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Senior Project

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REEF RESTORATION

The reason why I chose the topic of reef restoration was because I have always felt a connection to the ocean. The connection I felt became even deeper when I earned my dive certification and had my first experience in a new world. Then, the day came when I was getting my dive gear on and preparing for my first dive. At first I was nervous, but as soon as I began to sink below the lapping waves, I felt at peace. I stopped bobbing up and down and I was just floating there, a few feet from the ocean floor. Out of the corner of my eye, a flash of color bolted by. A small school of colorful fish, spooked by the unexpected guest in their home. All around me I saw new life, life I had never seen before.

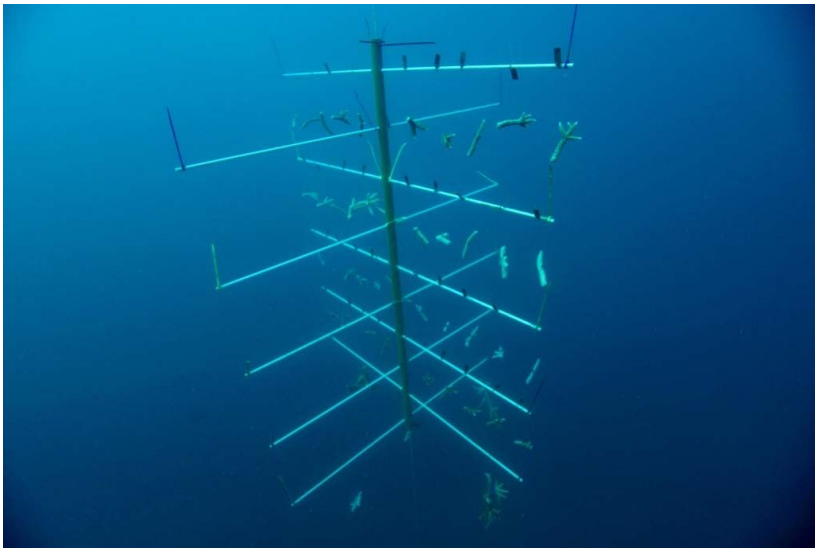
Before my first first experience as a diver, I had already known about the issues of the ocean, but had never witnessed it myself. In 2018, my family and I went on vacation to the island of Grand Cayman, and that is where I was first introduced to the world of scuba diving. This also is where I first really saw the true state of our coral reefs. The first time I entered the water in full scuba gear, I didn't really take in all of my surroundings, because it was my first time going under water for a long period of time without reemerging. The second time I got in the water, I felt much more comfortable with my gear and the amount of time that I was under. This really allowed me to be able to look around and absorb my surroundings. Even though the tropical coral reefs in the Grand Cayman are beautiful, I knew deep down that they used to be

even more magnificent. This is what led me to research the topic of our coral reefs and how, specifically, to conserve them.

I had already known for awhile that the reefs had begun to die off due to global warming, but I had no idea that there is so much more to it than just that. From that point, I needed to know the answers to certain questions that would be key to my research. What are the main causes of the reef die-off? What will be the outcome if the reefs were to die off? Is there a way for people in their everyday lives to contribute to the conservation of our coral reefs? In asking myself these questions, I was able to come up with my main research question: *How can I and others help our world's reefs grow and flourish from their current state of decay*?

THE STORY OF MY SEARCH/RESULTS

I began my research in mid-March by looking for different reef restoration programs around the world. I hoped that in understanding a program's approach to helping our reefs and how I could join one might increase my knowledge. At first all I really saw were some scams disguised as the programs I was looking for, but then I found one that looked legitimate. The name of this program is Coral Restoration Foundation and they offer three main programs: Restoration, Science and Education. In their restoration program, they grow coral on "Coral Tree Nurseries" to plant on dying reefs. This process is known as fragmentation. It is where programs such as this have their volunteers go out, collect finger like pieces of coral and connect them to pvc pipe tree structures via fishing line. This allows the coral to grow in a safe environment until they are big enough to be planted and survive.



