OF THE IPBES GLOBAL ASSESSMENT ON BIODIVERSITY AND ECOSYSTEM SERVICES

The IPBES Global Assessment on Biodiversity and Ecosystem Services is composed of i) a Summary for Policymakers (SPM) approved by the IPBES-7 Plenary at its 7th session (28 April-4 May 2019 -IPBES-7); and ii) a set of six chapters still in draft form pending the final editing.

The following evaluation, which is based on the analysis of the six chapters as released in August 2019, summarizes findings related to i) the implementation of CMS and ii) connectivity. The original text of the most relevant extracts is quoted.

IMPLEMENTATION OF CMS

From **Chapter 3.4.1. The Convention on the Conservation of Migratory Species of Wild Animals**

The CMS (or ‘Bonn Convention’) is an intergovernmental treaty aimed at conserving terrestrial, marine and avian migratory species throughout their range (CMS 2017). Signed in 1979 and entering into force in 1983, the Convention is currently ratified by 124 Parties. CMS Parties strive towards strictly protecting threatened migratory species (Appendix I species) and conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that threaten them (CMS 2017). Non-endangered species with unfavourable conservation status (Appendix II species) that would benefit from international cooperation, are also addressed by the Convention. As well as establishing obligations for CMS Parties, the Convention, promotes concerted action among the range states of migratory species (CMS 2017). CMS’s 11th Conference of the Parties adopted the Strategic Plan for Migratory Species 2015-2023 which has five Goals consisting of 16 Targets (CMS 2014). Indicators for measuring progress towards these are still in development.

Mainstreaming relevant conservation and sustainable use priorities across government and society to address the underlying causes of decline of migratory species (Goal 1) is underway, but progress has been slow. World Migratory Bird Day has been celebrated annually since 2006, with events now held in over 130 countries worldwide stimulating conservation of migratory birds and raising awareness about the need for their conservation (Target 1; Caddell 2013a, CMS 2016). Other efforts to raise awareness of migratory species and the steps needed to conserve them have included the ‘Year of the Bat’ (2017) and similar initiatives for gorillas (2007) and dolphins (2009), but the impact of these initiatives on awareness has not been systematically assessed. Little information is available on the degree to which the values of migratory species and their habitats have been integrated into development and poverty reduction strategies and planning processes and incorporated into national accounting (Target 2).

CMS coordinates the development and implementation of multilateral agreements among countries that share migratory species (Caddell 2013b). Migratory waterbirds, seabirds, cetaceans and bats are among the species groups covered by formal protocols concluded under the Convention. In the case of migratory birds, intergovernmental efforts to identify flyways and coordinate action have been highly successful. For most parts of the world, the policies and processes to secure the wellbeing of flyways is in place, but the challenge lies in implementing them (Boere and Piersma 2012). Hence, progress has been made towards improving national, regional and international governance arrangements and agreements affecting migratory species, and to make relevant policy, legislative and implementation processes more coherent, accountable, transparent, participatory, equitable and inclusive (Target 3). Insufficient information is available to assess progress towards ending or reforming incentives, including subsidies that are harmful to migratory species, and to developing and applying positive incentives to their conservation (Target 4).

The direct pressures on migratory species and their habitats have not decreased, and may be worsening, meaning we are not progressing towards achievement of Goal 2. Land-use change owing to agriculture is the most significant threat to terrestrial migratory species, affecting nearly 80% of all threatened and near-threatened migratory bird species (Kirby et al. 2008, Flockhart et al. 2015), while over-exploitation and its indirect impacts is the biggest threat to migratory species in the marine environment (e.g. Croxall et al. 2012). Habitat conversion and degradation limit the degree to which many species can modify their migratory routes and may increase the threat from climate change (Robinson et al. 2009, Studds et al. 2017). Forest fragmentation and deforestation in breeding areas has contributed to the declines of Nearctic–Neotropical bird migrants (Bregman et al. 2014; Flockhart et al. 2015) and Afro-Palaearctic migrants (Vickery et al. 2014). In non-breeding areas, the interaction between habitat degradation and climatic conditions (in particular, drought) are also possible factors (Vickery et al. 2014; Taylor and Stutchbury 2016). Infrastructure development including wind turbines, cables, towers and masts can also be a threat, particularly to migratory soaring bird species (Kirby et al. 2008; Angelov et al. 2013; Bellebaum et al. 2013) and migratory bats. Over-harvesting and persecution, often illegal, remain serious threats, particularly at key migration locations (Harris et al., 2011; Ogada et al. 2012; Brochet et al. 2016, 2017). Climate change is negatively affecting many bird species already and is expected to exacerbate these pressures (Howard et al 2018) as well as increasing competition between migratory and non-migratory species (Robinson et al. 2009). Climate change may have significant negative effects on the population size of 84% of migratory bird species, which is comparable to the proportion affected by all other anthropogenic threats (80%) (Robinson et al. 2009; Kuletz et al. 2014). Protected areas can help to mitigate some threats, but just 9% of migratory bird species are adequately covered by protected areas across all stages of their annual cycle, compared with 45% of non-migratory species, a pattern driven by protected area placement that does not cover the full annual cycle of migratory species (Martin et al. 2007; Runge et al. 2015).

