ARTICLES

MARINE BIODIVERSITY: CHALLENGES, TRENDS, AND A NEW TREATY

BY
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Marine biodiversity is an important component of global biodiversity, which is under threat from a variety of anthropogenic stressors. Some of the most important of these include overfishing, pollution, invasive species, climate change, and ocean acidification. After summarizing the scientific evidence that global marine biodiversity is declining, this article examines the two primary legal approaches to protecting marine biodiversity: area-based management, including marine protected areas; and species-specific protections. While, in general, place-based legal protections can offer the most holistic approach to protecting marine biodiversity, especially when warming oceans are inducing species shifts, this Article argues that both the United States and the global community should increase protections for individual species at the same time. Species-based protections are especially critical for highly migratory species, like bluefin tuna.

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I. INTRODUCTION

Marine biodiversity[1] is an important component of global biodiversity, especially in terms of "deep diversity," or distinct forms of life differentiated not as individual species but instead as completely different phyla. Phyla are the second level of taxonomic classification after kingdoms and hence represent fundamentally different forms of life. In the ocean, for example, important phyla include mollusks (snails, shellfish), echinoderms (sea urchins, sea stars), cnidarians (jellyfish, anemones), and arthropods (crabs, lobsters).[2] By the numbers, "35 animal phyla are found in the sea, 14 of which are exclusively marine, whereas only 11 are terrestrial and only one exclusively so."[3]

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[1] In general, "marine biodiversity integrates ecosystem components, encompassing all levels of biological organization from genes and species to populations and ecosystems, with the diversity of each level having structural and functional attributes." Alex D. Rogers et al., *Discovering Marine Biodiversity in the 21st Century*, 93 ADVANCES IN MARINE BIO. 23, 47 (2022) (citations omitted), https://perma.cc/6GHR-B2WS. *See id.* at 47–93 for an extended discussion of what marine biodiversity is and how it is studied, including through contemporary techniques such as eDNA, genetic analysis, and acoustics.

[2] *Marine Phyla*, MARINE EDUC. SOC'Y AUSTRALASIA, https://perma.cc/B6L7-NPTU (last visited Mar. 21, 2023).

[3] Enric Sala & Nancy Knowlton, *Global Marine Biodiversity Trends*, 31 ANN. REV. ENV'T & RES. 93, 94 (2006) (citations omitted). A more recent summary of marine biodiversity makes the same point, albeit with slightly different numbers:

> "[A]lthough species richness is higher on land the diversity of higher taxonomic categories such as phyla and orders is much higher in the ocean. The World Register of Marine Species (https://www.marinespecies.org/index.php), for example records 33 animal phyla of which 32 are found in the ocean and only 17 in terrestrial and freshwater ecosystems. Only one phylum in this list does not occur in the ocean although we note that the phylum *Onycophora* (velvet worms) is missing from this list and this is also only found on land.

Despite its importance, attempts to protect marine biodiversity through law face several challenges. The first challenge is basic scientific understanding of what exactly the law should be protecting.[4] The ocean is vast, deep, and generally difficult to access and observe—especially in terms of continuous and long-term observations of ecosystem function.[5] While relatively more is known about coastal ecosystems,[6] "[t]he coastal ocean encompasses a broad range of saltwater ecosystems, from estuaries and coral reefs to rocky shores and mangrove forests," and even these relatively close ecosystems require more study to fully understand their biodiversity and function.[7] In contrast, most information about remote ocean ecosystems, such as those on hydrothermal vents or scattered across the deep ocean floor, comes through semi-random snapshots and samplings from submersibles.[8] While scientific knowledge about the ocean and its marine species and ecosystems constantly improves, comprehensive understanding about marine biodiversity and the impacts humans can have on that biodiversity lags far behind what scientists and managers know about terrestrial ecosystems and species.[9] Indeed, as recently as 2022, marine scientists concluded that "[s]ixty-six to ninety percent of marine life remains undescribed, and many geographic regions of the ocean as well as entire ecosystems remain poorly explored."[10]

Even so, scientists know enough to assess trends and, as Part I will develop in more detail, the trend lines are not good. While commercial fishing, ocean pollution, and habitat destruction provided the first reasons to worry about anthropogenic impacts on marine biodiversity, noise pollution is also a concern, and climate change (ocean warming) and ocean acidification increasingly disrupt species distributions, marine food webs, and marine ecosystem viability.

Various national and international regimes recognize the importance of protecting marine biodiversity. The current emphasis is

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Rogers et al., *supra* note 1, at 28 (citations omitted).

[4] *See* Gloria Pallares, *The Most Important Facts We Don't Know About the Ocean*, LANDSCAPE NEWS (Sept. 10, 2019), https://perma.cc/N7LP-GDCB (describing the scientific uncertainty regarding the ocean and marine life).

[5] Francisco Ramírez et al., *Challenges for Marine Ecological Assessments: Completeness of Findable, Accessible, Interoperable, and Reusable Biodiversity Data in European Seas*, FRONTIERS MARINE SCI., (Jan. 2022), No. 802235, at 1–2.

[6] *See* Rogers et al., *supra* note 1, at 31 ("In general terms, as you move away from the coast and into deeper water there are less data." (citation omitted)).

[7] *Coastal Ecosystem Science*, NAT'L OCEAN SERV., https://perma.cc/7XXQ-ELJ4 (last visited July 6, 2023).

[8] *E.g.*, Cherie Winner, *An Ocean Instrument is Born*, WOODS HOLE OCEANOGRAPHIC INST.: OCEANUS (Sept. 5, 2013), https://perma.cc/G3UQ-HQYS; Johannes F. Imhoff & Michael Hügler, *Life at Deep Sea Hydrothermal Vents—Oases Under Water*, 24 INT'L J. MARINE & COASTAL L. 201, 201–02, 206, 208 (2009); Rogers et al., *supra* note 1, at 34 ("Global patterns of species richness in the deep sea are poorly understood, in part because of the sampling challenges.").

[9] Sala & Knowlton, *supra* note 3, at 94.

[10] Rogers et al., *supra* note 1, at 25 (citations omitted).

on place-based protections in the form of marine protected areas (MPAs), including marine reserves. Part II reviews this approach to marine biodiversity protection, including the treaty that the United Nations most recently approved to protect biodiversity in areas of the ocean outside of national control.

Commercial fishing, however, greatly impedes more targeted, species-specific protection. Moreover, a general reluctance to protect marine life—other than charismatic species such as marine mammals and sea turtles—remains. To demonstrate this reluctance, Part III offers the thoroughly endangered bluefin tuna as a case study.

This article concludes that, although place-based habitat protections remain an important tool, they do not adequately protect critically endangered marine species. In response to ocean warming, marine species' customary ranges are shifting towards cooler waters and away from existing MPAs. In addition, worsening ocean acidification makes reliance on MPAs increasingly problematic. MPAs also present inadequate solutions for highly migratory pelagic species, like bluefin tuna.

II. TRENDS IN MARINE BIODIVERSITY: WHAT DO WE KNOW?

Scientists know far less about the marine realm, including the extent of and changes to marine biodiversity, than they know about terrestrial ecosystems and species.[11] Somewhat perversely, "major changes in marine biodiversity over deep time" are clearer than "the dramatic changes in marine ecosystems that have occurred in historic times," thanks to a good fossil record but poorly documented historic baselines in most places.[12] Moreover, a number of stressors threaten marine biodiversity, complicating the picture even further.[13] This lack of scientific understanding has direct implications for law and policy, because:

> [H]uman society cannot fully comprehend the vital importance of a healthy ocean as a critical part of Earth's life support system and hence how it contributes to their own well-being. This situation, however, has been accepted as the *status quo* with the consequences that much of the ocean has fallen out of sight and out of mind, and hence there has been systematic unsustainable exploitation of marine resources (e.g. overfishing), destruction of marine ecosystems (e.g. coastal development, pollution, trawling) and subsequent degradation of the ocean systems.[14]

[11] Sala & Knowlton, *supra* note 3, at 94.

[12] *Id.* (citations omitted); *see also id.* at 97 (describing the lack of contemporary local data).

[13] Robin Kundis Craig, *Marine Biodiversity, Climate Change, and Governance of the Oceans*, 4 DIVERSITY 224, 225 (2012) [hereinafter Craig, *Marine Biodiversity*].

[14] Rogers et al., *supra* note 1, at 25.

Thus, increasing basic scientific understanding of marine biodiversity and especially "how it changes in response to human impacts and interventions is a foundation to addressing the biodiversity crisis in the ocean and managing its recovery."[15]

Nevertheless, the science *is* good enough to indicate that severe reductions of biodiversity are occurring in many parts of the ocean, and the resulting "jellyfish seas"[16] demonstrate that trends in marine biodiversity are not good.[17] In 2005, for example, the Millennium Ecosystem Assessment (MEA) described the cumulative existing degradation of coastal ecosystems, emphasizing that these systems "are now undergoing more rapid change than at any time in their history" through a complex combination of physical, chemical, and biological/ecological changes.[18] The MEA concluded that "[t]hese impacts, together with chronic degradation resulting from land-based and marine pollution, have caused significant ecological changes and an overall decline in many ecosystem services."[19]

This Part updates the MEA and summarizes current knowledge about marine biodiversity in terms of both numerical estimates and trends over time.

A. Numerical Estimates of Marine Biodiversity

Species richness, "defined as the count of species within an ecosystem, habitat or sampling unit within a scientific study," is "the simplest measure of diversity"[20] and the best studied in the marine environment. In contrast, "[o]ther patterns of biodiversity, including intraspecific genetic variation and habitat diversity, are . . . not well described, with some exceptions."[21] Even with respect to marine species, moreover, considerable scientific uncertainty remains about even this most basic of biodiversity measures. According to one group of scientists, "[t]here are approximately 300,000 described marine species, which represent about 15% of all described species."[22] According to another, "[e]stimates of global metazoan marine species diversity over the last 10 years vary depending on the methods used from approximately 300,000

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15 *Id.*

16 Robin Kundis Craig, *Avoiding Jellyfish Seas, or, What Do We Mean by "Sustainable Oceans," Anyway?*, 31 UTAH ENV'T L. REV. 17, 18–20 (2011).

17 Cheryl Lyn Dybas, *Jellyfish 'Blooms' Could Be Sign of Ailing Seas,* WASH. POST (May 6, 2002), https://perma.cc/7TYW-ZE2L.

18 Tundi Agardy et al., *Coastal Systems*, *in* 1 MILLENNIUM ECOSYSTEM ASSESSMENT, ECOSYSTEMS AND HUMAN WELL-BEING: CURRENT STATE AND TRENDS 513, 516 (Rashid Hassan et al. eds., Island Press 2005).

19 *Id.*

20 Rogers et al., *supra* note 1, at 25. See *id.* at 25–28 for a discussion of the difficulty in defining "species" and identifying those most important to ecosystem stability and function.

21 *Id.* at 34.

