Annotated Bibliography (MLA 7th Edition)

Bellwood, D. R., et al. "Confronting the Coral Reef Crisis." *Nature* 429.6994 (2004): 827 33. *ProQuest.*Web. 1 Sep. 2015.

Bellwood suggested that because of the destructive impacts of anthropogenic activities on coral reefs such as overfishing and pollution, there needs to be an increased focus on the management of coral reefs. These activities not only threaten corals, but also the fish that interact with corals. Corals maintain natural resiliency thanks to the help of three functional groups of fish: bioeroders, scrapers, and grazers. Members of these functional groups are typically plant-eating fish. They help support coral reefs by cleaning out dead coral, removing harmful sediments, and eliminating harmful algae in the immediate vicinity respectively. Unfortunately, overfishing has taken a toll on the populations of herbivorous fish in areas such as the Caribbean. Specifically, species that used to make up 30% to 50% of the fish population in the Caribbean have been completely wiped out due to overfishing. Because there are fewer fish to maintain the coral reefs, the corals’ rate of recovery slowed immensely. In order to prevent this, Bellwood stressed the importance of cracking down on the management of tropical fisheries as well as the creation of more NTAs (No Take Areas) in and around coral reefs. However, the act of expanding NTAs is easier said than done in some areas of the world. While Australia has increased the size of the NTA in the Great Barrier Reef Marine Park from about 5% to 33%, developing countries that rely almost solely on coral reefs are less likely to implement similar changes. This article touched upon the negative impact humans have on marine ecosystems and helped convey the relationship between humans, corals, and herbivorous fish in a way that stressed the importance of taking action against harmful anthropogenic activities.

Hoegh-Guldberg, Ove. "Coral Reef Sustainability through Adaptation: Glimmer of Hope or Persistent Mirage?" *Current Opinion in Environmental Sustainability*(2015): 127-33. *ScienceDirect*. Web. 8 Sept. 2015.

 Hoegh-Guldberg’s review article addressed research concerning the natural sustainability of coral reefs. Specifically, the article focused on a coral’s ability to change phenotype by attracting different symbiotic algae, evolving over generations, and migrating to more favorable climates. Unfortunately, these processes are inadequate when compared to the rate at which the global climate is changing. Because 75% of coral reefs worldwide are threatened and 95% are expected to be wiped out by 2050, Hoegh-Guldberg noted that it is nearly impossible for processes geared towards sustainability to keep up with the rate of rising global temperatures. There was even mention of a study done with corals exposed to pre-industrial, modern, and projected future climates. While the corals exposed to pre-industrial ocean conditions thrived, those exposed to modern conditions started to bleach and those exposed to projected future conditions died. However, sustainability processes do occur, albeit at a much slower rate and with limited effectiveness. For example, corals change and adapt slowly over long periods of time through the process of evolution. Even though organisms like bacteria with generations lasting from minutes to hours evolve fast enough to keep up with climate change, coral generations last anywhere from a few years to a century and take much longer to evolve. Also, although there is evidence for migration among corals, the rate of movement is much too slow to escape the effects of rising temperatures. The slow rate of change is not the only challenge faced by adapting corals because although changes in phenotype can occur much more rapidly, the act of attracting different symbiotic algae puts corals at risk for disease. Hoegh-Guldberg stressed that because the research on natural sustainability does not hold up against the rate at which global temperatures are rising, which is about 2 degrees Celsius per year, humans need to devote more attention to limiting pollution and slowing climate change. Otherwise, coral reefs will be wiped out long before they have the chance to adapt to changes in climate. This review article simultaneously outlined the current global issues concerning coral reefs, and projected a realistically grim future by debunking research surrounding the natural resiliency and adaptability of corals. In short, this article demonstrated that the rate of climate change is too fast for coral reefs to adapt to.

Maboloc, Elizaldy A., et al. "Stress Responses of Zooxanthellae in Juvenile Tridacna Gigas (Bivalvia, Cardiidae) Exposed to Reduced Salinity." *Hydrobiologia* (2015): 1-10. *Springer*. Web. 8 Sept. 2015.