The conservation status of migratory species and the ecological connectivity and resilience of their habitats is worsening, meaning that we are moving away from achievement of Goal 3. More than 11% of migratory land- and waterbirds are threatened or Near Threatened on the IUCN Red List (Kirby et al. 2008). Since 1988, the Red List Index shows that migratory birds have become more threatened, with 33 species deteriorating sufficiently to move to higher categories of threat on the IUCN Red List, and only six improving in status to qualify for downlisting (Kirby et al. 2008). More than half of migratory bird species across all major flyways have undergone population declines over the past 30 years (Kirby et al. 2008). There is increasing evidence of regional-scale declines in migrant birds: more Nearctic–Neotropical migrants have declined than increased in North America since the 1980s, and more Palearctic–Afrotropical migrants breeding in Europe declined than increased during 1970–2000. Regional assessments show that 51% of migratory raptors species in the African–Eurasian region and 33% of species in Central, South and East Asia have unfavourable conservation status. Some species appear to be particularly affected by declines in habitat extent and condition in non-breeding areas, notably in arid areas of tropical Africa (Kirby et al. 2008).

The prospect for large-bodied ungulates is no better. Mass migrations for six large-bodied ungulate species are extinct or unknown (Harris et al. 2009). With the exception of a few ungulates (such as Common Wildebeest Connochaetes taurinus and other migrants in the Serengeti Mara Ecosystem, White-eared Kob Kobus kob and Tiang Damaliscus lunatus in Sudan, and some Caribou Rangifer tarandus populations), the abundance of all other largebodied migrant ungulates has declined (Harris et al. 2009). In the case of migratory species occurring in the marine environment, 21% are classified as threatened (i.e. categorized as Critically Endangered, Endangered or Vulnerable) with an additional 27% classified as Near Threatened or Data Deficient (Lascelles et al. 2014). Sea turtles are the most threatened group

(85%), followed by seabirds (27%), cartilaginous fish (26%), marine mammals (15%) and bony fish (11%). Migratory species in marine ecosystems may be even more affected by climate change impacts than terrestrial species (Robinson et al. 2009). Highly migratory and straddling marine fishes (i.e., fish species that move through or exist in more than one exclusive economic zone) are further governed by the United Nations Fish Stocks Agreement (UNFSA), which has been in force since 2001. The objective of UNFSA is to “ensure the long-term conservation and sustainable use of straddling fish stocks and highly migratory fish stocks” (UNFSA 2018). A recent assessment of global progress towards implementing this agreement concluded that the overall status of migratory fish stocks and straddling fish stocks had not improved since the 2006 Review Conference (Baez et al., 2016). Moreover, since 2010, there has been a decline in the overall status of highly migratory fish stocks and straddling stocks, and 60% of shark species are considered to be potentially overexploited or depleted (Baez et al., 2016).

There is little information to assess progress towards enhancing the benefits to all from the favourable conservation status of migratory species (Goal 4). Some progress has been made towards enhancing implementation through participatory planning, knowledge management and capacity building (Goal 5). CMS Strategic Plan 2006-2011 and the Bali Strategic Plan for Technology Support and Capacity Building provide the framework for capacity building (CMS 2018). The Convention promotes a bottom-up and participatory approach in identifying specific objectives, strategies and activities for implementation by governments, NGOs and other stakeholders. Collaboration with NGOs to facilitate implementation and capacity building has increased over the years, enabling cost-sharing, especially in developing and emerging economies (Prideaux, 2015), despite some NGO relationships with CMS instruments tending to be ad hoc, with some key discussions closed to them (Prideaux, 2014). National Biodiversity Strategy and Action Plans (NBSAPs) often fail to consider adequately the needs of migratory species which are typically not endemic or may not comprise a significant component of the local biodiversity (CMS 2017).

Table 3.9. Progress towards achieving the goals of other global agreements related to nature and nature’s contributions to people, based on a synthesis of the literature and available information. Progress towards goals is scored as Good (substantial positive trends at a global scale relating to most aspects of the element), Moderate (the overall global trend is positive, but insubstantial or insufficient, or there may be substantial positive trends for some aspects of the goal, but little or no progress for others, or the trends are positive in some geographic regions but not in others), Poor (little or no progress towards goal, or movement away from goal; while there may be local/national or case-specific successes and positive trends for some aspects, the overall global trend shows little or negative progress), or Unknown '?' (insufficient information to score progress).

Convention	Goals	Progress
CMS	Goal 1: Address the underlying causes of decline of migratory species by mainstreaming relevant conservation and sustainable use priorities across government and society	Moderate
	Goal 2: Reduce the direct pressures on migratory species and their habitats	Poor
	Goal 3: Improve the conservation status of migratory species and the ecological connectivity and resilience of their habitats	Poor
	Goal 4: Enhance the benefits to all from the favourable conservation status of migratory species	?
	Goal 5: Enhance implementation through participatory planning, knowledge management and capacity building	Moderate

CONNECTIVITY

From Chapter 2. Status and trends; indirect and direct drivers of change

2.2 Status and Trends – Nature

2.2.3.4.1 Insular systems

The small population sizes typical of species living in small insular habitats can lead to genetic drift and inbreeding that greatly reduce genetic variation in some situations. As insular taxa are often very local, rare, unique, and vulnerable, active and specific conservation efforts are critical. On the one hand, it is particularly important to limit biological invasions, as the effects for insular taxa are often severe and irreversible. On the other hand, **insular taxa can often benefit from efforts to increase population sizes through habitat preservation and restoration, and to increase connectivity among isolated populations of a given species.**

2.2.5.2.5 Organismal traits

Changes in trait means can have important consequences for population dynamics, community structure, ecosystem functioning, and – more generally – nature's contributions to people. For example, the widespread declines of large species are already profound affecting many ecosystem functions at sea and on land (Dirzo et al. 2014; McCauley et al. 2015; Ripple et al. Unedited draft chapters 31 May 2019 65 2014). **Extinct terrestrial megafauna maintained a degree of openness in forest structure, giving landscapes high habitat diversity; their loss has led to more forest canopy closure and has also changed fire regimes (Johnson 2009), greatly reduced long-distance dispersal of many fruits (Pires et al. 2018) and dispersal of productivity-limiting nutrients (Doughty et al. 2013), as well as affecting many other ecosystem processes (Ripple et al. 2015). Likewise, the historical and ongoing loss of large species from oceans has reduced connectivity among ecosystems and reduced their temporal stability (McCauley et al. 2015).**