22 Sala & Knowlton, *supra* note 3, at 95 (citation omitted).

to 2.2 million," which is "significantly lower" than terrestrial species richness, as evidenced by the estimated 5.5 million species of insects alone.[23] However, examining biodiversity in terms of planetary biomass "gives a different perspective" on Earth's distribution of biodiversity:

> Plants make up the vast majority of biomass on Earth (~450 Gt [gigatons]) and are primarily located on land. However, if animals alone are considered, a very different pattern is observed. Marine arthropods are estimated to have the greatest biomass of any group of animals on Earth (~1 Gt) with groups such as copepods and even single species, such as Antarctic krill, *Euphausia superba* (~0.05 Gt), making a significant contribution to global animal biomass. The biomass of terrestrial arthropods, including the insects (0.2 Gt) is estimated to be considerably smaller than that of marine invertebrates. The fishes are the second largest group of animals on Earth in terms of biomass (0.7 Gt), being dominated by the mesopelagic fish (those living between 200 and 1000 [meters] depth in the ocean).[24]

Various uncertainties plague the estimate of total marine species, and the true number is probably much higher than even the 2.2 million estimate. In general, more is known about species that are closer to the coasts, commercially exploited, or large as compared to those that are found in deeper waters, commercially unimportant, or small.[25] For example, while most marine fish (~77%) and marine mammals (approaching 100%) have been found and described, "[m]arine invertebrates are much less studied, and their diversity can be much higher than vertebrate groups with as few as 3% of the estimated number of species in the ocean described."[26] In addition, "taxa that have been considered to be the same may actually be different," and "failure to recognize these cryptic or sibling species has probably resulted in a 10-fold underestimate of marine biodiversity in many groups."[27] Many discovered species lack description because of the relatively low numbers of taxonomists.[28] To give some sense of the magnitude of the uncertainty, before the Census of Marine Life concluded its work in 2010, estimates for the number of marine species ranged from 178,000 to over 10 million—and that is only for multicellular eukaryotes.[29] "[M]icrobial diversity may be enormous,"[30] because:

> [M]icrobes are dominant components of the ocean ecosystem, in functional terms. However, these organisms cannot be readily included in biodiversity inventories, both because of insufficient exploration and also difficulties in

[23] Rogers et al., *supra* note 1, at 28 (citations omitted).
[24] *Id.* at 30 (citations omitted).
[25] *Id.* at 31–32.
[26] *Id.*
[27] Sala & Knowlton, *supra* note 3, at 95–96 (citations omitted).
[28] *Id.* at 96.
[29] *Id.* (citations omitted).
[30] *Id.* at 97.

> applying standard concepts of species definition to these organisms. Novel discoveries using molecular assessments . . . are rapidly increasing our understanding of the diversity and distribution of microbes in the ocean . . . .[31]

The Census of Marine Life provided a better picture of marine biodiversity. Over ten years, the Census deployed "2,700 scientists from over 80 nations" to "delineat[e] a comprehensive baseline of Planet Earth's marine biodiversity for the first time ever."[32] "[A]t the outset of the Census, oceanographers estimated that only 5 percent of the ocean had been systematically explored for life."[33] By the end of the decade's research, Census scientists reported "an unanticipated riot of species," raising the number of known marine species to somewhere between 230,000 and 250,000 but still concluding that "the Census still could not reliably estimate the total number of species, the kinds of life, known and unknown, in the ocean."[34] Equally important, the Census "found living creatures everywhere it looked, even where heat would melt lead, seawater froze to ice, and light and oxygen were lacking. It expanded known habitats and ranges in which life is known to exist. It found that in marine habitats, extreme is normal."[35] Finally, the Census data reveal that "[u]nderstanding of marine biodiversity varies markedly across regional, national and, more importantly, trophic levels," suggesting that "marine species within Chinese, Australian and European waters are best known[,] with the tropical western Atlantic, tropical eastern Pacific and Canadian Arctic regions being poorly studied," while "deep sea, coral reefs, ice-covered areas and chemosynthetic habitats" are the least studied of marine ecosystems.[36]

Even taking into account sampling differences and differences in scientific attention being paid, however, the ocean clearly has biodiversity hotspots. "At a global scale analyses of marine biodiversity data indicate a peak at tropical to sub-tropical latitudes with particular hotspots focused around the Indo-Pacific Coral Triangle and to a lesser extent the Caribbean"; "[t]he central and western Indian Ocean, Red Sea, South West Pacific Islands (i.e., the Bismarck Archipelago, the Great Sea Reef of Fiji, New Caledonia, New Guinea, the Solomon Islands, Vanuatu) and Southeast Asia also show the highest levels of species richness."[37] "There are also steep longitudinal gradients in diversity, with an increase from both east and west towards Southeast Asia, and from east to west in the tropical Atlantic."[38]

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31 Rogers et al., *supra* note 1, at 35.

32 Craig, *Marine Biodiversity*, *supra* note 13, at 224.

33 FIRST CENSUS OF MARINE LIFE 2010: HIGHLIGHTS OF A DECADE OF DISCOVERY 6 (Jesse H. Ausubel et al. eds., 2010) [hereinafter FIRST CENSUS OF MARINE LIFE 2010].

34 *Id.* at 3.

35 *Id.*

36 Rogers et al., *supra* note 1, at 31.

37 *Id.* at 32.

38 *Id.* (citation omitted).

In addition, enough is known about marine biodiversity to know that the ocean is losing both species and ecosystem function. For example, the Census of Marine Life:

> found signs of decline in both species and the sizes of individuals—declines that had occurred fairly quickly, sometimes within a human generation. Perhaps most importantly, it found that phytoplankton, the basis of marine food webs and the source of approximately 50% of the world's atmospheric oxygen, have declined since 1899.[39]

Later refinements and modeling indicated that, "compared to 1950, the ocean has 40% less phytoplankton, small algae that are the basis of the ocean food web, and that human impacts are degrading coral reefs as well as increasing the risk of marine populations going extinct."[40] While habitat loss is more difficult to assess, studies indicate that seagrass beds lost 10% of their area per decade between 1970 and 2000, while "[t]he global cover of mangroves has declined by about 40% and that of saltmarshes by about 60%"; coral reefs have lost half their coral cover since 1870, with accelerating losses in recent decades.[41]

Impacts to coral reef ecosystems are critical to future marine biodiversity because, in terms of ecosystems, coral reefs and the deep sea are "the two biggest repositories of marine biodiversity"—coral reefs for their high concentration of species, and the deep sea for "its enormous area."[42] Otherwise, studies of spatial patterns of global marine biodiversity prior to pervasive climate change impacts revealed three major gradients of species richness: increasing diversity at tropical latitudes that declines as one moves toward the poles; "decreasing diversity as one moves west to east in the tropical Pacific and Atlantic"; and decreasing diversity with depth.[43] High levels of endemic species live around isolated islands.[44]

Moving beyond species, significant gaps remain in the scientific understanding of marine community diversity at any scale. The Large Marine Ecosystems (LME) project identified 64 distinct nearshore ecoregions globally. However, each LME is huge and encompasses a range of smaller-scale ecosystems; as a result, "they do not provide a detailed picture of biological distinctness."[45]

Losses of marine biodiversity portend considerable losses in ecosystem services to humans. Valuing *all* of the services that the ocean provides to humans is intrinsically difficult, especially given the ocean's

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[39] Craig, *Marine Biodiversity*, *supra* note 13, at 225 (citing FIRST CENSUS OF MARINE LIFE 2010, *supra* note 33, at 4, 31).

[40] *The Census of Marine Life*, SMITHSONIAN OCEAN (Apr. 2018), https://perma.cc/5MTT-2GNL.

[41] Rogers et al., *supra* note 1, at 42–43.

[42] Sala & Knowlton, *supra* note 3, at 96.

[43] *Id.* (citations omitted).

[44] *Id.* (citations omitted).

[45] *Id.* at 97.

role in basic regulating services such as temperature control, climate, the hydrological cycle, and carbon dioxide sequestration, but the estimates tend to skew high—in the *trillions* of dollars.[46] Increasingly, moreover, marine ecosystems such as mangrove forests, salt marshes, and seagrass meadows produce carbon sequestration credits known as "Blue Carbon" sinks—some of "the most intense carbon sinks in the biosphere."[47]

B. Human Impacts on Marine Species and Ecosystems

Like all other aspects of biodiversity, marine ecosystems and species change over time. Over evolutionary timescales, for example, "[t]he number of marine taxa, particularly large complex forms, increased dramatically with the onset of the Cambrian explosion" about 540 million years ago, and continued increasing, albeit punctuated with mass extinction events.[48] In addition, "the number of marine ecosystems and ways of making a living has increased from the primordial pre-Cambrian ocean," including the "marine Mesozoic revolution" after the Permian mass extinction event, when 98% of all species went extinct.[49]

Over more human timescales, "[m]arine biodiversity naturally changes locally at scales of years to centuries," a phenomenon known as ecological succession, which typically begins with a disturbance of some kind.[50] Large-scale disturbances tend to reduce local biodiversity, but small-scale disturbances can enhance biodiversity at the local scale by creating "patch[y]" habitats.[51] Absent human impacts, however, marine ecosystems tend to recover from even large disturbances.[52]

But, of course, human impacts *do* exist. Indeed, "human activities are without doubt now the strongest driver of change in marine biodiversity at all levels of organization."[53] In terms of species impacts, "[h]umans have directly caused the global extinction of more than 20 described marine species, including seabirds, marine mammals, fishes, invertebrates, and algae."[54] Europeans hunted the Steller's sea cow to extinction within 27 years of discovering it.[55] Eliminating the Caribbean

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[46] Rogers, *supra* note 1, at 38 (citations omitted).

[47] *Id.* at 39.

[48] Sala & Knowlton, *supra* note 3, at 98.

[49] *Id.* (citations omitted).

[50] *Id.* at 98–99.

[51] *Id.* at 99.

[52] *Id.*

[53] *Id.* at 100. For a more comprehensive overview of anthropogenic stressors to marine biodiversity, see Craig, *Marine Biodiversity*, *supra* note 13, at 226–28.

[54] Sala & Knowlton, *supra* note 3, at 102 (citations omitted).

[55] *Id.*; *see also* Rogers et al., *supra* note 1, at 40 ("The first known marine extinctions caused by humans occurred during colonial times, an example being the elimination of Stellar's sea cow in the North Pacific in 1768. The geographic distribution of this species was probably limited as a result of recent glaciations but may have been further reduced by Aboriginal hunting. Stellar's sea cow was discovered when the St Peter, Vitus Bering's ship leading the Great Northern Expedition, was wrecked in 1741 on Bering Island in the

monk seal, in contrast, took about four and a half centuries.[56] More disturbingly, "[m]any species may have disappeared unnoticed"; statistical methods for assessing loss, for example, estimate that approximately 1% of coral reef species perished by the early 21st century.[57] Local and regional extinctions are even more common, such as the loss of the gray whale from the Atlantic Ocean and of nine of fourteen species of kelp from the Mediterranean Sea.[58]

Human activities can also impact larger ecological function, with long-term and synergistic effects,[59] and have done so for centuries. Overfishing, for example, is a significant cause of ecological extinction in the ocean, which occurs when a species becomes "so rare that it no longer fulfills its natural ecosystem function"; ecological extinction signals threats to biodiversity because it "occurs long before species completely disappear."[60]

Overfishing, especially historical overfishing, frequently causes ecological extinction and traces forward to contemporary collapses of marine ecosystems around the globe.[61] This process began in the Middle Ages:

> During this period, religious practice encouraged the replacement of meat with seafood on up to 130 days of the year, driving demand for fish. At the same time, land-use changes caused significant alterations in freshwater and coastal ecosystems including sedimentation and eutrophication. The combination of fishing pressure and changes in water quality in freshwaters and estuaries drove a decline in these species causing them to disappear in many European waterways and coastal ecosystems by the 12th century for sturgeon and the Late Middle Ages for salmon. As these inland and coastal fisheries resources declined and technologies in sailing, fishing and preservation of fish improved, attention turned to offshore marine fish stocks, especially cod and herring in the Baltic and North Seas. Trade in fish was one of the drivers of the medieval commercial revolution, and the wealth of the Hanseatic League, a powerful trading confederation of the time, was partially founded on herring. However, by the Late Medieval Age a combination of heavy fishing, declining water quality and climate variation led to the successive collapse of important fish stocks including in the southern Baltic and North Seas.[62]

As a group of eminent marine biologists concluded in 2001, "[o]verfishing and ecological extinction predate and precondition modern

Commander Islands group. Within 27 years of its discovery, it was extinct as a result of hunting for its meat, fat and hide." (citation omitted).

