CLIMATE CHANGE AND POLICY: UNDERSTANDING THE RELATIONSHIP BETWEEN CORAL REEFS AND CLIMATE CHANGE

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I. INTRODUCTION

Coral reefs are one of the hardest-hit victims of global climate change. Damage caused by ocean acidification, warming ocean temperatures, cyclones, and general biodiversity loss have led to not only an increase in vulnerability and disease for reefs but devastation for the onshore communities that depend on them for their livelihoods.[2] Reefs are critically important to the livelihoods of almost a billion people, the tourism and fishing economies of multiple nations, and for protecting shorelines. This article examines stresses on reefs caused by global climate change, as increased temperatures dramatically impact the makeup of corals, as well as impact the humans who depend on reefs for food, money, and livelihoods.

Coral reef legislation has been created all around the world, namely by members of the United Nations. This article will delve into the international agreements, including the United Nations Convention on the Law of the Seas, Sustainable Development Goals, the Convention on Biological Diversity, and others, followed by reasons for preserving such fragile ecosystems, if they are even capable of being saved. This article will then explain some flaws in these international agreements and explore solutions. Because coral reefs are extremely vulnerable ocean communities and harbingers of climate change, there has been at least some minimal level of policy implemented throughout the globe.

Artificial reefs are a new technology to prevent coral extinction and biodiversity preservation. This article will consider the pros and cons of artificial reefs, as well as other possible solutions to saving the world's natural reefs. Artificial reefs alone will not solve the problem; rather, they must be accompanied by broader solutions like education, smaller-scale legislation, and other conservation methods.

Finding a proper solution to the destruction of coral reefs is not going to be easy, if at all possible, before all coral is permanently destroyed. Conflicts between whether to conserve with minimal human intervention, or restore corals with intense human intervention and even genetic mutation further complicates

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[2] G. Robin South et. al, *Global Changes in the Pacific: Engaging Scientists and Policy Makers in Fiji, Tonga, Samoa, Tuvalu*, 29 OCEAN YEARBOOK 195, 196 (2014).

the process.[3] Because reefs specifically and oceans generally transcend physical and jurisdictional boundaries, this article will discuss a more concrete, binding international framework to guide nations to act uniformly when dealing with the preservation and survival of these enormously important reefs.

II. AN INTRODUCTION TO CORAL REEFS

While coral reefs only cover one tenth of 1% of the ocean's sea bed, they are home to over 25% of all species found in the sea.[4] Over 1,000,000 animal species, including over 4,000 species of fish alone, call coral reefs home, and scientists estimate millions more animals have yet to be identified.[5] Tropical coral reefs are located in both developed and developing countries, and they are used and appreciated for differing purposes such as tourism, food, and erosion prevention.[6]

Corals are not plants but rather living animal species called polyps, which are made of a limestone skeleton. Individual corals grow and expand into colonies[7] and when aggregated, reefs are formed.[8] Reefs are most known for their bright colors and the abundance of wildlife who live within them; over a quarter of all ocean species inhabit reefs, which they use for protection, food, shelter, and even play.[9] But reefs are also critical for preserving coastlines, creating sand, preventing erosion, and signaling the physical effects of climate change around the world.

Corals have a symbiotic relationship with algae called zooxanthellae: the corals protect the algae by allowing them to adhere to the corals, in return for absorbing nutrients, energy, and bright colors from the algae.[10] However, when corals become physically stressed by events such as acidification and warming water temperatures, the polyps force the algae off them and the corals lose their color: this is commonly known as coral bleaching. Bleaching most commonly occurs as a stress response when ocean waters are one to two degrees warmer than average.[11] Bleaching events are "location-specific," so there is no one temperature

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[3] Irus Braverman, *Bipolarity: Coral Scientists Between Hope and Despair*, 8 ANTHROPOLOGY NOW 2 (Dec. 2016).
[4] *Coral Reefs – Valuable but Vulnerable*, UNITED NATIONS ENV'T PROGRAMME, http://coral.unep.ch/Coral_Reefs.html (last visited Feb. 19, 2020).
[5] Marjorie Mulhall, *Saving the Rainforests of the Sea: An Analysis of International Efforts to Conserve Coral Reefs*, 19 DUKE ENVTL L. & POLICY FORUM 2, 321-22 (2009).
[6] *Coral Reefs – Valuable but Vulnerable*, *supra* note 4.
[7] *Coral*, UNITED NATIONS CONVENTION ON BIOLOGICAL DIVERSITY, https://www.cbd.int/marine/coral.shtml (last visited Feb. 19, 2020).
[8] *What is a Coral Reef*, OCEAN CONSERVANCY, https://oceanconservancy.org/blog/2018/12/06/what-is-coral-reef/ (last visted Feb. 19, 2020).
[9] *Id*.
[10] *Id.*
[11] T.P. Hughes et al., *Climate Change, Human Impacts, and the Resilience of Coral Reefs*, 301 SCIENCE 5635, 929, 932 (2017).

that forces all coral to bleach; therefore, threshold temperatures are inconsistent worldwide.[12]

While bleached corals are still alive, their growth and reproduction rates are severely decreased.[13] They also become more vulnerable to death from an inability to absorb the proper nutrients they need to survive.[14] While the phenomenon of coral bleaching has been documented as far back as the 1980s, the past three years alone caused an incredible 72% of World Heritage-listed reefs to become bleached.[15] In addition, the world's worst coral bleaching events have occurred in the last decade. The Great Barrier Reef's two worst coral bleaching events alone took place in 2016 and then again one year later in 2017.[16] In each event, an astonishing 50% of the living corals perished.[17]