From Chapter 3. Assessing progress towards meeting major international objectives related to nature and nature's contributions to people

3.2 Progress towards the Aichi Targets

The strongest progress has been towards identifying/prioritizing invasive alien species (Target 9), increasing protected area coverage (Target 11), bringing the Nagoya Protocol into force (Target 16), and developing national biodiversity strategy and action plans (Target 17). However, **while protected areas now cover 14.9% of terrestrial and freshwater environments and 7.44% of the marine realm, they only partly cover areas of particular importance for biodiversity, and are not yet fully ecologically representative, well-connected, and effectively and equitably managed (well established)** {3.2}. While some species have been brought back from the brink of extinction (contributing towards Target 12 on preventing extinctions), species are moving towards extinction at an increasing rate overall for all taxonomic groups with quantified trends (well established).

On Aichi Target 11 *Conserving terrestrial and marine areas through protected areas and other area-based measures.*

While the world's protected area network continues to expand and may exceed numerical targets for coverage of terrestrial and marine environments by 2020, there has been only moderate progress towards other aspects of Aichi Target 11 in both the terrestrial and marine environment. This pattern is reflected regionally too (UNEP-WCMC 2016 a, b, c, d). By September 2018, the World Database on Protected Areas showed that 14.9% of the world's terrestrial and freshwater environments was covered by protected areas, with 7.44% of the marine realm area covered (17.2% of marine areas within national jurisdiction, and 1.18% of marine areas beyond national jurisdiction (UNEP-WCMC and IUCN 2018, Gannon et al. 2017). In Antarctica, <4% of the icefree terrestrial area is protected (Chown et al. 2017). Specific commitments made by particular countries for new/expanded protected areas through National Priority Actions, National Biodiversity Strategies and Action Plans or projects from the fifth and sixth replenishment of the Global Environment Facility total over 3.9 million km2 on land and over 13 million km2 in the oceans (CBD 2018b). If these are fulfilled before 2020, coverage is expected to exceed 10% of the global ocean and 17% of terrestrial and inland water (Fig. 3.3a, CBD 2018b).

Recent growth in the global protected area network has been greatest in the marine environment, with the coverage of marine protected areas increasing from 2 million km^2 (0.7% of the ocean) in 2000 to 26.9 million km^2 (7.44%) at present. This increase has resulted in particular from the establishment of some extremely large marine protected areas (Thomas et al. 2014, Gannon et al. 2017), such as the Marae Moana Marine Park in the Cook Islands in 2017 (1.97 million km^2) and the expansion in 2016 of the Papahānaumokuākea Marine National Monument in the Hawaiian Islands (1.5 million km^2), representing the second and fourth largest marine protected areas worldwide respectively. The establishment of marine protected areas in Areas Beyond National Jurisdiction has mostly been driven by the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) and the Convention for the Conservation of Antarctic Marine Living Resources (CCMALR) (UNEP-WCMC and IUCN, 2016). Protection of biodiversity in the high seas has considerable governance challenges. The organizations with the authority to protect and manage the marine resources in the high seas are: (1) the International Maritime Organization, which can designate Particularly Sensitive Sea Areas to control shipping activities, (2) the International Seabed Authority, which can designate Areas of Particular Interest to control deep seabed mining, and (3) the Regional Fisheries Management Organizations, which can designate closure for certain fisheries or protect Vulnerable Marine Ecosystems as defined by the UN (Wright et al., 2016), but protection of the high seas is still uneven and cooperation is weak across the existing agreements (Ardron et al., 2014; Ardron and Warner, 2015). In response, two major initiatives are underway to strengthen conservation of the marine environment, in particular through establishment of marine protected areas in the high seas. The CBD has developed criteria and processes to describe Ecologically or Biologically Significant Areas (EBSAs) to support national and international management of ocean habitats and resources (Dunn et al., 2014, Dunstan et al., 2016), 279 of which have been described to date (Bax et al., 2016, CBD 2017b). The second initiative has been driven by the United Nations General Assembly, with countries agreeing in 2015 to open negotiations for a new legally binding instrument on the conservation and sustainable use of marine biodiversity in Areas Beyond National Jurisdiction under the United Nations Convention on the Law of the Sea (Wright et al. 2013, 2016, Rochette et al. 2015).

The extent and distribution of 'other effective area-based conservation measures' (OECMs, as referred to in Aichi Target 11, such as some privately managed areas and territories and areas managed by Indigenous Peoples and Local Communities, is not well documented (UNEPWCMC and IUCN 2016, Gannon et al. 2017). This is partly because a definition of such areas has only recently been developed (CBD 2018h). Once documented, inclusion of such areas will likely also substantially increase the estimates above of terrestrial and marine coverage by protected areas and conserved areas. The contribution of IPLCs to protected area growth, and the impact of this on IPLCs, is discussed in greater detail in section 3.2.4.

