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Uncertain seas ahead: legal and policy approaches to conserving marine biodiversity in the face of changing climate

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Abstract
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<cn>3. <ct>Uncertain seas ahead: legal and policy approaches to conserving marine biodiversity in the face of changing climate

<au>**Richard Kenchington and Robin Warner**

<a>1. INTRODUCTION

Climate is a major factor in the habitat, food chains, competition, success and survival of species. Contemporary distributions and abundance of marine species and communities reflect adaptation to geologically recent climatic conditions and the impacts of human activities. Warming of the atmosphere and seawater has occurred in association with increasing levels of atmospheric carbon dioxide since the start of the twentieth century. Despite continuing scientific research and wider discussion of the relative roles of anthropogenic greenhouse gas increases and other influences on climate, climate change is occurring. The policy and legal issues have two core components: response to the effects of climate change, and addressing the human activities for which there is reasonable evidence of causation or exacerbation of climate change. For the purpose of this chapter, the focus will be on the response to the effects of climate change, rather than on the issue of anthropogenic causation and exacerbation.

The effects of climate change on marine biodiversity flow from increasing water temperature and absorption of carbon dioxide from the atmosphere with consequential changes in the chemistry of seawater; the strength and direction of ocean currents; and the intensity, frequency and geographic range of extreme weather events. The expected consequences of recent and projected anthropogenic increases in greenhouse gases on climate change are now considered inevitable, with temperatures set to continue to increase. This is because the period over which any stabilization or return to historic levels would occur is expected to be long.

In policy and legal terms, the effects of climate change on marine biodiversity compound and are difficult to separate from the effects caused by anthropogenic impacts such as the overexploitation of fisheries and marine resources; coastal habitat destruction; and operational and catastrophic accidental pollution arising from marine industries, shipping and land and freshwater uses. The combined effects may be linked over substantial distances, within and between jurisdictions, by run-off from land, and by currents transporting larvae, nutrients and food in water columns.

This raises issues that require multisectoral integration of policy and management within jurisdictions, coordination with adjacent and linked jurisdictions and regional and international mechanisms to address areas beyond national jurisdictions. These issues have been matters of concern since the United Nations (UN) Conference on the Human Environment in Stockholm in 1972. This conference led to the establishment of the United Nations Environment Programme (UNEP) and subsequently to the World Conservation Strategy (1987) and the World Environment Summit in Rio de Janeiro in 1992, which in turn produced in the UN Convention on Biological Diversity and Agenda 21. Chapter 17 of Agenda 21 specifically addresses

the protection of oceans, seas (including enclosed and semi-enclosed seas) and coastal areas, as well as the protection, rational use and development of their living resources.

The complexities of multisectoral and trans-jurisdictional policy and management have led to many systems and approaches designed to address specific sets of circumstances; for example, Integrated Coastal Zone Management, Integrated Coast and Ocean Management, Marine Spatial Planning and Ecosystem-based Management.

A World Bank (2006, pp. 9–12) report listed 32 marine management tools and developed a typology based on the objectives and extent of the environmental protection offered. It identified four groups:

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<bt> marine protected area tools, primarily for biodiversity conservation and habitat protection

<bt> multiuse management tools, primarily for balanced conservation and socioeconomic uses

<bt> sustainable use marine-resource management tools, primarily for extractive use

<bt> culture/ecological/social protection reserves, primarily for indigenous and traditional non-indigenous communities.</bl>

This list is not exhaustive, but it reflects the social and political challenge of integrating the objectives of competing sectoral approaches and addressing overarching issues such as the predicted effects of climate-related changes and the increasing range of human uses and impacts affecting marine space.

<a>2. CLIMATE CHANGE IMPACTS ON MARINE BIODIVERSITY

Changes in which climate is a major or significant driver include: increasing water temperature; changes in the chemical properties of seawater; sea level rise; increased frequency, severity and range of severe weather events; and increasing thermal and other stresses on species due to all these factors. These changes are discussed in more detail below.

<b>2.1 Increasing Water Temperature

A core consideration in the adaptation of a species or individual to changing climate is the thermal tolerance range of that species, defined by its upper and lower lethal temperature limit, and, within that, the optimal thermal range. Deser et al. (2010) reviewed tropical sea-surface temperature trends for the twentieth century. Their analysis was limited by poor and inconsistent historic sampling and measurement practices. However, they found reasonable concurrence in estimates of 0.35^{o}C for the century. For Australian regional seawater surface temperature rises to 2070, the predicted range is from 0.6^{o}C to 2.5^{o}C (Commonwealth of Australia 2007). The expected consequences of ocean warming include increased thermal stress on tropical species and communities, with the probability of substantial change and significant species loss (Cheung et al. 2009).

Typically, the distribution of tropical species reflects a range close to absolute upper level of thermal tolerance. Under increasing temperatures, they are likely to show local extinction in their original habitats and, where possible, movement or invasion through larval transport and settlement to follow the movement of their

preferred thermal range to higher latitudes. Some or many species may survive by gradual relocation through range extension or larval settlement in suitable habitats in higher latitude areas that have warmed. This is likely to cause a cascade effect, with such relocation causing competition with and displacement of species for which the temperature range of the invaded location has become too high. At polar latitudes, the pressures on species adapted to extremes of cold environmental conditions are expected to lead to species loss.