Protection of coral reefs has proven tremendously difficult, because even though reefs are set in place along the seabed, the effects of polluting an ocean on one side of the world may unfortunately still affect coral reefs located thousands of miles away. It takes anywhere from ten to twenty-five years for reefs to fully regain their coral-cover after large-scale bleaching events like those which have taken place in the last decade.[18]

Even though coral bleaching is a global issue, smaller scale national and local efforts to conserve and preserve these ecosystems will go a long way in building the resilience of reefs.[19] Reefs are also a constant reminder of the disparity in climate justice. While least developed nations and small-island developing nations (SIDS) are usually the least contributors to climate change around the world, they often see the worst effects.[20]

On an international scale, the 1998 United Nations Conference of Parties (COP) first brought attention to the problematic effects climate change has on coral reefs, including coral bleaching and warming waters.[21] Parties to the

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[12] HERON ET AL., IMPACTS OF CLIMATE CHANGE ON WORLD HERITAGE CORAL REEFS: A FIRST GLOBAL SCIENTIFIC ASSESSMENT, UNESCO WORLD HERITAGE CTR. (2017).
[13] *Id*.
[14] *Id*.
[15] *Achieving Paris Goals Key to Survival of Coral Reefs, United Nations Framework Convention on Climate Change*, UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE, July 6, 2018, https://unfccc.int/news/achieving-paris-goals-key-to-survival-of-coral-reefs [hereinafter *Achieving Paris Goals*] (last visited Feb. 19, 2020).
[16] Michael Slezak, *Worst Global Coral Bleaching Event Eases, as Experts Await Next One*, THE GUARDIAN, June 20, 2017, https://www.theguardian.com/environment/2017/jun/20/worst-global-coral-bleaching-event-eases-as-experts-await-next-one (last visited Feb. 19, 2020.
[17] *Id*.
[18] *Achieving Paris Goals*, *supra* note 14.
[19] T.P Hughes et al., *supra* note 11.
[20] *See* Seokwoo Lee & Lowell Bautista, *Part XII of the United Nations Convention on the Law of the Sea and the Duty to Mitigate Against Climate Change: Making Out a Claim, Causation, and Related Issues*, 45 ECOLOGY L. Q. 129, 132 (2018).
[21] *Ecosystem Services*, THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY, http://www.teebweb.org/resources/ecosystem-services/ (last visited Feb. 19, 2020).

conference demanded the topic be researched further and discussed at the next COP in 1999, where it was taken more seriously and the topic became much more integrated into the conference. The Specific Work Plan on Coral Bleaching developed at the conference acknowledged the needs of proper reef management, including gathering more research and knowledge on the topic, building resilience, establishing policies and procedures, and finding funding for such projects.[22]

The International Panel on Climate Change (IPCC) assesses the scientific research gathered by hundreds of scientists on climate change. IPCC chair Hoesung Lee recently remarked that limiting the Earth's warming by one and a half degrees Celsius as opposed to two degrees could have far-reaching impacts globally. For example, coral reefs would decline by 70 to 90% by sticking to a one-and-a-half-degree framework, whereas more than 99% of reefs would be completely destroyed working off a two-degree framework.[23] While the alarming rate of reef destruction may seem like a grim reality, the world is shifting from a more traditional mitigation ideology to that of adaptation, learning how to deal with the inevitable effects of global climate change on the world's coral reefs today.

III. ECOSYSTEM SERVICES

There are four broad categories of ecosystem services: provisioning services, regulating services, habitat or supporting services, and cultural services. Reefs are able to support all four categories.[24] Coral reefs are also home to over a quarter of all marine life, including both animals and plants.[25] They serve a variety of diverse environmental purposes and services.

Regulating services include controlling the quality of soil and water, as well as preventing floods or soil erosion. Coral reefs are situated in oceans, which act as a natural carbon sink. Reefs also help absorb strong waves associated with hurricanes and tsunamis, helping to prevent coastal erosion.[26] Reefs, when healthy, have the ability to absorb up to 90% of the impacts caused by wind-

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[22] *Id*.
[23] *IPCC Presents Findings of the Special Report on Global Warming of 1.5°C at Event to Discuss Viet Nam's Response to Climate Change*, INT'L PANEL ON CLIMATE CHANGE, https://www.ipcc.ch/2018/10/10/ipcc-presents-findings-of-the-special-report-on-global-warming-of-1-5c-at-event-to-discuss-viet-nams-response-to-climate-change/ [hereinafter IPCC] (last visited Feb. 19, 2020).
[24] *Ecosystem Services*, *supra* note 21.
[25] *Coral*, *supra* note 7.
[26] HAZEL THORNTON, UNITED NATIONS ENV'T WORLD CONSERVATION MONITORING CTR., CORAL REEFS AND SUSTAINABLE DEVELOPMENT GOALS (2017), https://www.icriforum.org/sites/default/files/ICRIGM32_SDG.pdf (last visited Feb. 19, 2020).

generated waves, which in turn protects coastal regions.[27] Corals also have the incredible ability to clean up oil spills and ingest microplastics to a small degree.[28]

Habitat or supporting services provide necessary food and shelter for species to survive and thrive. As stated above, reefs are home to millions of species of both animals and plants and are known as biodiversity "hotspots." In fact, only rainforest ecosystems boast as much biodiversity.

Provisioning services include animals and plants that receive nutrition from both biomass in reefs and from algae.[29] It also includes energy such as oil and gas deposits which are sometimes found in reef ecosystems.[30] Biomass materials such as manure, and abiotic materials such as minerals, are also a part of the provisioning services reefs may provide.