(image of a pvc pipe structure for the process of fragmentation)

This isn't the only process for regrowing/repopulating dying reefs. There is also a process where loudspeakers are placed all around a dying reef and the sounds of a thriving reef are played through them. Researchers found in doing this, it can increase the reef population in a dying reef by 50% within 40 days. With the fragmentation method, for seven years, they have successfully planted more than 74,000 critically damaged corals . In their science program, they work with 11 different species of coral with 303 coral genotypes (Coral Restoration Foundation). They do this in order to make sure that they can restore the reefs in a way that makes reefs resilient to the ever-changing ocean. Within the education program, they try to educate as many people as they can about the state of our reefs and how we can help them together.

After reading about all these amazing programs within the Coral Restoration Foundation, I was raring to join. It had everything that I was looking for. I decided to go back onto the web and find another reef restoration program, so that I could get a wider understanding of what different restoration programs were doing to help our reefs. A couple of days after researching

other programs, I found one. This reef restoration program is located on a small island off the coast of Belize called PODVolunteer (website PODVolunteer) and they help in a slightly different way. Instead of having three different programs, they just have one, which is that you go to this island for a week to dive, remove invasive species (e.g. lionfish) and help clean/restore the reefs. This program also made me extremely excited, and I wanted to participate in both in order to widen my knowledge of reef restoration.

I brought this to my parents who thought these two programs would be a great experience for me, but then they reminded me of the hard truth. In order for me to join these two volunteer reef restoration programs, I would have to spend a ridiculously large sum of money, which made it unreasonable to do both. Not only was the first program too expensive, it required a three week commitment and the school felt concerned about me missing that much school. This left me with a quite challenging decision. Should I go with the program that has a large reef restoration program that is based in just one location (Florida), or the program that has many bases of operation, which might give that program more knowledge on how to help our reefs. In the end, I decided to go with PODVolunteer in Belize. The reason why I chose to go with them is because from what I read, they seemed like they would have much more knowledge about the process of reef restoration than the program in Florida.

Once I had made my choice about a program and was happy with that choice, I moved onto the real research for my topic. I began by going onto the PODVolunteer website and reviewing their “World Environment Day-Lionfish Are Invading” and their “Why Does Sunscreen and Sun Cream Damage Coral Reefs" pages. From these two pages, I was able to get quite a bit more information than I was expecting. On the web page about the invasive

non-native species of lionfish, I learned about how lionfish came to be so invasive and how much of an impact they have on the coral reefs and their population. It is suspected that the invasion of the lionfish population started around the year 1985, when the owners of lionfish dumped their aquariums into the ocean to dispose of their pets. What they didn't know at the time was that the lionfish species breed at an extremely high rate (a female can produce up to 2 million eggs a year), meaning that this fish soon was all over the place. It is also not very helpful that the lionfish have absolutely no natural predators since they are not native to our waters. That's not all. Each one of these fish will eat anything that can fit in their mouths and that can be anything that is up to two-thirds their size. There have been some studies that show that just one lionfish can reduce the number of species that it can consume on a reef habitat by 80% in less then one week. If this extremely invasive species doesn't get stopped through population control soon, they could be the cause of the destruction of both reef and fish stocks. This is not only terrible for the places that this occurs, but it also will greatly impact the livelihood of the species that depend on the reefs (World Environment Day).

(image of a mature male lionfish)

As for the epidemic of sunscreen or sun cream, it has been calculated that around 14,000 tons (28,000,000 lbs) of sunscreen has come off humans each year while we participate in ocean activities. Awareness about sunscreen has grown to where people are sure that sunscreen plays a pretty big role in the one-fifth decline of the reefs over the past three years. The main destructive chemicals that are found within sunscreen are oxybenzone and octinoxate. When reefs are exposed to chemicals like these, the reef's new growth will be killed and it increases the bleaching of coral reefs. Sunscreen doesn't just affect coral reefs, but it also has an impact on the sea creatures living on the reefs. For example, sunscreen can cause defects in newborn shellfish and can cause male fish to demonstrate feminine traits. On the bright side, all of this can be avoided if we come together and start to use reef-safe sunscreen that has no poisonous chemicals. Finding reef safe sunscreen is really not that hard. All you have to do is when you go to buy your next bottle of sunscreen, check to see if it has no poisonous chemicals under ingredients or you can look for "reef-safe" labeled sunscreen. There are also mineral based sunscreens called "non-nano" sunscreen. This kind of sunscreen is made with zinc oxide and titanium oxide. These two mineral based oxides do exactly the same thing as traditional sunscreen, but they are environmentally safe (Why does Sunscreen).