Moderate progress has been made towards ecological representativeness, effective management and protection of areas of importance for biodiversity. Although ecological representation of protected area networks has increased (Kuempel et al. 2016), by April 2018, only 43.4% of the world's 823 terrestrial ecoregions have at least 17% of their area covered by protected areas and 42.7% of the 232 marine ecoregions (and 10.8% of pelagic provinces) have at least 10% of their area covered (EC-JRC 2018, CBD 2018b). One quarter of terrestrial ecoregions (207, 24%) have been identified as 'imperiled', where the area of protected and unprotected natural habitat remaining is less than or equal to 20% (and averages only 4%) (Dinerstein et al. 2017). Protected area coverage of species distributions also remains insufficient (Venter et al. 2017 Goettsch et al. 2018), and over half (57%) of 25,380 species assessed to date have inadequate coverage of their distributions by protected areas (Butchart et al. 2015). Recent protected area expansion has failed to target places with high concentration of threatened vertebrate species: if protected areagrowth during 2004-2014 had strategically targeted unrepresented threatened vertebrates, it would have been feasible to protect over 30 times more threatened species for the same area or cost as the actual expansion that occurred (Venter et al. 2017).

Only 20.7% of Key Biodiversity Areas ('sites contributing significantly to the global persistence of biodiversity') are completely covered by protected areas (Butchart et al. 2012, 2016, BirdLife International et al. 2018). The global mean percentage area of terrestrial Key Biodiversity Areas covered by protected areas increased from 35.0% in 2000 to 46.6% in 2018, with the equivalent figures being 31.9% to 43.5% for freshwater Key Biodiversity Areas and 31.7% to 44.3% for marine Key Biodiversity Areas (Fig. 3.3b; BirdLife International et al. 2018). Of the protected areas that overlap Key Biodiversity Areas and that have data available on governance, just 1.01% are managed by Indigenous Peoples and Local Communities, or are nationally designated as indigenous, local, or community lands, covering 2.37% of the overlapping area (based on spatial analysis of data from BirdLife International 2016b and IUCN and UNEP-WCMC 2016). A significant but unknown proportion of Key Biodiversity Areas are also likely to be covered by OECMs (BirdLife International 2014). Recent protected area expansion has disproportionately targeted area outside Key Biodiversity Areas (Butchart et al. 2012), meaning that insufficient attention is being paid to the element of Aichi Target 11 addressing 'areas of particular importance for biodiversity'.

Currently, there is no global indicator measuring the extent to which areas of importance for ecosystem services are protected or the effectiveness of such protection (Spalding et al. 2014), while national studies typically show a mismatch between the distribution of protected areas and locations of importance for ecosystem services (e.g. protected areas cover 15.1% of China's terrestrial surface, but only 10.2–12.5% of the source areas for four key regulating services; Xu et al. 2017). Similarly, there is a mismatch between marine protected areas and locations of importance for ecosystem services (Lindegren et al 2018).

Although there are positive trends in the number of protected areas with assessments of management effectiveness (Table 3.3), as of May 2018, only 21% of countries have assessed management effectiveness for at least 60% of their terrestrial protected areas (and 16% of countries had done so for at least 60% of their marine protected areas): the target under the CBD Programme of Work on Protected Areas (CBD 2010b, Coad et al. 2015, UNEP-WCMC 2018b). The Atlas of Marine Protection (an independent attempt to track the adequacy of protection of marine protected areas) estimates that as little as 3.6% of the global ocean is covered by fully implemented and actively managed protected areas (Marine Conservation Institute 2017). In many countries, less than half of protected areas are effectively managed, having the same level of modification as non-protected lands (Clark et al. 2013), while only 10% of protected areas are free from human pressure (Jones et al 2018). A main driver of ineffectiveness is the unsustainable use of biological resources (Shulze et al 2018), while some protected areas may be too small to conserve the target species they aim to protect (Mallari et al. 2016). Without a comprehensive global dataset on protected area management effectiveness, it is difficult to estimate what percentage of the terrestrial/freshwater and ocean environments is effectively protected, but it is likely to fall far short of the percentages for absolute coverage reported above. One recent assessment found that only 21% of a sample of marine protected areas met more than half of nine thresholds for effective management, although 71% of marine protected areas showed positive responses in fish biomass, which averaged 1.6 times higher than in matched unprotected areas (Gill et al. 2017). There is significant evidence, especially from “no-take” marine reserves, that protecting marine biodiversity and ecosystems delivers benefits (e.g. Aburto-Oropeza et al., 2011; Mellin et al., 2016). A recent meta-analysis found that most studies showed that protected areas helped to reduce declines in both species’ populations (74% of 42 relevant counterfactual studies) and habitat (79% of 60 studies) (Geldmann et al. 2013). Similarly, analysis of studies of biodiversity responses to land-use change found that protected areas were effective at retaining species richness and local abundance (Gray et al. 2016).

No agreed methodology exists for tracking progress towards equitable management of protected areas (Spalding et al. 2014, Corrigan et al. 2017), although indicators (Zafra-Calvo et al. 2017) and frameworks have been proposed (Schreckenberg et al. 2016). The proportion of sites in the World Database on Protected Areas reporting shared governance increased from 1.8% in 2016 to 3.3% in 2018 (CBD 2018b). Protected areas that explicitly integrated local stakeholders are significantly more effective at achieving conservation and socioeconomic outcomes (Oldekop et al. 2016), but data on protected area socio-ecological effects are generally lacking (Pendleton et al., 2017).

