

## The Wide Spread Negative Effects of Exposure to Excess Nutrients for Coral Reefs

### Introduction:

The majority of the Earth we live on is underwater, yet we know so little about life below the surface. It is not until the quality of our own lives are at risk of being diminished do we care to begin to understand these mysterious ecosystems and their inhabitants. Corals are incredibly fragile animals that live in shallow ocean waters. These animals form large colonies that form even larger systems that we know as coral reefs. The health of these coral reefs depends on quality of the water that they live in. Coral reefs play many important roles as a functioning ecosystem not only to the marine life that directly live within them but also to we humans on land. "Coral ecosystems are a source of food for millions; protect coastlines from storms and erosion; provide habitat, spawning and nursery grounds for economically important fish species; provide jobs and income to local economies from fishing, recreation, and tourism; are a source of new medicines, and are hotspots of marine biodiversity.[8]" For all of these services coral reefs have an estimated annual value of thirty-billion dollars(appendix A)[1,8]. However, corals are under dangerous threat pressure today. Over a quarter of the world's coral reefs have already been lost and another quarter are at risk of being lost within the next thirty years (appendix B)[1]. Threats that can harm corals are complicated, wide-ranging, little studied, and often interdependent upon many other factors. Some of the top most prevalent environmental threats are "global climate change, unsustainable fishing impacts, and land-based pollution.[1]"

*For conciseness, this paper will focus on the effects of excess nutrients on coral reefs in Florida waters.*

The popular coral reefs of Florida serve several important services to the locals and tourists of the area. Two of the major services that coral reefs provide are fishing and scuba diving. Tourists come from far and wide to go scuba diving at the Florida reefs. These tourists support the local economy by supporting local hotels, scuba gear rental, diving guides, restaurants, etc. Locals who participate in fishing are benefiting from the reefs that provide habitat and necessary biodiversity to support and attract the fish and lobsters that fishermen seek. But as more and more people move to the shores of Florida small towns soon become housing developments that increase the sewage output into the ocean[9].

In 1988 a group of over fifty scientists met to pinpoint the factor driving corals to die in the shores of Florida. They identified excess nutrients to be the top priority stressor effecting the health of the corals[6]. This still remains true today while factors from other stressors also continue to increase such as increase in water temperature, overfishing, and direct physical damage from anchors and dredging[7]. The health of coral reefs depends on the water quality that it lives in. Sewage and land run off is toxic to corals. Two major chemical components from sewage and land run off that contribute to coral death are nitrogen and phosphorous.

Recently a group of biologists sought out to provide scientific evidence that would prove excess nutrients are harmful to corals. In June of 2009 they set up four test areas in Florida's coral reefs where corals would continuously and consistently be exposed to elevated levels of nitrogen and phosphorous. For each test area there was also a control area that was only exposed to the ambient amounts of nutrients. After three years of exposure the biologists went back to survey the results. "Over 1,200 corals were examined for signs of disease and bleaching. Corals within the enrichment plots had a two-fold increase in both severity and prevalence of disease as compared to corals in unenriched control plots[7]." Some coral species showed even more dramatic impact, such as the *Agaricia* species which had a 3.5 fold increase in bleaching as compared to its control (appendix C)[7]. One year after nutrient enrichment had ceased, the biologists returned to the plots. They discovered that there were no differences between the plots that were previously enriched and not enriched, suggesting that simple water quality improvement even over a short period of time can lead to vast improvement and stability of coral health [7].

With this evidence the most clear solution would be to build wastewater treatment plants in Florida not only where the most nutrients are being dumped into the ocean but also anywhere along the coast where nutrient sediment may be carried to the reefs via ocean current [4]. One such proposed wastewater treatment plant for the Florida Keys would cost \$65 million to build and \$4 million annually to operate and maintain [1]. "However, in the long-term, the benefits to the local population are much higher, estimated at around US\$ 700 million in Net Present Value terms [1]."

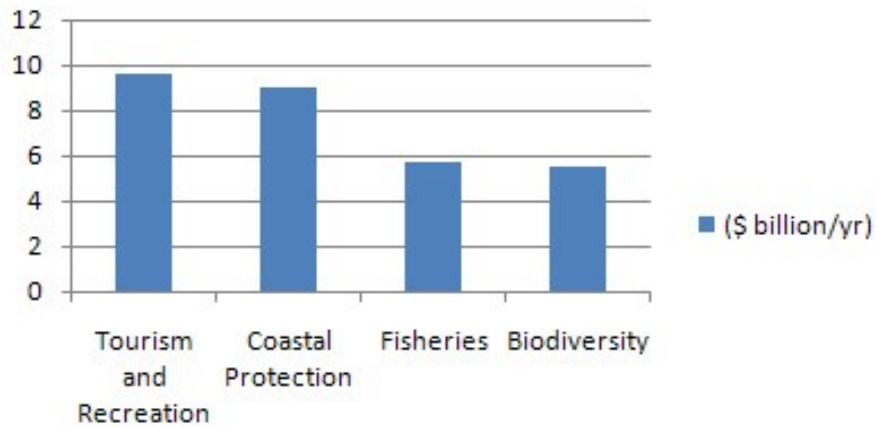
Excess nutrients are not the only threat to corals. To fully protect these fragile animals several other steps must be taken. The laws regulating how many and what of a fisherman's catch he is allowed to remove from the ocean in areas