56 Sala & Knowlton, *supra* note 3, at 102; Rogers et al., *supra* note 1, at 40–41.

57 Sala & Knowlton, *supra* note 3, at 102 (citation omitted).

58 *Id.*

59 Rogers et al., *supra* note 1, at 41.

60 Sala & Knowlton, *supra* note 3, at 102 (citations omitted).

61 Jeremy B.C. Jackson et al., *Historical Overfishing and the Recent Collapse of Coastal Ecosystems*, 293 SCIENCE 629, 629 (2001).

62 Rogers et al., *supra* note 1, at 40 (citations omitted).

ecological investigations and the collapse of marine ecosystems in recent times, raising the possibility that many more marine ecosystems may be vulnerable to collapse in the near future."[63] They also painted a vivid picture of an ocean full of ghost species:

> There are dozens of places in the Caribbean named after large sea turtles whose adult populations now number in the tens of thousands rather than the tens of millions of a few centuries ago. Whales, manatees, dugongs, sea cows, monk seals, crocodiles, codfish, jewfish, swordfish, sharks, and rays are other large marine vertebrates that are now functionally or entirely extinct in most coastal ecosystems. Place names for oysters, pearls, and conches conjure up other ecological ghosts of marine invertebrates that were once so abundant as to pose hazards to navigation, but are witnessed now only by massive garbage heaps of empty shells.
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> Such ghosts represent a far more profound problem for ecological understanding and management than currently realized. Evidence from retrospective records strongly suggests that major structural and functional changes due to overfishing occurred worldwide in coastal marine ecosystems over many centuries.[64]

Other studies suggest that humans likely effected significant changes in marine ecosystems—at least coastal ecosystems—through hunting and fishing since prehistoric times.[65]

The exact number of ecological extinctions in the ocean remains difficult to estimate, but the International Union for Conservation of Nature (IUCN) Red List of Threatened Species provides a decent—although likely conservative—proxy.[66] As of June 2023, 1,555 marine species on the Red List are vulnerable, endangered, or critically endangered, while another 625 marine species are "near threatened."[67] Thus, roughly 2,185 marine species are already ecologically extinct, or fast approaching ecological extinction.[68] Moreover, "[a]n analysis of Red List Assessments indicates that by far the most significant driver of biodiversity loss in the ocean is overfishing and the destructive effects of fishing (e.g. habitat damage by trawling or bycatch of seabirds with

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[63] Jackson et al., *supra* note 61, at 629.

[64] *Id.* (citations omitted).

[65] *See generally* Jon M. Erlandson & Torben C. Rick, *Archeology Meets Marine Ecology: The Antiquity of Maritime Cultures and Human Impacts on Marine Fisheries and Ecosystems*, 2 ANN. REV. MARINE SCI. 231 (2010) (tracing such prehistoric impacts in the Channel Islands, California, and Polynesia).

[66] Sala & Knowlton, *supra* note 3, at 103.

[67] IUCN RED LIST, https://perma.cc/AJD2-Y4PX (last visited June 27, 2023) (navigate to "Red List Category"; select "Critically Endangered," "Endangered," and "Vulnerable"; navigate to "Systems"; select "Marine").

[68] Species at risk are not distributed equally across marine taxa, however. As two extremes, only about 4% of ray-finned fish (most bony fish) are threatened with extinction, while "the abundance of oceanic sharks and rays has declined by 71% since 1970 and now more than three quarters are threatened with extinction." Rogers, *supra* note 1, at 41 (citations omitted).

longlines). This is followed by coastal development, pollution, climate change, invasive species and transportation as drivers of extinction risk."[69] On the brighter side, however, ecological extinction in the ocean rarely leads to actual extinction, and "detailed studies of extinction levels in fish and molluscs suggest that marine taxa are genuinely at a lesser extinction risk than terrestrial or freshwater."[70]

Population declines precede ecological extinction, and the best source of data regarding population declines among marine species is commercial catch data in wild fisheries.[71] Global wild fisheries catch "has been declining since the 1990s."[72] The best source of information about wild fisheries globally is the U.N. Food & Agriculture Organization's (FAO's) biennial report, *The State of World Fisheries and Aquaculture*. In 2022, the FAO reported that "[f]ishery resources continue to decline due to overfishing, pollution, poor management and other factors."[73] More specifically,

> [t]he fraction of fishery stocks within biologically sustainable levels decreased to 64.6 percent in 2019, that is 1.2 percent lower than in 2017. This fraction was 90 percent in 1974. In contrast, the percentage of stocks fished at biologically unsustainable levels has been increasing since the late 1970s, from 10 percent in 1974 to 35.4 percent in 2019.[74]

Beyond direct impacts from hunting and fishing, humans also indirectly affect marine biodiversity, and these indirect impacts are cumulatively more threatening to marine biodiversity. Until recently, "human impacts on water quality (toxic pollutants, nutrients, carbon, acidity)" were the most important indirect stressors to marine biodiversity.[75] However, human activities can also favor more adaptable species, such as seagulls, or facilitate highly invasive species through mechanisms such as ships' ballast water.[76] "Although the arrival of new species increases species richness, the consequences for local biodiversity are generally negative—sometimes catastrophically so."[77] The Mediterranean Sea and San Francisco Bay provide apt examples of how new arrivals and invasive species can devastate local biodiversity.[78]

Temperature increases from climate change and ocean acidification are now at least as important as any other indirect human stressor on

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69 *Id.*

70 *Id.*

71 Sala & Knowlton, *supra* note 3, at 103.

72 *Id.*

73 U.N. FOOD & AGRIC. ORG., THE STATE OF WORLD FISHERIES AND AQUACULTURE: TOWARDS BLUE TRANSFORMATION xvi (2022) [hereinafter 2022 FAO REPORT].

74 *Id.* at 46 (citation omitted).

75 Sala & Knowlton, *supra* note 3, at 103.

76 *Id.* at 104–05 ("It is estimated that as many as 3000 alien species are transported daily in ballast water, although only a few survive the trip and/or establish themselves in a new environment.").

77 *Id.* at 104–05.

78 *Id.* at 105.

the ocean.[79] According to the *Impacts, Adaptation and Vulnerability* (Working Group II) report of the Intergovernmental Panel on Climate Change's (IPCC's) Sixth Assessment Report,[80] human-induced climate change causes heat extremes in the ocean known as marine heat waves; warm water coral reef bleaching and mortality; ocean acidification; and rising sea levels.[81] Climate change causes substantial and increasingly irreversible damage to coastal and ocean ecosystems, and "[a]pproximately half of the species assessed globally have shifted polewards."[82] Increasing heat causes mass mortality events in the ocean and the loss of kelp forests.[83] "Ocean warming and ocean acidification adversely affect food production from shellfish aquaculture and fisheries in some oceanic regions . . . ."[84] Moreover, ocean "acidification decreases abundance and richness of calcifying species," and the "[s]ynergistic effects of warming and acidification will promote shifts towards macroalgal dominance in some ecosystems and lead to reorganisation of communities."[85]

Marine heat waves increasingly undermine marine biodiversity:

> Marine heatwaves (MHWs) are extended periods of unusually warm ocean temperatures relative to the typical temperatures for that location and time of year. Due to climate change, the number of days with MHWs has increased by 54% over the past century. These MHWs cause mortalities in a wide variety of marine species, from corals to kelp to seagrasses to fish to seabirds, and have consequent effects on ecosystems and industries like aquaculture and fisheries.[86]

Indeed, "MHWs attributable to climate change can cause fatal disease outbreaks or mass mortality among some key foundational species and contribute to ecological phase shifts."[87]

The IPCC projects some impacts to marine biodiversity with great confidence. As noted, for example, coral reefs are critical to marine biodiversity—but also the marine ecosystems most vulnerable to climate change:

> Warm-water coral reef ecosystems house one-quarter of the marine biodiversity and provide services in the form of food, income and shoreline protection to coastal communities around the world. These ecosystems are

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79 *Id.* at 103–04 (citations omitted). For an overview of how climate change affects marine biodiversity, see Craig, *Marine Biodiversity, supra* note 13, at 228–30.

80 INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CONTRIBUTION TO THE SIXTH ASSESSMENT REP. OF WORKING GRP. II, CLIMATE CHANGE 2022: IMPACTS, ADAPTATION AND VULNERABILITY (2022) [hereinafter 2022 IPCC ADAPTATION REPORT].

81 *Id.* at 9.

82 *Id.*

83 *Id.*

84 *Id.*

85 *Id.* at 418 (cleaned up).

86 *Id.* at 416.

87 *Id.* at 415, 418 (citation omitted) (cleaned up).

> threatened by climate-induced and non-climate drivers, especially ocean warming, MHWs, ocean acidification, SLR [sea level rise], tropical cyclones, fisheries/overharvesting, land-based pollution, disease spread and destructive shoreline practices. Warm-water coral reefs face near-term threats to their survival . . . .[88]

However, coral reefs are not alone; "kelp and other seaweeds in most regions are undergoing mass mortalities from high temperature extremes and range shifts from warming."[89] The IPCC notes that "kelp ecosystems are expected to decline and undergo changes in community structure in the future due to warming and increasing frequency and intensity of MHWs."[90] The Arctic is the third marine ecosystem already undergoing profound change:

> The profound climatic and environmental changes projected for the Arctic region by 2100 are also anticipated to alter the composition of apex assemblages like marine mammals. Under both RCP2.6 and 8.5 scenarios the most vulnerable marine mammal species will be the North Pacific right whale (Eubalaena japonica, listed as an endangered species; IUCN, 2020) and the grey whale (Eschrichtius robustus, which has critically endangered subpopulations; IUCN, 2020). The extinction of the most-vulnerable species will disproportionately eliminate unique and important evolutionary lineages as well as functional diversity, with consequent impacts throughout the entire marine ecosystem.[91]

In short, anthropogenic stressors directly and indirectly reduce marine biodiversity, even if marine biologists cannot precisely document all the species, ecosystem functions, and ecosystems already lost or irreparably damaged. "Fishing, habitat destruction, pollution, and other human activities can deplete populations to such a level that most genetic variability is lost"; fishing also favors smaller and less fecund fish.[92] Commercial fishing's efficiency at removing top predators "can reduce species richness and biomass by orders of magnitude and cause a decline in structural diversity" within the relevant ecosystem. In Alaska, for example, the overhunting of sea otters allowed sea urchins to multiply and decimate the entire kelp ecosystem.[93] Jellyfish overran the Black Sea after humans overfished the species at the top of the ecosystem's food chain.[94]

Nutrient pollution and climate change affect biodiversity from the opposite direction, reducing lower-trophic species—and hence the start

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88 *Id.* at 410 (citations omitted).
89 *Id.* at 418.
90 *Id.* at 419 (cleaned up).
91 *Id.* at 441 (citations omitted).
92 Sala & Knowlton, *supra* note 3, at 105.
93 *Id.* at 106.
94 *Id.* at 107.

of the food web—first.[95] Nutrient pollution often leads to hypoxic zones, causing the "large-scale loss of biodiversity at the ecosystem level, where diverse and structurally complex benthic and pelagic communities are turned into simpler microbial communities."[96]

Climate change impacts on marine biodiversity are more pervasive, and "[g]lobal projections anticipate a *likely* future reorganisation of marine life of variable magnitude, contingent on emission scenario."[97] In addition, "[c]limate-change-driven changes in ocean characteristics and the frequency and intensity of extreme events increase the risk of persistent, rapid and abrupt ecosystem change, often referred to as ecosystem collapses or regime shifts."[98]

Unhelpfully, overfishing, marine pollution, biological invasions, and global warming "typically act in synergy and produce changes in biodiversity that are more pervasive than those caused by single disturbances."[99] For these and other reasons, predicting the future trajectory of marine biodiversity remains fraught with uncertainty. As the IPCC explained:

> [B]iodiversity observations remain sparse, and statistical and modelling tools can provide conflicting diversity information because correlative approaches assume that the modern-day relationship between marine species distribution and environmental conditions remains the same into the future, whereas mechanistic models permit marine species to respond dynamically to changing environmental forcing. Moreover, existing global projections of future biodiversity disproportionately focus on the effects sea surface temperature, typically overlooking other factors such as ocean acidification, deoxygenation and nutrient availability, and often failing to account for natural adaptation.[100]

Despite scientific uncertainty, however, the net result is that humans are homogenizing the ocean, reducing marine biodiversity on a global scale[101] with no end in sight.