Cultural services that reefs provide include tourism through snorkeling, diving, and simply interacting with native animal species.[31] Corals, plants, and other animals represent symbolic and spiritual importance to some coastal indigenous communities.[32] Even the aesthetic experience of simply being present in a reef ecosystem is a service in itself.[33]

If reefs are continually destroyed, the world will lose $500 billion[34] annually by 2100 from the loss of potential ecosystem services provided by reefs.[35] Of course, the most profound impacts will be seen in small island developing states and areas where native people depend on reefs for sustenance and economic support.[36] Reefs are just as important to humans as they are to marine species. Around 40% of humans live within 100 kilometers of a coastline.[37] In addition, there are almost 300,000,000 people who depend on reefs directly for their food and careers every single day.[38] These facts all demonstrate the importance of protecting the world's coral reefs.

IV. CONVENTIONS, FRAMEWORKS, AND NON-BINDING GOALS

Although there have been a host of environmental international frameworks created and ratified to combat climate change, these frameworks are not ideal to adequately control and prevent the rapid impacts of climate change on

[27] J.C. Sylvan, *How to Protect a Coral Reef: The Public Trust Doctrine and the Law of the Sea*, 7 SUSTAINABLE DEV. L & POLICY 32, 32-35, 81-82 (2006).
[28] THORNTON, *supra* note 26.
[29] *Id.*
[30] *Id.*
[31] *Id.*
[32] *Id.*
[33] *Id.*
[34] Amount is in U.S. dollars.
[35] HERON ET AL., *supra* note 12.
[36] *Achieving Paris Goals*, *supra* note 15.
[37] Sylvan, *supra* note 27.
[38] *What is a Coral Reef*, *supra* note 8.

coral reefs. This section looks in depth at various international agreements - including the United Nations Convention on the Law of the Seas, Sustainable Development Goals, the Convention on Biological Diversity, the World Heritage Convention, and the Paris Agreement - which are all relevant to the protection of reefs in a time of climate crisis. This section begins by discussing the relevant portions of these binding and non-binding agreements and then explains their pitfalls for appropriately protecting reefs around the world.

A. UNCLOS (1982)

The United Nations Convention on the Law of the Seas (UNCLOS) serves as an international constitution for the oceans.[39] UNCLOS was established in 1982, before climate change was widely researched and accepted by the scientific community.[40] UNCLOS is perhaps the most comprehensive and thorough agreement regarding oceans.[41] The convention divided the ocean into jurisdictions based on nautical miles, allowing each state to individually decide whether to preserve or exploit the vast resources of coral reefs.[42] Articles 56 and 57 specifically grant states sovereign rights up to 200 miles off their shores.[43] Each state that borders an ocean has jurisdiction over twelve nautical miles from their respective shore, as well as an economic zone up to 200 miles out to sea.[44] Because most warm-water reefs[45] are located in shallow waters less than fifty meters deep, most tropical reefs fall within the jurisdiction of state waters. The broad nature of UNCLOS' text allows for a fluid interpretation of its articles and for it to handle new and upcoming oceanic issues in a consistent manner.[46]

The most relevant portion of UNCLOS to protect reefs from climate change is Part XII, which considers the protection and preservation of the marine environment and sets forth international legal restrictions and requirements.[47] Article 192 creates a broad obligation of states "to protect and preserve the marine environment" but provides no further explanation regarding how to do so.[48] The article does demand, however, that states take "all measures consistent with the Convention that are necessary to prevent, reduce, and control [any type of]

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[39] United Nations Convention on the Law of the Seas, Dec. 10, 1982, http://www.un.org/Depts/los/convention_agreements/texts/unclos/unclos_e.pdf [hereinafter UNCLOS] (last visited Feb. 19, 2020).
[40] Erika J. Techera & John Chandler, *Offshore Installations, Decommissioning and Artificial Reefs: Do Current Legal Frameworks Best Serve the Marine Environment,* 59 MARINE POLICY 53 (2015).
[41] Sylvan, *supra* note 27.
[42] *Id*. at 81.
[43] Mary Gray Davidson, *Protecting Coral Reefs: The Principal National and International Legal Instruments*, 26 HARV. ENVTL. L. REV. 499, 527 (2002).
[44] *See* UNCLOS, *supra n*ote 39, at art. 56-57.
[45] This paper is specific to tropical, or warm-water reefs.
[46] Lee & Bautista, *supra* note 20.
[47] UNCLOS, *supra* note 39, at part XII.
[48] *Id.* at art. 192.

pollution" of ocean environments.[49] The article also requires a state to prevent its pollution from spreading to and affecting other states' environments – this sounds and probably is impossible, as there are no physical boundaries to separate states' jurisdictions in the open water.[50] Article 193 also recognizes the right of states to exploit their resources as they see fit, while still continuing to uphold their duty to protect and preserve the environment.[51] These two articles (192 and 193) are binding on all states who have ratified the convention.[52]

Another important aspect of UNCLOS is that non-parties to the convention may still be bound by its text. Even though not every state that possesses coral reefs within its jurisdiction is a party to UNCLOS, all states may still be considered "bound" to the language in the convention because of customary international law. This occurs when non-party states feel obligated to act in the same way as other states who have signed onto international agreements, even though the former have not technically ratified any agreement.[53] Therefore, states may be bound by the consistent actions of a large number of other states as opposed to their own non-ratification of a document.[54]

While UNCLOS is a starting point for protecting the world's oceans, it does not establish specific guidelines or rules for states to follow when it comes to how to regulate marine activities in order to protect coral reefs. In fact, it only requires a nation to "consider" the effects of its actions on the environment, a rather loose threshold that can be easily followed.[55] In addition, because most coral reefs fall within the jurisdiction of a specific state due to their location close to the coast, there is no real international protection for a majority of them.[56] What's more, there is no way to challenge the actions of another nation's marine activities.[57] With a duty to act but no method of enforcement, UNCLOS cannot become a game-changing treaty or the solution we need to solve the crisis facing coral reefs.