Cheung et al. (2009) have modelled likely patterns of such changes and predicted significant species extirpation in the equatorial South Asian/Indian Ocean and west Pacific Ocean, with the highest levels in the enclosed Java Sea, but low levels of species invasion in the Asia-Pacific region generally. They did not address the potential implications of climate change on habitat-building species such as corals, so the predicted levels of extirpation may be regarded as conservative.

The immediate policy and legal issues arising from species distribution changes are likely to relate to species of fisheries importance. Cheung et al. (2009) modelled projected changes to 2055 in maximum fishery catch potential. Their projections show widespread reductions of 30 to 50 per cent or more in most of the equatorial Asia-Pacific region through reductions in current tropical fisheries. Conversely, they predict increases in excess of 100 per cent in the south-eastern tropical Indian Ocean and sub-tropical and temperate south-west Pacific.

In addition to the changes expected to flow from gradually rising mean sea-surface temperatures, relatively short periods of extreme temperature rise can also have major ecological consequences. In 1998/99, substantial areas of the Indo-Pacific experienced a prolonged period of severe high water temperature,

which caused widespread coral bleaching. Many days of water temperatures two or more degrees above normal summer maxima stressed corals, which responded by rejecting their symbiotic algae, zooxanthellae. The stress continued for so long that there was widespread coral death, with large areas experiencing more than 95 per cent coral mortality. In many of these areas, there has been recovery of coral cover through recruitment. However, recovery of the structural complexity and requisite habitat for the broad range of species associated with healthy coral reefs is a longer-term prospect.

<b>2.2 Changes in the Chemical Properties of Seawater

Seawater is a complex and dynamic solution of interacting salts and ions that interact directly with the atmosphere at the sea surface. Atmospheric gases dissolve in seawater to an extent determined by their partial pressure and the consequential chemical reactions they have with other solutes. The increasing levels of atmospheric carbon dioxide have translated into increasing concentrations of carbon dioxide in the oceans, causing the acidification of seawater. The consequences are difficult to predict because of the complex dynamics of seawater chemistry, but there is evidence that acidification is reducing the density of calcium carbonate in the skeletons of corals and other calcifying species, including planktonic species.

<b>2.3 Sea-level Rise

International Panel on Climate Change (IPCC) model-based predictions of sea-level rise for the remainder of the twenty-first century are 20 to 42 mm per decade in a low scenario and 28 to 65mm per decade in a high scenario. These scenarios exclude

considerations of ice flow because of the lack of published literature. Douglas (1997) used long time-series data from tide gauges to derive a global mean rise of sea level of 20 mm per decade for the twentieth century. There are regional differences and Webb (2010) discusses Pacific Regional Island Shoreline Monitoring System data from studies of 27 islands for between 20 and 60 years, showing island stability and some areas of land increase, with a mean sea level increase of 100 mm since the mid-twentieth century.

The phenomenon of sea level rise is real, but it is occurring amidst tidal cycles and the greater shorter-term variations caused by the El Niño Southern Oscillation (up to 600 mm over periods of months every 5–10 years) and atmospheric pressure (from 700 to 1300 mm over periods of hours to months).

The significance for biodiversity is that the effects of sea-level rise will include inundation of low-lying areas and changes to the availability of habitats for intertidal and sub-tidal plants and animals. In unpopulated and undeveloped areas, the habitats of sub-tidal and intertidal plant and animal communities would follow the gradual landward movement of the tidal band. Elsewhere it can be expected that actions to protect property and infrastructure will restrict this process.

<b>2.4 Increasing Frequency and Intensity of Severe Weather Events

While warming may be a gradual process, the changes it brings are expected to be delivered through weather events including severe destructive cyclonic storms and extremes of temperature, drought and rainfall. Before mean sea level reaches levels predicted in IPCC scenarios, severe storm surge events beyond high water are likely to have more frequent major destructive impacts on beaches, islands, low lying land,

urban, industrial, agricultural and communications infrastructure, and on soils that are increasingly flooded with seawater.

<b>2.5 Issues of Scale in Space and Time

The significance of climate change for biodiversity is that animal and plant communities are shaped by severe events. Shallow marine and coastal communities, particularly those in exposed coastal areas, are directly and quite frequently impacted by events such as severe storm waves, extremes of temperature and freshwater dilution or displacement of seawater through flooded river run-off plumes or intense localized rainfall events. Such events cause substantial damage, death or removal of species in an impacted area, but they also provide subsequent opportunities for recruitment or invasion of plants and animals to colonize that affected area.

Initial recovery after such events may involve regeneration of surviving damaged benthic species such as sea grasses and corals; larval recruitment of opportunistic short-lived species different to those that were displaced; and, over time, subsequent succession may lead to different mature communities from those destroyed by the impact event. Connell, Hughes and Wallace (1997) discuss long-term variations observed in 30 years of study of corals on Heron Island Reef and highlight that the mechanisms that influence abundance operate over many scales of space and time, with the consequence that studies on small and large scales are needed to understand them.

