

SAVING THE RAINFORESTS OF THE SEA: AN ANALYSIS OF INTERNATIONAL EFFORTS TO CONSERVE CORAL REEFS

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“The descent into the sea reveals a fantastic world, the coral reef. For some, its infinite diversity and beauty make it an almost mystical experience. The panorama of the coral reef is like the view from a Himalayan mountaintop; they both arouse the same excitement, the same sense of mystery.”¹

I. INTRODUCTION

Coral reefs, home to some of the most diverse life in the world, are dying faster than scientists can count them.² Today, these fragile ecosystems face myriad threats unprecedented in the 200–300 million years over which they have evolved.³ But it is not yet time to give up on coral reefs, believing that their doom is sealed. This past year, 2008, was named “International Year of the Reef,” and a worldwide campaign is on to raise awareness about reef ecosystems and the bold steps we must take to save them.⁴ The world community still has a chance to ensure that our children and grandchildren experience the awe of coral reefs firsthand and benefit from the many services reef ecosystems provide.

This note outlines the principal threats faced by coral reefs, analyzes several main approaches the international community is employing to conserve reef ecosystems, and ultimately calls for a new

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1. EUGENE H. KAPLAN ET AL., *A FIELD GUIDE TO CORAL REEFS: CARIBBEAN AND FLORIDA 1* (Houghton Mifflin Co. 1999) (1982).

2. J.C. Sylvan, *How to Protect a Coral Reef: The Public Trust Doctrine and the Law of the Sea*, 7 *SUSTAINABLE DEV. L. & POL’Y* 32, 33 (2006).

3. International Year of the Reef 2008, What Are Coral Reefs?, <http://www.iyor.org/reefs/> (last visited Mar. 22, 2009) [hereinafter What Are Coral Reefs].

4. International Year of the Reef 2008, International Year of the Reef, <http://www.iyor.org/> (last visited Mar. 22, 2009) [hereinafter International Year of the Reef].

international treaty wholly devoted to protecting these unique living structures. Part II describes the significance and benefits of reef ecosystems, as well as the basic biology of coral reefs. Part III focuses on the numerous threats imperiling coral reefs, including challenges associated with climate change and ocean acidification. Part IV discusses three current international approaches to reef conservation. Part V calls for the creation of a new international treaty devoted exclusively to coral reef protection, and recommends provisions this treaty must include to help fill the gaps in existing international approaches.

II. CORAL REEFS—AN OVERVIEW

Before examining the threats that reefs face, it is important to understand the immense benefits that coral reefs provide, and the far-reaching impacts that the demise of these ecosystems would have. Additionally, understanding current declines in the world's reefs requires a basic knowledge of the biology of these living structures.

A. *Significance and Benefits of Coral Reefs*

Coral reefs are often referred to as “the rainforests of the sea.”⁵ The comparison is fitting—despite occupying less than one percent of the ocean floor, an area about half the size of France,⁶ temperate and tropical reefs provide a home for as much as twenty-five percent of the world's marine species.⁷ Scientists are only just beginning to account for the more than one million species believed to live in coral reefs, but they know that more than four thousand species of fish alone call the reefs home.⁸ Only tropical rainforests can compete with the sheer concentration of biodiversity found in coral reefs, and rainforests occupy twenty times as much area as reefs.⁹

In addition to providing habitats for a stunning array of biodiversity, coral reefs provide numerous other benefits. More than

5. Rhett A. Butler, Mongabay.com, *Coral Reefs: The Tropical Rainforests of the Sea*, <http://rainforests.mongabay.com/09reefs.htm> (last visited Feb. 20, 2009).

6. Mary Gray Davidson, *Protecting Coral Reefs: The Principal National and International Legal Instruments*, 26 HARV. ENVTL. L. REV. 499, 501 (2002).

7. Sylvan, *supra* note 2, at 32.

8. Am. Univ. Washington Coll. of Law, *International Environmental Law and Policy—Coral Reefs*, <http://www.wcl.american.edu/environment/iel/sup3.cfm> (last visited Mar. 3, 2009); *International Year of the Reef 2008, Benefits of Coral Reefs*, <http://www.iyor.org/reefs/benefits.asp> (last visited Mar. 22, 2009) [hereinafter *Benefits of Coral Reefs*].

9. Sylvan, *supra* note 2, at 32.

one hundred million tons of fish are consumed globally each year, providing two and a half billion people with more than twenty percent of their animal protein intake.¹⁰ Nearly ten percent of all fish consumed worldwide is caught on reefs, with one square kilometer of healthy reef providing enough fish to feed three hundred people.¹¹ Additionally, reefs provide millions of tourism jobs in the more than one hundred countries and territories that have reefs in their coastal waters.¹² Tourism generates half of the gross national product for Caribbean countries, with reef exploration serving as a major attraction for those who visit this part of the world.¹³

Another benefit of reefs is that these structures serve as important protective barriers for coastal cities and other communities. Healthy reefs absorb as much as ninety percent of the impact of wind-generated waves, sheltering coastal cities and other communities from hurricanes and other storms, as well as from erosion.¹⁴ Replicating this protective benefit of reefs is an expensive endeavor—an artificial, substitute barrier constructed in the Maldives cost twelve million dollars.¹⁵

As with tropical rainforests, coral reefs are hot spots for the pharmaceutical industry. Thus far, researchers have identified dozens of antimicrobial, anti-inflammatory, and other medical properties in reef species.¹⁶ For example, chemicals from a Caribbean reef sponge are used to produce AZT, a treatment for the human immunodeficiency virus (HIV), and scientists are also evaluating the use of coral in repairing broken bones.¹⁷

Numerous attempts have been made to estimate the monetary value of coral reefs worldwide. This task is a daunting one, in that reefs provide both “direct use values” (e.g., fisheries and tourism), as well as “indirect use values” (e.g., coastline protection).¹⁸ As of 2006, the United Nations estimated that the total economic value of reefs from both direct and indirect uses was as much as six hundred

10. Food & Agric. Org., United Nations, Many of the World’s Poorest People Depend on Fish (June 7, 2005), <http://www.fao.org/newsroom/en/news/2005/102911/index.html>.

11. Sylvan, *supra* note 2, at 32.

12. Benefits of Coral Reefs, *supra* note 8.

13. Davidson, *supra* note 6, at 503.

14. Sylvan, *supra* note 2, at 33.

15. *Id.*

16. *Id.*

17. Davidson, *supra* note 6, at 502–03.

18. Benefits of Coral Reefs, *supra* note 8.

thousand dollars per square kilometer a year.¹⁹ This estimate of course does not include the value of unknown opportunities lost, pharmaceutical and otherwise, when a given area of reef is damaged or destroyed.²⁰

B. Biology of Coral Reefs

In order to understand the threats currently facing coral reefs and approaches to addressing these challenges, one must understand the basic biology of these living structures. Corals are actually invertebrate animals and are in the same taxonomic group as jellyfish and sea anemones.²¹ Each individual coral animal is called a polyp. Most coral polyps live in “colonies,” which are groups of hundreds to thousands of genetically identical polyps formed when the original polyp grows copies of itself (the process is called budding).²² Corals are grouped into two types—hard corals and soft corals. Hard corals are the “reef-building” corals, and there are approximately eight hundred known species of hard coral.²³

Hard corals extract calcium from the surrounding seawater and use this calcium to create a hardened structure that protects the coral and helps it grow.²⁴ Millions of coral polyps growing on top of the calcium carbonate (limestone) remains of former colonies create the massive reefs with which we are familiar.²⁵ Coral reefs are not only the largest living structures on the planet, they are also the only living structures that are visible from space.²⁶

Coral reefs have evolved over the past two hundred to three hundred million years, developing a unique form of symbiosis with single-celled algae called zooxanthellae.²⁷ Inside each coral polyp’s white calcium exoskeleton also lives a zooxanthella, which gives the coral its brilliant color.²⁸ This zooxanthella takes in carbon dioxide (CO₂) through photosynthesis, giving off oxygen as a by-product.²⁹

19. *Id.*

20. Sylvan, *supra* note 2, at 33.

21. What Are Coral Reefs, *supra* note 3.

22. *Id.*

23. *Id.*

24. *Id.*

25. Reef Relief, All about the Coral Reef, http://www.reefrelief.org/coral_reef_body.shtml (last visited Mar. 22, 2009).

26. What Are Coral Reefs, *supra* note 3.

27. *Id.*

28. Reef Relief, *supra* note 25.

29. *Id.*

The coral polyp uses that oxygen, as well as nutrients from the zooxanthella, to survive.³⁰ In return, the zooxanthella converts the coral's waste to sugars and starches.³¹

The growth rate of corals depends on the specific species and environmental conditions. Even under ideal conditions, reef building corals are slow growers. Most massive (non-branching) corals grow about one half to two centimeters a year, and even the faster growing massive coral species only expand about four and a half centimeters a year under ideal circumstances (high light exposure, consistent temperature, and moderate wave action).³² This slow growth rate means that reefs take a very long time to recover when they are damaged or destroyed—the recovery process can even take several millennia.³³

Temperate and tropical coral reefs are only found in a band extending from thirty degrees north of the equator to thirty degrees south of the equator, and at depths of less than one hundred feet.³⁴ These corals can only grow in warm waters between seventy and eighty-five degrees Fahrenheit, and also require high light levels.³⁵ Their specific needs make tropical corals extremely vulnerable to changes in the ocean environment.