Unfortunately, UNCLOS was not written at a time when climate change was recognized as a threat to the environment as it is recognized by most states today.[58] Therefore, the text has no climate-change related rules pertaining to warming oceans or intense ocean acidification. One suggestion to fix this problem would be to provide an annex to UNCLOS that supports the world's current stance on climate change, as well as some duty to report or at least consider the

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[49] *Id.* at art. 194.
[50] *See id*.
[51] Davidson, *supra* note 43.
[52] *Id.*
[53] *Customary International Law*, LEGAL INFO. INST., CORNELL LAW SCHOOL https://www.law.cornell.edu/wex/customary_international_law (last visited Feb. 19, 2020).
[54] *Id*.
[55] *See* Sylvan, *supra* note 27, at 81.
[56] Davidson, *supra* note 43, at 537.
[57] *Id.*
[58] *See* Lee & Bautista, *supra* note 20.

effects of climate change on states' marine actions. Although there are broad responsibilities of states to prevent the cause and spread of ocean pollution internationally, there is nothing in the text about finding states liable for causing or spreading ocean pollution; perhaps this could be a useful addition to this international framework.[59]

Another way to help preserve reefs is to find states liable for their direct contributions to climate change under UNCLOS could be by finding states liable for a failure to mitigate.[60] Even though states have an affirmative duty to protect oceans, no case has been brought to date regarding failure to mitigate according to UNCLOS on any international stage.[61] With reefs deteriorating and losing their value before our very eyes, now may be the time to take more drastic measures.

B. Sustainable Development Goals (SDGs) (2015)

In 2015, the UN created universal sustainable development goals or SDGs with the plan of improving seventeen broad areas worldwide to help eradicate poverty and hunger and simultaneously combat climate change by 2030.[62] In fact, an entire "dimension" of these goals targeted the environment, with the other two sections being related to economic and social goals.[63] A Global Partnership among United Nations states was created to help establish and achieve each of the unique development goals. Three of these SDGs are relevant to the protection of coral reefs.

SDGs Thirteen, Fourteen, and Fifteen are most relevant when looking at problems associated with climate change and coral reef degradation. SDG Thirteen is to "take urgent action to combat climate change and its impacts."[64] This includes improving resiliency among states and including climate change research in national and global policies. One of the most important items under this goal is that the parties to the United Nations Framework Convention on Climate Change (UNFCCC) pledged to gather $100 billion[65] each year by 2020 to address the needs of SIDS and least-developed countries battling climate change with little resources to mitigate the massive problem.[66]

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[59] *See* UNCLOS, *supra* note 39, at art. 194-95, 212.
[60] Lee & Bautista, *supra* note 20, at 153.
[61] *Id*. (citing Meinhard Doelle, *Climate Change and the Use of the Dispute Settlement Regime of the Law of the Sea Convention*, 37 OCEAN DEV. & INT'L L. 319, 324 (2006)).
[62] *Transforming Our World: the 2030 Agenda for Sustainable Development*, UNITED NATIONS SUSTAINABLE DEV. GOALS KNOWLEDGE PLATFORM https://sustainabledevelopment.un.org/post2015/transformingourworld [hereinafter *Transforming Our World*] (last visited Feb. 19, 2020).
[63] *Id*.
[64] *Id*.
[65] Amount given in U.S. dollars.
[66] *Transforming Our World*, *supra* note 63.

SDG Fourteen is to "conserve and sustainable use the oceans, seas, and marine resources for sustainable development.[67] This goal was expected to be reached by 2020 and contained measures like conserving at least 10% of marine and coastal lands, sustainably managing ecosystems to avoid catastrophic effects of climate change, regulating overfishing, conserving 10% of coastal areas, and restoring ocean ecosystems so they can build up their resiliency against the effects of climate change.[68] Goal fourteen's text also lists goals for 2030, which include increasing economic potential for SIDS and least-developed countries by sustainably implementing tourism and fishery resources.

SDG Fifteen is to "protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and reverse land degradation and half biodiversity loss."[69] This includes "tak[ing] urgent and significant action to reduce the degradation of natural habitats…" and using biodiversity to ecosystems' benefits.[70] These goals, similar to the rules laid out in UNCLOS, are extremely broad and thus malleable to up-and-coming global issues such as climate change.

Certain groups have formed to help achieve particular SDGs. The Global Coral Reef Partnership is one such group.[71] This group is aimed at achieving SDGs Twelve[72], Thirteen, and Fourteen and shares the goal of implementing internationally agreed upon commitments to best manage and strengthen the resilience of reefs worldwide.[73] Partners meet annually to share ideas, policies, and methods of preserving reefs. Their biggest areas of development are: 1) building resilience among reefs in a time of climate change and acidification; 2) embracing ecosystem services provided by reefs; and 3) further researching and sharing information about reef planning and management.[74]

Unfortunately, SDGs are simply goals. These ambitious goals seem slightly out of reach when there is no actual plan for action to support them. It seems as though such broad and expansive tasks such as to "prevent and significantly reduce marine pollution of all kinds [by 2025]" are impossible without any indication as to the methods of implementation.[75] Almost every goal, although they may sound like necessary adaptations, leaves the informed reader with the question of "okay…how?"

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[67] *Id*.
[68] *Id*.
[69] *Id.*
[70] *Id.* at goal 15.5.
[71] *Global Coral Reef Partnership,* UNITED NATIONS SUSTAINABLE DEV. GOALS P'SHIP PLATFORMS, https://sustainabledevelopment.un.org/partnership/?p=7450 (last visited Feb. 19, 2020).
[72] *Id*.
[73] *Id.*
[74] *Id.*
[75] *Transforming Our World*, *supra* note 63, at goal 14.1.