Adequately connected protected areas cover only 9.3-11.7% of the terrestrial realm, with only about a third of the world’s ecoregions and 30.5% of countries currently having 17% of their area covered by well-connected protected areas, indicating that the spatial arrangement of protected areas is only partially successful in ensuring connectivity of protected lands (Saura et al. 2017, 2018, Santini et al. 2016). Connectivity of marine protected areas has not yet been assessed (Gannon et al. 2017). Protected area management strategies would be more effective if they took greater consideration of connectivity (particularly in freshwater ecosystems), contextual vulnerability, and required human and technical capacity (Juffe-Bignoli et al. 2016b), and were better embedded within integrated spatial planning. While uptake of the latter appears to be accelerating in the marine realm, only c.10% of jurisdictional waters are currently under some level of marine spatial planning (Spalding et al. 2014). Finally, few protected areas are currently taking into account climate change in their management (Poiani et al., 2010), but the effects of climate change on protected areas will be profound (e.g. Hole et al. 2009, Araujo et al. 2011, Bagchi et al. 2012; Baker et al. 2015, Zomer et al., 2015), and addressing them will require the development and implementation of coherent, network-scale, adaptation plans (Dudley et al., 2010, Hole et al. 2011, Wiens et al., 2011). **This is particularly important given that effectively managed protected areas can help to buffer the negative impacts of climate change, reduce disaster risks, and contribute to climate change mitigation and adaptation** (Hole et al. 2011, Lawson et al. 2014, Virkkala et al. 2014, Nogueira et al. 2018)

Impacts of trends in Nature on progress towards the Sustainable Development Goals (SDGs)

SDG	Target	Relevance for Migratory Species and Connectivity
6 Clean Water and sanitization	Target 6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.	Protecting and restoring freshwater ecosystems presents unique challenges due to their interconnected nature. For example, although there are approximately 2300 Ramsar Wetlands of International Importance, upstream unprotected areas often impact on the health of the downstream Ramsar Sites. **The development of indicators measuring protection of waterrelated ecosystems should account for how this connectivity impacts on the health of protected water-related ecosystems.**
14 Life Below Water	Target 14.5. By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information.	Effective MPA design and management is critical to their ability to deliver ecological and social outcomes (Mascia, Claus et al. 2010, Edgar, Stuart-Smith et al. 2014). **Previous research has identified five key features in determining the relative success of MPAs in conserving fish species: no take regulations, enforcement, MPA age, MPA size, and degree of isolation (Edgar, Stuart-Smith et al. 2014). Connectivity between MPAs may be particularly important for biodiversity persistence (Magris, Andrello et al. 2018).** However, there are indications that management in many marine protected areas remains relatively weak due to capacity shortfalls in staffing and funding (Gill, Mascia et al. 2017).
15 Life on Land	Target 15.1. By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements	There has been considerable progress towards achieving the target of 17% coverage of terrestrial and freshwater ecosystems by protected areas. **However, as outlined in Section 3.2 in relation to Aichi Target 11, coverage of areas of importance for biodiversity by protected areas, and ecological representation within protected areas, and connectivity between them are insufficient. Only 9.3-11.7% of protected areas are estimated to be adequately connected.**

3.7 Implications for development of a new strategic plan on biodiversity and revised targets

- Future target setting will be more inclusive if it integrates insights from the conservation science community, social scientists, IPLCs, indigenous and local knowledge, and other stakeholders
- Future protected area targets that focus on enhancing coverage of important locations for biodiversity and **strengthening management effectiveness** may be more effective than simply setting a specific percentage of the terrestrial and marine environments to be conserved.
- Future targets for marine protected areas may deliver better biodiversity benefits if they focus on management effectiveness in particular. (…) **Increased consideration of the connectivity of marine protected areas is also needed** (Toonen et al. 2013, Lagabrielle et al. 2014).

- Future protected area targets may be more effective if they also explicitly address freshwater ecosystems and their processes, integrating nature and people, considering also the threats impacting them, and the actions needed to sustain them, **including management strategies that consider connectivity,** contextual vulnerability, and human and technical capacity (Juffe-Bignoli et al. 2016b).
- A greater focus on protected area governance is important.
- The implementation of future targets on conservation of species and sites could be more efficient through effective prioritization.
- A new framework for biodiversity will be less effective if it does not explicitly address the implications of climate change for nature conservation.

From Chapter 4. Plausible futures of nature, its contributions to people and their good quality of life

4.2 Plausible futures for Nature

4.2.1.3 The importance of feedbacks between hierarchical levels of biodiversity

Some well described feedbacks between different hierarchical levels and facets of biodiversity are self-reinforcing and could likely amplify negative effects of global changes on biodiversity (Brook et al., 2008). Integration of processes acting at different organizational biodiversity levels is essential for future predictions of global change impacts on Nature (Mouquet et al., 2015; Thuiller et al., 2013). The feedback between population size and genetic diversity (S4 in Box 4.2.1) is known as an extinction vortex (Frankham et al., 2014) because the reduction in population size leads to the loss of genetic diversity which in turn, leads to decrease in population fitness and adaptability and further reduction in population size.

The feedback between species' range and genetic diversity (S5 in Box 4.2.1) means that the contraction and fragmentation of species ranges are expected to cause genetic loss through decrease in effective population size and extinction of genetic lineages as well as extinction of local populations with unique genetic characteristics (Bálint et al., 2011; Pauls et al., 2013). Genetic loss, in turn, may decrease species adaptability and migration capacity. The feedback between species composition and genetic diversity (SD3 in Box 4.2.1) means that changes in species composition alter the selection pressure affecting genetic diversity. For example, reduction in pollinator abundance could lead to selection favoring self-fertilization in plant populations, leading to a decrease in genetic diversity (Neaves et al., 2015). Introductions of alien species may result in hybridization, out-breeding depression and decrease in genetic diversity of native species. However, hybridization may also facilitate adaptation to novel environments (Hoffmann and Sgro, 2011). Changes in genetic diversity, in turn, contribute to further disturbance of species relationships.