III. EXISTING AND EMERGING THREATS TO CORAL REEFS

The world's coral reefs are on a downward trajectory. A 2004 study estimates that since the 1950s, twenty percent of all reefs worldwide have been destroyed, with no chance of recovery, and an additional twenty-four percent of reefs are under "imminent threat of collapse."³⁶ Twenty-two percent of the Caribbean reefs were already dead as of 2002, with only five percent of Jamaica's reefs remaining.³⁷ These worldwide declines are being witnessed by scientists and reef enthusiasts in their own lifetimes.³⁸ There are numerous causes of

30. *Id.*

31. Am. Univ. Washington Coll. of Law, *supra* note 8.

32. What Are Coral Reefs, *supra* note 3.

33. Mike Mastry, *Coral Reef Protection under the United States Federal Law: An Overview of the Primary Federal Legislative Means by which Coral Reef Ecosystems and their Associated Habitat may be Protected*, 14 U. BALT. J. ENVTL. L. 1, 2 (2006).

34. What Are Coral Reefs, *supra* note 3.

35. Reef Relief, *supra* note 25.

36. Juliet Eilperin, *Yes, the Water's Warm . . . Too Warm*, WASH. POST, July 15, 2007, at P4.

37. Davidson, *supra* note 6, at 504.

38. *See id.* (discussing rapid declines in reefs both in the Caribbean and throughout the world).

these rapid and immense reef losses—some causes are localized to reefs in particular countries or regions, while others are caused by global threats. The future of reefs depends on humans successfully tackling most, if not all, of these challenges. This section explores the specific threats faced by reefs, providing context that is important for assessing the international reef conservation approaches discussed in Part IV.

A. *The Many Threats to Reefs*

1. Overfishing

Simply put, we are running out of fish. Fully exploited fish stocks have reached or nearly reached their maximum catch limits.³⁹ One recent study estimates that virtually all ocean fish stocks will be gone by the middle of this century, and as one scientist says, “Unless we fundamentally change the way we manage all ocean species together, as working ecosystems, then this century is the last century for wild seafood.”⁴⁰ Already, humans have wiped out one third of the world’s fish stocks, causing fishermen to go after smaller fish that are lower on the food chain.⁴¹

The loss of so many fish and fish species harms not only the humans who depend on fish for food, but also the coral reefs where these fish once lived for some or all of their lifecycles. Coral reefs have a complex relationship with the fish that live within them—each depends on the other. Reefs provide security and habitat for many species of fish, and in return, herbivorous fish control the abundant algae found in reef environments.⁴² Without adequate numbers of plant-eating fish, a reef can become overwhelmed by algae.⁴³

2. Destructive Fishing Practices

Because of the strong interdependence between coral reefs and the fish that inhabit them, any type of overfishing can threaten a reef. There are two types of fishing practices, however, that not only deplete fish stocks but also directly damage the reefs themselves—blast fishing and the use of cyanide. Blast fishing, used in nations

39. *Id.* at 505.

40. Richard Black, ‘Only 50 Years Left’ for Sea Fish, BBC NEWS, Nov. 2, 2006, <http://news.bbc.co.uk/2/hi/science/nature/6108414.stm>.

41. Davidson, *supra* note 6, at 505.

42. *Id.* at 505–06.

43. *Id.*

including the Philippines, Jamaica, and Micronesia, involves using dynamite to stun or kill fish via shock waves, and then collecting the fish as they float to the surface.⁴⁴ The fishermen get a “one-time bonanza” from this blasting, but the dynamite kills all marine life in the area, including sensitive corals, and leaves nothing to replenish fish stocks.⁴⁵

Another fishing technique, outlawed in many countries but employed nonetheless, is pouring cyanide into the water around reefs. This stuns tropical fish and allows for their capture for the growing ornamental aquarium fish market.⁴⁶ As with blast fishing, cyanide has a devastating impact on surrounding corals and other marine life.⁴⁷ Despite being illegal in many countries, cyanide fishing is spreading from regions such as Asia all the way to Africa.⁴⁸ Since the 1960s, more than one million kilograms of cyanide have been illegally used for fishing in the Philippines alone.⁴⁹

3. Pollution

Because tropical reefs only grow in warm water environments with abundant sunlight, these reefs are found in shallow waters along coastlines. Unfortunately for reefs, forty percent of the world's human population now also lives along coastlines.⁵⁰ Approximately eighty percent of all marine pollution now comes from land-based activities, including agricultural, municipal and industrial runoff; agricultural wastes; and atmospheric deposition.⁵¹ Coral reefs' close proximity to land renders them especially vulnerable to this land-based pollution.

Agricultural and industrial runoff carries herbicides and other chemicals that harm corals, in addition to excess nutrients that create algae and phytoplankton blooms that suffocate corals.⁵² Other types

44. *Id.*

45. *Id.*

46. *Id.*

47. Am. Univ. Washington Coll. of Law, *supra* note 8.

48. Davidson, *supra* note 6, at 506.

49. *Id.*

50. *See* Sylvan, *supra* note 2, at 33.

51. United Nations Env't Programme, Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities, <http://www.gpa.unep.org/> (last visited Apr. 10, 2009).

52. International Year of the Reef 2008, Status of and Threat to Coral Reefs, <http://www.iyor.org/reefs/status.asp> (last visited Mar. 22, 2009) [hereinafter Status of and Threat to Coral Reefs].

of land-based pollution, such as sewage, wreak havoc on coral reefs as well. In Indonesia, a country located at the center of the greatest known land and marine biodiversity on the planet, massive migration of the population from rural areas to coastal cities is taking its toll on the country's reefs.⁵³ Of all the pollution washing off the land and into the reef systems, untreated sewage is likely the worst. In Jakarta, the capital city, enough untreated sewage is released directly into the bay "to fill seventy-five Olympic-sized swimming pools . . . each day."⁵⁴ By 1993, one biologist had noted that all the coral reefs in Jakarta Bay were "functionally dead."⁵⁵

4. Irresponsible Tourism

Done the wrong way, tourism associated with coral reefs threatens the very reefs on which the industry depends. The global economics of reef-based tourism are significant—The Nature Conservancy estimates that the annual value of world tourism based on coral reefs is just under ten billion dollars.⁵⁶ Australia's Great Barrier Reef alone supports a \$4.2 billion tourism industry, with nearly two million tourists each year.⁵⁷

Irresponsible tourism threatens reefs in a variety of ways, from careless swimmers and divers damaging the reefs, to improperly placed boat anchors, to discharges of sewage and other wastewater from hotels and resorts.⁵⁸ The cruise ship industry is of particular concern for reefs, given the sheer magnitude of the business. Cruise ships regularly "disgorge" throngs of passengers onto coastal reef areas, with around two thousand cruise ship passengers diving in Cozumel, Mexico's reefs, in a given day.⁵⁹ Wastewater discharge from cruise ships is another concern for reefs.⁶⁰

53. Davidson, *supra* note 6, at 508–09.

54. *Id.*

55. *Id.*

56. Bonnie Tsui, *Saving Coral Reefs Becomes a Tourism Priority*, N.Y. TIMES, June 24, 2007, § 5, at 13, available at <http://travel.nytimes.com/2007/06/24/travel/24headsip.html?emc=eta1>.

57. *Id.*

58. Status of and Threat to Coral Reefs, *supra* note 52.

59. Tsui, *supra* note 56, at 13.

60. See Asia N. Wright, *Beyond the Sea and Spector: Reconciling Port and Flag State Control Over Cruise Ship Onboard Environmental Procedures and Policies*, 18 DUKE ENVTL. L. & POL'Y F. 215, 225 (2007) (discussing types of cruise ship waste, including sewage and gray water, which is "water collected from sinks, showers, galleys, and laundry").