In addition, the SDGs - namely Goal Fourteen - do not seem to acknowledge the current status of reefs; that is, it does not seem to consider that reefs are already being degraded and destroyed. While the goals are plans for the future, there is a lack of acknowledgement of reefs' present in-peril status. For example, the goal to conserve at least 10% of coastal and marine areas by 2020 seems like a good idea, but 70% of reefs were currently threatened as of 2017.[76] Why shouldn't the percentage be greater than 10%? Why can't there be a goal of 100% coral reef protection?

The biggest downfall of the SDGs is that they are neither binding nor a treaty but rather goals created by the United Nations. The goals have no way of being enforced and no repercussions if they are not followed.

C. Convention on Biological Diversity (1992)

The Convention on Biological Diversity (CBD) expresses that the vast varieties of unique plant and animal species around the world are a "common concern of humankind" that are becoming reduced at the hands of humans.[77] This convention acknowledges the critical importance of biodiversity, without which humans would have fewer food sources, medicinal research, tourism, and natural resources necessary for survival in the twenty-first century.[78] The CBD was established in 1992 at the Rio Earth Summit in Brazil. The convention aims at not only preserving diversity among habitats and ecosystems but also sustainably using the living and non-living products of such ecosystems and sharing in the benefits that they provide.[79] Coral reefs fall under the ecosystems and habitats that the convention aims to protect, due to the large number of species that can be found there, as well as the economic, cultural, medicinal, and other services which reefs may provide.[80]

States who are parties to the CBD are obligated to identify and monitor ecosystems like reefs that fall within their jurisdiction. Two examples of monitoring ecosystems include establishing protected areas and educating the public about the vast benefits of reefs.

Another aspect of the CBD is "common but differentiated responsibilities" (CBDR).[81] This term means that different states have greater abilities to provide for developing states when it comes to addressing problems with climate

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[76] Carrie Manfrino, *Can We Save Coral Reefs*, 54 UNITED NATIONS CHRONICLE 28 (2017).
[77] United Nations Convention on Biological Diversity, *opened for* signature June 5, 1992, at Preamble, https://www.cbd.int/doc/legal/cbd-en.pdf (last visited Feb. 19, 2020).
[78] Davidson, *supra* note 43 at 533.
[79] *Id*. at 530.
[80] *Id*. at 531.
[81] *See* Rajesh Sehgal, *Legal Regime Towards Protecting Coral Reefs: An International Perspective and Indian Scenario*, 2 LAW ENVTL. AND DEV. J. 2, 183, 191 (2006).

change.[82] Even though all states are responsible globally for dealing with climate change, some are inherently more capable than others, due to their sheer size, influence, and economic power.[83] While CBDR are ethically and morally sound and call for an inclusive approach to solving climate change, some developed countries fail to acknowledge that they should help their poorer or weaker neighbors. Ironically, it is these developed countries, such as the United States, that contribute the most to climate change.[84] If CBDRs were mandated on some global level, developing countries who are hit the hardest by the effects of climate change could build their resiliency with the help of stronger developed countries. This could certainly help lessen the harsh effects of damage to reefs, or at least buy more time.

The CBD Conference of Parties of 2010 established a Strategic Plan for Biodiversity which included twenty biodiversity "targets" to achieve by 2020.[85] Similar to the SDGs, these targets are extremely broad and lofty, but unlike SDGs they are still binding law, as they are a part of the convention. Target Ten, for example, is 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."[86] This target was not met nor even under control in 2015, as some of the worst events of coral bleaching occurred after 2015. What is being done about the CBD now that the target has not been reached? What are the repercussions for not meeting this goal? Now that the 2015 goal has not been met, should they try to accomplish the same task by 2020, the date for most of the other targets?

This convention has other downfalls. There is no proper method of enforcement listed in the CBD. Even though parties to the convention are bound by its text, there is no real method of monitoring compliance among the states, aside from the submission of annual reports. Therefore, it appears to be at the discretion of each states' current administration to decide how strictly or loosely they want to adhere to the text of the convention. Without a proper enforcement mechanism, states may be pressured by other states and public opinion, which could either help or hinder a state's environmental conservation goals.[87] Not every state has ratified the CBD, including the United States,[88] and those countries

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[82] Charlotte Epstein, *Common but Differentiated Responsibilities*, ENCYCLOPAEDIA BRITANNICA https://www.britannica.com/topic/common-but-differentiated-responsibilities (last visited Feb. 19, 2020).
[83] *Id*.
[84] *Id*.
[85] *Convention on Biological Diversity*, INTERNATIONAL YEAR OF THE REEF https://www.iyor2018.org/organization/convention-on-biological-diversity/ (last visited Feb. 19, 2020).
[86] *Aichi Biodiversity Targets,* UNITED NATIONS CONVENTION ON BIOLOGICAL DIVERSITY https://www.cbd.int/sp/targets/default.shtml (last visited Feb. 19, 2020).
[87] Mulhall, *supra* note 5, at 338.
[88] There are 196 parties to the convention, only 168 of whom have ratified it. *List of Parties,* UNITED NATIONS CONVENTION ON BIOLOGICAL DIVERSITY https://www.cbd.int/information/parties.shtml (last visited Feb. 19, 2020).

therefore are not held to the standard that others are, giving them free reign to take actions as they see fit for protecting (or not protecting) coral reefs.