The critical factor for future policy and management is the expectation that gradual changes in sea level, seawater temperature and chemistry will be accompanied by an increased frequency of intense events. Recovery intervals for

affected biological communities are consequently expected to reduce, favouring resilient, fast growing and opportunistic species. Long-term studies, such as that reported by Connell, Hughes and Wallace (1997), are rare and this limits current capacity to predict the changes likely to occur in biological communities and their implications.

<a>3. POLICY AND LEGAL IMPLICATIONS OF CLIMATE CHANGE FOR BIODIVERSITY

The effects of climate change will increase the stress on plant and animal communities and the ecological services they provide. These effects compound stresses from human uses such as pollution, habitat loss and damage, and changed environmental flows of freshwater, sand and nutrients.

It is clear from experience of extreme events, such as coral bleaching and severe storm impacts, that the likely effects of climate change will not be uniformly distributed. The life cycles of many of the species on the seabed or in the water column of a specified area may include breeding sites, larval growth areas and migrations outside and often far beyond the boundaries of a specified management area. The economic benefits derived in one place in a catchment may have significant environmental and economic costs at another location lower in the same catchment or in coastal waters where a river reaches the sea.

Areas remote from significant centres of human population or industrial activity, and with intact biological communities and predator prey components, are likely to be less impacted. For other locations, an important issue is resilience: the

capacity to survive and return to normal functional efficiency following a departure from preferred range conditions. In part, this reflects the health of the communities and, in part, can reflect connectivity to areas that have been less affected.

Understanding and managing other human uses on a basis of verifiable sustainability, and the identification and protection of suitable areas as reference sites and sanctuaries becomes particularly important in the face of climate change. Reference sites enable the monitoring and understanding of changes, while sanctuaries provide for mature breeding populations whose offspring can re-populate impacted areas. The maintenance of biodiversity in its broadest sense, and the support of fisheries and other ecosystem services are likely to become an increasingly important issue of food and resource security.

The policy options for managing marine biodiversity relate primarily to achieving a sustainable balance of measures that minimize direct anthropogenic stresses on the capacity of species and communities to survive and adapt in the face of climate change, human uses and impacts, and the on-going natural biophysical dynamics affecting marine ecosystems. This requires an approach to policy and the management of human activities and impacts within the constraints of ecosystem function. A current term for such an approach is ‘ecosystem-based management’, which is described by the UNEP as:

> <quotation>In ecosystem-based management, the associated human population and economic/social systems are seen as integral parts of the ecosystem. Most importantly, ecosystem-based management is concerned with the processes of change within living systems and sustaining the goods and services that healthy ecosystems produce. Ecosystem-based management is

therefore designed and executed as an adaptive, learning-based process that applies the principles of the scientific method to the processes of management. (UNEP 2011, p. 13) </quotation>

The core of the approach is coordination of sectoral management within an institutional arrangement that establishes and addresses mutually sustainable ecological, social and economic objectives and constraints. Within a jurisdiction, this may be addressed by overarching legislation or policy that integrates and binds agencies within an operational framework of explicit objectives. Between jurisdictions, such an arrangement may be addressed through agreement to coordinate policy and operations within a framework of policy objectives (Kenchington and Crawford 1993). The task of marine ecosystem management is made particularly challenging by the combination of climate and other far-reaching changes. Many of the elements that have to be addressed in management are strongly connected across jurisdictional and sectoral boundaries.

<a>4. LEGAL AND POLICY FRAMEWORKS FOR CONSERVATION OF MARINE BIODIVERSITY AND LINKAGES WITH CLIMATE CHANGE

Scientists acknowledge that measures to conserve marine biodiversity are important bulwarks against the adverse effects of climate change on marine species, their habitats and ecosystem structures. Even before the emergence of climate change as a driving issue, global, regional and national communities had invested significant efforts in establishing legal and policy frameworks to support the conservation of terrestrial and marine biodiversity. The World Congress on National Parks in 1962

was one of the first international conservation meetings to address marine management from an ecosystem conservation perspective. The need for a systematic approach to establishing protected areas in marine environments was first clearly articulated at an International Conference on Marine Parks and Protected Areas, convened in Tokyo in 1975 by the International Union for Conservation of Nature (IUCN 1976). This concept was revisited in 1988 at the Seventeenth General Assembly of the IUCN, which recognized the urgency of the need for a spectrum of measures addressing the roles of conservation, and adopted a resolution with the primary goal:

> <quotation>To provide for the protection, restoration, wise use, understanding and enjoyment of the marine heritage of the world in perpetuity through the creation of a global representative system of marine protected areas and through the management, in accordance with the principles of the World Conservation Strategy, of human activities that use or affect the marine environment. (IUCN 1988, p. 105, para. 17.38)</quotation>

In the narrower sense, this meant the strict protection of special areas, while in the broader sense, it meant sustainability and stewardship consistent with the *World Conservation Strategy* (IUCN/UNEP/WWF 1980).