5. Mining of Reefs

Mining of coral reefs also threatens the future of reef ecosystems. Particularly in East Africa, Southeast Asia, and the Pacific, coral reefs are mined for the great quantities of limestone (calcium carbonate) they contain.⁶¹ This limestone is often mixed with sand and made into cement.⁶² The limestone is also used to make calcium supplement pills, and more recently, researchers have used mined corals for bone graft clinical trials.⁶³

Corals are also mined to collect pieces of living and dead coral, which are used in aquariums, utilized as home decorations, or turned into jewelry.⁶⁴ As of 2002, Indonesia supplied ninety-five percent of the world's exported coral, while the United States was the world's top importer of coral, importing eighty-five percent of dead coral and ninety-eight percent of the live coral traded internationally.⁶⁵

6. Other Threats

In addition to those threats described above, coral reefs face an array of other challenges. These challenges include sedimentation associated with coastal development and deforestation, dredging of reefs to create deep-water channels and marinas, and coral disease.⁶⁶ The occurrence of coral disease has increased dramatically in the past ten years, likely due to a combination of the threats discussed above and those discussed in the next section below.⁶⁷ Also, invasive species that are discharged into reef areas from the ballasts of ships pose threats, especially when no predators or parasites for these introduced species exist in the host reef environment.⁶⁸

One particular native species, though not as invasive as other species also posing challenges, has increasingly been damaging reefs, most notably Australia's Great Barrier Reef. This animal, the crown-of-thorns starfish, is a voracious coral polyp eater.⁶⁹ Declines in predators of this spiny and toxic starfish due to overfishing and

61. Coral Reef Alliance, Mining and Harvesting, http://www.coral.org/resources/issue_briefs/mining_and_harvesting (last visited Feb. 20, 2009).

62. *Id.*

63. *Id.*

64. Davidson, *supra* note 6, at 534.

65. *Id.* at 534-35; *see also infra* Part IV.C.1 (discussing the international coral trade).

66. Status of and Threat to Coral Reefs, *supra* note 52.

67. *Id.*

68. *Id.*

69. *Id.*

pollution have led to population explosions of this starfish that can destroy “huge” areas of coral reef.⁷⁰

B. Reef Threats Caused by Anthropogenic Greenhouse Gas Emissions

1. Climate Change

Though coral reefs are under great threat because of the varied challenges described above, many scientists believe that human-induced climate change poses risks that are greater still.⁷¹ Tropical reefs have a discrete range of water temperatures in which they can survive.⁷² This makes increased water temperatures a giant threat for reefs.⁷³ When water temperature increases 1.8 to 3.6 degrees Fahrenheit above average maximum summer temperatures, coral polyps expel the zooxanthellae (unicellular algae) that live within them.⁷⁴ This expulsion is called “coral bleaching” because without zooxanthellae the reefs lose their characteristic color, and all that remains to the visible eye is the white calcium exoskeleton of the coral polyps.⁷⁵ Because the coral polyps need the symbiotic zooxanthellae to survive, a coral polyp will die if it does not take up another alga within a short period of time.⁷⁶

Mass coral bleachings, undocumented prior to 1979, have had profound effects on the landscapes of coral reefs over the past three decades. Mass bleaching events were recorded in 1982, 1987, and 1992.⁷⁷ The “strongest sea surface warming event ever recorded”⁷⁸ took place in 1998, when approximately sixteen percent of the world’s reefs were destroyed.⁷⁹ The 1998 event had particularly devastating impacts on reefs in certain parts of the world—in the western Indian Ocean, for instance, fifty percent of all corals were extremely

70. *Id.*

71. Davidson, *supra* note 6, at 507. Anthropogenic (human-induced) climate change is caused when greenhouse gases emitted from the burning of fossil fuels collect in the atmosphere “like a thickening blanket,” causing the planet to warm. Natural Res. Def. Council, Global Warming Basics, <http://www.nrdc.org/globalWarming/f101.asp> (last visited Mar. 22, 2009).

72. *See supra* note 35 and accompanying text.

73. Am. Univ. Washington Coll. of Law, *supra* note 8.

74. Eilperin, *supra* note 36.

75. *Id.*

76. *Id.*

77. Status of and Threat to Coral Reefs, *supra* note 52.

78. *Id.*

79. Davidson, *supra* note 6, at 507.

damaged or destroyed.⁸⁰ Unfortunately, warming events and coral bleachings have continued since 1998. In 2005, “sea surface temperatures were the highest reported in more than a hundred years, and there was . . . significant coral bleaching following this warming.”⁸¹ Even this past year, in 2008, coral bleachings were reported in numerous spots around the world.⁸² As one reef researcher in Belize states,

More than half of the corals of the Belize barrier reef are bleached white. They appear lifeless. Will they recover? It is a deeply troubling question, because it highlights the scary notion that we do not know what will happen next. . . . We humans now live on a strange planet whose atmosphere and ecology we no longer comprehend.⁸³

If scientists’ latest predictions on future ocean temperature increases prove true, the chance of survival for the world’s reefs is bleak. A recent study published in *Science* estimates that under the current rate of increase in global CO₂ emissions, reefs face “vastly reduced habitat complexity and loss of biodiversity.”⁸⁴ In the “worst case scenario” of future greenhouse gas emissions (upwards of five hundred parts per million (ppm)), “probably half, and possibly more, of coral-associated fauna [will] becom[e] rare or extinct.”⁸⁵ The researchers go on to say that “[w]hether or not one defines the transition from . . . 400 to 500 ppm as the tipping point for coral reefs, it is clear that coral reefs as we know them today would be extremely rare at higher [atmospheric CO₂ concentrations].”⁸⁶

In addition to warming events and the resulting coral bleaching, corals face other challenges in a changed climate. Sea level rise will likely affect the amount of sunlight reaching coral reefs, disrupting the reefs’ sensitive ecological balance.⁸⁷ Additionally, rapid rises in sea level, coupled with slowed calcification/reef growth,⁸⁸ could likely

80. Status of and Threat to Coral Reefs, *supra* note 52.

81. *Id.*

82. *Id.*

83. Eilperin, *supra* note 36 (quoting Wildlife Conservation Society senior conservationist Archie Carr III).

84. O. Hoegh-Guldberg et al., *Coral Reefs under Rapid Climate Change and Ocean Acidification*, 318 *SCIENCE* 1737, 1740 (2007).

85. *Id.* at 1741.

86. *Id.* This prediction considers not only increases in ocean temperature, but also impacts from ocean acidification, discussed in the next section below.

87. Duke Univ. Biology Dep’t, Coral Reefs & Sea Level Rise, <http://www.biology.duke.edu/bio217/2001/sealevel/page2.html> (last visited Mar. 22, 2009).

88. *See infra* Part III.B.2 and accompanying text (discussing ocean acidification).

lead to “drowned” reefs, whereby corals are unable to build reefs fast enough to keep pace with rising seas.⁸⁹

Scientists also predict that severe weather events like hurricanes will become stronger as our climate warms.⁹⁰ This bodes poorly for coral reefs, given that a single event like a hurricane can have devastating consequences for a reef. According to a dive captain in Belize, the hurricanes that have come through that country in recent years, such as Hurricane Mitch in 1998 and Hurricane Iris in 2001, have had just as devastating an impact on the reefs as the marked coral bleaching occurring in that country.⁹¹

2. Ocean Acidification

Another coral reef threat, only just now beginning to be understood by scientists, is ocean acidification. This phenomenon is related to climate change in that it, too, is caused by the unprecedented levels of carbon dioxide that humans are emitting into the atmosphere. Humanity currently releases nearly fifty billion tons of carbon dioxide into the atmosphere each year.⁹² The oceans act as a giant carbon sink, and have absorbed at least half of this anthropogenic CO₂ since 1750.⁹³ This absorption of CO₂ actually slows climate change, which is of course a good thing.⁹⁴ But when the CO₂ and water combine they form carbonic acid, which releases hydrogen ions.⁹⁵ These hydrogen ions have, so far, increased the acidity of the ocean surface water by approximately thirty percent.⁹⁶ As of 2007, the Intergovernmental Panel on Climate Change (IPCC) predicted that depending on future CO₂ emissions, ocean acidity could increase 150% by 2100.⁹⁷

89. Hoegh-Guldberg et al., *supra* note 84, at 1741.

90. John Schwartz, *Two Studies Link Global Warming to Greater Power of Hurricanes*, N.Y. TIMES, May 31, 2006, at A16, available at <http://www.nytimes.com/2006/05/31/science/31climate.html>.

