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### The Degradation of Earth's Coral Reefs

The current status of the Earth's tropical and coldwater coral reefs has reached a breaking point in recent years resulting from increased human interaction and various other new threats to their fragile ecosystems. Commonly referred to as the rainforests of the sea, these living structures make up some of the oldest and most diverse environments on the planet. They are capable of supporting thousands of marine species; thus they provide not only a major ecological aspect to today's modern world, but an economical one as well. While these aesthetic masterpieces are protected by a number of laws, organizations, and regulations they have been degrading at increasingly alarming rates within the past few decades. The gradual degradation of coral reef ecosystems continues to be an ever prevalent concern worldwide due to coral bleaching, the introduction of invasive species, and the utilization of damaging fishing practices.

Within the vast oceans covering the planet there are two very different 'species' of coral: Deep-sea or coldwater and tropical corals. Unlike the well known tropical coral reefs which thrive in warm water regions along the equator, coldwater corals don't have algae living within the pores of their limestone structures; as a result, they don't need sunlight to survive. Feeding solely by capturing organic particulates from the surrounding water. Coldwater coral reefs are commonly found where the ocean's current flow is accelerated. These organisms are found on the continental shelf, and also in deep-sea areas with topographic highs, such as plateaus, ridges, and pinnacles. According to information gathered by the National Oceanic and Atmospheric

Administration (NOAA), “Living deep-sea corals have been dated to be more than 4,000 years old, and dead corals forming deep banks have been radiocarbon-dated to be more than 40,000 years old.”(NOAA, “*Fishing Impacts*”) These coldwater corals grow slowly, approximately 5-25mm a year: In comparison, tropical corals can average growth over 200mm in a single year. Both of these ecosystems are well known for their biodiversity and it is through such biological variety that they are capable of impacting the modern world in rather significant ways.

Based on the ecological impacts and influence reefs hold, there should be no question as to the viability of coral reefs being a necessity to the continuation of life on Earth. This, partnered with their economical importance, shows why these ecosystems are a key shard to the human race’s survival. The living structures support more species per unit area (ft<sup>2</sup>, m<sup>2</sup>, etc.) than any other marine environment on the planet. This includes around 4,000 species of fish, 800 species of corals, and hundreds of other marine crustaceans/ invertebrates. By providing enhanced feeding opportunities, hiding places from predators, fish spawning sites, and nursery areas for juveniles, coral reefs provide a natural utopia for marine life to thrive. These underwater paradises have a tendency to draw the attention of vacationers from around the world; thus, ecotourism is a common economical benefit spawning from the reefs. Tourism to such tropical utopias generates an immense source of income for many areas and according to one NOAA estimate, “the total global value of coral-reef based recreation and tourism at \$9.6 billion of the total global net benefit of coral reefs... US, reef-related recreation and tourism account for an estimated \$364 million in added value to Hawai`i’s economy each year and its nearshore reefs annually contribute nearly \$1 billion in gross revenues for the state alone.” (NOAA, “*Fishing Impacts*) In Caribbean nations, upwards of 50% of their annual revenue is generated from ecotourism and commercial fishing on the reefs. However, over the last few decades, these

popular tourist destinations have taken a serious blow, greatly weakening such economies. New impediments to the sustainment of healthy ecosystems has resulted due to the gradual collapsing of many reefs in the tropics.

Over the last two decades coral bleaching has become one of the primary concerns of marine biologists across the globe. Occurring in the tropical reefs along the equator, this event is caused by symbiotic algae being repelled from the coral's pores due to heat stress: This process often results in the death of the coral if temperatures do not stabilize or they are unable to adapt(See figure 1). Simon Winchester, a New York Times bestselling author, wrote in his novel *Pacific: Silicon Chips and Surfboards, Coral Reefs and Atom Bombs, Brutal Dictators, Fading Empires, and the Coming Collision of the World's Superpowers* that scientists, “had already

Figure(s) 1



In 2007, these *Acropora* corals in the Tumon Bay Marine Preserve in Guam bleached, likely due to higher-than-normal water temperatures caused by global climate change. Photo credit: Dave Burdick (NOAA, "Fishing Impacts.")

put forward a convincing case that corals, uniquely, foretold with great accuracy the coming of global climate change—they could be considered the mine shaft canaries of approaching climate problems.”(Winchester, Chapter 9: pg. 342) Such statements couldn't be more true considering that corals are some of the most acutely sensitive of all Mother Nature's early-warning devices. Within the last 18 years alone, Earth has experienced its ten hottest years in any recorded history(See figure 2); thus, coral bleaching has become increasingly prevalent. From the Bahamas to Guam to Australia more and more reefs are being destroyed by such events; unsurprisingly,