Key elements and mechanisms within these frameworks provide the legal authority for recognizing the adverse effects of climate change on marine biodiversity and taking remedial measures to adapt and mitigate its worst effects. At the global level, the 1982 United Nations Convention on the Law of the Sea (LOSC) signalled the advent of a more holistic approach to the protection of the marine environment. Article 194(5) recognized that measures taken to protect and preserve the marine

environment should include those necessary to protect and preserve rare or fragile ecosystems, as well as the habitat of depleted, threatened or endangered species and other forms of marine life. A decade later, the 1992 Convention on Biological Diversity (CBD) was negotiated as a conventional international law framework to assist States in arresting the alarming rate of extinction of species and destruction of their habitats (Birnie et al. 2009, pp. 612–613; Grubb et al. 1993, p. 75; Joyner 1995, p. 644). The provisions of the CBD share similarities with the vision enunciated in the Rio Declaration and Agenda 21, as agreed upon at the United Nations Convention on Environment and Development (UNCED), of integrated and ecosystem-based management of the environment, including of marine areas beyond national jurisdictions (Grubb et al. 1993, pp. 75–76). The three broad objectives of the CBD, set out in Article 1, are the conservation of biodiversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. Chapter 17 of Agenda 21 concerns the protection of the oceans, seas (including enclosed and semi-enclosed seas), and coastal areas, and the protection, rational use and development of their living resources. It identifies specific needs for marine conservation; calling for new approaches to marine and coastal area management and development at the national, subregional, regional and global levels. It recommends that these approaches be integrated in content and precautionary and anticipatory in ambit, as reflected in the following programme areas:

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a. integrated management and sustainable development of coastal areas, including exclusive economic zones

b. marine environmental protection
c. sustainable use and conservation of marine living resources of the high seas
d. sustainable use and conservation of marine living resources under national jurisdiction
e. addressing critical uncertainties for the management of the marine environment and climate change
f. strengthening international, including regional, cooperation and coordination
g. sustainable development of small islands.</nl>

In support of these objectives, the Contracting Parties have developed a variety of supplementary guidelines that elaborate on key tools for mitigating the adverse effects of human activities on biodiversity. These include environmental impact assessments (EIA), strategic environmental assessments and marine spatial planning. At the Asia-Pacific regional level, specific legal and policy frameworks to conserve marine biodiversity and reduce the negative effects of human activity on regional marine ecosystems have emerged through organizations and arrangements such as Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), the Coral Triangle Initiative (CTI) and the South Pacific Regional Marine Environment Programme (SPREP). These include some specific initiatives to monitor the impacts of climate change on regional marine ecosystems and address efforts towards alleviating adverse effects.

At the national level, enactments such as Australia's 1975 Great Barrier Reef Marine Park Act and 1999 Environment Protection and Biodiversity Conservation Act

(EPBC) incorporate the processes necessary to identify the adverse effects of human activity on marine biodiversity, including the effects linked to anthropogenically induced climate change. Further, these Acts provide the authority to impose relevant mitigation measures on the perpetrators of such activities. Australia's marine bioregional planning process is also taking into account the projected impacts of climate change on coastal and offshore areas under national jurisdiction.

The following section will further examine some global, regional and national legal frameworks and initiatives for the conservation of marine biodiversity to determine how capable they are of recognizing climate change impacts and limiting their adverse effects.

<b>4.1 Global Frameworks

The LOSC established a spatially based framework of jurisdictional rights and responsibilities for the management of living resources and the protection and preservation of the marine environment. Table 3.1 sets out key provisions of the LOSC relevant to conservation and management of marine living resources and protection and preservation of the marine environment.

Table 3.1 Provisions of the United Nations Convention on the Law of the Sea particularly relevant to the management of living resources and the protection and preservation of the marine environment

Part V Exclusive Economic Zone	Article 61:	Conservation of living resources
	Article 62:	Utilization of living resources, including provisions for access to resources not utilized by the coastal state

Part VII High Seas	Article 118:	Cooperation of States in the conservation and management of living resources
	Article 119:	Conservation of the living resources of the high seas
	Article 120:	Marine mammals
Part XII Protection and Preservation of the Marine Environment	Article 192:	General obligation to protect and preserve the marine environment
	Article 194:	Measures to prevent, reduce and control pollution of the marine environment
	Article 197:	Cooperation on a global or regional basis
	Article 206:	Assessment of potential effects of activities
	Article 237:	Obligations under other conventions on the protection and preservation of the marine environment

<c>4.1.1 1992 Convention on Biological Diversity

The CBD provides a set of guiding principles and recommended processes for Contracting Parties establishing national programmes for biodiversity conservation. Moreover, it highlights the need for *in situ* conservation of biodiversity, which is defined in Article 2 as ‘the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings’ (Grubb et al. 1993, pp. 82–83; Kimball 1995, p. 765). These elements can also be applied in any programme implemented collaboratively by States to conserve marine biodiversity across marine boundaries and in marine areas beyond

national jurisdiction. Under Article 7, Contracting Parties are directed to identify components of biodiversity important for conservation and sustainable use, with an indicative list of categories set out in Annex I. Following identification, Contracting Parties are advised to monitor, through sampling and other techniques, these components of biodiversity, paying particular attention to the need for urgent conservation measures and to those components that offer the greatest potential for sustainable use.