91. Interview with a Ramon's Village Resort dive captain, in San Pedro, Ambergris Caye, Belize (Mar. 13, 2008).

92. See Jonathan Leake, *Ocean Acidification Threatens Underwater Ecosystems*, TIMES ONLINE (London), Feb. 23, 2008, <http://www.timesonline.co.uk/tol/news/uk/science/article3423465.ece>.

93. Crystal Davis, World Res. Inst., *September 2007 Monthly Update: Ocean Acidification, the Other Threat of Rising CO₂ Emissions*, EARTHTRENDS ENVIRONMENTAL INFORMATION, Oct. 2, 2007, <http://earthtrends.wri.org/updates/node/245>.

94. Leake, *supra* note 92.

95. Davis, *supra* note 93.

96. *Id.*

97. *Id.*

Scientists report that the average human would not actually be able to detect a 150% increase in ocean acidity, as is predicted by the IPCC.⁹⁸ But a number of marine organisms, corals included, are especially threatened by even small changes in ocean acidity because they cannot build their calcium carbonate exoskeletons in environments with raised pH (acid) levels.⁹⁹ Already, scientists at the Great Barrier Reef in Australia have found that calcification—the process through which corals build their exoskeletons—has slowed more than twenty percent in just the last sixteen years.¹⁰⁰

Another alarming challenge for corals in more acidic oceans is that their existing calcium carbonate exoskeletons will simply dissolve if the pH level becomes too great.¹⁰¹ This dissolving of reefs would of course have significant adverse consequences for the many other species that depend on reefs for habitat and food.¹⁰² Many of the scientists who now study ocean acidification worry that this phenomenon might be far more destructive to reefs in the near term than even climate change.¹⁰³

IV. INTERNATIONAL APPROACHES TO CORAL REEF CONSERVATION

The impressive worldwide economic value, untold medical benefits, and (as many assert) inherent worth of the world's coral reefs create strong arguments for conserving these threatened living structures. As discussed above, some reef threats, including sedimentation and destructive fishing practices, are localized within particular nations. Yet other coral reef challenges, such as climate change, ocean acidification, and international trade in coral products, are global in nature. How, then, should international environmental law address the complex and varied threats that reefs face? This section examines three existing and emerging approaches to international reef conservation by describing international treaties and other efforts for each approach; the reef threats addressed by each approach; the weaknesses of each approach; and, where appropriate, recommendations for improvement.

98. *Id.*

99. *Id.*

100. Leake, *supra* note 92.

101. Davis, *supra* note 93.

102. *Id.*

103. Leake, *supra* note 92.

A. *Approach 1: Special Protection Status for Coral Reefs*

This approach to international coral reef protection regulates the activities permitted on or around reefs by affording reef areas special protection status. The World Heritage Convention and the Convention on Biological Diversity are two existing international treaties that employ this approach.

1. World Heritage Convention

The United Nations Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention) was adopted in 1972.¹⁰⁴ This Convention endeavors, among other things, to

encourage States . . . to establish management plans and set up reporting systems on the state of conservation of their World Heritage sites; help States . . . safeguard World Heritage properties by providing technical assistance and professional training; provide emergency assistance for World Heritage sites in immediate danger; [and] . . . encourage international cooperation in the conservation of our world's cultural and natural heritage.¹⁰⁵

Currently, 186 nations, including the United States, are parties to the World Heritage Convention, and 878 cultural and natural sites are now on the World Heritage List.¹⁰⁶ Among these World Heritage Sites are the Great Barrier Reef in Australia, Belize's Barrier Reef, and Tubbataha Reef Marine Park in the Philippines,¹⁰⁷ as well as at least eight other sites that contain coral reefs.¹⁰⁸ The World Heritage Convention requires each member state to "do all it can" to protect and conserve its listed sites for future generations.¹⁰⁹ Once a site is added to the World Heritage List it becomes the duty of the international community, not just the host country, to protect the site.¹¹⁰

104. Convention Concerning the Protection of the World Cultural and Natural Heritage, Nov. 16, 1972, 27 U.S.T. 37, 1037 U.N.T.S. 151, available at <http://whc.unesco.org/archive/convention-en.pdf>.

105. World Heritage Centre, United Nations Educ., Scientific, and Cultural Org. [UNESCO], World Heritage, <http://whc.unesco.org/en/about/> (last visited Mar. 22, 2009).

106. World Heritage Centre, UNESCO, World Heritage List, <http://whc.unesco.org/en/list> (last visited May 3, 2009).

107. *Id.*

108. Davidson, *supra* note 6, at 537.

109. Lucy Wiggins, *Existing Legal Mechanisms to Address Oceanic Impacts from Climate Change*, 7 SUSTAINABLE DEV. L. & POL'Y 22, 22 (2007).

110. *Id.* at 23.

When a coral reef is included, in whole or in part, in a World Heritage Site, the threats to that reef—including pollution, overfishing, destructive fishing practices, and irresponsible tourism—can theoretically be better addressed by local government officials, thanks to the technical and financial assistance that comes with the World Heritage designation.¹¹¹ Though the assistance available through the World Heritage Committee is actually quite limited,¹¹² World Heritage Sites often end up receiving additional funds through other means. For example, international organizations often give these listed sites priority when making grants or providing other types of technical assistance.¹¹³ Additionally, national governments and national organizations often place greater focus on funding listed sites within their jurisdictions.¹¹⁴

In addition to addressing *local* threats that imperil listed coral reefs, some hope that the World Heritage Convention can be leveraged to address *global* threats to listed reefs. World Heritage Sites may be designated as “in danger” when listing alone has not adequately slowed or stopped the destruction of a site.¹¹⁵ For example, the Everglades National Park in the United States has been listed as “in danger” under the Convention since 1993.¹¹⁶ This “in danger” status increases the amount of international funding and international attention that a site receives.¹¹⁷ Scientists and non-governmental organizations recently attempted to use the Convention’s “in danger” listing status to highlight damage that Belize’s Barrier Reef is experiencing because of climate change. In 2004, the Belize Institute of Environmental Law and Policy, Friends of the Earth International, the Climate Justice Programme, and Greenpeace together petitioned the World Heritage Committee to list the Belize Barrier Reef as “in danger” because of climate change impacts that have damaged more than forty percent of the Belize reef since 1998.¹¹⁸ Specifically, these groups asked the Committee to

111. Davidson, *supra* note 6, at 537.

112. George Wright Soc’y, The World Heritage Convention: What’s It All About?, <http://www.georgewright.org/whc.html#Anchor-What-47857> (last visited Mar. 22, 2009).

113. *Id.*

114. *Id.*

115. Wiggins, *supra* note 109, at 23.

116. Davidson, *supra* note 6, at 538.

117. Wiggins, *supra* note 109, at 23.

118. Roger Harrabin, *Reef at Forefront of CO₂ Battle*, BBC NEWS, June 12, 2006, <http://news.bbc.co.uk/2/hi/science/nature/5064870.stm>; *see also* Press Release, Climate Justice

send a mission of qualified observers to visit [the Belize reef and four other listed sites, including the Great Barrier Reef in Australia] to evaluate the nature and extent of the threat [of climate change] and to propose measures that could be taken to mitigate the threat; and recognize that countries that have signed the World Heritage Convention must significantly cut their greenhouse gas emissions as part of their duty to protect and transmit World Heritage Sites to future generations.¹¹⁹

Despite having published a survey documenting the “enormous” threats that climate change poses to listed reefs and other listed sites all over the globe, the World Heritage Committee in June 2006 denied granting “in danger” status for the Belize reef and four other sites that were put before the commission as needing “in danger” status due to climate change.¹²⁰ The Committee instead endorsed a “weak” climate change strategy document, which advocates say focuses on the impacts, rather than the causes, of climate change.¹²¹ Perhaps in reaching its determination the Committee succumbed to opponents of the “in danger” listing proposal, namely the United States, which argued, among other things, that “accepting the [‘in danger’ listing] petition on a controversial issue such as climate change would spoil the harmonious relations of the World Heritage Committee.”¹²²

Given the disappointing results of the recent World Heritage Committee decision, it is unclear whether the World Heritage Convention will ever serve as an instrument by which listed reefs can be protected from global threats such as climate change. However, this Convention does at least currently provide financial assistance (both directly and indirectly) to listed sites, and this assistance likely helps managers protect listed reefs from local threats.¹²³ Obvious recommendations for improving this Convention would be: (1) recognizing climate change and ocean acidification as threats sufficient to give listed reefs “in danger” status, thus requiring Convention parties, including the United States, to address their greenhouse gas emissions; and (2) listing more of the world’s reefs under this Convention.