4.2.3 Freshwater ecosystems

4.2.3.2 Future climate change impacts on freshwater biodiversity and ecosystem functioning

Increased water temperatures often lead to progressive shifts in the structure and composition of assemblages because of changes in species metabolic rates, body size, migration timing, recruitment, range size and interactions (Daufresne et al., 2009; Myers et al., 2017; Parmesan, 2006; Pecl et al., 2017; Rosenzweig et al., 2008; Scheffers et al., 2016). **There is already evidence of regional and continental shifts in freshwater organism distributions following their thermal niches (Comte et al., 2013), local**

extirpations through range contractions at the warm edges of species' ranges (Wiens, 2016), and body size reductions (Daufresne et al. 2009). Warmer water temperatures also enhance microorganism metabolism and processing of organic matter (unless dissolved oxygen is limiting), causing eutrophication when nutrient levels are high (Carpenter et al. 2011, Mantyka-Pringle et al., 2014) as well as increased omnivory. Warming also induces phenological mismatches between consumers and resources in highly seasonal environments, potentially destabilizing foodweb structure (Guy Woodward et al., 2010).

4.2.4 Terrestrial ecosystems.

4.2.4.3 Future global ecosystem functioning and biodiversity in strong climate change mitigation scenarios

Hydropower is expected to increase worldwide whatever the RCP scenario unless other renewable energy sources are installed. Regions where significant losses in streamflow and decreased capacity production are projected, or where human population is expected to continue to increase (such as in many countries of Africa), should be most affected. **Fragmentation of rivers by dams increases species extinction risks by blocking spawning/rearing migrations and/or reducing population sizes and gene flow.** Hydropower infrastructures alter rivers, floodplain lakes, wetlands and estuaries. Dams transform river basins by creating artificial lakes locally, fragmenting river networks, and greatly distorting natural patterns of sediment transport and seasonal variations in water temperatures and flows (Latrubesse et al., 2017). **Altered flow seasonality in rivers has led to less diverse fish assemblages, decreased inland fisheries production, less stable bird populations and lower riparian forest production** (Jardine et al., 2015; Kingsford et al., 2017; Sabo et al., 2017). Sediment retention by dams leads to delta recession (Luo et al. 2017), decreased coastal fisheries catches, and degraded tropical mangrove forests that are major carbon sinks (Atwood et al., 2017). Dams also prevent upstream-downstream movement of freshwater animals, facilitate settlement of non-native species, cause local species extirpations and replacements and increase risk of water-borne diseases in reservoirs and highly altered environments by modifying productivity (Fenwick, 2006; Poff & Schmidt, 2016). Dams have also caused a significant displacement of IPLC around the world and projected expansion of dams, as shown in Figure 4.2.13, suggest significant overlap with areas held and/or managed by IPLC (Garnett et al 2018). **The fragmentation of river corridors also reduces population sizes and gene flows of aquatic species, increasing species extinction risks** (Cohen et al., 2016; Dias et al., 2017). Dams are mainly concentrated in highly industrialized regions, but future hydropower development will be concentrated in developing countries and emerging economies (Grill et al., 2015, Zarfel et al. 2015). Hydropower is expected to expand worldwide whatever the RCP scenario (Figure 4.2.13). Most hydropower plants are currently situated in regions where considerable declines in streamflow are projected, resulting in mean reductions in usable hydropower capacity (Turner et al., 2017; van Vliet et al., 2016). Those regions may increase dam building to compensate for the losses unless other energy options are implemented (Zarfel et al. 2015). Also, growing population density is expected to also increase demands for hydropower globally, especially in tropical regions (Winemiller et al., 2016) where freshwater biodiversity is concentrated (Tisseuil et al., 2013a) (United Nations, 2016).

4.3 Plausible Futures for Nature's Contributions to People

4.3.3 How changes in nature's contributions to people will manifest in different regions, including teleconnections across regions

Ecosystems and biomes (or IPBES units of analysis) are interconnected, influence each other and thus many NCP are also interconnected in space (Álvarez-romero et al., 2017; Liu et al., 2015). These interactions can occur in the natural system (e.g., via the atmosphere, or through river flows), often called teleconnections. In socio-economic and socio-ecological systems the telecoupling concept considers interactions, feedbacks and spillover between different and typically distant system components (e.g., by trade or migration (Liu et al., 2015; Liu et al., 2013a; Melillo et al., 2009; Güneralp et al., 2013). Through those mechanisms, resource use and ecosystem management in some regions affects NCP from other regions (Pascual et al., 2017) (see section 4.5 and Chapter 5). For example, the displacement of timber extraction from Finland to Russia has created environmental impacts in Russia that in turn affected migratory birds in Finland (Mayer et al., 2005).

4.6 Links to Sustainable Development Goals, Aichi Targets and other international objectives for Nature and Nature's Contributions to People

4.6.2.3 Vulnerable ecosystems (Coral Reefs) (Target 10)

There is strong evidence that reducing other stresses on ecosystems will generally improve the capacity of ecosystems to adapt to climate change. For tropical coral reefs, reducing nutrient loading and maintaining or reinforcing herbivorous fish populations helps reduce the competition by algae and these and other measures are projected to substantially improve the capacity of coral reefs to maintain their integrity in the face of climate change (Box 4.2.3 in 2.2.3.1; Gattuso et al., 2015; Kennedy et al., 2013). Other examples include the importance of halting terrestrial habitat fragmentation **and increasing connectivity between natural habitats to allow species to move so that they can track favourable climates** (Imbach et al., 2013).