As part of these initial steps towards biodiversity conservation, Contracting Parties are advised to identify processes and categories of activities that have or are likely to have significant adverse impacts on the conservation and sustainable use of biodiversity, and to monitor their effects. Data obtained from these identification and monitoring processes are to be maintained and organized by Contracting Parties. This process of information gathering specified in the CBD provisions is relevant to climate change, as it will capture information related to climate change impacts on marine ecosystems and data on human activities causally linked to climate change, such as the emission of greenhouse gases by industry.

Two key biodiversity conservation measures outlined in Articles 8 and 14 of the CBD are closely linked to identifying and mitigating climate change impacts on marine biodiversity. Article 8 provides a comprehensive description of the principles and measures associated with *in situ* conservation of biodiversity, advising Contracting Parties to promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings, to rehabilitate and restore degraded ecosystems and to promote the recovery of threatened species. One of the principal means of achieving *in situ* conservation emphasized in the CBD

is the establishment of protected areas or areas in which special measures need to be taken to conserve biodiversity. Under Article 8(b), Contracting Parties are directed to develop guidelines for the selection, establishment and management of such areas. The processes already implemented by States at the national level to identify and manage marine protected areas or areas in which special measures are taken to conserve marine biodiversity can also be utilized to capture and monitor information on climate change impacts and to introduce mitigation measures.

Under Article 14 of the CBD, Contracting Parties are advised to introduce EIA procedures for proposed projects that are likely to have significant adverse effects on biodiversity, to avoid or minimize such effects. They are also urged to promote notification, exchange of information and consultation on activities under their jurisdiction or control that are likely to have significant adverse impacts on the biodiversity of areas beyond national jurisdiction by encouraging the conclusion of regional and multilateral arrangements. The introduction of EIA processes at national and regional level provides a further means of capturing information on climate change impacts on marine biodiversity and developing mitigation measures to address their adverse effects.

The Conference of the Parties to the CBD (COP CBD) has established an Ad Hoc Technical Expert Group on Biodiversity and Climate Change. At its tenth meeting in October 2010, the COP CBD considered the findings of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change and recommended that Contracting Parties and other Governments consider the guidance of the Committee on a range of matters relating to biodiversity and climate change (CBD 2012, X/33 para. 1). In particular, they recommended that States identify, monitor and

address the impacts of climate change and ocean acidification on biodiversity and ecosystem services and assess the future risks for biodiversity and the provision of ecosystem services using the latest available vulnerability and impact assessment frameworks (CBD 2012, X/33 para. 8(a)). They also recommended a number of strategies, some of which are particularly relevant to marine biodiversity, to reduce the impacts of climate change on biodiversity and increase the adaptive capacity of species and the resilience of ecosystems in the face of climate change. These strategies include:

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<bt> reducing non-climatic stresses such as pollution, over-exploitation, habitat loss and fragmentation, and invasive alien species

<bt> reducing climate-related stresses where possible, through enhanced adaptive and integrated marine and coastal management

<bt> strengthening protected area networks

<bt> integrating biodiversity into wider seascape and landscape management

<bt> restoring degraded ecosystems and ecosystem functions

<bt> facilitating adaptive management by strengthening monitoring and evaluation systems (CBD 2012, X/33 para. 8(d)). </bl>

COP 10 recommended that States develop a strategy for biodiversity conservation and sustainable use that includes seascape management in those areas that are becoming accessible to new uses as a consequence of climate change, and that specific measures be taken for species that are vulnerable to climate change, including migratory species (CBD 2012, X/33 para. 8(f), (g), (i)). Ecosystem-based approaches for climate change mitigation were suggested, including enhancing the conservation,

sustainable use and restoration of marine and coastal habitats that are vulnerable to the effects of climate change or which contribute to climate change mitigation, such as mangroves, peatlands, tidal salt marshes, kelp forests and seagrass beds (CBD 2012, X/33 para. 8(j), (m)).

In relation to climate change mitigation and adaptation measures, COP 10 emphasized the need to take into account the effects of such activities on marine biodiversity and the provision of ecosystem services through building on a scientifically credible knowledge base and developing ecosystem and species vulnerability assessments (CBD 2012, X/33 para. 8(v)). In particular, States were urged to ensure that no climate-related geo-engineering activities, such as ocean fertilization, that may affect biodiversity take place until there is an adequate scientific basis to justify such activities. Further, appropriate consideration of the associated risks to the environment and biodiversity was encouraged (CBD 2012, X/33 para. 8(w)).