Programme, World Heritage Committee Fails to Act (July 20, 2006), <http://www.climatelaw.org/media/2006Jul20/>.

119. Press Release, Climate Justice Programme, *supra* note 118.

120. *Id.*

121. *Id.*

122. Harrabin, *supra* note 118.

123. *See supra* notes 111–14 and accompanying text.

2. Convention on Biological Diversity

The Convention on Biological Diversity (CBD) was adopted in 1992 and serves as the primary international agreement governing biodiversity issues.¹²⁴ CBD focuses on “conservation of biological diversity, sustainable use of its components, and a fair and equitable sharing of the benefits of genetic resources.”¹²⁵ There are currently 191 parties to the CBD.¹²⁶ The United States, one of only several nations that have not joined the Convention, has cited concerns regarding intellectual property rights, finance provisions, and technology transfer under the CBD.¹²⁷

The CBD directs member states to implement conservation strategies for biodiversity and to create systems of protected areas to support biodiversity.¹²⁸ The CBD explicitly includes “marine and other aquatic ecosystems and the ecological complexes of which they are a part” in its definition of biological diversity to be conserved under the Convention.¹²⁹

As some of the most biologically diverse ecosystems on the planet, coral reefs are particularly well-suited for protection under the CBD. Unfortunately, as the CBD Secretariat has acknowledged, areas that protect reefs and other biologically rich marine environments are still “under represented” under the CBD.¹³⁰ The CBD Secretariat has, however, worked to implement marine protected areas (MPAs) as a means by which to protect coral reefs.¹³¹ At the seventh meeting of the CBD Conference of the Parties (CoP) in 2004, the Parties agreed that “marine protected areas are one of the essential tools and approaches in the conservation and sustainable use of biodiversity.”¹³² The Parties also adopted a target of establishing “comprehensive, effectively managed, ecologically

124. Convention on Biological Diversity, June 5, 1992, 1760 U.N.T.S. 79, available at <http://www.cbd.int/doc/legal/cbd-un-en.pdf>; see also Davidson, *supra* note 6, at 530.

125. BUREAU OF OCEANS & INT’L ENVTL. & SCIENTIFIC AFFAIRS, U.S. DEP’T OF STATE, BIODIVERSITY AND THE CONVENTION ON BIODIVERSITY (Jan. 5, 1999), http://www.state.gov/www/global/oes/fs-biodiversity_990105.html.

126. Convention on Biological Diversity, List of Parties, <http://www.cbd.int/convention/parties/list.shtml> (last visited May 3, 2009).

127. Davidson, *supra* note 6, at 532.

128. Wiggins, *supra* note 109, at 24.

129. Convention on Biological Diversity, *supra* note 124, art. 2.

130. Wiggins, *supra* note 109, at 24.

131. Marjo Vierros, Secretariat, Convention on Biological Diversity, Presentation at the 2005 International Coral Reef Initiative General Meeting: MPAs and CBD (Nov. 2, 2005), available at www.icriforum.org/secretariat/mpa/CBD_goal_MPAs.ppt.

132. *Id.*

representative national and regional systems of MPAs” by 2012.¹³³ The Parties noted that “full participation of . . . local communities and relevant stakeholders is important for achieving the global goal [of establishing national and regional MPA systems by 2012].”¹³⁴

The national systems of MPAs envisioned by the CBD CoP contain three components: (1) “[a]reas managed for sustainable use, which may allow extractive uses;” (2) “[a]reas where extractive uses are excluded and other significant human pressures [are] minimized” (known as “no-take” zones); and (3) “[s]ustainable management over the wider marine and coastal environment.”¹³⁵

The CBD Parties acknowledge that individual MPAs are not enough to adequately protect biodiversity within those MPAs, and this is why they see an MPA network approach as “essential.”¹³⁶ The CBD Parties have also taken up the issue of how coral bleaching relates to the establishment of MPAs, creating a “Work Plan on Coral Bleaching” that includes some “high priority actions.”¹³⁷ These actions include identifying “coral reef areas that exhibit resistance and/or resilience to raised sea temperatures” and “integrat[ing] bleaching resilience principles into MPA network design” and “reduc[ing] other localized stresses (water quality, overfishing, etc.).”¹³⁸

While these efforts by the CBD Parties are encouraging, one major weakness of any effort undertaken through the CBD is that the CBD contains no enforcement mechanism, leaving compliance largely to “informed self-interest [of the Parties] and peer pressure from other countries and from public opinion.”¹³⁹ Also, though the marine protected areas conceived and created under the CBD will likely address coral reef threats such as overfishing and destructive fishing practices, these protected areas will not be adequate to address land-based reef threats like sedimentation, climate change, and ocean acidification. Therefore, one obvious recommendation is that the CBD should broadly examine the challenges that coral reefs face, and should implement measures to address land-based coral reef threats. These land-based pollution initiatives ought to be

133. *Id.*

134. *Id.*

135. *Id.*

136. *Id.*

137. *Id.*

138. *Id.*

139. Davidson, *supra* note 6, at 531.

coordinated with existing CBD efforts to establish MPAs. Further, adding an enforcement mechanism to the CBD would likely ensure stronger compliance with the 2012 MPA network target. Finally, the United States, a nation with coral reefs, should join the CBD to help ensure a truly global effort to protect reefs under this Convention.

B. Approach 2: Regional Reef Protection Agreements and Regional Coordination

An approach involving regional reef protection agreements and regional coordination is a way to ensure broader reef protection than can be afforded at the national level, while still tailoring solutions to the particular threats that reefs face in a given part of the world. Like the MPA network currently being created under the CBD, these regional efforts utilize information sharing and other techniques to maximize the effectiveness of their conservation endeavors. The North American Marine Protected Areas Network and the Coral Triangle Regional Agreement are two existing international efforts that employ a regional approach.

1. North American Marine Protected Areas Network

The North American Marine Protected Areas Network (NAMPAN) is an effort by the United States, Canada, and Mexico to coordinate the management of these nations' MPAs. At a meeting in August of 2007, President Bush, Canadian Prime Minister Harper, and Mexican President Calderon identified this collaborative effort as a "key accomplishment" for North America, and issued a statement declaring: "To improve the ecological health of our shared marine resources, our governments continue to expand [NAMPAN]. The Network will use our countries' marine protected areas in the development of a tri-national MPA-based monitoring program stretching from Baja to the Bering Strait."¹⁴⁰ The stated goal of NAMPAN is to "work with a tri-national, multi-sectoral group of stakeholders in establishing an effective system of North American MPA networks that enhances and strengthens the protection of marine biodiversity."¹⁴¹

NAMPAN seems to be the very sort of regional MPA coordination that the CBD CoP has identified as "essential" to

140. National Marine Protected Areas Center, International Marine Protected Area Efforts, http://mpa.gov/helpful_resources/international_pr.html (last visited Mar. 22, 2009).

141. *Id.*

conservation of biodiversity.¹⁴² Specifically, NAMPAN aims to “[b]uild regional, national, and international capacity to manage, conserve, and monitor the status of critical marine and coastal habitats by sharing effective conservation approaches, lessons learned, . . . [and by] increasing access to and synthesis of relevant information.”¹⁴³

The concept of sharing “relevant information” between the three NAMPAN nations is a concept likely derived from the United States’ domestic system of MPA information sharing. In 2000, President Clinton signed Executive Order 13,158, which brought the more than 1500 protected marine areas in the United States under one national system, placing primary responsibility of this system under the Department of the Interior and the Department of Commerce.¹⁴⁴ Creating this coordinated MPA system was a daunting task, as the U.S. MPAs before the Executive Order had differing definitions and had been created by different levels of government—local, tribal, territorial, state, and federal.¹⁴⁵ Clinton’s Executive Order broadly defined MPAs to include MPAs designated by all levels of government, and required the relevant federal agencies to develop a national MPA web site to promote information sharing.¹⁴⁶ Further, the Executive Order created an MPA Federal Advisory Committee “to provide expert advice on and recommendations for the national system of MPAs,” and a National MPA Center that is charged with “provid[ing] Federal, State, territorial, tribal, and local governments with the information, technologies, and strategies to support the [national MPA] system.”¹⁴⁷ Not only are the relevant agencies charged with supporting this national MPA network, but they are also directed to identify opportunities for improving existing MPAs and recommending creation of additional MPAs.¹⁴⁸

The tri-national NAMPAN initiative offers great promise for helping protect reefs in North America. To maximize its effectiveness, NAMPAN should borrow more concepts of coordinated MPA management from the United States’ national

142. See *supra* notes 131–38 and accompanying text (discussing CBD’s MPA initiative and target).

143. National Marine Protected Areas Center, *supra* note 140.

144. Exec. Order No. 13,158, 65 Fed. Reg. 34,909 (May 26, 2000).

145. Davidson, *supra* note 6, at 517.

146. *Id.*

147. *Id.* at 517–18.