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95 *Id.* at 107–08. However, some fisheries, such as those for sardines, anchovies, baleen whales, and shellfish like oysters, can similarly destroy diverse ecosystems from the bottom up. *Id.* at 108.

96 *Id.* at 108.

97 2022 IPCC ADAPTATION REPORT, *supra* note 80, at 441 (citation omitted).

98 *Id.* at 442 (citations omitted) (cleaned up).

99 Sala & Knowlton, *supra* note 3, at 110.

100 2022 IPCC ADAPTATION REPORT, *supra* note 80, at 441 (citation omitted).

101 *Id.* at 45–46.

III. Legally Protecting Marine Biodiversity through Area-Based Protections: MPAs and a New Treaty

A. Use of Marine Protected Areas and Marine Reserves

1. Overview

Given the complexities of marine ecosystems, MPAs—especially marine reserves—are the preferred protection for marine biodiversity both domestically and internationally.[102] "MPAs are management designations with various levels of protection designed to protect and preserve natural resources and ecological systems. They can safeguard a wide range of habitats and species."[103] Marine reserves are a subset of MPAs legally established as "no take," generally meaning that no collecting or fishing is allowed,[104] but they can be even more restrictive in their prohibitions. As a result, "MPA classifications range from 'no-take' areas, to small 'no-access' areas that prohibit all consumptive human uses, to large 'multiple-use' areas that permit a wide range of economic, social, and conservation activities."[105]

IUCN provides one widely accepted set of criteria and guidelines for MPAs.[106] Distinguishing MPAs from fishery management areas and other area-based management tools, IUCN operates on the principle that, "whatever form the MPAs take, the primary focus is the conservation of biodiversity."[107] IUCN also emphasizes that commercial and industrial activities in MPAs should be minimized:

> If fishing or other extractive activities are compatible with an MPA's objective(s) and are permitted within the MPA, they must have a low ecological impact, be sustainable, be well managed as part of an integrated approach to management, and fit within the definition and category of an IUCN protected area. Any industrial activities and infrastructural developments (e.g. mining, industrial fishing, oil and gas extraction) are

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102 *See* Linwood H. Pendleton et al., *Debating the Effectiveness of Maine Protected Areas*, 75 ICES J. MARINE SCI. 1156, 1156–57 (2018) (detailing the increased popularity of MPAs and their relative successes); *see also* Randall S. Abate, *Marine Protected Areas as a Mechanism to Promote Marine Mammal Conservation: International and Comparative Law Lessons for the United States*, 88 OR. L. REV. 255, 307–08 (2009) (explaining the value of the MPAs and providing context regarding two particularly successful examples).

103 *Marine Protected Areas*, CAL. SEA GRANT, https://perma.cc/8BF6-DMT4 (last visited Apr. 8, 2023).

104 *Id.*

105 Abate, *supra* note 102, at 259–60 (citations omitted).

106 Jon Day, Nigel Dudley, Marc Hockings, Glen Holmes, Dan Laffoley, Sue Stolton, Sue Wells & Lauren Wenzel, IUCN, *Guidelines for Applying the IUCN Protected Area Management Categories to Marine Protected Areas* (2d ed. 2019).

107 *Id.* at 8.

> not compatible with MPAs and should be excluded from such areas if they are to be considered as MPAs.[108]

IUCN describes seven categories of MPAs, from strictly protected areas—usable as reference sites that almost completely limit human access and use—to areas protected specifically because of their distinct human interactions or cultural significance.[109] Thus, even when MPAs share a common goal of protecting marine biodiversity, they "differ in many ways, including the objectives for which they were created, the ecological and human contexts in which they are situated, the degree to which they involve stakeholders, and how well their management and enforcement is resourced."[110]

Using IUCN's definitions, the Marine Conservation Institute keeps track of MPAs globally through the Marine Protection Atlas.[111] As of July 2023, the Atlas identifies 16,854 MPAs globally and categorizes them in terms of protection from fishing.[112] Notably, only 1,042 of these MPAs, or about 6.2%, are fully or highly protected from fishing.[113] Most MPAs—over 11,000—are very small, encompassing less than 10 square kilometers (approximately 3.86 square miles, or 2,470 acres).[114]

MPAs successfully protect and enhance biodiversity if the legal protections they provide are strong and enforced. In the Mediterranean Sea, for example, well-enforced true marine reserves tend to support healthy predator-dominated ecosystems "characterized by large fish biomass and benthic communities dominated by non-canopy algae."[115] In contrast, poorly enforced marine reserves, MPAs that allowed fishing, and parts of the Mediterranean open to fishing had lower fish biomass and, in the worst areas, barrens.[116] More generally, marine biologists conclude that:

> The potential ecological benefits of strongly protected MPAs (those that prohibit commercial activity and allow only light fishing) and fully protected MPAs that prohibit fishing are well documented. Strongly protected MPAs increase fish biomass and diversity. MPAs can also promote the dispersal of larvae and adults of target and non-target species to areas outside their borders, potentially benefiting both fisheries and

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108 *Id.*
109 *Id.* at 9, tbl.1.
110 Pendleton et al., *supra* note 102, at 1157.
111 *Marine Protection Atlas*, MARINE CONSERVATION INST., https://perma.cc/4C7Z-QBN6 (last updated Apr. 21, 2023).
112 *Id.*
113 *Id.*
114 *Id.*
115 Enric Sala et al., *The Structure of Mediterranean Rocky Reef Ecosystems Across Environmental and Human Gradients, and Conservation Implications*, PLOS ONE (Feb. 2012), No. e32742, at 5.
116 *Id.*

> biodiversity outside the MPA, although the extent to which this occurs and whether there is any net fisheries benefit, are unknown for most MPAs.[117]

As noted, fully or highly protective MPAs are rare, although some of them are very large.[118]

Importantly, MPAs work best to restrict human activities with direct impacts on marine biodiversity, like fishing. MPA managers around the world are discovering that even the most legally restrictive MPAs offer little protection against the direct effects of climate change and ocean acidification because they provide no barrier to increasing ocean temperature, MHWs, or decreasing ocean pH. For example, "there has been massive coral bleaching and death in iconic MPAs, including in the Great Barrier Reef Marine Park and Chagos MPA, revealing the limits of MPAs to protect against all main threats."[119] Under certain circumstances, however, when MPAs remove more direct anthropogenic stressors, marine ecosystems become more resilient to climate change.[120] As a result, MPAs can, under the right circumstances, mitigate some of climate change's impacts on marine biodiversity.

2. Area-Based Marine Protections under the United Nations Convention on Biological Diversity

As one group of researchers noted in 2018, "[i]ncreasing the size and number of [MPAs] is widely seen as a way to meet ambitious biodiversity and sustainable development goals."[121] More specifically, MPAs:

> have been embraced by high level international bodies as being important for achieving biodiversity goals (e.g. the Convention on Biodiversity's Aichi Targets), as a key tool for meeting Sustainable Development Goals (U.N. Oceans Conference Voluntary Commitments), and to protect the natural heritage of humankind (UNESCO's World Heritage Program).[122]

This Part will focus on the United Nations Convention on Biological Diversity ("CBD" or "Biodiversity Convention"), the most general global treaty for protecting biodiversity.

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117 Pendleton et al., *supra* note 102, at 1157 (citations omitted).

118 *See Marine Protection Atlas*, *supra* note 111 (map showing area covered by 1,015 fully or highly protective MPAs).

119 Pendleton et al., *supra* note 102, at 1156–57.

120 *See id.* at 1156 ("Proponents cite the maturity of the science supporting the effectiveness of certain types of MPAs in maintaining or restoring biodiversity and the potential for MPAs to make marine ecosystems more resilient to climate change." (citations omitted)).

121 *Id.*

122 *Id.*

The CBD opened for signature in 1992 at the Rio Earth Summit[123] and "entered into force on 29 December 1993, which was 90 days after the 30th ratification."[124] The Convention has three primary objectives:

1. The conservation of biological diversity
2. The sustainable use of the components of biological diversity
3. The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.[125]

As of February 2023, 196 nations are parties to the Convention, making the treaty nearly universally binding; only the United States and the Holy See have not ratified or acceded to the CBD, although the United States signed it in June 1993.[126]

Marine biodiversity has concerned the parties since the first Conference of the Parties (COP) in 1994.[127] COP 2 resulted in the Jakarta Mandate on Marine and Coastal Biological Diversity, as well as several workplans.[128] COPs 4 through 6 focused on coral reef bleaching and the resulting biodiversity loss, but COP 7 added attention to MPAs, marine aquaculture, and high seas biodiversity.[129]

COP 8 extended these new emphases:

> The conservation and sustainable use of high-seas biodiversity, specifically deep seabed genetic resources beyond the limits of national jurisdiction, was taken up at COP 8 (decision VIII/21), when Parties noted that hydrothermal vent, cold seep, seamount, coldwater coral and sponge reef ecosystems contain genetic resources of great interest for their biodiversity value and for scientific research as well as for present and future sustainable development and commercial applications, and recognized an urgent need to enhance scientific research and cooperation.[130]

COP 8 also "recognized the importance of integrated marine and coastal area management (IMCAM)," "expressed its deep concern over the range of threats to marine ecosystems and biodiversity beyond national

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123 *What is the Convention?*, CONVENTION ON BIOLOGICAL DIVERSITY, https://perma.cc/69VG-ME26 (last visited Mar. 19, 2023).

124 *History of the Convention*, CONVENTION ON BIOLOGICAL DIVERSITY, https://perma.cc/V7E7-DG2Q (last visited Mar. 19, 2023).

125 *Marine and Coastal Biodiversity: Background*, CONVENTION ON BIOLOGICAL DIVERSITY, https://perma.cc/P5MW-BR38 (last visited Mar. 19, 2023).

126 *List of Parties*, CONVENTION ON BIOLOGICAL DIVERSITY, https://www.cbd.int/information/parties.shtml (last visited Mar. 15, 2023).

127 *Marine and Coastal Biodiversity: COP Decisions*, CONVENTION ON BIOLOGICAL DIVERSITY, https://perma.cc/F9CC-EFFJ (last visited Mar. 15, 2023) [hereinafter *COP Decisions*]; U.N. Conference of the Parties to the Convention on Biological Diversity, *Report of the First Meeting*, U.N. Doc. UNEP/CBD/COP/1/17 (Feb. 28, 1995).

128 *COP Decisions*, *supra* note 127.