In its decisions on marine and coastal biodiversity, COP 10 highlighted the adverse impact of climate change on marine and coastal biodiversity and recognized that the ocean is one of the largest natural reservoirs of carbon, which can significantly affect the rate and scale of global climate change (CBD 2012, X/29 para. 7). COP 10 expressed serious concern that increasing ocean acidification, as a direct consequence of increased carbon dioxide concentration in the atmosphere, reduces the availability of carbonate minerals in seawater, which are important building blocks for marine plants and animals. Therefore, it was recommended that the ecological effects of ocean acidification be considered in conjunction with the impacts of global climate change (CBD 2012, X/29 para. 64). To this end, COP 10 proposed that the CBD

develop a series of joint expert review processes to monitor and assess the impacts of ocean acidification on marine and coastal biodiversity in collaboration with other international organizations including the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (IOC/UNESCO), the Food and Agriculture Organization (FAO), the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC), the World Conservation Monitoring Centre of the United Nations Environment Programme (UNEP-WCMC), the International Coral Reef Initiative (ICRI), the Ramsar Convention, the Antarctic Treaty, and the Arctic Council, and that the results of these assessments be transmitted to the UNFCCC Secretariat (CBD 2012, X/29 para. 66).

The COP 10 decision on marine and coastal biodiversity placed particular emphasis on the application of the scientific criteria developed by the CBD COP 9 for the identification of ecologically and biologically significant areas (EBSAs). These provide a tool that Contracting Parties and competent intergovernmental organizations can use to identify areas and features of the marine environment, both within and beyond national jurisdictions, that are important for conservation and the sustainable use of marine and coastal biodiversity (CBD 2012, X/29 para. 25). To assist in implementing this work, the CBD is sponsoring a series of regional workshops in conjunction with the FAO, regional seas conventions and action plans, and regional fisheries management organizations prior to COP 11 in 2012, with the primary objective of facilitating the description of EBSAs within and beyond national jurisdictions (CBD 2012, X/29 para. 36).

At the national level, COP 10 recommended that States further integrate climate-change-related aspects of marine and coastal biodiversity into national

biodiversity strategies and action plans, national integrated marine and coastal management programmes, and the selection, design and management of marine and coastal protected areas (CBD 2012, X/29 para. 77). Finally, in its decision on marine and coastal biodiversity, COP 10 proposed convening an expert workshop with the UNFCCC on the role of marine and coastal biodiversity and ecosystems in adaptation to and mitigation of climate change impacts. The purpose would be to provide guidance for planning and implementing ecosystem-based approaches to climate change mitigation and adaptation and their integration in broader adaptation, mitigation and disaster risk reduction strategies (CBD 2012, X/29 para. 77). The focus on climate change impacts on marine and coastal biodiversity in the COP 10 decisions reflects an approach that seeks to incorporate climate change considerations into the traditional tools for ecosystem-based management of the marine environment, including the establishment of marine protected areas or areas in which special conservation measures are applied, as well as marine spatial planning.

<b>4.2 Asia-Pacific Regional Law and Policy Frameworks

To avert some of the worst impacts of climate change and to mitigate its detrimental effects on the marine and coastal biodiversity of the Asia-Pacific, collaboration among the countries of the region, extra-regional partners and global and regional organizations is needed at many levels. Some of this cooperation is already occurring. However, extension and innovative development will be required to reverse some of the adverse impacts of climate change on the environmental and economic security of the region. The following section will examine some of the regional initiatives to improve the resilience of marine and coastal biodiversity to climate change impacts.

<c> 4.2.1 Climate change initiatives in the Asia-Pacific region

In the Asia-Pacific, efforts are being taken to mitigate and adapt to the adverse impacts of climate change on the coastlines and marine biodiversity under the auspices of non-treaty-based regional environmental protection arrangements. Two such regional initiatives that have been taken in East Asia and the Asia-Pacific to protect the shared marine environment have strong climate change components. PEMSEA and the CTI reflect a common concern between East Asian States and some adjacent Pacific States for their shared marine environments in both the semi-enclosed seas of East Asia and the Pacific Ocean areas to the east of Japan and the Philippines. A group of 12 States and 15 non-State entities are partners in PEMSEA, which was established as a regional project of the Global Environment Facility (GEF) in 1994 with the initial aim of preventing and managing marine pollution in the East Asian seas (PEMSEA 2012a). PEMSEA's principal objective has developed into building interagency, inter-sectoral and intergovernmental partnerships for achieving the sustainable development of East Asian seas.

In November 2009, PEMSEA signed an agreement with the World Bank to address the challenges posed by the growing populations of and continued rural migration to the coastal cities in East Asia, which are threatening the quality and sustainability of coastal life (PEMSEA 2012c). The partnership will complement the efforts of 11 East Asian States, the UN, the GEF and 19 regional partners in protecting mangroves and coral reefs, preventing overfishing, improving water quality, and creating greater preparedness for natural disasters and the effects of climate change. Information on local climate change adaptation strategies was exchanged between

PEMSEA member States at an Experts' Forum on Climate Change Adaptation Strategies for Coasts and Oceans in the Philippines in early 2010 (PEMSEA 2012b). The initiative is still at an early stage and subject to resource and technical capacity limitations.