148. *Id.* at 517.

network of MPAs. Also, though MPAs can address localized reef threats like overfishing, these protected marine areas are incapable of fully protecting North American reefs from the global threats of climate change and ocean acidification. If the United States is serious about protecting its marine areas, including coral reefs, then it should take responsibility for its contribution to climate change and join international efforts to curb CO₂ emissions.

2. Coral Triangle Regional Agreement

The “Coral Triangle” is a 2.3 million square mile area in the Indo-Pacific Ocean that boasts the highest biodiversity of any reef system on the planet.¹⁴⁹ Between 500 to 600 reef-building coral species live here, compared to 350 such species in Australia’s Great Barrier Reef, and just 70 such species in Belize’s Barrier Reef.¹⁵⁰ Unfortunately, the reefs of the Coral Triangle face all the threats discussed above in Part III, including coral bleachings that hit these reefs hard, particularly in 1997 and 1998.¹⁵¹ Also, destructive fishing practices, such as the use of dynamite, are “quite prevalent” in the area, damaging corals all the more.¹⁵² And perhaps worst of all for the area’s reefs is the concentrated human population—approximately 150 million people live in the Triangle area, producing large amounts of pollution that further limit the ability of corals to persist.¹⁵³

Yet it is not all bad news for the reefs of the Coral Triangle. In December 2007, top officials from the six Coral Triangle nations (Indonesia, Malaysia, Papua New Guinea, the Philippines, the Solomon Islands, and Timor-Leste) agreed to create an action plan to manage the Triangle sustainably.¹⁵⁴ These countries finalized this plan in October 2008, and formally adopted it in May 2009, at the World Ocean Conference in Indonesia.¹⁵⁵ Numerous entities, including the World Bank and the Asian Development Bank, have offered to help

149. Peter N. Spotts, *Can the Crown Jewel of World’s Coral Reefs Be Saved?*, CHRISTIAN SCI. MONITOR, Jan. 24, 2008, at 13.

150. *Id.*

151. *Id.*

152. *Id.* at 13, 16.

153. *Id.* at 16.

154. *Id.*

155. Lis Stedman, ‘Coral Triangle’ Countries Meet to Finalise Action Plan, WATER21, Oct. 28, 2008, <http://www.iwapublishing.com/template.cfm?name=news205>; Elshinta Marsden, *CTI Summit*, WORLD OCEAN CONFERENCE 2009, May 17, 2009, http://www.woc2009.org/show_news.php?Berita_Id=32.

these six nations pay for their planning efforts.¹⁵⁶ The United States also pledged nearly \$40 million to the project.¹⁵⁷

It is too early to evaluate the strengths and weaknesses of this Coral Triangle regional agreement, yet the mere existence of this planning effort offers great hope for the region's coral reefs. But while this agreement might well reduce local threats to the Triangle's reefs, there is arguably little that these six Triangle nations can do about climate change and ocean acidification. Hopefully, by at least highlighting the impacts that these global challenges pose to their reefs, the Coral Triangle nations can add their voices to the international chorus calling for CO₂ emissions reductions by the largest emitting nations, including the United States.

C. Approach 3: Protection of Individual Reef Species

Unlike the previous two approaches, which focus on protecting coral reefs as a whole, this approach focuses on conservation of individual species within coral reef ecosystems. Some countries implement this method at the national level. The United States, for example, has an Endangered Species Act¹⁵⁸ designed “to protect and recover imperiled [plant and animal] species and the ecosystems upon which they depend.”¹⁵⁹ At the international level, protection of individual threatened species has focused on restricting international trade in these species.¹⁶⁰ The Convention on International Trade in Endangered Species is the primary international agreement in this arena.¹⁶¹

156. Press Release, Embassy of the United States, USAID and Partners Support Coral Triangle Initiative to Protect Six Nations' Marine and Coastal Ecosystems (Oct. 23, 2008), available at http://jakarta.usembassy.gov/press_rel/Oct08/USAID-CTI.html.

157. *Id.*

158. Endangered Species Act of 1973, 16 U.S.C. §§ 1531–44 (2006).

159. U.S. FISH & WILDLIFE SERV., ESA BASICS: MORE THAN 30 YEARS OF CONSERVING ENDANGERED SPECIES (2009), available at http://www.fws.gov/endangered/factsheets/ESA_basics.pdf (last visited May 3, 2009).

160. DAVID HUNTER, JAMES SALZMAN & DURWOOD ZAEKE, INTERNATIONAL ENVIRONMENTAL LAW AND POLICY 1003 (3d ed. 2007) (noting that while the “protection of wildlife has historically been considered a matter of domestic law . . . [i]nternational cooperation has also proven necessary to respond to international economic activities—most notably the growing international trade in wildlife and plants”).

161. See Joel Heinen, *Convention on International Trade in Endangered Species of Flora and Fauna*, THE ENCYCLOPEDIA OF EARTH, [http://www.eoearth.org/article/Convention_on_International_Trade_in_Endangered_Species_of_Wild_Fauna_and_Flora_\(CITES\)](http://www.eoearth.org/article/Convention_on_International_Trade_in_Endangered_Species_of_Wild_Fauna_and_Flora_(CITES)) (last visited Mar. 22, 2009).

1. The Convention on International Trade in Endangered Species

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) was created in 1973, in response to growing concern that international trade in wild animals and plants was threatening the survival of some species.¹⁶² Originally signed by 80 countries, the first of which was the United States,¹⁶³ today CITES has grown to include 175 member nations.¹⁶⁴ The main purpose of CITES is to provide varying levels of trade protection for the species listed within its three appendices.¹⁶⁵ CITES forbids the trade of endangered species listed on Appendix I, except in extraordinary circumstances.¹⁶⁶ Trade of species listed on CITES Appendix II and Appendix III is allowed, but is subject to a permit system that allows states to monitor and even limit exports and imports, if deemed necessary.¹⁶⁷ Exporting countries of Appendix II-listed species must assess and monitor the exports, and also must manage those species such that trade is not “detrimental” to the survival of the species.¹⁶⁸ As of 2002, there were 230 species of coral listed in CITES Appendices II and III.¹⁶⁹ This includes all reef-building corals, black corals, blue corals, and antler corals.¹⁷⁰ However, many non-reef-building coral species and most reef-dwelling fish species are not covered under CITES.¹⁷¹

Though CITES can be an effective tool in ameliorating certain coral reef threats like mining for coral, critics point out that enforcement of CITES’ provisions is not always successful.¹⁷² For example, coral taken from countries where collection is illegal (the

162. Convention on International Trade in Endangered Species of Wild Fauna and Flora, Mar. 3, 1973, 27 U.S.T. 1087, 1976 U.N.T.S. 244 [hereinafter CITES]; *see also* Heinen, *supra* note 161.

163. Davidson, *supra* note 6, at 534.

164. Convention on Int’l Trade in Endangered Species of Wild Fauna and Flora, What is CITES?, www.cites.org/eng/disc/what.shtml (last visited May 3, 2009).

165. Convention on Int’l Trade in Endangered Species of Wild Fauna and Flora, How CITES Works, <http://www.cites.org/eng/disc/how.shtml> (last visited May 3, 2009).

166. CITES, *supra* note 162, art. III; *see also* Davidson, *supra* note 6, at 535.

167. CITES, *supra* note 162, arts. IV, V; *see also* Davidson, *supra* note 6, at 535.

168. CITES, *supra* note 162, art. IV; *see also* Coral Reef Alliance, *supra* note 61.

169. Davidson, *supra* note 6, at 535.

170. *Id.*

171. *See, e.g.*, Barbara Best & Alan Bornbusch, *Overview, in* GLOBAL TRADE AND CONSUMER CHOICES: CORAL REEFS IN CRISIS 2 (Barbara Best & Alan Bornbusch eds., 2001), available at http://www.aaas.org/international/africa/coralreefs/Coral_Reefs.pdf.