One place that people use sunscreen a lot is at resorts. Some resorts have started a movement to become more sustainable to help the environment. It is hoped that this resort sustainability movement will have a ripple to all resorts around the world. Since sustainability is such a big topic right now, the resorts participating in the movement have begun to ramp up their efforts to reduce their energy and consumption. There is also a resort called The 114-room Conrad Bora Bora Resort in French Polynesia that has started to regenerate 17 different coral

structures as an activity for tourists (Suri). This, to me, is a great way to get people to help out in a fun way.

Once I had researched all about the main causes of why the reefs are dying off, I began looking at what could be the outcome if the reefs were to completely die off. The main possibility, if this were to happen, would be that the life reefs support could die off and it could also further affect our atmosphere. The reason why the die off of reefs could affect our atmosphere is because corals remove carbon dioxide from the atmosphere. Without corals, greenhouse gases and fossil fuels could accumulate more quickly in our atmosphere. There is also the possibility for a toxic algae that grows at a fast rate and grows in the place of dead coral to take over a whole reef ecosystem. Reefs are our first line of defense against storms that erode the land, and so if reefs go extinct, we will no longer have that defense. This means that the land will more easily erode, and if there were to be an intermediate storm near a coastal city, it could wipe that city out.

In learning about that issue, I wanted to know more about how we as the people who are causing this could help. Unfortunately minimal information was available about this topic in my research. I came to understand that we need to cut down or completely cut out fossil fuels and greenhouse gases. In order to achieve this, we would need to drastically reduce our carbon footprint. We can also help in the process of removing invasive species around the world by using reef safe sunscreen and reducing the impact of commercial fishing.

After learning all this new information , I began my first interview with a member of one of the reef restoration programs I had found. Since my interviewee, Gemma, is based out of Europe, I had to converse with her over email. This proved to be a bit of a challenge because

once I had sent my email to her, she didn't respond for a week. Finally when Gemma responded to my interview questions, I was somewhat let down because she answered my questions very minimally and I already knew all the information she sent me. The information that Gemma gave me were some simple articles that I actually had already found and used "World Environment Day" and "Why does Sunscreen". I didn't feel very fulfilled after that and this is what led me to look for someone that I already knew for my second interview.

For my second interviewee, I chose my step-uncle, Alec Norschow, who has a degree in marine biology and had much to say about the state of our reefs in the interview. His thoughts about our reefs and what the outcome could be if they die off are very scientific and clearly he has put a lot of time into learning about our ocean's ecosystems . When I asked Alec, "how do you think people in their everyday lives can help support the restoration of our coral reefs?" his response was:

> "Unfortunately earth's ecosphere changes on a time scale that is all but impossible for a species with a life span of less than 100 years to relate to. I think the best we can do is try not to contribute to global warming and ocean acidification. That means reducing our carbon footprint by trying to use little or no fossil fuels and reducing or abstaining from eating beef which is a major source of methane, another greenhouse gas that is even better at trapping heat in our atmosphere then carbon dioxide. I believe however that even if we completely eliminated our production of both these gases tomorrow, it would still be too late to stop or reverse the current atmospheric and biological trends affecting our reefs."

His thoughts on the matter are quite insightful and I agree with him one hundred percent. I believe that we need more people who think like Alec in our community, so that we can grow and come together to be able to conquer the issues of our planet.

GROWTH AS A RESEARCHER

Throughout the course of writing my research paper, I was able to go out and answer the questions that I had set out to uncover at the beginning of the process. Although I was able to find all this great information about our reefs, all I did was scratch the surface of my journey for the future. As I continue on with this research topic for my senior project and possibly more, I will hopefully be able to uncover more secrets about how to become more sustainable in my lifestyle. This will make it so that my actions don't have the negative impact that a person's everyday life has on our earth's reefs and ecosystems.