D. World Heritage Convention (1972)

The United Nations Convention Concerning the Protection of World Cultural and Natural Heritage (World Heritage Convention), adopted in 1972, understands the link between humans and nature and sought to create a balance between the two.[89] Natural heritage is defined as:

> [n]atural features, geological and physiographical formations and delineated areas that constitute the habitat of threatened species of animals and plants and natural sites of value from the point of view of science, conservation or natural beauty. It includes nature parks and reserves, zoos, aquaria and botanical gardens.[90]

Natural heritage sites, by definition, certainly include some coral reefs due to the threatened species that may live there, their valuable resources, and their natural beauty. To date, the World Heritage List contains nearly 1,100 properties, twenty-nine of which are coral reefs.[91] Once a site is listed as a World Heritage Site, the convention provides financial assistance (and increased federal funding), as well as expert training on how to conserve and preserve the area.[92] Designations must meet at least one of the natural heritage criteria, which include representing evolutionary history, geological processes and biological evolution, contain areas of exceptional natural beauty, and contain rare or endangered plants and animals.[93]

The Great Barrier Reef, which meets all four of these criteria, was the first coral reef ecosystem to become a World Heritage Site in 1981 for its "outstanding universal value."[94] Designations trigger certain protections, such as emergency assistance in times of imminent danger, financial training and assistance to help keep the site clean and well-preserved, and a push for international appreciation of the site because of its cultural significance.[95] Once a site is listed, it becomes

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[89] *The World Heritage Convention*, UNESCO, https://whc.unesco.org/en/convention/ (last visited Feb. 19, 2020).
[90] *Natural Heritage*, UNESCO, http://uis.unesco.org/en/glossary-term/natural-heritage (last visited Feb. 19, 2020).
[91] *World Heritage List*, UNESCO, https://whc.unesco.org/en/list/ (last visited Feb. 19, 2020).
[92] Davidson, *supra* note 43, at 537.
[93] *Criteria Values and Attributes*, GREAT BARRIER REEF MARINE PARK AUTH., AUSTRALIAN GOV'T, http://www.gbrmpa.gov.au/the-reef/heritage/great-barrier-reef-world-heritage-area/criteria-values-and-attributes (last visited Feb. 19, 2020).
[94] *Heritage*, GREAT BARRIER REEF MARINE PARK AUTH., AUSTRALIAN GOV'T, http://www.gbrmpa.gov.au/the-reef/heritage (last visited Feb. 19, 2020).
[95] *See generally*, *World Heritage,* UNESCO, http://whc.unesco.org/en/about/ (last visited Feb. 19, 2020).

the job of all parties to the World Heritage Convention to care for and protect the site for future generations.[96]

Designating coral reefs as World Heritage Sites is not a cure-all, especially if waters continue to warm, because reefs will still nonetheless be destroyed. However, continuing to designate at least moderate-sized reefs shows that a universal appreciation for these unique ecosystems exists and are an area that should be preserved for future generations.[97] In addition, designated sites have management plans that ensure preservation and an increase in sustainable tourism. While local management of reefs alone is likely insufficient to ensure long-term viability, it is one step that should be taken rather than not. Therefore, more UNESCO World Heritage Site designations for reefs worldwide may not be the foolproof answer we need, but it certainly could buy time for reefs to grow, build resilience, and adapt to warming waters. This way, states with these sites can request additional financial assistance and expert training, and spread knowledge about the importance of such locations.[98]

Evidence shows that listing reefs as World Heritage Sites promotes the conservation and preservation of their ecosystems. The Belize Barrier Reef Reserve System, the second largest barrier reef in the world, was listed in 1996 and found to be a site "in danger" in 2009.[99] This designation gives sites an extra layer of added protection, by increasing the amount of international funding that sites receive. Marine ecosystems in Belize were becoming destroyed due to unsustainable oil extractions and development projects. When the World Heritage committee placed an immediate moratorium on extracting oil in Belize and created more strict mangrove forest management, the country's marine ecosystems, including reefs, mangroves, and atolls, were restored to the point where the site was taken off the "in danger" list in 2018.[100]

Reefs like the Belize Barrier Reef should not have to wait to be on an "in danger" list before something is done to protect them. Even more, if the reef is not listed as a World Heritage Site at all, there is no chance it will be listed as "in danger" and receive the proper attention it needs. Therefore, allowing more coral reefs to become World Heritage Sites could eliminate these potential problems and limit the chances that reefs will face threats such as occurred in Belize.

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[96] Lucy Wiggins, *Existing Legal Mechanisms to Address Oceanic Impacts from Climate Change*, 7 SUSTAINABLE DEV. L. & POL'Y 22, 22 (2007).
[97] *The World Heritage Convention*, *supra* note 90.
[98] *See* Sehgal, *supra* note 82, at 195.
[99] *Belize Barrier Reef Reserve System Removed from the List of World Heritage in Danger*, UNESCO (June 26, 2018), https://whc.unesco.org/en/news/1838/ (last visited Feb. 19, 2020).
[100] *Belize Praised for 'Visionary' Steps to Save Coral Reef*, BBC NEWS (June 27, 2018), https://www.bbc.com/news/world-latin-america-44627719 (last visited Feb. 19, 2020).