172. Davidson, *supra* note 6, at 536.

Philippines, for example) is often exported with the false impression of having been collected in a country where collection is legal.¹⁷³ Also, CITES has long struggled with inadequate enforcement because of “look-alike” concerns between listed and non-listed species, making it difficult for enforcement officers to determine whether shipments of certain species are permissible.¹⁷⁴

Another obstacle to protecting coral reefs under CITES is getting reef species listed on the CITES appendices in the first place. The challenge of the CITES listing process was highlighted at the most recent CITES CoP in 2007. At this CoP, the United States proposed listing all red and pink corals, which comprise about thirty species found around the world,¹⁷⁵ under CITES Appendix II.¹⁷⁶ Red and pink corals have been used for thousands of years to create valuable jewelry and ornaments, among other things.¹⁷⁷ Some necklaces made from red and pink corals can cost as much as \$25,000.¹⁷⁸ Over the last 200 years, exploitation of Mediterranean stocks of these corals has caused a two-thirds decline in their populations.¹⁷⁹ Because the strongest concentration of red and pink coral jewelry artists and traders is located in Italy, is not surprising that the United States’ Appendix II listing proposal “provok[ed] the ire of a group of Armani-clad [Italian] families steeped in a long tradition of artisanal jewelry.”¹⁸⁰ Unfortunately, the red and pink coral listing proposal ultimately failed, probably due in large part to these Italian artisans who have a strong lobby within the CITES CoP and who expressed livelihood concerns for those in their trade.¹⁸¹ The

173. *Id.*

174. *See id.* (discussing coral traders’ claims that the corals they shipped were “live rock,” which until 2000 was not listed under CITES, rather than CITES-listed “hard coral”).

175. Press Release, Int’l Union for Conservation of Nature, CITES Conference to Impact Food, Music, Food, and Jewelry Industry (June 1, 2007), *available at* <http://cms.iucn.org/what/species/wildlife/index.cfm?uNewsID=92>.

176. *See* Conference of the Parties to CITES, Fourteenth Meeting, June 3–15, 2007, *Consideration of Proposals for Amendment of Appendices I and II*, *available at* <http://www.cites.org/eng/cop/14/prop/E14-P21.pdf>; *CITES CoP14 Highlights*, EARTH NEGOTIATIONS BULL. (Int’l Inst. for Sustainable Dev., New York, N.Y.), June 12, 2007, at 1, *available at* <http://www.iisd.ca/download/pdf/enb2157e.pdf>.

177. Press Release, Int’l Union for Conservation of Nature, *supra* note 175.

178. *Id.*

179. *Id.*

180. *See CITES CoP14 Highlights*, EARTH NEGOTIATIONS BULL. (Int’l Inst. for Sustainable Dev., New York, N.Y.), June 8, 2007, at 2, *available at* <http://www.iisd.ca/download/pdf/enb2155e.pdf>.

181. *See id.*

failure of the red and pink coral listing proposal highlights that human livelihood concerns are increasingly becoming as much a part of the CITES CoP discussions as the scientific data supporting species listing.¹⁸² These livelihood considerations are noted by both developed countries (e.g., the concerns of Italian craftspeople that were so influential in the red and pink coral debate), as well as developing countries.¹⁸³ If these livelihood considerations continue to gain prominence at these discussions, it will no longer be adequate for coral advocates to make arguments for coral species listing based on species population and trade data alone. Advocates will also need to demonstrate how protection of coral species will not be detrimental to human livelihoods.

Because CITES focuses on regulating trade of discrete species, it is simply not designed to fully protect entire ecosystems like coral reefs. However, two principal changes to CITES could help this Convention do more to protect coral species and thus, indirectly, the ecosystems of which these species are a part. First, under CITES when species are listed in Appendices II and III, the burden is on the exporting country to ensure that trade in a listed species is sustainable and will not threaten the species or its ecosystem.¹⁸⁴ This helps explain why the United States, which bans the collection and export of coral from its own reefs, is the world's top importer of live and dead coral,¹⁸⁵ allowing coral imports from other countries like Indonesia where reefs are also threatened.¹⁸⁶ Some advocates suggest that importing countries, such as the United States, "must share some of the responsibility [for regulating these CITES-listed species], whether through cooperative bilateral and multilateral efforts or regulatory actions."¹⁸⁷ Second, human livelihood concerns, though of course themselves critical, should not be allowed to drown out scientific reasons for listing a species under CITES. The CITES CoP should be careful to not let the "livelihood concerns" movement

182. See *Summary of the Fourteenth Conference of the Parties to the Convention on International Trade in Endangered Species of Wild Fauna and Flora*, EARTH NEGOTIATIONS BULL. (Int'l Inst. for Sustainable Dev., New York, N.Y.), June 18, 2007, at 6, available at <http://www.iisd.ca/download/pdf/enb2161e.pdf> (discussing the new "CITES and Livelihoods" initiative discussed at the CoP14 meetings).

183. *Id.*

184. See Best & Bornbusch, *supra* note 171, at 2.

185. Davidson, *supra* note 6, at 544.

186. See *id.* at 536.

187. Best & Bornbusch, *supra* note 171, at 2.

unravel altogether the purpose of CITES, which is to protect species from overexploitation through international trade.

V. TOWARD A FUTURE WHERE REEFS REMAIN—A CALL FOR AN INTERNATIONAL CORAL REEF CONSERVATION TREATY

The three international reef conservation approaches discussed in the preceding section are all important in the overall equation of conserving coral reefs, but they are not the only types of international efforts being employed. Two other notable approaches are (1) efforts to address land-based marine pollution affecting coral reefs;¹⁸⁸ and (2) efforts to educate the public about threats to coral reefs, and how our choices as consumers can impact the survival of reefs.¹⁸⁹

The great challenge of reef conservation is that no international regime on its own can fully address the challenges reefs face, given that so many of these threats are local in nature and require local solutions and enforcement. On the other hand, an international solution to coral reef conservation is absolutely vital, given that two of the biggest threats facing reefs—climate change and ocean acidification—are global in nature and cannot be “fixed” by any one nation alone. How then should we move forward?

Quite simply, we need all the approaches so far discussed in this note and more—much more—to protect the world’s remaining reefs. Countries with reefs in their coastal waters must recognize, even more than most do currently, the essential role that coral reefs serve in providing food, income, and protection from severe weather events. And based on this recognition, these reef nations need to step up and

188. The efforts undertaken by the U.N. Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities are an example. See United Nations Env’t Programme, *supra* note 51. Another example is the World Bank’s Guidelines for Coastal Zone Management, which stem from a recommendation from the 1992 U.N. Conference on Environment and Development in Rio de Janeiro that “[g]uidelines on Integrated Coastal Zone Management (ICZM) be drafted to minimize conflicts and to provide for optimal sustainable resource use.” Ismail Serageldin, *Foreword*, in GUIDELINES FOR INTEGRATED COASTAL ZONE MANAGEMENT, at v (Jan C. Post & Carl G. Lundin, eds. 1996), available at http://www-wds.worldbank.org/external/default/WDSPContentServer/WDSP/IB/1996/08/01/000009265_3961219091924/Rendered/PDF/multi_page.pdf.

189. For example, the “Too Precious to Wear” campaign, created by the non-profit group SeaWeb, aims to “empower consumers and industry professionals to create a demand for coral conservation” by raising awareness of alternatives to coral products that have been harvested unsustainably. Too Precious to Wear, <http://www.tooprecioustowear.org> (last visited Mar. 7, 2009). Also, the International Coral Reef Initiative’s “International Year of the Reef 2008,” discussed earlier, is “a worldwide campaign to raise awareness about the value and importance of coral reefs and threats to their sustainability, and to motivate people to take action to protect them.” International Year of the Reef, *supra* note 4.

do all they can to prioritize reef conservation at the national and local level. But these coral reef nations cannot do it alone.

To complement national reef conservation efforts, more must be done at the international level to conserve the world's remaining reefs. Namely, this includes development of an international treaty wholly devoted to coral reef conservation. Some might argue that a separate treaty on coral reefs is unnecessary, citing the existing international efforts that in some way involve reef conservation, such as the World Heritage Convention, the Convention on Biological Diversity, and the Convention on Trade in Endangered Species.¹⁹⁰ However, a coral reef-specific treaty is very much needed because, as this note demonstrates, these existing international legal instruments are not slowing the frantic pace at which we are losing healthy coral reefs around the world.