Coming to the realization that I can help the planet and hopefully teach others to do the same has really got me excited to continue on with my research and work hard when I join the reef restoration program in Belize. I will take with me for the rest of my life what I learn from the program in Belize and my continued research to help our planet to the best of my abilities. Overall, my experience of going out to research a topic that I care about has given me the skills I need to go confidently into my senior project.

Finally in a week in November of 2019, I went to Belize to join the reef restoration program one hour off the coastline. It was a bumpy ride there, but when the other volunteers and I got to the island named Tom Owens Caye, we settled in quickly. We got to explore the island which didn't take long because you could walk around it in two minutes or less. The whole island was covered with beautiful tropical trees and the buildings were really amazing as well.

The buildings were really old and falling apart, but there was something about them that made you feel like you were completely disconnected from the rest of the world, and you could just be yourself.

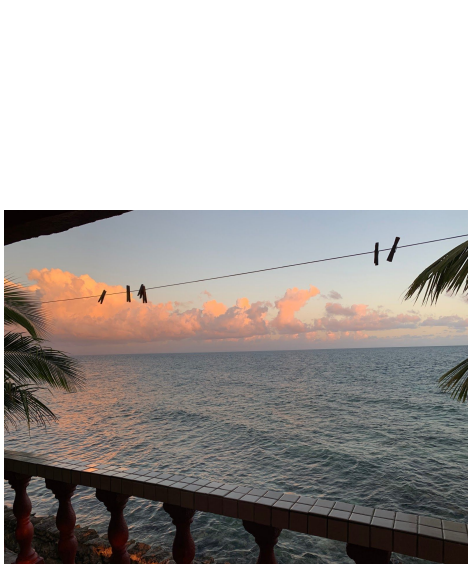
(island of Tom Owens Caye off the coast of Placencia, Belize)

During my trip to Belize, I listened to several short presentations about invasive species and bleaching coral and went on three dives a day to observe coral around the island I stayed on. The first day I arrived on the island, we had a presentation about what we would be doing for the week that we were there and we went on two dives. On the second day, we got an early start and went on a morning dive offshore to observe the coral nearby. For the second dive of the day, we went on a boat to where we did some invasive species (lionfish) removal. On this dive, our mission was to split into two groups, find the lionfish and remove them before they do too much damage. To hunt the lionfish, we took Hawaiian slings with us and that is what we used to spear the lionfish. A Hawaiian sling is a three prong spear with a slingshot like thick rubber band on the other end (see image below).

(hawaiian sling)

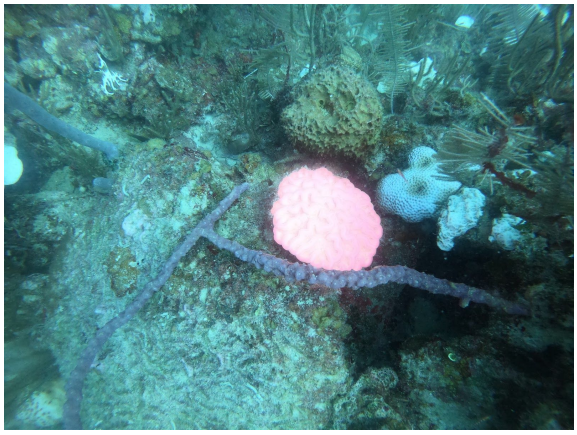
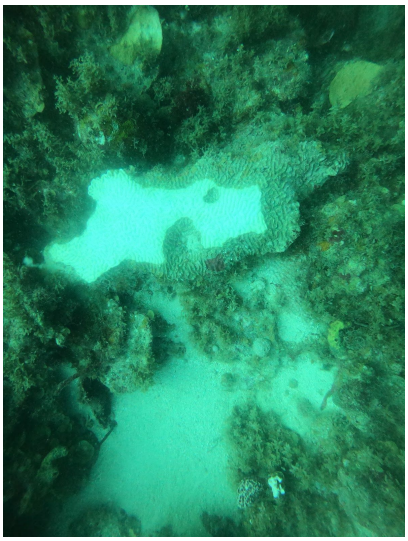
That evening, just before dinner, we went on our third dive of the day off shore and did some more coral observations. When I reached the coral on each of my dives, I could really tell the dead from the living. Either there were bright vibrant coral heads, or there were the groups of dull and smashed coral. To see all of this death was really quite sad and with every dead coral I saw, all I wanted to do was find a way to restore everything back to before global warming. Everyday after that was pretty much the same, except for on wednesday of the week we went on a two tank dive (where you do one dive off a boat and then a second one about 30 minutes to an hour later) off the boat and then went to another island where we collected trash for an hour and brought it back to the mainland when we returned. Spending that hour collecting all the trash that had washed up on that small island's shore, gave a feeling of hopefulness that if more people do activities such as collecting trash, we could really make a difference. Thursday, our last full day on the island was a bit odd. After waking up that morning to a very nice sunrise, there was some light rain and choppy waves and then there was a moment where there was a full on storm with winds up to 80 mph and huge waves. The thing was, that storm only lasted approximately