E. Paris Agreement (2015)

The twenty-first Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC) is most remembered for its landmark Paris Agreement, named for the location of that year's COP. This agreement brought together world environmental leaders to undertake the colossal task of combatting climate change head-on.[101] The most notable goal for the Paris Agreement is to prohibit a temperature change higher than two degrees Celsius above pre-industrial levels.[102] While the determination of two degrees appeared to be the proper number to achieve long-term sustainability and avoid the most disastrous climate change consequences, it is now accepted that this number is not conducive to the success of coral reefs. As previously mentioned, limiting a two-degree increase in global warming would inevitably destroy more than 99% of reefs worldwide.[103]

Another key product of the Paris Agreement is nationally determined contributions or NDCs.[104] NDCs are state-set efforts to implement and report emissions reductions. In addition to NDCs, each state will take "stock" of their environmental efforts, whether successful or otherwise, and contribute to a global discussion about further efforts to achieve Paris goals.[105]

Four years after the ratification of the Paris Agreement, the new consensus among parties is that global temperature should now not exceed one and a half degrees. Although this small change in number may not seem significant, keeping global warming to one and a half degrees has significant impacts on reefs and other ecosystems.[106] For example, by 2100, sea level rise would be around ten centimeters lower with the new threshold as opposed to the two-degree threshold. Coral reefs would have a better chance of survival, as it is predicted that as few as 70% of reefs would be destroyed at a one-and-a-half-degree threshold.[107]

As with other agreements, there are major players who have not signed onto the Paris Agreement. In 2016, President Obama signed the United States onto the Paris Agreement.[108] However, the next year President Trump expressed his intention to withdraw the United States from the Paris Agreement.[109] The first

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[101] *The Paris Agreement*, UNITED NATIONS CLIMATE CHANGE https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement (last visited Feb. 19, 2020).
[102] *See id*.
[103] *IPCC*, *supra* note 23.
[104] *The Paris Agreement*, *supra* note 102.
[105] *See id*.
[106] *IPCC*, *supra* note 23.
[107] *Id*.
[108] Blog Post, Tanya Somanader, The White House, President Obama: The United States Formally Enters into the Paris Agreement (Sept. 3, 2016), https://obamawhitehouse.archives.gov/blog/2016/09/03/president-obama-united-states-formally-enters-paris-agreement (last visited Feb. 19, 2020).
[109] Johannes Urpelainen, *Trump's Withdrawal from the Paris Agreement Means Other Countries Will Spend Less to Fight Climate Change*, WASHINGTON POST, Nov. 21, 2017,

day that President Trump would be able to formally withdraw would be November 5, 2020, after the next United States presidential election.[110] For now, the United States appears to be the only country not on board with the terms of the Paris Agreement. The one-and-a-half-degree threshold is based on the most extreme end of implementing the 2015 Paris Agreement and appears to be one of the only international agreements that involves acting and making tangible changes to save reefs.[111]

V. SOLUTIONS

A. Artificial Reefs, Managed Relocation, and MPAs

Artificial reefs are "submerged structures placed on the seabed deliberately, to mimic some characteristics of natural reefs,"[112] with the anticipation that marine species build an ecosystem throughout the structure. These reefs may play an important part in marine ecosystems by increasing biodiversity in an area once lacking an adequate habitat for native species; they may also serve as tourist attractions and fishing hubs.[113]

Although artificial reefs may seem like a solution to build capacity and resilience of reef species, which includes the ability to resist disease and recover from natural disasters and other disturbances.[114] Such a novel idea does not come without costs and cynics. International law comes into play when considering placing structures on the seabed which may interfere with navigation and shipping.[115]

The First International Conference on Artificial Reefs, held in Houston, Texas in 1974, was open to all parties interested in "any aspect of artificial reef research, construction, or use."[116] While there have been multiple International Conference on Artificial Reefs and Related Aquatic Habitats (CARAH) meetings since the first conference, there has been no solution to solving the problems associated with climate change and coral reefs. The first group meeting expressed

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https://www.washingtonpost.com/news/monkey-cage/wp/2017/11/21/trumps-noncooperation-threatens-climate-finance-under-the-paris-agreement/?utm_term=.e5d9e5306c71 (last visited Feb. 19, 2020).

[110] *Id*.

[111] *Paris Agreement only Chance for Coral Reef Survival*, INTERNATIONAL UNION FOR CONSERVATION OF NATURE https://www.iucn.org/news/secretariat/201709/paris-agreement-only-chance-coral-reef-survival-%E2%80%93-iucnParis (last visited Feb. 19, 2020).

[112] Erika J. Techera & John Chandler, *Offshore Installations, Decommissioning and Artificial Reefs: Do Current Legal Frameworks Best Serve the Marine Environment?,* 59 MARINE POLICY 53 (2015).

[113] *See id*.

[114] HERON ET AL., *supra* note 12.

[115] In which case, the law of the seas would govern. *Id*.

[116] S.A. Bortone, *CARAH (International Conference on Artificial Reef and Related Aquatic Habitats): An Historical Perspective of Accomplishments,* 31 J. OF APPLIED ICHTHYOLOGY 3 (2015).

concern over the uncertain future of reefs' sustainability as fishing oases and that alternative options may need to be considered.[117] Using automobile tires to create artificial reefs, for example, may seem attractive until the day the tire finally breaks down and collapses, damaging plants and animals which looked to the tire for protection.

Along with artificial reefs, more marine protection areas (MPAs) should be created to separate delicate and vulnerable reefs from less valuable marine ecosystems. An MPA is a locally or nationally designated area that has the ability to prohibit "takings" of valuable reef resources, ban humans from interference, and preserve habitats for endemic species in reefs.[118] MPAs are not international regimes, but similar to world heritage sites, they can separate valuable or vulnerable ecosystems from other portions of the ocean. However, troubles arise when no physical boundaries are created between MPAs and unrestricted areas.

Managed relocation is the transfer of coral species from their current habitat to a new location, outside of where they normally exist.[119] This is commonly performed in an effort to spread resilient corals from one ecosystem to another similarly situated ecosystem.[120] Effects of managed relocation include a decrease in the chances of coral species becoming endangered or extinct and increasing the chances the corals will survive in a time of growing climate problems and warming waters, if successful in their new locations.