The CTI is another example of non-treaty-based maritime cooperation in the Asia-Pacific region, with a strong focus on climate change adaptation. The Coral Triangle is a region located along the equator at the confluence of the Western Pacific and Indian Oceans, which covers all or part of the exclusive economic zones of six countries: Indonesia, Malaysia, the Philippines, Papua New Guinea, the Solomon Islands and Timor L'Este. The Coral Triangle is regarded by scientists as one of the richest repositories of marine biodiversity on earth. It contains 76 per cent of all known coral species, 37 per cent of coral reef fish, and 33 per cent of the world's coral reefs. Further, it contains a wealth of mangrove forests and the spawning and juvenile growth areas for the world's largest tuna fishery (ARC 2008). Threats to the CTI region include overfishing, destructive fisheries practices, land-based sources of marine pollution and the ravages of climate change (CTI 2009). The CTI was proposed by Indonesia in 2007 as a multilateral partnership to protect the region's coastal and marine resources. Member States, Indonesia, the Philippines, Malaysia, Timor L'Este, Papua New Guinea and the Solomon Islands have committed to five overall goals over 10 years:

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<bt> the designation of priority seascapes

<bt> the implementation of an ecosystem approach to managing fisheries and other marine resources

<bt> the establishment of marine protected areas

<bt> the development of strategies to adapt to climate change

<bt> the protection of threatened species (CTI 2009).</bl>

The member States have committed to guiding principles including the recognition of the trans-boundary nature of important marine resources and the need to align their activities with existing international law instruments, such as the LOSC, CBD, regional fisheries management agreements and the UNFCC. Many of the regional and national actions under the CTI are contributing directly to climate change adaptation along the coasts and in the offshore maritime zones of the CTI region (CTI 2009).

In the Pacific, a key climate change policy initiative is the Pacific Adaptation to Climate Change (PACC) project. This project, funded by the GEF with the United Nations Development Programme (UNDP) as its implementing agency, and the SPREP as implementing partner, is designed to promote climate change adaptation as a key prerequisite to sustainable development in the Pacific Island countries and to enhance the capacity of the participating countries to adapt to climate change, including climate variability, in key development sectors (SPREP 2012). It is to be conducted over four years, from 2008 to 2012, and covers 13 Pacific Island countries. The aim is to build the Pacific countries' resilience to climate change by addressing the three key areas of food production and food security, coastal management, and water resource management. Adaptation projects are being implemented nationally.

Under the project, the Cook Islands, the Federated States of Micronesia, Samoa and Vanuatu are developing their coastal management capacity to adapt to climate change impacts. Climate change risks are being incorporated into relevant

governance policies and strategies for achieving coastal development. At the sub-national level, pilot demonstration activities are being undertaken in the form of practical experience in the planning and implementation of response measures that reduce vulnerability to climate change impacts. The project will also foster regional collaboration on climate change adaptation. As with the PEMSEA climate change initiatives, the PACC is subject to significant resource and technical capacity constraints. As these regional initiatives evolve, the supplementary guidance on climate change adaptation strategies related to marine and coastal biodiversity being developed at the global level through the CBD and other international organizations should be channelled into pilot activities at the regional level.

<b>4.3 National Law and Policy Frameworks – the Australian Example

The principal legislative authority for conserving marine and coastal biodiversity from threats, including climate change, is found in the 1999 EPBC. However, as climate change has emerged as one of the most prominent threats to marine and coastal biodiversity, more specific policy statements have been generated to define the threat and appropriate policy responses. Australia has attempted to address the causal links between climate change and declines in marine and coastal biodiversity through a hierarchy of high-level policy statements, coupled with the implementation of more concrete action plans. The National Strategy for the Conservation of Australia's Biodiversity (NSCABD), issued in 1996 and reviewed in 2001, is relevant because it set the broad parameters for the protection of Australia's biodiversity (NSCAB 2001, pp. 146–147). Some of the principles enunciated in the NSCABD relate specifically to the protection of marine and coastal biodiversity from the adverse effects of climate

change and underpin the implementation of further action plans. These principles include:

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<bt> Biological diversity is best conserved *in situ*.

<bt> It is vital to anticipate, prevent and attack at source the causes of significant reduction or loss of biodiversity.

<bt> Lack of full knowledge should not be an excuse for postponing action to conserve biodiversity.

<bt> The conservation of Australia's biodiversity is affected by international activities and it requires actions extending beyond Australia's national jurisdiction.

<bt> Central to the conservation of Australia's biological diversity is the establishment of a comprehensive, representative and adequate system of ecologically viable protected areas, integrated with the sympathetic management of all other areas, including agricultural and other resource production systems (NSCAB 2001, pp. 146–147). </bl>

The NSCABD has now been supplemented by the Australian Biodiversity Conservation Strategy 2010–2020, which draws a more explicit link between the conservation of biodiversity and the impacts of climate change. A key objective under this strategy is 'to ensure our biodiversity is healthy, resilient to climate change and valued for its essential contribution to our existence' (Department of Sustainability 2010).