Figure 2

NASA			NOAA		
Rank	Year	51-80 Anomaly	Rank	Year	51-80 Anomaly
1 (tie)	2010	0.67°C	1	2010	0.62°C
1 (tie)	2005	0.66°C	2	2005	0.61°C
3	2007	0.63°C	3	1998	0.59°C
4 (tie)	2002	0.62°C	4 (tie)	2003	0.58°C
4 (tie)	1998	0.62°C	4 (tie)	2013	0.58°C
6	2003	0.61°C	6	2002	0.57°C
7 (tie)	2013	0.60°C	7 (tie)	2006	0.56°C
7 (tie)	2009	0.60°C	7 (tie)	2009	0.56°C
7 (tie)	2006	0.60°C	9	2007	0.55°C
10	2012	0.58°C	10	2004	0.54°C

(NOAA, "Fishing Impacts.")

over 20% of today's coral reefs have either been killed or damaged beyond repair, and another 24% are under imminent threat of collapsing due to such increases in global temperatures. Coral bleaching is not the only concern facing reefs, the introduction of a new

predator to their fragile ecosystems has made a major splash as well.

Natives of the warm, tropical waters of the Pacific Ocean and Red Sea, the lionfish was first spotted in Florida in 1985: These vibrantly colored fish from the scorpionfish family are considered invasive species in the Atlantic Ocean where they have already managed to establish sizeable populations on the tropical coral reefs in the region (See Figure(s) 3). In an article

Figure(s) 3

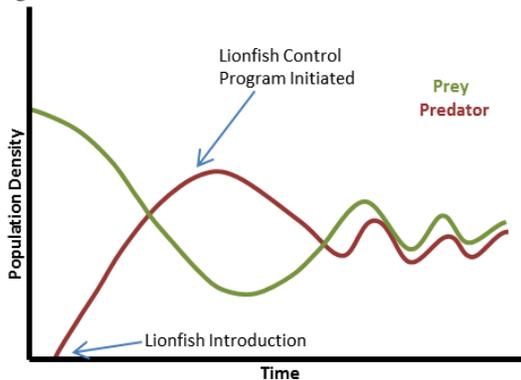


written for Business Insider speculations were made theorizing that they were first introduced by individuals releasing their exotic pets into the ocean. Inside that same article, background for how these fish got established was offered, "They can now be found in an area covering more than 1.5 million square miles (4 million square kilometers) in the western Atlantic, Caribbean, and Gulf of Mexico. With 18



*Encyclopedia of Modern Coral Reefs: Structure, Form and Process*

Figure 4



*Encyclopedia of Modern Coral Reefs: Structure, Form and Process*

venomous spines that can cause intense pain, and no natural enemies besides humans, these members of the scorpionfish family scare off any would-be predators. Even sharks will not eat them.” (Sheridan, "Florida Fishermen Take Lionfish Hunting to New Extreme.") Thanks to such defensive, evolutionary bodyparts, lionfish are free to feed, grow, and reproduce unhindered. Alone, this would not be an issue; however, this invasive species is willing to consume anything that is smaller than itself including the spawn of other fish such as vermilion snapper, nassau grouper, and red porgy.

Under the *Encyclopedia of Modern Coral Reefs: Structure, Form and Process* all three

of these fish species are considered to be keystone species due to their importance to coral reef construction, evolution, and ecology. With lionfish beginning to enervate the spawn populations of these immensely important reef fish, the overall biodiversity in the tropical reef systems has begun to gradually decrease(See Figure 4 above). James Morris, a leading lionfish researcher at the National Oceanic and Atmospheric Administration (NOAA) expressed his concern stating, “It is quite alarming that a small population of lionfish can literally consume millions of prey over the course of the year, so that is one of the reasons we are very focused on control.”(Sheridan,

"Florida Fishermen Take Lionfish Hunting to New Extreme.") Morris’ fears have been validated considering that by

introducing this truly ‘invasive’ species to the tropics of the Atlantic, perpetrators have already greatly weakened the ecological well being of these reef systems; however, this has not been nearly as detrimental as the impacts of direct human interaction has had on coldwater reefs.