Maboloc’s study was interesting because it investigated the effects of reduced salinity on reef-dwelling organisms, other than corals, that share symbiotic relationships with algae. In short, this research article acknowledged that a reef is a complex ecosystem made up of a variety of organisms. Specifically, juvenile giant clams from the Philippines called *Tridacna gigas* were exposed to low salinities in order to compare their response to that of corals exposed to reduced salinity. This change in salinity typically causes corals to expel zooxanthellae through a process referred to as bleaching. Bleaching, which occurs when an organism expels its zooxanthellae, is deadly because without a symbiotic relationship, organisms like corals are more likely to starve and die. The conditions in this study were modeled off those in and around the Philippines because monsoons can cause dramatic drops in salinity in these areas. While water with 35 parts per thousand salinity served as the control salinity, water with 18 parts per thousand and 25 parts per thousand salinities served as the experimental salinities. Remarkably, although the density of zooxanthellae in the clams in the lower salinities decreased, bleaching was not observed. Because this study observed only juvenile clams, it would be interesting to observe whether or not mature clams would respond in a similar fashion. Nevertheless, Madoloc’s study stressed that it is crucial to take into account the responses of a variety of organisms living in a coral reef in order to determine both the health of the reef, and how the health might be affected by changes in its environment. In addition, this experiment offered a different perspective on the biological responses to stress in a coral reef since it focused on giant clams rather than corals.

Sabine, A. M., et al. "Environmental Conditions Influence Tissue Regeneration Rates in

Scleractinian Corals." *Marine pollution bulletin* 95.1 (2015): 253-64. *SCOPUS.*Web. 1 Sep. 2015.

Sabine’s study investigated how several environmental factors impacted the recovery rate of scleractinian corals located near St. Thomas, U.S. Virgin Islands. Artificial lesions were created to replicate physical damage commonly caused by predatory fish or inclement weather. While the corals all possessed similar lacerations, their environments differed in water clarity, current strength, and proximity to human activity. By observing how long it took for each coral to regenerate tissue at the site of a lesion, Sabine noticed a general trend that revealed that corals exposed to higher currents, clearer water, and less human intervention healed up to three times faster than corals exposed to murkier water. One hypothesis for this phenomenon stated that because humans indirectly stirred up sediment in and around reefs through the development of nearby areas, they increased the turbidity of the water and put more stress on the corals. Stress can be devastating for corals because stressed corals expel zooxanthellae, the algae that share a symbiotic relationship with the coral, and starve. The major stressor in this experiment was turbidity. Turbidity caused permanent damage in the 15% of corals that did not regenerate new tissue. In addition, lesions that took longer to heal were hypothesized to be less likely to heal completely. Unfortunately, the lack of regeneration left these corals more susceptible to the adverse effects of diseases such as bleaching. This study observed the risks associated with environmental variables, such as turbidity, that slowed regeneration and left corals susceptible to disease. In addition, it revealed how even indirect human activity can cause lasting damage to coral reefs.

Van Dam, J.W., et al. "Combined Thermal and Herbicide Stress in Functionally Diverse Coral Symbionts." *Environmental Pollution*204 (2015): 271-79. *ScienceDirect*. Web. 8 Sept. 2015.

Van Dam’s study demonstrated how herbicides can impact and accentuate the negative effects of thermal stress on corals and symbiotic microalgae. While this article did investigate environmental factors, it also devoted some attention to genotypic factors by observing how two different types of algae (referred to as clade C1 and clade D) reacted to the environmental factors. Exposure to increased temperatures and diuron (a type of herbicide) occurred simultaneously in order to model the conditions that the Great Barrier Reef is exposed to during monsoon season. During this time of year, the weather gets warmer and runoff increases due to heavy rain. On their own, herbicides and increased temperatures have been shown to overwhelm the photosynthetic ability of symbiotic microalgae, causing corals to bleach and starve by expelling their algae. The clade C1 algae, which was known for its rapid growth, exhibited early signs of bleaching after exposed to these conditions. In addition, even though the clade D algae was known for its increased tolerance to rising temperatures, its tolerance was canceled out by the combination of high temperatures and herbicide. This research suggested that because different genotypes failed to counteract the negative effects of increased temperatures and herbicides, genotypic advantages among symbiotic algae may not be enough to protect corals from bleaching. In addition, this article revealed the complexity of the cause-and-effect relationship between corals and their environments by examining the combination of increased temperatures and herbicides caused by monsoons.