BASIS Scottsdale

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Senior Project Proposal
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I. The Coral of it All: Air Pollution and Marine Degradation

II. Behind the sheer glass planes lies a world normally unseen to those not lucky enough to spend their time underwater. Aquariums are special in that they bring underwater life normally obscured by the inaccessibility of water up close and personal to the curious and fascinated public eye. The environments in the aquarium are tailored to the specific organisms therein, creating delicate ecosystems of marine life living independently of the greater ocean. Aquariums are different than the natural world in many ways, but one way that is often overlooked is pollution. Aquariums will never have the same levels of pollution that are found in our world's oceans. In order to examine how much pollution affects marine life , I want to ask how does a major aspect of pollution, pH, effect the foundation of many aquatic environments - coral?

III. In a literal and a figurative sense, I grew up on the water. I've been drawn to the water ever since I could articulate that I liked it. Aquariums are the perfect museum for me; they bring me right to the fish and the environments that I love most, and even allow me to learn from the exhibits. I want to have a career that allows me to work on the water and with marine life, and working at an aquarium provides me with a starting point to further pursue that career path. My familiarity with water and everything in it comes from a passion for fishing. Through that, I have learned a great deal about different environments all around the world talking to locals about their home marine environment.

Over the course of my senior project, I hope to find out more about the consequences of global warming by looking at its effects on a specific species. I'm excited to be in an environment where I'm surrounded by aquatic life, because I have never been given an opportunity to spend any extended amount of time working so closely with fish. As far as previous experience goes, I have a basic knowledge in biology and have spent most of my life fishing, but no in-class or research experience specific to marine biology. This internship will be a great entry-level opportunity for me to get my feet wet in the field.

IV. Surprisingly, there has been almost no research done on the treatment of marine life in aquariums. Research does exist in the form of full-scale investigations launched by the likes of *Blackfish* concerning large animals such as orcas and dolphins, however minimal research exists concerning the smaller fish. Instead, there are patents on methods to properly run an aquarium and guides for how to keep your in-home aquarium healthy, but I am concerned about the commercial aspect. However, many in-home aquarium tips apply to larger aquariums, and those standards can be used to judge other aquariums by. While the practical treatment of marine life has had little research, there are commercial standards put into place by the Association of Zoos and Aquariums.

The Association of Zoos and Aquariums (AZA) was founded in 1924 and is dedicated to the advancement of conservation, education, science, and recreation in Zoos and Aquariums. The AZA offers accreditation to institutions that pass their rigorous standards. According to the AZA, "animal care, welfare and sustainable population management" are the most critical aspects (AZA). While the AZA goes on to consider many aspects of aquariums, they focus on the institutional, rather than the biological, standards. The AZA focuses on the animal's physical and physiological needs, but never goes on to define what either of those are. Odysea Aquarium is currently seeking AZA accreditation status, and the aquarium employs many active members of the AZA, including committee members.

Unlike from the treatment of life in aquariums, coral has been steadily researched alongside pollution. In 2009, Carnegie Science warned that if carbon dioxide levels continued to increase, coral would simply start dissolving away. The increase in carbon dioxide in the water not only increases pH, but it also reacts in such a way to prevent the production of calcium carbonate, which is the figurative skeleton of many species of coral. On top of this, the rising temperature levels has started a phenomenon known as "coral bleaching" where the symbiotic algae that grows on coral and is essential for healthy coral growth has started to die off, leaving the coral 'bleached' white.

A 2010 research paper by Roleda, et. al found that young, growing coral grew the best in pH levels around 8.0, and the growth became less quick as the pH decreased. This shows that the increasingly acidic environment of our oceans is by no means an ideal environment for coral, and as the trend continues coral will simply not be able to grow. Research at the Advanced Aquarist shows that the problem is more than just a simple rise in pH, but rather how the pH is rising. The oceans absorb about half of all of our carbon dioxide emissions, and carbon dioxide raises pH. However, it may not be the pH that is causing the coral harm but only the carbon dioxide. Carbon dioxide increases the amount of carbonic acid, which inhibits the exchange of hydrogen ions and in turn prevents the production of calcium carbonate, which again provides the skeleton for coral.

V. The effects of carbon dioxide emissions on the oceans has detrimental effects in a multitude of ways. The ocean is becoming more acidic, which will ultimately affect all of marine life, but coral is being especially harmed. Coral reefs are some of the most diverse ecosystems in the world, providing tourist attractions and homes for all types of aquatic life. As coral becomes more and more damaged through the increasing pollution of the ocean, those incredibly diverse ecosystems will be damaged with it, eventually causing the death of one of the most unique environments in the world. By studying the main cause of the damage to coral, we can better understand how to prevent future damage.

VI. In order to analyze the effects of pollution to the world's waters on natural marine environments, I will simulate pollution and record the effects on populations of coral. Starting with four coral spores, I will grow two of the spores in identical spaces, recording pH and coral growth at regular intervals. Once the coral has grown to a predetermined amount, I will begin to grow the other two coral spores, also at the same time and in identical containers to the previous two. At the same time, I will begin to bubble Carbon Dioxide through the water of one of the new growth containers, and in one of the already grown containers. By bubbling carbon dioxide through the water, the

water will become more acidic, simulating the effects of pollution. I will continue to record the pH of the water and the size and rate of growth of the coral.

By comparing the two coral spores that have already grown, I will be able to show the effects of pollution on coral that is already established. By comparing the two coral spores I will grow in conjunction with the carbon dioxide addition, I will be able to show the effects of pollution on future coral growth potential. By directly analyzing the effects of an increase in pH as a means to measuring the effects of pollution, I can extrapolate my results to the world's marine ecosystem as a whole.

VII. The largest difficulty I see coming up with this project will be obtaining all of the resources necessary - although that can be solved quickly if OdySea Aquarium is generous - and the practical construction of the experiment. I will need to create four separate coral ecosystems as similar as possible with no previous experience, however I am confident with time and guidance I will be able to create a manageable environment for me to gather results in. Another potential problem could be a small sample size with only four separate resources to gather results from. This can also be remedied with time, where I can repeat the experiment in a different setting.

VIII.

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