129 *Id.*

130 *Id.*

jurisdiction, and recognized that marine protected areas are an essential tool to help achieve conservation and sustainable use of biodiversity in these areas."[131] At COP 9, "the Parties requested the Executive Secretary to compile and synthesize scientific information on the potential impacts on marine biodiversity of both direct human-induced ocean fertilization to sequester CO_2 and ocean acidification," and they "adopted scientific criteria for identifying ecologically or biologically significant marine areas in need of protection and scientific guidance for designing representative networks of marine protected areas."[132]

Thus, an early interest in coral reefs led the parties to the Biodiversity Convention towards a more general interest in MPAs. This interest became a biodiversity target in 2010, when the parties adopted the Aichi Biodiversity Targets at COP 10 in Japan.[133] Four targets were particularly relevant to marine biodiversity. First, in Target 6, the parties acknowledged the biodiversity impacts of overfishing and established a goal that:

> By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.[134]

Second, in Target 8, the parties acknowledged the potentially devastating role of nutrient pollution: "[b]y 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity."[135] Third, in Target 10, the parties maintained their earliest focus on coral reefs, setting a goal that "[b]y 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning."[136] Finally, although MPAs are implicitly tools for addressing overfishing and protecting coral reefs, COP 10 explicitly addressed MPAs in Target 11, where the parties set the following goal:

> By 2020, at least 17 per cent of terrestrial and inland water, *and 10 per cent of coastal and marine areas*, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected

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131 *Id.*
132 *Id.*
133 Secretariat of the Convention on Biological Diversity, Strategic Plan for Biodiversity 2011–2020 and the Aichi Targets (2019), https://perma.cc/4657-TTZY.
134 *Id.*
135 *Id.*
136 *Id.*

> systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascapes.[137]

COP 11 received the first reports on ecologically or biologically significant marine areas (EBSAs), a first step in establishing MPAs in a more biodiversity-conscious way:

> An EBSA is an area of the ocean that has special importance in terms of its ecological and/or biological characteristics, for example, as essential habitats, food sources or breeding grounds for particular species. These areas can include seabed habitats from the coastline to deep ocean trenches, and can be located at a variety of depths in the water column from the surface to the abyss.[138]

The parties at COP 11 also worried about marine noise pollution, marine litter, the impacts of climate change on coral reefs, and the impacts of fisheries on marine biodiversity more generally.[139]

At COP 12, the parties accepted a second set of EBSA reports, addressed underwater noise pollution and ocean acidification, and adopted priority actions to enhance protections for coral reefs to achieve Aichi Target 10, "includ[ing] reducing land-based pollution, promoting sustainable fisheries and *improving the design of marine protected area networks for coral reefs*, implementing poverty-reduction programmes for reef-dependent coastal communities, and developing socioeconomic incentives for coral reef conservation."[140] More EBSA reports greeted the parties at COP 13.[141] At COP 14 in 2018, the parties requested further identification of options for modifying marine ESBA descriptions, describing new ESBAs, and EBSAs' scientific credibility and transparency.[142]

So, what has the CBD accomplished with respect to marine biodiversity? As of 2022, party nations have identified and described over 300 EBSAs around the world based on seven internationally agreed-upon scientific criteria.[143] These EBSAs provide the relevant national governments and the international community with critical

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137 *Id.* (emphasis added).

138 *Marine and Coastal Biodiversity: Ecologically or Biologically Significant Marine Areas (EBSAs)*, CONVENTION ON BIOLOGICAL DIVERSITY (Feb. 16, 2022), https://perma.cc/KG3L-QZB6 [hereinafter *EBSAs*].

139 *COP Decisions*, *supra* note 127.

140 *Id.* (emphasis added).

141 *Id.*

142 *Id.*; Conference of the Parties to the Convention on Biological Diversity, *Decision Adopted by the Conference of the Parties to the Convention on Biological Diversity*, ¶ 2, U.N. Doc. CBD/COP/DEC/14/9 (Nov. 28, 2018), https://perma.cc/W4PM-CCWK. COP 15 was disrupted by the COVID-19 pandemic and concluded only in December 2022. *UN Conference Concludes With 'Historic' Deal to Protect a Third of the World's Biodiversity*, UN NEWS (Dec. 19, 2022), https://perma.cc/7MA3-S7MS.

143 *EBSAs*, *supra* note 138.

information regarding where to focus and prioritize marine biodiversity conservation efforts, including MPAs and marine reserves.[144]

However, the parties failed to achieve *any* of the Aichi Biodiversity Targets by 2020.[145] With respect to Target 6, "[a]lthough there has been progress in some regions, the proportion of overfished marine stocks has increased in the last decade to a third of the total, and many non-target species are threatened because of unsustainable levels of bycatch."[146] Nutrient pollution remains a significant threat, and "[m]ore than 60% of the world's coral reefs are under threat, especially because of overfishing and destructive practices."[147]

Finally, at COP 15, the parties set a new goal of protecting 30% of the global ocean by 2030.[148] However, as of 2023, only "2.9% of the ocean is fully or highly protected from fishing impacts," and only 8.2% of the ocean is covered by any form of IUCN-complying MPA.[149]

3. United States

While not a party to the Biodiversity Convention, the United States also pursued the goal of protecting 10% of the ocean in MPAs by 2020.[150] Unlike the international community at large, the United States met that goal: "As of June 2020, 26% of U.S. waters (including the Great Lakes) are in some type of MPA, and 3% of U.S. waters are in the most highly protected category of MPAs ('no take' MPAs that prohibit extractive uses)."[151]

However, the largest no take MPAs in the United States protect only two Pacific Ocean coral reef ecosystems: "Nearly all the highly protected MPAs in the U.S. are located in two large MPAs in the remote Pacific Ocean—Papahānaumokuākea Marine National Monument and Pacific Remote Islands Marine National Monument. Less than 0.1% of U.S. waters outside of these sites are in highly protected MPAs."[152]

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144 *See id.* (describing the "core focus" of ESBAs).

145 Patrick Greenfield, *World Fails to Meet a Single Target to Stop Destruction of Nature–UN Report*, GUARDIAN (Sept. 15, 2020, 09:15 EDT), https://perma.cc/MB56-PJBG.

146 *Id.*

147 *Id.*

148 Conference of the Parties of the Convention on Biological Diversity, *Decision Adopted by the Conference of the Parties to the Convention on Biological Diversity, Kunming-Montreal Global Biodiversity Framework*, ¶ 13, U.N. Doc. CBD/COP/DEC/15/4 (Dec. 19, 2022), https://perma.cc/RH3R-YG29.

149 *The Marine Protection Atlas*, MARINE CONSERVATION INST., https://perma.cc/B6P6-5BHN (last visited Mar. 20, 2023); *see also What's the Difference Between MPAtlas and WDPA?*, MARINE CONSERVATION INST., https://perma.cc/L392-4LLT (last visited Mar. 20, 2023) (discussing the difference between "protected" marine areas and "fully and highly protected" marine areas).

150 NAT'L MARINE PROTECTED AREAS CTR., NAT'L OCEANIC & ATMOSPHERIC ADMIN., MARINE PROTECTED AREAS 2020: BUILDING EFFECTIVE CONSERVATION NETWORKS 2 (2020); *List of Parties*, CONVENTION ON BIOLOGICAL DIVERSITY, https://perma.cc/8DTK-QQMA (last visited Mar. 20, 2023).

151 NAT'L MARINE PROTECTED AREAS CTR., *supra* note 150, at 2.

152 *Id.*

Outside of these two marine national monuments, highly protected marine reserves in the United States exist mostly along the West and Alaska coasts, with additional sprinklings in Florida and the far Northeast.[153]

In terms of protecting the nation's full range of marine biodiversity, the U.S. system of MPAs does a fair—but not exemplary—job:

> [T]he current collection of federal and state MPAs in the U.S. is moderately representative of the nation's key eco-regions, ecosystems, and taxa. In 2015 and 2020, NOAA's National MPA Center conducted preliminary assessments of the degree of representativeness in the nation's portfolio of MPAs. These analyses found that all of the 19 marine ecoregions in the U.S. contained at least one and often many MPAs. The relative number and sizes of these MPAs vary widely within and among ecoregions, as do their levels of protection, management approaches, and likely conservation impacts on those ecosystem features.[154]

As is true internationally, moreover, the United States' collection of MPAs favors certain kinds of marine ecosystems. Specifically, state and federal MPAs protect "80% of shallow tropical corals, 83% of mangroves, 63% of seagrasses, and 54% of deep corals" found in U.S. marine waters.[155] For both biodiversity and economic reasons, U.S. coral reefs have received the lion's share, historically, of legal attention,[156] while other ecosystems important to marine biodiversity, such as kelp forests, still receive little legal protection outside of California.[157]

Nor, with two state exceptions, is the United States' collection of MPAs truly a biodiversity-maintaining *system*.

> Ecological connectivity is only beginning to be a factor in the design and adaptive management of MPAs and MPA networks in U.S. waters. To date, the states of California and Hawai'i have created the nation's first MPA networks that take connectivity into account in the location of sites. In contrast, most other U.S. MPAs were established over several decades by many different programs, each with distinct conservation goals and management approaches. MPA establishment processes have historically

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153 *Id.*

154 *Id.* at 5.

155 *Id.*

156 *See, e.g.*, Robin Kundis Craig, *Coral Reefs, Fishing, and Tourism: Tensions in U.S. Law and Policy Reform*, 27 STAN. ENV'T L.J. 3, 3 (2008); Robin Kundis Craig, *Taking Steps Toward Marine Wilderness Protection? Fishing and Coral Reef Marine Reserves in Florida and Hawaii*, 34 MCGEORGE L. REV. 155, 160, 183 (2003) (both tracing legal efforts in the United States to protect coral reefs).

157 *See* Marine Life Protection Act, CAL. FISH & GAME CODE §§ 2850–2863 (multiple code sections giving more extensive protection to Californian marine ecosystems); *see also Kelp Forest Monitoring and MPAS*, REEF CHECK WORLDWIDE, https://perma.cc/P5LB-LTKZ (last visited Apr. 9, 2023) (discussing California's network of MPAs protecting kelp forests along the Pacific coastline).

> focused on individual sites of local significance, rather than on connected networks of ecologically linked sites.[158]

Moreover, of these two states—California and Hawai'i—only California's system of MPAs meets the high standards necessary to truly protect marine biodiversity in a comprehensive fashion, taking account of various human stressors and ecological connectivity:

> The state of California's portfolio of MPAs is the nation's only example of an intentionally designed, ecologically connected, cohesive, regional network of MPAs. This network design involved significant stakeholder input and relied on models and studies of ocean circulation, larval dispersal, optimal size and spacing distances, and projected impacts on commercial and recreational fisheries.[159]

Under the 1999 state Marine Life Protection Act,[160] California networked 124 marine reserves and other MPAs, established based on science and stakeholder input and subject to both monitoring and adaptive management.[161] In so doing, California created a model for the nation in terms of marine biodiversity legal protection, because California MPAs cover 16% of state waters, and "[a]bout 9% of the state's MPAs are no-take marine reserves."[162]

B. The New BBNJ Treaty

As noted, the parties to the Biodiversity Convention have become increasingly interested in biodiversity in the open ocean—the area beyond national jurisdiction. Under international law, national jurisdiction over ocean waters stops 200 nautical miles from shore, beyond which are the high seas.[163] Marine conservation in the high seas has traditionally depended on regional treaties, especially regarding the regulation of fishing.[164]

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158 NATIONAL MARINE PROTECTED AREAS CTR., *supra* note 150, at 7.

159 *Id.*

160 CAL. FISH & GAME CODE §§ 2850–2863. For more information about the implementation of the Marine Life Protection Act, see generally Britta Phillips, Comment, *Southern California's Recent Adoption of the Marine Life Protection Act to Create Marine Protected Areas*, 2 ARIZ. J. ENV'T. L. & POL'Y 1053 (2011) and Deborah A. Sivas & Margaret R. Caldwell, *A New Vision for California Ocean Governance: Comprehensive Ecosystem-Based Marine Zoning*, 27 STAN. ENV'T L.J. 209 (2008).

161 *Marine Protected Areas,* CAL. SEA GRANT, https://perma.cc/3VGB-WYQH (last visited Feb. 19, 2023).