4.6.2.4 Protected Areas and other Effective Area-based Measures (Target 11)

While the world may be on track to meet or exceed the numeric target of protecting globally 17% of the land and 10% of the oceans by 2020 (Chapter 3), other aspects of the target, including the global **connectivity and representativity of protected areas, and their coverage of areas important for biodiversity (including Key Biodiversity Areas), have made little or no progress** (Butchart et al., 2015; Santini, 2015). **These aspects may be more important that numeric targets per se**, as demonstrated by the evidence that if new protected areas between 2004 and 2014 had targeted unrepresented threatened vertebrates, it would have been possible to protect >30 times more threatened species for the same area or cost as the actual expansion that occurred (Venter et al., 2014).

From Chapter 5. Pathways towards a Sustainable Future

Recognizing that current evaluations (Chapters 2, 3) and most future scenarios (Chapter 4) show humanity failing to achieve one or more of the 2030 Sustainable Development Goals (SDGs), the 2020 Aichi Biodiversity Targets, and Paris agreement on climate change, this chapter examines pathways towards successfully achieving these overarching goals. Are key findings pertaining to these:

- 5. The fourth focus **is maintaining freshwater for nature and humanity (SDG 6**, also considering 2 and 12). Pathways exist that improve water use efficiency, increase storage and improve water quality while minimising disruption of natural flow regimes. Promising interventions include practising integrated water resource management and landscape planning across scales; protecting wetland biodiversity areas; guiding and limiting the expansion of unsustainable agriculture and mining; slowing and reversing de-vegetation of catchments; and mainstreaming practices that reduce erosion, sedimentation and pollution run-off and that minimize the negative impact of dams (well established). **Major interventions enable achievement of these SDGs, differing across contexts. Key among these are three general changes: (a) Improving freshwater management, protection and connectivity;** (b) participation of a diversity of stakeholders, including Indigenous Peoples and Local Communities, in planning and management of water and land-use (including protected areas and fisheries); and (c) strengthening and improving implementation and enforcement of environmental laws, regulations, and standards
- 7. The sixth focus is **sustaining cities while maintaining the underpinning ecosystems** (both local and regional) **and their biodiversity (SDG 11, also 15).** Successful pathways generally entail city-specific targets for retaining species and ecosystem in cities and surrounding regions, as well as limits on urban transformation. These can be achieved by strengthening local- and landscape-level governance and enabling transdisciplinary planning to bridge sectors and departments, and to engage businesses and other organizations in protecting public goods (well established).

- Opportunities to integrate ecological and built infrastructure are increasingly important, particularly for cities in developing countries with high deficits of infrastructure. **Maintaining and designing for ecological connectivity within urban space is critical for nature and people, especially in large cities.** Particularly important at the regional scale are policies and programmes that promote sustainability-minded collective action protect watersheds beyond city jurisdiction and **ensure the connectivity of ecosystems and habitat** (e.g., through green-belts), and that city expansion towards key regional biodiversity sites does not undermine their conservation mandates.

5.3 Pathways derived from the scenarios review process.

5.3.2.3 Conserving and restoring nature on land while contributing positively to human well-being

Existing PAs suffer from several challenges. **Isolated areas can lack functional connectivity for species. Some authors argue that biodiversity within PAs continues to decline, questioning the effectiveness of current conservation management approaches** (Coad et al., 2015), while other studies document the effectiveness of PAs, at least relative to other land uses (Gray et al., 2016). Today's PAs are likely not adequate to conserve many species whose distributions will shift due to climate change (SCBD, 2014); they may also suffer from additional degradation (e.g., increased fire risk). In **this context, to protect habitats and species and maintain connectivity, attention has been directed towards biodiversity-rich land under private ownership and under the governance and management of IPLCs, who already contribute to the management of around 40% of PAs globally** (Tikka and Kauppi, 2003; Paloniemi and Tikka, 2008; Kamal et al., 2015, Drescher and Brenner, 2018, Maron et al., 2018; Garnett et al., 2018)

What do scenarios say about how to achieve these goals?

Local scenarios propose a combination of **protected areas and land-sharing approaches through landscape planning. The ‘land sharing’ strategy has the potential to improve connectivity** between natural areas by boosting natural elements within the agro-ecological matrix. Meanwhile, increasing productivity reduces the land area needed for agricultural production and consequently reduces biodiversity loss. But the sustainability of that intensification depends on reserving large areas within the agro-ecological matrix for natural elements (Perfecto & Vandermeer, 2010).

Synthesis and open questions about conservation and restoration pathways.

The expansion of the current PA network is necessary to ensure that PAs are ecologically representative and connected, including in light of climate change. However, to accommodate conservation and restoration where land is increasingly limited, the reviewed literature points out that participatory spatial planning based on a landscape approach is key.

5.3.2.4 Maintaining freshwater for nature and humanity

The GBO-4 (2014) re-assessment of the PBL (2012) Roads from Rio+20 used the same 3 scenarios designed to attain SDG targets, but with metrics addressing Aichi targets relating to inland waters. Elements of all three scenario pathways address the maintenance of freshwater ecosystems and their multiple contributions. Aside from the systemic integration of freshwater nature into planning, development and communications, GBO-4 pathways include national accounting of water stocks. Specifically, in these pathways **IPLC are involved in creating and governing protected areas (PAs), PA networks are expanded to be more representative of freshwater ecosystems, and protection is enhanced for river reaches upstream and downstream of terrestrial PAs to maintain connectivity**

5.3.2.5 Balancing food provision from oceans and coasts with nature protection

Achieving marine protected area (MPA) targets should contribute positively to both biodiversity **conservation and sustainable food production, although the extent of co-benefits would depend on timeframe, site selection, and design and effectiveness of the protected areas.** Scenario modelling efforts for **MPA targets focus strongly on site selection with a primary objective of biodiversity conservation.** Across many contexts, scenario and modelling studies that evaluate different MPA designs and the pathway to achieving MPA targets generally suggest that MPA networks would benefit both biodiversity and fisheries in the long-term, particularly in overexploited ecosystems, in part because of demonstrated spillover effects by which effectivelymanaged MPAs boost fisheries in surrounding waters (Gill et al., 2017). However, trade-offs often exist in the short-term because of the time lag in biological responses to protection relative to the immediate cost of losing resource use opportunities (Brown et al., 2015). **The degree of such trade-offs and co-benefits is shown to be sensitive to ecosystem and MPA attributes such as mobility of organisms, dispersal of the populations, size of and connectivity between protected areas (Gill et al., 2017**).