around threatened reefs needs to be more strictly re-evaluated and upheld. The law must crack down on fishermen that are overfishing around reefs because overfishing limits the biodiversity of the coral reef ecosystem causing massive changes to their structure and order. Also, limits must be placed and enforced on the number of scuba diver visits to the threatened reefs. Too often inexperienced scuba divers cause physical damage to stony coral that may take hundreds of years to repair itself [9].

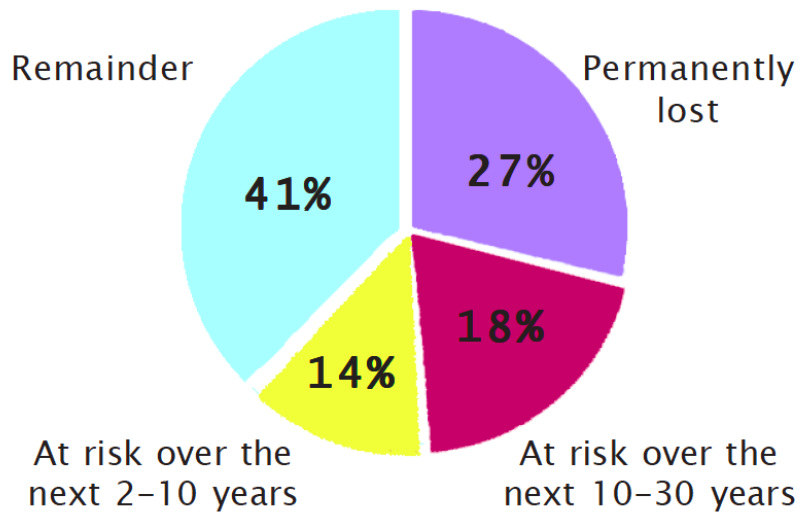
There are many aspects to our lives that are effected by the fragile balance of the ocean where coral reefs live. Coral animals are the backbone of reef ecosystems and without these coral animals the entire reef ecosystem would collapse. The health of these corals is dependent upon the ocean water quality where they live. Coral reefs provide many services to humans from recreational scuba diving to admire their aesthetic beauty to fishing for foods such as lobster and fish. As more people move to the shore, more waste and sewage is being emptied into the ocean. This waste contains chemicals such as nitrogen and phosphorous that are toxic to corals and causing them to die at high rates. If we want to enjoy the beneficial services provided by these reefs in the future then action needs to happen today. Wastewater treatment plants, stricter fishing laws, and scuba diving restrictions are corals only hope to survive.