162 *Id.*

163 U.N. Convention on the Law of the Sea art. 57 (Dec. 10, 1982), 1833 U.N.T.S. 3 (entered into force Nov. 16, 1994) [hereinafter UNCLOS].

164 *See Regional Seas Programme*, U.N. ENV'T PROGRAMME, https://perma.cc/A2LW-Z6YN (last visited Feb. 19, 2023) (UN program facilitating regional regulation of international fishing rights).

A new United Nations treaty will allow for area-based marine biodiversity protection on the high seas. On June 19, 2023, the United Nations formally adopted the High Seas Biodiversity Treaty,[165] which, if it becomes effective,[166] will become a new protocol to the United Nations Convention on the Law of the Sea, the international "constitution" for the ocean.[167] Its formal title is the *Agreement under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction*.[168]

As adopted, the High Seas Biodiversity Treaty acknowledges the need for a "comprehensive global regime under the Convention to better address the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction" and the desire for parties "to act as stewards of the ocean in areas beyond national jurisdiction on behalf of present and future generations by protecting, caring for and ensuring responsible use of the marine environment, maintaining the integrity of ocean ecosystems and conserving the inherent value of biological diversity of areas beyond national jurisdiction."[169] It will apply to both the high seas and the areas of seabed beyond national jurisdiction[170] and seeks "to ensure the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction, for the present and in the long term, through effective implementation of the relevant provisions of the Convention and further international cooperation and coordination."[171] However, party militaries and other official vessels and aircraft are exempt from the requirements of any high seas MPAs created:

> This Agreement does not apply to any warship, military aircraft or naval auxiliary. Except for Part II, this Agreement does not apply to other vessels or aircraft owned or operated by a Party and used, for the time being, only on government non-commercial service. However, each Party shall ensure, by the adoption of appropriate measures not impairing the operations or operational capabilities of such vessels or aircraft owned or

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[165] United Nations General Assembly, Agreement under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction, A/CONF.232/2023/4 (adopted June 19, 2023), *available at* https://perma.cc/VRY5-VMYD.

[166] The new treaty will come into force 120 days after 60 parties properly ratify it. *Id.* art. 68(1).

[167] *Id.*

[168] *Id.*

[169] *Id.* pmbl.

[170] *Id.* arts. 1(2) (defining "areas beyond national jurisdiction"), 3 ("This agreement applies to areas beyond national jurisdiction.").

[171] *Id.* art. 2. The inclusion of "long term" protection was controversial. *See* Elizabeth M. De Santo et al., *Stuck in the middle with you (and not much time left): The third intergovernmental conference on biodiversity beyond national jurisdiction,* MARINE POL'Y (Mar. 29, 2020), No. 103957, at 5 (discussing how Russia and other nations challenged "long-term" to terminate area-based management tools after their effective period).

> operated by it, that such vessels or aircraft act in a manner consistent, so far as is reasonable and practicable, with this Agreement.[172]

The United Nations negotiators agreed on an ecosystem-based precautionary approach centered on the best available information[173]—including indigenous and local knowledge[174]—"that builds ecosystem resilience, including to adverse effects of climate change and ocean acidification, and also maintains and restores ecosystem integrity, including the carbon cycling services that underpin the role of the ocean in climate."[175] Within that overall goal and subject to an overarching duty to cooperate for conservation,[176] the High Seas Biodiversity Treaty addresses four specific topics: (1) exploitation and sharing of marine genetic resources;[177] (2) use of area-based protections/marine protected areas on the high seas or on the seabed;[178] (3) environmental impact assessments for activities on the high seas or on the seabed;[179] and (4) capacity building and technology transfer.[180]

While many of the treaty's provisions are both fascinating and controversial, for purposes of this Article the area-based protections are the most important. The treaty defines "area-based management tool" as "a tool, including a marine protected area, for a geographically defined area through which one or several sectors or activities are managed with the aim of achieving particular conservation and sustainable use objectives in accordance with this Agreement."[181] Part III of the treaty seeks to "[c]onserve and sustainably use areas requiring protection, including through the establishment of a comprehensive system of area-based management tools, with ecologically representative and well-connected networks of marine protected areas;" to "[s]trengthen cooperation and coordination in the use of area-based management tools, including marine protected areas;" to "[p]rotect, preserve, restore, and maintain biodiversity and ecosystems;" to support food security and protect cultural values; and to support developing nations:[182]

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172 *Id.* art. 4.

173 *Id.* art. 7(e), (f), (i).

174 *Id.* art. 7(j), (k). The Preamble also emphasizes the rights of indigenous peoples, "*[r]ecalling* the United Nations Declaration on the Rights of Indigenous Peoples" and "*[a]ffirming* that nothing in this Agreement shall be construed as diminishing or extinguishing the existing rights of Indigenous Peoples, including as set out in the United Nations Declaration on the Rights of Indigenous Peoples, or of, as appropriate, local communities . . . ." *Id.* pmbl.

175 *Id.* art. 7(h).

176 *Id.* art. 8(1).

177 *Id.* pt. II.

178 *Id.* pt. III.

179 *Id.* pt. IV.

180 *Id.* pt. V.

181 *Id.* art. 1(1).

182 *Id.* art. 17.

> [I]n particular the least developed countries, landlocked developing countries, geographically disadvantaged States, small island developing States, coastal African States, archipelagic States and developing middle-income countries, taking into account the special circumstances of small island developing States, through capacity-building and the development and transfer of marine technology in developing, implementing, monitoring, managing and enforcing area-based management tools, including marine protected areas.[183]

However, the treaty also makes clear that the establishment of an area-based management tool is *not* an exercise of sovereignty over the ocean, because "[t]he establishment of area-based management tools, including marine protected areas, shall not include any areas within national jurisdiction and shall not be relied upon as a basis for asserting or denying any claims to sovereignty, sovereign rights or jurisdiction, including in respect of any disputes relating thereto."[184] Moreover, "[i]n cases where an area-based management tool, including a marine protected area, . . . subsequently falls, either wholly or in part, within the national jurisdiction of a coastal State, the part within national jurisdiction shall immediately cease to be in force."[185]

To establish an area-based management tool in the high seas, including an MPA, individual or collective parties submit a proposal to the Secretariat based on the best available science and, "where available, relevant traditional knowledge of Indigenous Peoples and local communities, taking into account the precautionary approach and an ecosystem approach."[186] Proposals must include ten elements:

> (a) A geographic or spatial description of the area that is the subject of the proposal by reference to the indicative criteria specified in Annex I;
>
> (b) Information on any of the criteria specified in Annex I, as well as any criteria that may be further developed and revised in accordance with paragraph 5 below applied in identifying the area;
>
> (c) Human activities in the area, including uses by Indigenous Peoples and local communities, and their possible impact, if any;
>
> (d) A description of the state of the marine environment and biological diversity in the identified area;
>
> (e) A description of the conservation and, where appropriate, sustainable use objectives that are to be applied to the area;

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183 *Id.* art. 17(e).
184 *Id.* art. 18.
185 *Id.* art. 22(6).
186 *Id.* art. 19(1), (3).

(f) A draft management plan encompassing the proposed measures and outlining proposed monitoring, research and review activities to achieve the specified objectives;

(g) The duration of the proposed area and measures, if any;

(h) Information on any consultations undertaken with States, including adjacent coastal States and/or relevant global, regional, subregional and sectoral bodies, if any;

(i) Information on area-based management tools, including marine protected areas, implemented under relevant legal instruments and frameworks and relevant global, regional, subregional and sectoral bodies;

(j) Relevant scientific input and, where available, traditional knowledge of Indigenous Peoples and local communities.[187]

There are 22 Annex I criteria that can justify area-based management, including an area's vulnerability, fragility or sensitivity; the "uniqueness" and "rarity" of the area; or importance of the area to species, biodiversity, or humans.[188] Before submitting the proposal, moreover, the proposers must "collaborate and consult, as appropriate, with relevant stakeholders, including States and global, regional, subregional and sectoral bodies, as well as civil society, the scientific community, the private sector, Indigenous Peoples and local communities."[189]

Once submitted, the proposal becomes public and goes to the Scientific and Technical Body for preliminary review,[190] while the Secretariat facilitates consultation on the proposal with affected nations and other potentially affected entities such as treaty bodies, Indigenous Peoples, and local communities.[191] These consultations "shall be inclusive, transparent and open to all relevant stakeholders, including States and global, regional, subregional and sectoral bodies, as well as civil society, the scientific community, Indigenous Peoples and local communities."[192]

The COP ultimately decides whether to establish the area-based management tool, based on "the final proposal and the draft management plan, taking into account the contributions and scientific input received during the consultation process established under this Part, and the scientific advice and recommendations of the Scientific and Technical Body."[193] Unless otherwise specified, the tool comes into

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187 *Id.* art. 19(4).
188 *Id.* annex I.
189 *Id.* art. 19(2).
190 *Id.* art. 20.
191 *Id.* art. 21(2).
192 *Id.* art. 21(1).
193 *Id.* art. 22(1).

force 120 days after the COP meeting.[194] The COP can also develop mechanisms to coordinate with existing high seas protected areas, such as fishing zones already created under regional fisheries treaties.[195] Moreover, if an area-based management tool established under the High Seas Biodiversity Treaty subsequently falls within the purview of a different legal instrument, framework, or international regulatory body, that tool "shall remain in force until the Conference of the Parties reviews and decides, in close cooperation and coordination with that instrument, framework or body, to maintain, amend or revoke the area-based management tool, including a marine protected area, and related measures, as appropriate."[196]

The COP must also adopt emergency measures to protect high seas biodiversity when warranted. Specifically, it:

> shall take decisions to adopt measures in areas beyond national jurisdiction, to be applied on an emergency basis, if necessary, when a natural phenomenon or human-caused disaster has caused, or is likely to cause, serious or irreversible harm to marine biological diversity of areas beyond national jurisdiction, to ensure that the serious or irreversible harm is not exacerbated.[197]

However, such measures are necessary "only if . . . the serious or irreversible harm cannot be managed in a timely manner through the application of the other articles of this Agreement or by a relevant legal instrument or framework or a relevant global, regional, subregional or sectoral body."[198] Any emergency measures taken must "be based on the best available science and scientific information and, where available, relevant traditional knowledge of Indigenous Peoples and local communities and shall take into account the precautionary approach,"[199] and the emergency measures terminate after two years unless the COP acts to put in place a permanent area-based management tool using the normal procedures.[200]

Ultimately, parties become obligated to act consistently with the decisions made—although they can enact more stringent protections if they want.[201] Together, the parties and the Scientific and Technical Body monitor the area-based management tool's implementation.[202] The

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194 *Id.* art. 23(3). Parties can also object to the decision during the 120-day period. *Id.* art. 23(4)–(9).
195 *Id.* art. 22(4).
196 *Id.* art. 22(7).
197 *Id.* art. 24(1).
198 *Id.* art. 24(2).
199 *Id.* art. 24(3).
200 *Id.* art. 24(4).
201 *Id.* art. 25(1)–(2).
202 *Id.* art. 26(1)–(4).