five minutes and after it was done, there was a beautiful rainbow that arched right next to the island.



(photos taken within two minutes of each other)

After that the weather was a bit off for the rest of the day, so we decided to coral observation dives instead of traveling far out to remove lionfish. This is where I got most of my footage of dead or dying coral, which to my suprise can also be bright pink.

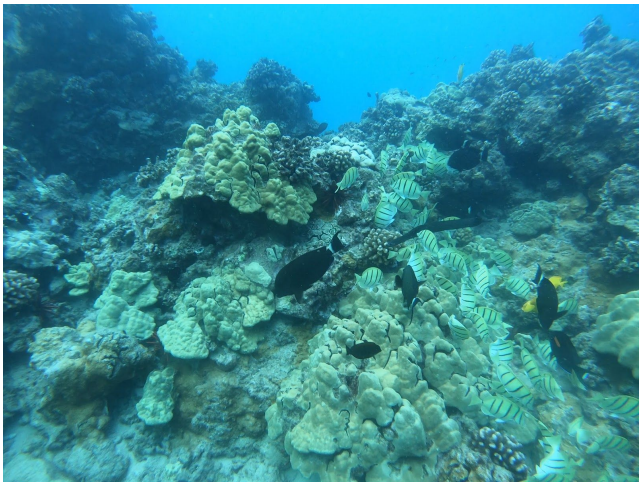
(head of bleached coral) *(head of partly bleached coral)*

(heads of completely bleached coral heads)

(sections of coral destroyed by bleaching, algae, lionfish and commercial fishing)

(sections of living coral heads)

(parts of two different reefs in Hawaii that are full of life)



(vibrant section of reef)

I didn't have a camera filter that shows the true colors of the coral, so it is difficult to see the difference between these photos of dying versus living coral reefs. Although the colors are muted in the photos, you can still see the difference in amount of life (fish) in each one. After observing the life and death of coral in person, I went back through the photos I had taken and I saw the dramatic differences. When I saw these differences, I got a sinking feeling in my gut and all I wanted to do was go back in time and stop global warming from ever starting. This is why I will continue to do what I can to help our oceans from removing invasive species like lionfish and sea urchins, to picking up trash on the beaches and using reef safe sunscreen. Overall, the experiences I have had throughout my life and in Belize will drive my passion to help try and save our oceans and in turn our planet.

Works Cited

"Coral Reefs." *Ocean Health Index*, www.oceanhealthindex.org/methodology/components/coral-reefs-area. Accessed 5 April, 2019.

This website explains all about coral reefs, the major sources that damage reefs, what impacts them and what has been done to help them. This page's main thesis is all about how the coral reefs are a very complex ecosystem and how they support quite a bit of sea life (25% of all sea life). Since all of the information given by this web page relates to my research topic, I was able to use a little bit of info here and there from the whole page.

Coral Restoration Foundation, www.coralrestoration.org. Accessed 12 May 2019.

On the homepage of the Reef Restoration Foundation, I was able to find information about their different programs and what is going on with our reefs. Within this foundation, they have three different programs: Restoration, Science and Education. From reading about these programs, I was able to get information that I needed for this paper.

Gemma. First Personal Interview. 5 April 2019.

In this interview with Gemma from PODVolenteer, I had to interview her over email due to her being into a different country. Since the interview was over email, it wasn't as enlightening as I would have liked it to be. When Gemma answered my questions, she did so very minimally and all of the information she gave me, I already knew. Even

though the interview wasn't exactly what I was looking for, I was able to learn a little more about the program she works for.