While there have been no large-scale successful relocations of corals yet, that does not mean the process is impossible or should not be attempted. Problems should be accounted for and expected, however, because around 30% of the transplanted corals result in mortality of the species upon arrival to its new location.[121] Differences in wave strength, water salinity, sun exposure, and water pollution may also have negative effects on the newly located corals.[122] An even larger problem may occur if unapparent diseases are transferred from the old location to the new, or if the zooxanthellae from the displaced corals become invasive to their new environment.[123] Generally, the physical transferring of the corals is also stressful to the species and must be done both quickly and carefully to avoid stressing the animals to the point that they bleach.[124] These are all considerations that should be understood and taken into account when trying to create new reefs or transplant corals from one ecosystem to a different location with similar characteristics.

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[117] *Id*. at 4 (stating old tires and used automobiles may be a good structure for reefs*)*.
[118] *See* Sehgal, *supra* note 82, at 189.
[119] NAT'L ACADEMIES OF SCI., ENG'G, AND MED., A RESEARCH REVIEW OF INTERVENTIONS TO INCREASE THE PERSISTENCE AND RESILIENCE OF CORAL REEFS 94 (2018), https://doi.org/10.17226/25279 (last visited Feb. 19, 2020).
[120] *Id*.
[121] *Id*. at 103.
[122] *Id*.
[123] *Id*. at 108.
[124] *See id*. at 110.

B. Education

Millions of people depend on the success of coral reefs for their employment, food and medicine, and tourism. Reefs currently exist at a critical stage, however, where habitat destruction through climate change is imminent and reconstruction and rehabilitation can take at least a decade. Big changes need to come about for reefs to be adequately protected, from both top-down and bottom-up approaches. Reefs need to be protected so as to grow their resilience and strength against storms and seemingly inevitable warming waters. The education of climate change in schools should be taught throughout the world, especially in small island developing countries whose people rely on reefs the most to survive. This unprecedented task of preserving reefs in a time of immense climate change is not only necessary but critical to the survival of reef ecosystems.

Coral reefs serve as a model for climate change, a basis off of which research can be discovered and lessons can be learned. Reefs are one of the first examples of how climate change can affect the entire globe, no matter the location of the pollution or the individual states at fault.[125] The hope is that while a majority of reefs will inevitably be destroyed due to the relentless effects of climate change, international regimes will come together to learn from this painful experience and try to find solutions to hang on to what remains of coral reefs throughout the next decade.

C. International Treaty on Coral Reefs

There is no one convention or law which every nation harboring coral reefs has signed onto; therefore, there is little consistency in the way states protect reefs globally. Because of the precise needs of reefs situated around the world, and the local threats that come with each unique location, there is no one international treaty that can address all the reefs' problems sufficiently.[126] On the other hand, climate change is a global issue that needs to be handled on an international scale in an effort to streamline states' efforts to protect reefs.[127]

What is needed is some combination of these multiple treaties and conventions. The treaty needs the ingenuity similar to UNCLOS. Like UNCLOS, the new convention needs to be broad and all-encompassing, a thorough and comprehensive constitution for coral reefs. This could be complemented well by broader goals like those found in the SDGs. Goals such as transforming 25% of reefs into MPAs by 2025, or even researching and identifying the most critical reefs by 2020 could help. Another possible goal could be to state generally that climate change exists and plays a critical role in the biology and future of coral reefs.

[125] *Coral Reefs – Valuable but Vulnerable*, *supra* note 4.
[126] *See* Mulhall, *supra* note 5, at 346.
[127] *Id*.

Along with these suggestions, the convention on coral reefs should take stock similar to that in the Convention on Biological Diversity. This allows states to monitor the ecosystems that fall within their jurisdiction. Common but differentiated responsibilities should also be incorporated into the convention. Because we know that most reefs fall into jurisdictions of small island developing nations with less financial power than countries like Australia and the United States, we can put larger, more financially powerful nations in charge of stepping up to help protect reefs in less fortunate jurisdictions. This would allow financial powerhouses like the United States to provide for and fill in the much-needed economic gaps that countries like Indonesia may not be able to close themselves.

The convention needs special designations like those in the World Heritage Convention. Some reefs are going to be inherently more vulnerable than others, and the stronger, more resilient reefs may not need as much immediate attention. Designating certain reefs as being "in danger" provides for the extra financial assistance that is needed to protect reefs that stand little chance of surviving the next decade. Finally, the convention needs another big goal, like the one-and-a-half-degree limit in the Paris Agreement. Such a big overarching, international goal that the whole world can get on board with could be the knot that ties together all the nations interested in having a stake in saving the reefs.

Perhaps fixing the issues of coral destruction and climate change is better suited for a smaller scale, state-by-state operation and implementation. Even though states may informally adopt an international agreement without ratifying it (like the United States has done with UNCLOS), they may still adopt such regulations as customary law and create their own individual avenues to protect the oceans on a national scale.[128] This would also allow for actual binding promises by governments, which would explicitly restrict states' ability to act or refrain from action.

Because there is so little successful international law when it comes to adequately protecting reefs, some sort of additional governance is needed, perhaps on the state-by-state level if coral reefs stand a chance of survival throughout the current decade or those to come.[129] The existing international treaties are simply not working to ensure reefs will be around in the future. MPAs are an effective way of nationally designating areas to be set apart from the rest of a state's open or usable waters. But because humans are the main contributors of climate change that is destroying reefs, they certainly need to be the ones to solve this problem.

[128] Roncevert Ganan Almond, *U.S. Ratification of the Law of the Sea Convention,* THE DIPLOMAT, May 24, 2017, https://thediplomat.com/2017/05/u-s-ratification-of-the-law-of-the-sea-convention/ (last visited Feb. 19, 2020).
[129] *See* Robin Kundis Craig, *Marine Biodiversity, Climate Change, and Governance of the Oceans*, 4 DIVERSITY 224 (2012).