COP can amend, extend, or eliminate area-based management tools as a result of this continuing review.[203]

Once in force, the new High Seas Biodiversity Treaty will extend the increasing global concern for marine biodiversity and international law endorsement of MPAs into the high seas, reflecting over three decades of international effort to protect marine biodiversity. However, the open ocean of the high seas is generally low in biodiversity.[204] Thus, the new treaty is most likely to promote marine biodiversity by protecting deep-sea ecosystems from deep seabed mining,[205] with more occasional use for protecting unusual open ocean ecosystems, such as the Sargasso Sea in the Atlantic Ocean.[206]

IV. THE UNDERUSED APPROACHES TO PROTECTING MARINE BIODIVERSITY: SPECIES PROTECTIONS FOR MARINE SPECIES

As helpful as MPAs can be for protecting marine biodiversity, they cannot be the only tools deployed. Leaving climate change and ocean acidification to the side,[207] the need for other legal biodiversity tools remains *even if* no-take marine reserves become fully integrated into fisheries management. As the discussions in Parts II and III emphasize, threats to marine biodiversity take many forms, and ocean pollution in particular must be addressed through legal tools other than area-based management.[208]

Even when the focus stays on species and ecosystems, area-based management will not adequately protect all species. For example, because of overfishing, most "[l]arge predatory fishes have seen their abundance reduced to 10%" or less of historical levels, with some "sensitive species, such as sharks to [approximately] 1% of their carrying capacity."[209] For large and highly migratory pelagic species, MPAs provide little conservation assistance. Instead, these species need

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203 *Id.* art. 26(5).

204 *Ecosystems of Oceans and Freshwater: Biological Diversity and Water*, STUDY.COM, https://perma.cc/8KDV-37DJ (last visited Feb. 19, 2023).

205 *See, e.g.*, K.A. Miller et al., *Challenging the Need for Deep Seabed Mining From the Perspective of Metal Demand, Biodiversity, Ecosystems Services, and Benefit Sharing*, FRONTIERS MARINE SCI. (July 2021), No. 706161, at 4 (describing the potential impacts of deep-seabed mining on marine biodiversity); Catrin Einhorn, *Nations Agree on Language for Historic Treaty to Protect Ocean Life*, N.Y. TIMES (Mar. 4, 2023), https://perma.cc/H237-DYV3 (discussing the High Seas Biodiversity Treaty's goal of promoting biodiversity from threats such as sea mining).

206 *What Is the Sargasso Sea?*, NOAA (last updated Jan. 4, 2021), https://perma.cc/5JYA-CQQZ.

207 For a more comprehensive discussion of immediate ways to protect the ocean from climate change and ocean acidification, see Robin Kundis Craig, *Re-Valuing the Ocean in Law: Exploiting the Panarchy Paradox of a Complex System Approach*, 41 STAN. ENV'T L.J. 3, 61–78 (2022).

208 *Id.* at 7–8.

209 Sala & Knowlton, *supra* note 3, at 103; *see also The Census of Marine Life*, *supra* note 40 (listing the same 10% figure for large apex predators).

legal protection from overfishing. After surveying the primary legal tools for species-specific protection, this Part presents a particularly cogent case study of this last gap in marine biodiversity protection.

A. Early Protections for Marine Mammals

Marine mammals, as charismatic megafauna, historically enjoy special legal protections implemented to halt the direct impacts of hunting and whaling. One early example is the North Pacific Fur Seal Treaty of 1911,[210] also known as the North Pacific Sealing Convention of 1911. As one historian recounted, "By the year 1911 the North Pacific fur seal was little more than a reminder of the greed and rapacity of man. The magnificent American herd on the Pribilof Islands had been reduced in numbers from approximately 4,000,000 in 1867 to rapidly dwindling 100,000."[211] Sealing in U.S. territory created tensions among the United States, Great Britain, Russia, and Japan, and in July 1911, they collectively "prohibited pelagic sealing by citizens or subjects of the signatory nations, leaving to the respective governments owning seal rookeries the right to deal independently with land killing."[212] The treaty also enacted a profit-sharing scheme under which signatory nations benefitted if the fur seal herds thrived.[213]

The treaty was an immediate success:

> Within one year after the cessation of this practice the Pribilof herd had shown a noticeable increase, particularly in females. By 1932, the 100,000 or so of 1911 had increased to 1,219,000. Yet in that same year, under the government monopoly now existing, 49,336 superfluous males were killed and their skins sold, netting a handsome profit. In fact, from 1918 to 1930, after deducting the annual payments to Canada and Japan, the United States government received a total revenue of $4,477,000 from the seal herd.[214]

The Fur Seal Treaty thus demonstrated that controlling an international free-for-all in marine mammal hunting could benefit both species and economies.

The more comprehensive International Convention for the Regulation of Whaling (IWC)[215] emerged in 1948 and, in 1949, Congress passed the Whaling Convention Act[216] to implement that treaty within

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210 Convention for the Preservation and Protection of Fur Seals (July 7, 1911), T.S. No. 564.

211 Thomas A. Bailey, *North Pacific Sealing Treaty of 1911*, 4 PAC. HIST. REV. 1, 1 (1935).

212 *Id.* at 11.

213 *Id.* at 11–12.

214 *Id.* at 13 (citations omitted).

215 International Convention for the Regulation of Whaling (Dec. 2, 1946), 62 Stat. 1716, 161 U.N.T.S. 72 (entered into force Nov. 10, 1948).

216 Whaling Convention Act of 1949, 16 U.S.C. §§ 916–916*l* (2018).

the United States. Currently, 88 nations are parties to the IWC.[217] As the treaty name suggests, the IWC originally *regulated* whaling globally; however, in 1986, the parties adopted a global moratorium on whaling in response to the overexploitation of whale stocks.[218] Although the parties originally intended a temporary moratorium, the general prohibition on whaling continues.[219]

Nevertheless, many whale species remain in trouble. According to IUCN's "Red List"—a global compendium of scientific assessments of species' statuses—blue whales[220] and sei whales,[221] two of the largest hunted baleen whales, still face endangerment. Perhaps worst off is the North Atlantic right whale, the target of New England whalers at the time of *Moby Dick*,[222] which remains critically endangered.[223]

However, other whale species rebounded in the absence of whaling. For example, the eastern North Pacific gray whale population is one of marine conservation's great success stories. With hunting eliminated, this population's numbers began to increase,[224] and by the mid-1990s, these gray whales made a strong recovery.[225] IUCN considers the gray whale a species of "least concern."[226] Humpback whales are also in IUCN's "least concern" category,[227] while fin whales are recovering but still considered "vulnerable."[228]

In the United States, the legacy of special legal protections for marine mammals lives on in the Marine Mammal Protection Act (MMPA).[229] In this legislation, Congress found that "certain species and population stocks of marine mammals are, or may be, in danger of extinction or depletion as a result of man's activities," that "such species and population stocks should not be permitted to diminish beyond the point at which they cease to be a significant functioning element in the ecosystem of which they are a part," and that "there is inadequate knowledge of the ecology and population dynamics of such marine

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[217] *International Whaling Commission*, NOAA FISHERIES, https://perma.cc/C4RY-GXTM (Nov. 17, 2022).

[218] *Id.*

[219] *Id.*

[220] *Blue Whale*, IUCN RED LIST, https://perma.cc/H4Z2-5EGD (last visited Mar. 20, 2023).

[221] *Sei Whale*, IUCN RED LIST, https://perma.cc/WR74-GZDM (last visited Mar. 20, 2023).

[222] HERMAN MELVILLE, MOBY DICK: OR THE WHITE WHALE 322 (1851).

[223] *North Atlantic Right Whale*, IUCN RED LIST, https://perma.cc/G2G6-JJQ2 (last visited Mar. 20, 2023).

[224] J.G. COOKE, THE IUCN RED LIST OF THREATENED SPECIES, *ESCHRICHTIUS ROBUSTUS*, GRAY WHALE 5 (2018), https://perma.cc/Q67H-H6KG.

[225] *Id.*

[226] *Id.* at 1.

[227] J.G. COOKE, THE IUCN RED LIST OF THREATENED SPECIES, *MEGAPTERA NOVAEANGLIAE*, HUMPBACK WHALE 1–2 (2018), https://perma.cc/W3JE-QT26.

[228] J.G. COOKE, THE IUCN RED LIST OF THREATENED SPECIES, *BALAENOPTERA PHYSALUS*, FIN WHALE 1–2 (2018), https://perma.cc/9EFL-HRG9.

[229] Marine Mammal Protection Act of 1972, 16 U.S.C. §§ 1361–1423h (2018).

mammals and of the factors which bear upon their ability to reproduce themselves successfully."[230] Relevant to this Article, the MMPA seeks to prevent the ecological extinction of marine mammals despite limited scientific knowledge.

For purposes of the Act, a "marine mammal" is:

> any mammal which (A) is morphologically adapted to the marine environment (including sea otters and members of the orders Sirenia, Pinnipedia and Cetacea), or (B) primarily inhabits the marine environment (such as the polar bear); and, for the purposes of this chapter, includes any part of any such marine mammal, including its raw, dressed, or dyed fur or skin.[231]

Consistent with the lack of scientific knowledge, the MMPA enacts a general "moratorium on the taking and importation of marine mammals and marine mammal products, . . . during which time no permit may be issued for the taking of any marine mammal and no marine mammal or marine mammal product may be imported into the United States."[232] The moratorium has exceptions that require permits, such as for scientific research or incidental take in commercial fishing.[233] National Oceanic and Atmospheric Administration (NOAA) Fisheries issues yearly stock assessment reports, through which it tracks 259 stocks of marine mammals.[234]

B. More General Legal Tools for Marine Species Protection

While species-specific legal instruments help in certain biodiversity-threatening situations like overhunting, both the international community and the United States also implement more flexible legal regimes that list species according to various levels of protection as needed. Internationally, for example, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)[235] protects species threatened through international trade. CITES sorts species into one of three Appendices. Appendix I includes:

> all species threatened with extinction which are or may be affected by trade. Trade in specimens of these species must be subject to particularly

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230 *Id.* § 1361(1)–(3).

231 *Id.* § 1362(6).

232 *Id.* § 1371(a).

233 *Id.* § 1371(a)(1)–(2).

234 *Marine Mammal Stock Assessment Reports*, NOAA FISHERIES, https://perma.cc/E6VM-HEBF (last visited Feb. 20, 2023). For the full list of marine mammals that NOAA Fisheries tracks, including their biodiversity status, see *Species Directory: Marine Mammals*, NOAA FISHERIES, https://perma.cc/QJJ9-975Z (last visited Feb. 20, 2023).

235 Convention on International Trade in Endangered Species of Wild Fauna and Flora, Mar. 3, 1973, 27 U.S.T. 1087 (entered into force July 1, 1975).

> strict regulation in order not to endanger further their survival and must only be authorized in exceptional circumstances.[236]

Appendix II includes:

> (a) all species which although not necessarily now threatened with extinction may become so unless trade in specimens of such species is subject to strict regulation in order to avoid utilization incompatible with their survival; and
>
> (b) other species which must be subject to regulation in order that trade in specimens of certain species referred to in sub-paragraph (a) of this paragraph may be brought under effective control.[237]

Finally, Appendix III includes "all species which any Party identifies as being subject to regulation within its jurisdiction for the purpose of preventing or restricting exploitation, and as needing the cooperation of other parties in the control of trade."[238] CITES functions by restricting parties' trading in listed species,[239] limiting trade in Appendix I species to noncommercial uses and requiring parties to issue export permits and monitor imports of all listed species.[240]

As of May 2023, the CITES Appendices list over 40,900 species and subspecies, 34,310 of which are plants and 39,246 of which are listed under Appendix II.[241] In contrast, "There are currently almost 2,400 marine species listed in CITES Appendices, accounting for less than 10 percent of all CITES-listed species and around 40 percent of CITES-listed animal species."[242] Most of the included marine species are charismatic: all seven species of sea turtle, seahorses, all beaked whales, almost all great whales, six fur seal species, all dolphins, most porpoises, and some large sharks.[243] Sharks and rays are often relatively recent additions under CITES's protections.[244]

The United States implements CITES, as well as its own endangered species protections, through the federal Endangered Species Act (ESA).[245] The ESA's dual national and international focus is evident in Congress's statement of the statute's purposes, which are:

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[236] *Id.* art. 2(1).
[237] *Id.* art. 2(2).
[238] *Id.* art. 2(3).
[239] *Id.* art. 2(4).
[240] *E.g.*, *id.* art. 3 (detailing the requirements for trading in Appendix I species).
[241] *The CITES Species*, CITES, https://perma.cc/S6DT-KFUS (last visited Feb. 20, 2023).
[242] 2022 FAO Report, *supra* note 73, at 184 (citation omitted).
[243] *Convention on International Trade in Endangered Species of Flora and Fauna*, NOAA FISHERIES, https://perma.cc/2G5P-9AJ2 (last visited Feb. 20, 2023).
[244] 2022 FAO Report, *supra* note 73, at 185–86.
[245] Endangered Species Act, 16 U.S.C §§ 1531–44 (2018).