Beneath these overarching policy statements of Australia's biodiversity protection objectives, a *National Approach to Addressing Marine Biodiversity Decline*

has been prepared by a Working Group convened by the Marine and Coastal Committee of the Natural Resource Management Ministerial Council. This document identifies the key threats to marine biodiversity from climate change and proposes priority actions for Federal and State Governments to implement in addressing these threats (Department of Sustainability 2008). Among the likely implications of climate change for the marine environment, the report highlights:

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<bt> loss or degradation of habitat, or changes in its distribution and density

<bt> changes in ocean currents, upwellings and productivity

<bt> displacement or distributional and abundance changes of marine species

<bt> loss of synchronization between essential climate, weather and seasonal events affecting biota (such as a mismatch between phytoplankton blooms and zooplankton growth)

<bt> lower ocean productivity and disrupted or changed food chains

<bt> ocean acidification (changing the ability of calcium carbonate producing organisms to construct shells) (Department of Sustainability 2008). </bl>

Two of the key policy responses recommended by the report relate to climate change impacts on marine biodiversity and propose that Federal and State jurisdictions improve their understanding of the vulnerability of marine biodiversity to climate change, focusing on ecosystems and species that are at particular risk. Further, it is recommended that these jurisdictions develop regional climate adaptation policies and plans based on predictive modelling and integrate them into marine bioregional planning processes (Department of Sustainability 2008, p. 34). Priority actions proposed by the report include:

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<bt> identifying species and systems at particular risk from climate change (such as local endemics restricted to a small area of suitable habitat, like the spotted handfish) or exceptional ecosystems with unique evolutionary origins unlikely to be replicated in another area (e.g., Bathurst Harbour, south-west Tasmania)

<bt> identifying processes threatened by climate change (e.g., tightly coupled processes that become decoupled due to changes in timing, chemical changes in the oceans caused by acidification, and coral bleaching caused by increased temperature maxima)

<bt> developing regional climate models and scenario modelling to assess the potential effects of major regional climate change on marine activities (particularly fisheries and aquaculture) and biodiversity

<bt> developing regional marine climate change adaptation plans that identify climate risks and vulnerabilities and also marine management scenarios and adaptations for marine industries and activities (fisheries, aquaculture and coastal development)

<bt> integrating current knowledge of regional climate change risks and vulnerability into current large-scale bioregional planning and decision-making processes

<bt> developing a national governance framework to assess and review the integration of current understanding of marine climate change into marine management frameworks and directions (Department of Sustainability 2008, p. 34).</bl>

One of the key goals of the marine bioregional planning process currently being undertaken by the Federal Government in Australia is to improve the resilience of Australia's marine ecosystems so that they are better able to adapt to the impacts of climate change (Department of Sustainability 2011). More specific action plans are also being implemented for specific marine industries and areas. Under the National Climate Change Adaptation Framework, agreed upon by the Council of Australian Governments (COAG) in 2007, a five-year Climate Change Action Plan is underway to minimize the impact of climate change on the Great Barrier Reef through increasing its resilience. Additionally, a National Fisheries and Climate Change Action Plan has been endorsed by COAG and is in the process of implementation (Department of Sustainability 2008). The Australian policy response to the projected impacts of climate change on marine and coastal biodiversity has been intensive, but is still in the early stages of implementation. Future assessments will determine whether it has contributed to buffering Australia's abundant marine and coastal biodiversity from the worst effects of climate change.

The legal and policy infrastructure for conserving marine biodiversity from the adverse impacts of climate change is steadily growing at the global level, in regional organizations in the Asia-Pacific and through policy development at the national level, as in the Australian example. However, the most daunting challenge lies in effectively implementing the plethora of priority actions recommended to arrest the decline of coastal and marine biodiversity in the face of growing threats from climate change.

<a>5. CONCLUSIONS

The challenges of marine and coastal management are not new, but they are difficult to address in the conventional framework of sectoral competition. The sectoral focus on biodiversity management has been on establishment of marine protected areas (Toropova et al. 2010) and the development of an ecosystem-based approach to the management of fisheries (FAO 2008). Recent attention on the complex policy issues of integration and coordination between sectors and jurisdictions is reflected in a growing number of publications on marine spatial planning and ecosystem approaches to marine management from the coast to the oceans (UNEP 2011; Ehler and Douvere 2009; Kidd et al., 2011; McLeod and Leslie 2009). Nevertheless, the legal and policy challenges associated with providing reasonably consistent frameworks for biodiversity management across marine areas within and beyond national jurisdiction remain substantial. While some regions have developed biodiversity conservation and management plans across areas within national jurisdiction through their regional sea programmes, gaps in coverage remain, and there is no comprehensive conservation and management system for marine biodiversity beyond national jurisdiction.

On-going efforts to address the impacts of climate change on marine biodiversity will benefit from the development of more integrated legal and policy frameworks for the conservation and management of biodiversity across national boundaries and beyond national jurisdictions. The Biodiversity Beyond Areas of National Jurisdiction process established by the UN General Assembly is likely to be a focal point for legal and policy development supported by scientific and technical advice from the CBD and the global marine science community. The burden of implementation in the Asia-Pacific and other regions will continue to rest with national jurisdictions working collaboratively to address the challenges of conserving

and managing biodiversity in the face of climate change impacts across national boundaries and in proximate areas beyond national jurisdiction.

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