5.4 Key Constituents of Pathways to Sustainability: Addressing the Indirect Drivers of Change

5.4.2.4 Management for resilience, uncertainty, adaptation, and transformation

Possible points of action: Biggs et al. (2012) offer a set of general recommendations for building resilience of ecosystem services, including maintaining diversity and redundancy in both ecological and governance aspects; **understanding and managing connectivity**, recognizing that there may also be negative effects like disease; managing feedback mechanisms and 'slow' variables important to nature's contributions to people, including monitoring and adaptive management; accounting for complexity in scenarios and planning, including non-linearity and critical thresholds; promoting learning, participation, and polycentric governance; and enabling the self-organization of agents of change.

From Chapter 6. Options for Decision Makers

Main options for decision makers: Instruments that can be included in smart policy mixes (Table 6.1)

Decision maker	Instruments that can be included in smart policy mixes within or across issues: Conservation
Intergovernmental organizations	Facilitate expansion and improved management, functionality and connectivity of (transboundary) protected areas
Governments (national, subnational, local)	Expand and improve management, functionality and connectivity of (transboundary) protected area
NGOs	Engage in expansion and improved management, functionality and connectivity of (transboundary) protected areas
Donor agencies	Support expansion and improved management, functionality and connectivity of (transboundary) PAs;

Options for integrated approaches for sustainable landscapes (Table 6.3)

Long-term options (in the context of transformative change)	Key obstacles, risks, spill-over, unintended consequences, trade-offs	Major decision maker(s)	Main level(s) of governance	Main targeted indirect driver(s)
For Protecting nature				
Improving spatial and functional connectivity of PAs	Isolation of PAs; geographical and ecological biases; limited spatial planning; trade-offs among societal objectives	Global organizations; governments; NGOs; donors	All	Governance; institutions, technological

6.3 Transformative change in and across issues, goals and sectors

6.3.2.3 Protecting nature within and outside of protected areas

Improving spatial and functional connectivity of PAs.

The functionality of PA networks cannot be maintained when the habitat area is too small and fragmented, and when the landscape beyond PA boundaries is inhospitable (Bengtsson et al., 2003). **PAs then become islands of biological conservation** (Bauer & Van Der Merwe, 2004; Crooks et al., 2011; Seiferling et al., 2012; Barber et al., 2014; Wegmann et al., 2014) threatening the long-term viability of **their biodiversity, especially many wildlife populations** (DeFries et al., 2005; Newmark, 2008; Riordan et al., 2015). There are also significant geographic and ecological biases in the representation of habitats and ecosystems in PAs (e.g., Pressey et al., 2003; Joppa & Pfaff, 2009, Butchart et al., 2012, 2015), which result in unplanned assemblages of PAs confined to economically unproductive areas (Scott et al., 2001; Evans, 2012), with little ecological relevance (Opermanis et al., 2012), which ultimately compromise their overall conservation potential (Watson et al., 2014).

Options to address these challenges include several policy support tools for (spatial) conservation prioritization to inform where to establish new PAs so that more biodiversity is conserved in a cost-effective way, accounting for multiple competing sea- or land uses and socioeconomic factors (e.g., Dobrovolski et al., 2014; Forest et al., 2007; Isaac et al., 2007; Montesino Pouzols et al., 2014; Nin et al., 2016; Di Minin et al., 2017). **Spatial conservation planning can be a useful tool for enhancing landscape connectivity, maximizing the ecological representation of PA networks and safeguarding Key Biodiversity Areas.**

6.3.5.1 Urban planning for sustainability

Options for sustainable urban planning include: bioregional planning; nature-friendly urban development; increasing green space in cities; and protecting land for urban agriculture:

- **Nature-friendly urban development**: Ecosystems are often highly fragmented in urban areas, which can alter the genetic diversity and threaten long-term survival of sensitive species. To ensure viable urban populations, **urban planners need to understand species' needs for habitat quality and connectivity** (Kabisch et al. 2017; Braaker et al. 2014; Colding 2011). Ecologically progressive urban planning and policy are already demonstrating how biodiversity conservation and management to enhance local ecosystem services production can be part of urban transitions and transformations for sustainability (Kabisch et al. 2017).
- • **Increasing green space and greenbelts throughout cities:** GIS and other holistic spatial planning tools and technologies can be used to create new green spaces and improve and connect existing ones using (Pickett & Cadenasso 2008; Vergnes 2012).

6.3.5.2 Nature-based solutions and green infrastructure

Green infrastructure can be a critical source for security and improving human wellbeing in urban areas (Gill et al. 2007; Foster et al. 2011; Depietri et al. 2011). Different types of GI can play a role in providing nature's contributions to urban residents such as storm water management and flood protection, temperature regulation, cleaner air and water, urban food production, recreation, and health benefits, as well as contributing to habitat creation and **restoration, connectivity of ecological networks**, **and increasing urban biodiversity** (Andersson et al. 2014; Garmendia et al. 2016).