Believed by scientists to be more diversified in coral species than their tropical sibling, coldwater reefs are a recently discovered natural phenomenon; regrettably, they are being destroyed before marine biologists are even able to study them in detail. Deep sea trawling is a popular commercial fishing practice worldwide, especially in the cold waters of Alaska and Norway. However, these are the locations of coral reefs which have endured thousands of

Figure(s) 5



The top *Oculina* coral reef is undisturbed. Trawling has devastated the one below, located at Oculina Banks off the coast of Florida. Only about 10 percent of *Oculina* habitat remains intact. Photo Credits: Top: R.G. Gilmore (NOAA, "Fishing Impacts.")

years of climate change, tectonic shifts and other global events through evolution, only to be destroyed by massive metal weights being dragged behind the boats of such fishermen (See figure 5). John Pickrell, from National Geographic, reported on the subject concerning actions being taken by the United Nations, “Concerned that many species may be lost before they are identified, a group of 1,136 scientists from 69 countries is (are) appealing for new laws to protect deep-ocean corals and sponges... ‘We urge the United Nations and appropriate

international bodies to establish a moratorium on bottom trawling on the high seas’.”(Pickrell,

"Trawlers Destroying Deep-Sea Reefs, Scientists Say.") While there has been a tightening on the management of such industries since the preliminary debates held back in 2004, there continues to be vast

amounts of destruction to the coldwater reefs. It is believed that through tighter international restriction the devastation can be stopped: Laws allotting specific areas to be trawled and utilized for commercial fishing would provide personal incentives to the fishermen to preserve those plots of ocean. Such legislation has failed to be passed as of yet. However, based upon recent efforts to preserve and even restore the damaged coral reefs, there is hope for the future.

The state of Florida contains over 50% of the United States tropical reefs and has been the primary region afflicted by reef degradation from invasive predators and coral bleaching. Over the past decade, numerous organizations have formed to both combat continued degradation and restore damaged reef systems throughout the state. The Coral Restoration Foundation, based out of Key Largo, has been a predominant source of restoration efforts in the Florida Keys. Through programs to establish coral nurseries and restoration projects, the foundation has been highly effective in its efforts. Researchers for the group explained the process, “Corals are grown in the nursery for approximately six to nine months. After they have reached a reef competent size, they are removed from the nursery, tagged, and taken to a local reef where they are attached directly to the reef using an underwater adhesive.” (“Restoration Efforts.” *Coral Restoration Foundation*) The nurseries are checked regularly for any signs of disease, predation, bleaching, and many other deteriorating factors that may impact the communities. During one event held in 2015 the foundation was able to raise \$120,000 to put towards its annual goal of transplanting over 20,000 corals to the coral reefs in the Keys. One of a multitude of organizations with similar motives, the Coral Restoration Foundation has managed to meet its goals of restoring the damaged reefs of Florida for the past several years; however, their actions are not the only methods being employed to counter the issue of continued degradation.

The rising populations of lionfish within the keys and gulf coast regions of Florida continue to mar the fragile reefs in the region: In order to combat this invasive species a number of organizations have begun to raise awareness for the issue through competitions and



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community events. The Reef Environmental Education Foundation (REEF) hosted its first annual ‘lionfish derby’ in 2009. A spearfishing competition, REEF’s event has since grown in popularity, having spread throughout the surrounding areas into the Keys and Florida

peninsula by groups with similar goals. A marine ecologist at Oregon State University, Stephanie Green, has been monitoring lionfish populations before and after such derbies, “Her team has found that killing between 75% and 95% of lionfish off reefs in the Bahamas was enough to help populations of local fish rebound.”<sup>2</sup>(Sheridan, “Florida Fishermen Take Lionfish Hunting to New Extreme.”) This is a hopeful prediction for the communities instituting these new competitions within local waters, as experienced scuba-divers can take several dozen fish off a single dive: These divers can make as many as four dives in a day equating to the possibility of removing hundreds of the invasive predators from the reefs. With tropical reefs beginning to rebound, researchers anticipate the re-creation of stronger systems than before the crisis thanks to the durability of the individual organisms that survived their predicament.

With coral degradation continuing to be an imminent threat to tropical and deepwater reefs, continued action has never been so urgently needed to rectify the issue. Considering the numerous threats which have only recently become impediments to the stability of these beautiful ecosystems, one could be hopeful for the future if the steps already being taken to

counteract such entities continue to be utilized. In 1936, Winston Churchill made a prediction: “The era of procrastination, of half-measures, of soothing and baffling expedients, of delays is coming to its close. In its place we are entering a period of consequences.” Churchill may have been referring to the impending onset of World War II but this statement has never rang more true than when applied to today’s coral crisis. While the majority of progress has been made in tropical waters around the Keys, rather than in the deep abysses which contain the deepwater reefs, scientists are still optimistic towards future legislation coming in time to conserve the degrading ecosystems of the deep before they transpire. Until such regulations come, efforts to reduce the invasive species and restore the reef systems are humanity’s best chance of preserving their most valuable resource.

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