> [T]o provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of [certain] treaties and conventions . . . ."[246]

Specifically, Congress lists six treaties, conventions, and groups of treaties and conventions that it intended the ESA to implement or help to implement:

> (A) migratory bird treaties with Canada and Mexico;
>
> (B) the Migratory and Endangered Bird Treaty with Japan;
>
> (C) the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere;
>
> (D) the International Convention for the Northwest Atlantic Fisheries;
>
> (E) the International Convention for the High Seas Fisheries of the North Pacific Ocean; [and]
>
> (F) the Convention on International Trade in Endangered Species of Wild Fauna and Flora[.][247]

Under the ESA, the U.S. Fish & Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) list species as either endangered or threatened on the basis of the best science available.[248] Once the FWS or NMFS lists a species, no entity subject to U.S. jurisdiction can take members of the species or trade them in commerce.[249] Moreover, the federal government must ensure that neither its own actions nor the activities that it permits, licenses, or funds jeopardize the species' continued existence or harm the species' critical habitat.[250]

"NOAA Fisheries has jurisdiction over 163 endangered and threatened marine species (79 endangered; 84 threatened), including 65 foreign species (39 endangered; 26 threatened)."[251] In addition, NMFS proposed the Queen conch for listing in 2022,[252] and 18 other marine species await decision.[253]

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246 *Id.* § 1531(b).

247 *Id.* § 1531(a)(4).

248 *Id.* § 1533(b).

249 *Id.* § 1538(a).

250 *Id.* § 1536(a)(2).

251 *Species Directory: ESA Threatened and Endangered*, NOAA FISHERIES, https://perma.cc/YNY5-9E7J (last visited Mar. 19, 2023) [hereinafter NOAA FISHERIES].

252 Endangered and Threatened Wildlife and Plants: Proposed Rule to List the Queen Conch as Threatened Under the Endangered Species Act (ESA), 87 Fed. Reg. 55200 (Sept. 8, 2022) (to be codified at 50 C.F.R. pt. 223).

253 NOAA FISHERIES, *supra* note 251.

C. Case Study: Protecting the Bluefin Tuna

"Bluefin tuna" refers to three different species of fish: Atlantic bluefin tuna (*Thunnus thynnus*); the Southern bluefin tuna (*Thunnus maccoyii*); and the Pacific bluefin tuna (*Thunnus orientalis*).[254] They represent a quintessential conflict between biodiversity protection and human gustatory desires:

> As top predators with few natural enemies, bluefin tuna once enjoyed long lifespans in thriving oceans. However, over the past 80 years, overfishing led to an estimated 80% to 90% population reduction. Consumers seek out this highly prized delicacy in the form of sushi and sashimi, resulting in enormous payouts for tuna fisheries, with a single bluefin tuna selling for over three million dollars.[255]

Moreover, all three species of tuna are vulnerable to overexploitation through fishing because they grow slowly and cannot reproduce until they are four to eight years old.[256]

By any standard, bluefin tuna deserve legal protection. As of 2021, the Atlantic bluefin tuna was a species of "least concern," according to IUCN.[257] However, IUCN considered the species "endangered" in 2011, and population trend status data remain unavailable.[258] The Atlantic bluefin tuna ranges across the North Atlantic and into the South Atlantic and the Gulf of Mexico.[259] Substantial uncertainty surrounds the 2021 assessment of the species:

> There has been considerable uncertainty associated with assessments of the Eastern Atlantic and Mediterranean Sea stock of Atlantic Bluefin Tuna due to issues with the catch per unit effort data, misreporting of catch during the late 1990s and 2000s, a lack of understanding of stock-recruit relationships and potential recruitment levels. Overfishing occurred during the late 1990s and 2000s . . . .[260]

Moreover, "[t]he eastern stock of Atlantic Bluefin Tuna is fished by many nations, and achieving consensus on management measures, especially allocation issues, is extremely difficult, which greatly increases management response time. Data deficiencies remain,"

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[254] 2022 FAO REPORT, *supra* note 73, at 52; *Bluefin Tuna: Endangered Species or Gourmet Food?*, TULANE UNIV. L. SCH. (Apr. 9, 2021), https://perma.cc/2N7K-RZTT [hereinafter *Bluefin Tuna*].

[255] *Bluefin Tuna*, *supra* note 254 (citations omitted).

[256] *Id.*

[257] *Atlantic Bluefin Tuna*, IUCN RED LIST, https://perma.cc/ZDC8-HLEL (last visited Mar. 19, 2023).

[258] B.B. COLLETTE ET AL., THE IUCN RED LIST OF THREATENED SPECIES, *THUNNUS THYNNUS*, ATLANTIC BLUEFIN TUNA 2 (2021), https://perma.cc/ZS9P-EQ8F [hereinafter COLLETTE ET AL., ATLANTIC BLUEFIN TUNA].

[259] *Id.* at 4.

[260] *Id.* at 7.

potentially compromising the assessment.[261] Further, the western population of Atlantic bluefin tuna is distinctly vulnerable to climate change because it breeds in the Gulf of Mexico:

> The warm ambient temperatures on their breeding grounds in the Gulf of Mexico potentially present a distinct threat to these large, endothermic fish, and this potential threat will increase with increasing water temperatures due to global warming. Substantial breeding habitat loss for both adult and larval Atlantic Bluefin Tuna is thus predicted for the main spawning grounds in the northern Gulf of Mexico as water temperatures continue to warm.[262]

State and non-state actors have petitioned to list the Atlantic bluefin tuna under both CITES and the ESA, to no avail.[263] The failure to impose additional protections, especially in light of climate change threats, could be particularly problematic for the western population of the species. As IUCN noted in 2021, "while the larger, eastern population of Atlantic bluefin tuna, which originates in the Mediterranean, has increased by at least 22% over the last four decades, the species' smaller native western Atlantic population, which spawns in the Gulf of Mexico, has declined by more than half in the same period."[264]

The Pacific bluefin tuna's numbers continue to decrease and, as of January 2021, IUCN categorizes the species as "near threatened."[265] This species has vacillated among IUCN classifications, moving from "least concern" in 2011 down to "vulnerable" in 2014 before bouncing back to "near threatened" in 2021.[266] The Pacific bluefin tuna ranges across the North Pacific and into select parts of the South Pacific, including the ocean around New Zealand.[267] Fishing is the primary threat to the Pacific bluefin tuna, which "is a high-value species in the global fresh-fish markets, particularly in the sashimi and sushi markets of Japan . . . . It is the most expensive fish in the world."[268] However, this species was successfully aquacultured recently, and "aquaculture production has now spread to Mexico, where the total production may now exceed wild catch."[269] Thus, the continued need for wild catch of

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261 *Id.* at 10.
262 *Id.*
263 *Id.*
264 *Tuna Species Recovering Despite Growing Pressures on Marine Life - IUCN Red List*, IUCN (Sept. 4, 2021), https://perma.cc/RT8S-EUXN [hereinafter *Tuna Species Recovering*].
265 *Pacific Bluefin Tuna*, IUCN RED LIST, https://perma.cc/D7Z8-5L7Z (last visited Mar. 21, 2023).
266 B.B. COLLETTE ET AL., THE IUCN RED LIST OF THREATENED SPECIES, *THUNNUS ORIENTALIS*, PACIFIC BLUEFIN TUNA 2 (2021).
267 *Id.* at 3.
268 *Id.* at 7.
269 *Id.*

Pacific bluefin tuna is questionable, especially because the species "remains severely depleted at less than 5% of its original biomass."[270]

IUCN considers the Southern bluefin tuna endangered.[271] While this status is an improvement from its "critically endangered" assessments in 1996 and 2011,[272] this species remains in trouble. Southern bluefin tuna range across the very southern parts of the Pacific, Indian, and Atlantic Oceans, skirting the edges of the Southern Ocean surrounding Antarctica.[273] Overfishing caused the species' current extremely low biomass, and the practice of Australian fishers catching immature juveniles to grow in cages further complicates fisheries management.[274] Indeed, the caging problem prompted the Commission for the Conservation of Southern Bluefin Tuna to recommend "the use of stereoscopic cameras to accurately estimate the amount of caged fish in farming operations, but this recommendation has not yet been realized."[275]

The plight of these three species of bluefin tuna illustrates the limits of MPAs as biodiversity conservation tools. With ranges that cross entire oceans, these tuna benefit little from small MPAs—unless the MPAs protect their known breeding grounds.[276] However, the relatively new practice of catching juvenile tuna and caging them to grow to marketable size undermines even a breeding-ground-focused MPA strategy because these captured juveniles never breed.[277] As a result, both the international community and the United States should list bluefin tuna for individual species protections as endangered species and under CITES Appendix I, despite their commercial value as food.

V. CONCLUSION

Protecting marine biodiversity often feels like an uphill battle, especially considering the recently magnifying impacts on marine species and ecosystems from climate change and ocean acidification. Nevertheless, the global community and the United States must

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270 *Tuna Species Recovering*, *supra* note 264.

271 *Southern Bluefin Tuna*, IUCN RED LIST, https://perma.cc/C2UA-9J7X (last visited Mar. 21, 2023),

272 B.B. COLLETTE ET AL., THE IUCN RED LIST OF THREATENED SPECIES 2021, *THUNNUS MACCOYII*, SOUTHERN BLUEFIN TUNA 2 (2021) [hereinafter COLLETTE ET AL., SOUTHERN BLUEFIN TUNA].

273 *Id.* at 3.

274 *Id.* at 6.

275 *Id.*

276 *About Southern Bluefin Tuna,* COMMISSION FOR THE CONSERVATION OF SOUTHERN BLUEFIN TUNA, https://perma.cc/HLB8-3TR2 (last visited June 27, 2023) (explaining that Southern Bluefin Tuna are found throughout the Southern Hemisphere but only breed in a single area southeast of Java); *See ESBAs*, *supra* note 138 (explaining that conservation focused on breeding grounds better protects marine biodiversity).

277 COLLETTE ET AL., ATLANTIC BLUEFIN TUNA*, supra* note 258, at 10; COLLETTE ET AL., SOUTHERN BLUEFIN TUNA, *supra* note 272, at 6.

remember that *other* threats to marine biodiversity still exist, and these additional stressors frequently worsen the impacts of climate change.

Therefore, while the world works toward reducing carbon dioxide emissions—the ultimate "fix" to both climate change impacts and ocean acidification—we should more enthusiastically deploy *all* the legal tools in the marine biodiversity toolbox. Carefully located, designed, and enforced MPAs that limit exploitation of marine resources remain an important biodiversity tool, and the global consensus to protect 30% of the ocean in MPAs by 2030 is an ambitious but desirable goal.

Nevertheless, commitment to area-based strategies should not prevent increased deployment of "no take" protections for individual species like bluefin tuna. Bluefin tuna, and other highly migratory species, need protection from capture *wherever* they are found. While fisheries management appears to be improving, "less bad" fishing does not change the fact that many of these apex marine predators remain severely depleted, approaching ecological extinction and warping marine ecosystem function. Only a complete ban on fishing for these species might allow them to recover their historical biomass and ecological function despite a rapidly changing ocean.