An international coral reef treaty could be based on Agenda 21 of the 1992 United Nations Earth Summit in Rio de Janeiro.¹⁹¹ Chapter 17 of Agenda 21 “gives the protection of coral reefs a high priority and calls for an integrated, international approach for their protection and use.”¹⁹² Chapter 17 led to creation of the International Coral Reef Initiative (ICRI) in 1994.¹⁹³ The ICRI is “an informal and voluntary partnership”¹⁹⁴ that aims to stop and reverse the global degradation of coral reefs.¹⁹⁵ The ICRI has “provided advice to the international community on a wide range of coral-reef related issues, including marine protected areas; destructive fishing; . . . [and] trade in coral reef species.”¹⁹⁶ While the work of the ICRI is of course important, as an informal and voluntary endeavor the ICRI lacks any real teeth for changing nations' behaviors. More ought to be done in light of the high priority placed on coral reefs in Agenda 21.

190. See *supra* Part IV for a discussion of these international agreements.

191. UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT, AGENDA 21, U.N. Doc. A/CONF.151/4 (1992), available at <http://www.un.org/esa/sustdev/documents/agenda21/english/Agenda21.pdf>.

192. Davidson, *supra* note 6, at 529.

193. *Id.*

194. International Coral Reef Initiative, How Does ICRI Work?, http://www.icriforum.org/secretariat/how_icri.html (last visited Feb. 11, 2009).

195. See U.S. DEP'T OF STATE, HISTORY OF THE DEPARTMENT OF STATE DURING THE CLINTON PRESIDENCY, GLOBAL ISSUES II (2001), <http://www.state.gov/r/pa/ho/pubs/8524.htm>.

196. INT'L CORAL REEF INITIATIVE, http://www.icriforum.org/secretariat/pdf/ICRI_Brochure.pdf (last visited Mar. 7, 2009).

To bring something new and valuable to the fight to save coral reefs, an international coral reef treaty, whatever form it ultimately takes, must contain the following three provisions.

1. Adequate Funding

Lack of funding is a common theme in current reef conservation efforts. It is reflected by coral reef nations who want to do more to protect their reefs, but lack the resources. It is also demonstrated by existing international agreements, like the World Heritage Convention, that do not provide adequate resources to protect these ecosystems.¹⁹⁷

A successful coral reef treaty must contain innovative provisions for adequately funding reef conservation efforts. An example of such an innovative funding provision is a “debt-for-nature” agreement, by which developed nations such as the United States could purchase a portion of the commercial debt of a country that has coral reefs, “in exchange for that country designating [coral reef] territory to be free from development or using the additional funds for environmental education or for the improvement of land management.”¹⁹⁸ Such a “debt-for-nature” scheme could be modeled off the U.S. Tropical Forest Conservation Act,¹⁹⁹ reauthorized in 2001, which “allows other countries to apply debt payments to projects aimed at saving tropical forests.”²⁰⁰

2. Enforcement Mechanism

Many of the international agreements currently promoting reef conservation do not contain enforcement mechanisms, and compliance with these agreements relies on the “informed self-interest” of countries, as well as “peer pressure” from other nations.²⁰¹

197. See *supra* note 112 and accompanying text (discussing the limited funds available through the World Heritage Convention).

198. Davidson, *supra* note 6, at 534.

199. Tropical Forest Conservation Act of 1998, 22 U.S.C. § 2431 (2006).

200. ALYSSONDR A CAMPAIGNE ET AL., NATURAL RES. DEF. COUNCIL, HOLDING THE LINE: THE ENVIRONMENTAL RECORD OF THE 107TH CONGRESS 34 (2002), available at <http://www.nrdc.org/legislation/107Congress/107Congress.pdf>. Note, too, that a similar U.S. law for coral reef “debt-for-nature” was introduced in Congress in 2001. This bill, the Coral Reef and Coastal Marine Conservation Act of 2001, H.R. 2272, 107th Cong. (2001), was passed by the House but the Senate took no action on the bill. *Id.* at 34–35.

201. Davidson, *supra* note 6, at 531 (discussing the lack of an enforcement mechanism in the Convention on Biological Diversity); see also *supra* notes 172–74 and accompanying text (discussing enforcement difficulties associated with the Convention on International Trade in Endangered Species).

The United Nations Convention on the Law of the Sea (UNCLOS) is a marine treaty that actually contains enforcement mechanisms.²⁰² But unfortunately, UNCLOS's enforcement capabilities do not extend to most coral reefs. That is because most reefs are located so close to land that they are "well within coastal states' jurisdiction, entitling [those states] to conserve or to exploit most of the world's reefs as they see fit."²⁰³

To ensure that it, too, is not an instrument followed only at the whim of nations, a new coral reef treaty must contain an enforcement mechanism requiring compliance on the part of all signing nations. And this treaty's jurisdiction must extend to all parts of the ocean where coral reefs are found, shallow coastline waters included.

3. Address Anthropogenic Greenhouse Gas Emissions

Creating a coral reef conservation treaty that ignores greenhouse gas emissions would be like tidying up a house while it is burning down. As previously discussed, two of the gravest threats to coral reefs—climate change and ocean acidification—are brought on by increased atmospheric emissions of CO₂ (and, for climate change, other greenhouse gases). An effective coral reef treaty must tackle the sources of climate change and ocean acidification head on, and ought to require signing parties to reduce greenhouse gases to a level at which coral reefs may persist in some form. As previously discussed, recent research suggests that once atmospheric CO₂ concentrations reach 500 ppm or greater, coral reefs as we know them will become "extremely rare."²⁰⁴ However, this same research suggests that if atmospheric CO₂ concentrations are leveled off at today's concentration (approximately 380 ppm), "coral reefs will continue to change *but* will remain coral dominated and carbonate accreting in most areas of their current distribution."²⁰⁵ More research is needed, but based on current findings it looks like there is still hope for reefs, so long as nations quickly commit to marked CO₂ reductions.

Of course, a greenhouse gas emissions reduction provision in a new coral reef treaty ought not replace or interfere with nations' obligations under the United Nations Framework Convention on

202. United Nations Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397; *see also* Davidson, *supra* note 6, at 528–29.

203. Sylvan, *supra* note 2, at 34.

204. *See supra* notes 84–86 and accompanying text.

205. Hoegh-Guldberg et al., *supra* note 84, at 1740 (emphasis added).

Climate Change.²⁰⁶ This coral reef treaty provision should instead be a means to reaffirm signing nations' commitment to greenhouse gas reductions, and should take into account the atmospheric CO₂ concentrations at which coral reefs can no longer persist. This greenhouse gas provision also should provide for further research into the impacts of climate change and ocean acidification on coral reefs, though this ongoing research should not be used as a means to delay actual greenhouse gas emissions reductions.

Many will argue that it is not feasible to include a greenhouse gas provision in a coral reef treaty. These opponents will perhaps use the same reasoning that the United States did when it objected to listing the Belize reef as "in danger" because of climate change.²⁰⁷ Those using this logic will say that inclusion of a contentious issue like greenhouse gas emissions reductions in an otherwise "harmonious" coral reef treaty would make the treaty impracticable, with few nations agreeing to sign it. This argument would have had more merit even a few years ago, but times are changing. As our knowledge about climate change and the world's acknowledgement of this issue increase, a greenhouse gas provision in a coral reef treaty will become feasible indeed. And, as this note demonstrates, such a provision is absolutely critical to the survival of the world's coral reefs.

It is important to reiterate that even the very "best" international coral reef treaty, one containing these three suggested provisions and more, cannot adequately protect coral reefs on its own. Given the local nature of many reef threats, local and national conservation measures are critically needed to complement international efforts.

VI. CONCLUSION

It is not yet time to give up on coral reefs, but conserving these unique ecosystems will take bold and swift action on the part of the international community. Existing international approaches to reef conservation are important components of a solution, but they are not enough. More needs to be done to adequately address the causes of the global challenges that reefs face, namely climate change and

206. United Nations Framework Convention on Climate Change, May 9, 1992, 1771 U.N.T.S. 107, available at <http://unfccc.int/resource/docs/convkp/conveng.pdf>.

207. See *supra* note 122 and accompanying text (discussing the United States' objection to listing the Belize reef as "in danger" due to climate change, citing that such a status listing based on a "controversial issue" like climate change would harm the "harmonious relations of the World Heritage Committee").

ocean acidification. Also, more international funding is needed to help coral reef countries tackle local threats to their reefs. A new, coral reef-specific treaty should be created that addresses these issues. Such a treaty should also have an enforcement mechanism to require compliance on the part of member states. Finally, as indicated throughout this piece, the United States—the world’s biggest importer of coral products and a top emitter of greenhouse gases—must step up, taking an active and genuine role in international reef conservation efforts. As one organization puts it, “The first generation to discover scuba may be the last to enjoy coral reefs, if we don’t get involved.”²⁰⁸ Indeed, it is time for the international community to meaningfully “get involved” and save our coral reefs for the generations to come.

208. Reef Relief, *supra* note 25.