APPENDIX

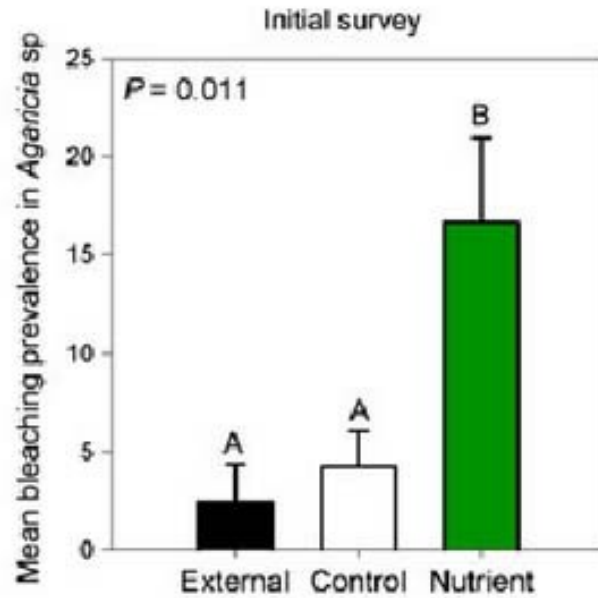
### Economic Value of Reefs



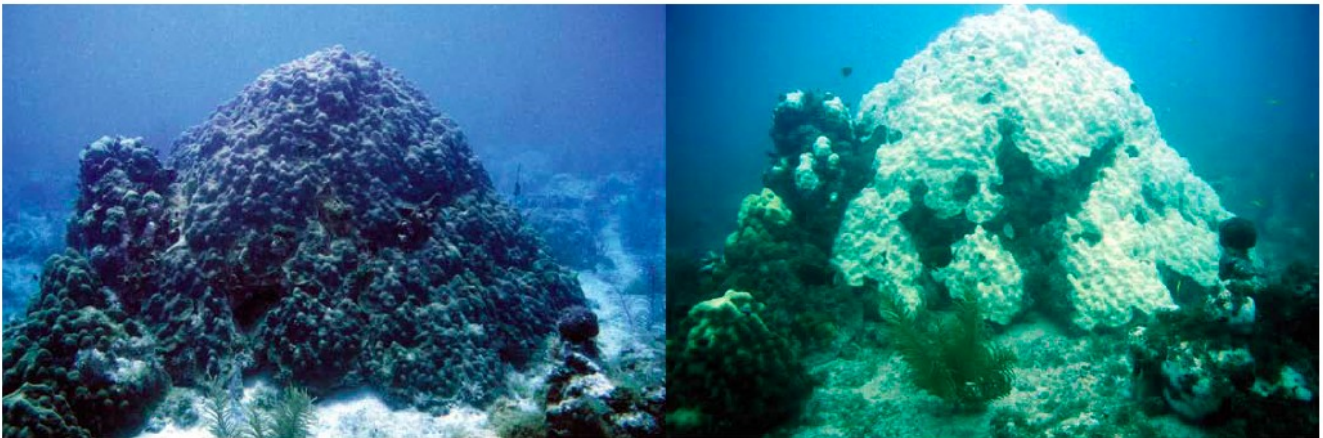
**Appendix A:** This bar graph visualizes the economic value of coral reefs in USD dollars in billions per year. [8]



**Appendix B:** This pie chart visualizes percentage of coral reefs lost and at risk of being lost in the near future. [1]



**Appendix C:** This bar graph visualizes the amount of *Agaricia* species coral found to be bleached after nutrient enrichment (green) versus the amount found bleached in the control group (white). [7]



**Appendix D:** A before and after photo example of the damage caused to reefs by coral bleaching. [2]

## BIBLIOGRAPHY

- 1) Cesar, Herman, Laretta Burke, and Lida Pet-Soede. "The Economics of Worldwide Coral Reef Degradation." (2003): n. pag. Web. <[https://www.wwf.or.jp/activities/lib/pdf\\_marine/coral-reef/cesardegradationreport100203.pdf](https://www.wwf.or.jp/activities/lib/pdf_marine/coral-reef/cesardegradationreport100203.pdf)>.
- 2) "Climate Carbon and Coral Reefs." World Meteorological Organization (2010): n. pag. Web. <[http://www.wmo.int/pages/prog/wcp/agm/publications/documents/Climate\\_Carbon\\_CoralReefs.pdf](http://www.wmo.int/pages/prog/wcp/agm/publications/documents/Climate_Carbon_CoralReefs.pdf)>.
- 3) "Environmental Issues with Coral Reefs." Wikipedia. Wikimedia Foundation, n.d. Web. <[http://en.wikipedia.org/wiki/Environmental\\_issues\\_with\\_coral\\_reefs](http://en.wikipedia.org/wiki/Environmental_issues_with_coral_reefs)>.
- 4) Leichter, James J., Hannah L. Stewart, and Steven L. Miller. "Episodic Nutrient Transport to Florida Coral Reefs." *Limnology and Oceanography* 48.4 (2003): 1394-407. Web. <[http://aslo.org/lo/toc/vol\\_48/issue\\_4/1394.html](http://aslo.org/lo/toc/vol_48/issue_4/1394.html)>.
- 5) Pastorok, Robert A., and Gordon R. Bilyard. "Effects of Sewage Pollution on Coral-Reef Communities." *Marine Ecology Progress Series* 21 (1985): 175-89. Web. <<http://www.int-res.com/articles/meps/21/m021p175>>.
- 6) Porter, James W., and Karen G. Porter. "Nutrient Enrichment and the Decline of Coral Reefs in the Florida Keys." *The Everglades, Florida Bay, and Coral Reefs of the Florida Keys: An Ecosystem Sourcebook*. Boca Raton, FL: CRC, 2002. 639-45. Print.
- 7) Thurber, Rebecca L. Vega, Deron E. Burkepile, Corinne Fuchs, Andrew A. Shantz, Ryan Mcminds, and Jesse R. Zaneveld. "Chronic Nutrient Enrichment Increases Prevalence and Severity of Coral Disease and Bleaching." *Global Change Biology* 20 (2013): 544-54. Web. <<http://onlinelibrary.wiley.com/doi/10.1111/gcb.12450/abstract>>.

- 8) "Value of Coral Ecosystems." NOAA's Coral Reef Conservation Program. N.p., n.d. Web. <<http://coralreef.noaa.gov/aboutcorals/values/>>.
- 9) Ward, Fred. "Florida's Coral Reefs Are Imperiled." *National Geographic* Jan. 1990: 115-32. Web. <<http://in-geol-server2.ads.iu.edu/Academics/CLASSES/G130/reefs/NG.htm>>.