Nace, Trevor. "Underwater Speakers Help Revive Dying Coral Reefs, Study Finds." *Forbes*, https://www.forbes.com/sites/trevornace/2019/11/30/underwater-speakers-help-revive-dying-coral-reefs-study-finds/#1c765fd751f2. Accessed 2 March 2020.

Here's a quick overview of how this process works: For this method, the speakers are interspersed in a dying coral reef and recordings of vibrant and healthy reefs. Researchers found that in playing these sounds, it increased the population of fish species by 50%. The same experiment was also done with a completely dead reef and within 40 days the number of species increased. Even though this isn't regrowing the coral, it is beginning the process.

Nordschow Alec. Second Personal Interview. 16 May 2019.

My interview with Alec was quite enlightening, in that he brought a lot of new thoughts about our reefs to light. Since he has had experience with programs and marine biology centers, Alec was able to answer all my questions very thoroughly. After I had read all of Alec's thoughts about what I asked him, I felt very good and that I knew a lot more than I had before. Overall, this interview was much better than the first and I will use his information for my i-search and senior project.

"PODVolunteer." *PODVolunteer,*

https://www.podvolunteer.org/?gclid=CjwKCAjw-YT1BRAFEiwAd2WRtqfOG1-jtehV7tJaJ_5knlD_bWRxWAekfFF4IZfOa3i21-nLapHLBRoCFi4QAvD_BwE

Suri, Charu. "Hotels and Resorts Ramp Up Sustainability Efforts." *The New York Times*, www.nytimes.com/2019/04/17/travel/hotels-sustainability-ecotourism.html. Accessed 22 April 2019.

In this article Charu goes into how if resorts can become more sustainable, it will hopefully make a ripple effect out to other resorts and help our environment. Their main thesis is that since there are rising sea levels, rising carbon dioxide levels and plastic, so much plastic in landfills and the ocean, sustainability has become a big topic. From my research I was able to use the entirety of this article, especially the last section "Saving Coral Reefs." In this section, Charu goes into how some resorts have created programs to restore the reefs around their resort.

Threewitt, Cherise. "Scientists Develop Quick-Growing Coral Method to Save Dying Reefs." *Howstuffworks*,

https://science.howstuffworks.com/environmental/green-tech/remediation/scientists-develop-quick-growing-coral-method-to-save-dying-reefs.htm. Accessed 2 March 2020.

In this article, the author goes into detail about how fragmentation works. Here's a quick summary of the process: Go out and collect the living sections of a dying reef. Once collected, break down the coral into small "finger" like pieces. After this is done,

connect the coral pieces to a PVC pipe tree like structure. These coral trees should be placed in a safe aquatic environment until they reach a point where once they are reattached to a reef, they can continue to grow. Once the coral reaches the size that it can grow in its natural environment, they are removed from the PVC pipe trees and glued (biodegradable, reef safe glue) back onto the dead reef that they came from.

"Why Does Sunscreen and Sun Cream Damage Coral Reefs". *PODVolenteer,* www.podvolunteer.org/blog/why-does-sunscreen-and-sun-cream-damage-coral-reefs. Accessed 6 April, 2019.

On this web page the main topic is about why sunscreen and sun cream have such a damaging effect on our coral reefs. They go into how these two sun protection creams that tourists use have played a big role in our reefs dying off. Towards the end of the article, they talk about what you need to know about reef-safe sunscreen and they also give some examples of some reef-safe sunscreen. As with the web page before, I was able to use all the information given for my research.

"World Environment Day - Lionfish Are Invading." *PODVolenteer*, www.podvolunteer.org/blog/world-environment-day-lionfish-are-invading. Accessed 6 April, 2019.

On this web page the main topic is all about how lionfish are an invasive species, how they came to be so invasive and how we can reduce their population. The more I read the information about this invasive species, the more I was shocked about what their impact

is on the coral reef ecosystems. There was a study that proved that a single lionfish can reduce the number of a species on a reef by 80% in less than one week. For this page I was able to use the whole web page for my research.