METHODS OF ENCOURAGING PLASTIC LITTER REDUCTION AMONG COLLEGE STUDENTS

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ABSTRACT

The health of the environment is our responsibility, especially since we are the culprits behind its degradation. I theorize that it is neglect, misdirection, and ignorance that keep people on the sidelines and allow further harm to our earth; the negative consequences of yesterday's apathy are affecting us today. The question I wish to answer is how does exposure to empirical truths affect student action toward reducing plastic waste. Put simply, if one learns the truth, will they be more likely to help out? It would also be interesting to note the impact of environmental education methods typically used by the media. The next steps begin with a thorough education on the effects of plastics on our waterways, guided by ocean toxicologist Dr. Daniel Schlenk. We will start by learning about current projects similar to ours and reviewing literature associated with effective communication, notable data, and the decision-making process. Compiling the information in a palatable and illuminating format, as well as finding opportunities to share what we have found with the community, would come next. Once the visuals have been constructed, we will then lead groups of volunteers through a presentation with varying levels of empirical data. The final step will be to record how the information has influenced the individual's willingness to clean up common waste. At this point, we should have an answer to our question: once people know about the problem, what comes next?

ACKNOWLEDGEMENTS

This research cannot be called a product of my own effort. First, it was my faculty mentor, Dr. Daniel Schlenk, who patiently educated me on one of the most important problems of today and spent months ensuring the actuality of the project. It was also my Honors counselor, Dennis McIver, who connected the Capstone with reality and encouraged me to think boldly. Finally, it was my family, who left me alone when I wanted to be left alone and spent time with me also when I wanted to be left alone (lovingly). Without the support of these individuals, this project would be nothing more than a fading thought in the mind of a girl who never pushed herself in college. I thank you, your guidance has affected my life more than you will ever know.

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INTRODUCTION

Have you ever done something you thought might be good for the environment? If so, that is great! Have you ever done something you thought might be good for the environment without really knowing if it would be good for the environment? If so, welcome to the club. Perhaps you were told to recycle every piece of plastic with a recycling triangle on the bottom, or you heard that beach cleanups will single handedly save our oceans. You may find yourself surrounded by idle advice rather than factual methodology. Does that worry you?

It certainly worried me- hours spent berating my friends and family on "green" practices, while the only listing on my "Works Cited" page was Instagram. I see our world and the natural outdoor spaces we enjoy degenerating despite our good intentions. Those dazzling hikes, wonderous snorkeling spots, and relaxing beaches now seem to have a lifespan. What worried me was that "environmentalism" seemed to do little to no good in the face of our declining ecosystems. I thought we had to be doing something wrong and I pinned the issue entirely on misinformation about acting on the problem. There seemed to be only one course of action: research the truth about effective environmental practices.

I only began to make headway into uncovering these secrets when Dr. Daniel Schlenk agreed to lead me as my mentor. Dr. Schlenk is a professor of aquatic ecotoxicology and environmental toxicology at the University of California Riverside. His extensive knowledge on aquatic plastics, toxic chemicals, and their effects on aquatic life has been very apparent even before our first meeting. Having Dr. Schlenk's counsel on ocean plastic fundamentals, key research papers, and general study procedures was an integral part of the study and without his guidance, this capstone project would be frozen at square one. I am extremely grateful for his input and direction on the enactment of the study.

The scientific focus of the study became the effects of ocean plastic on marine life. It felt as if we had uncovered a trove of threats to aquatic life that I have never heard of before: “microplastics”, “plastic leaching”, and “obstruction” were words I had hardly ever uttered. Now, the cat was out of the bag and the answers were mind-consuming. With this wealth of information came the desire to share the truth with others to inspire action, thus, the title of the study: “Methods of Encouraging Plastic Litter Reduction among College Students”.

Anyone with a truth they are bursting to share knows that there are many ways to present their truth with the public. Not all methods of sharing, however, are created equal and have the same effects on the listener. With scientific content, we boiled it down to three pathways: highly data-oriented, highly emotional, and a mixture of both. Our goal was to find out which of the three lenses (facts, empathy, or a mixture) would paint the issue of ocean plastic in a way that would encourage individuals to take action for the cause. With this study, we have scientifically expanded previous knowledge of inciting environmentalism. We hope that the content and results can be used to chip away at the ocean plastic problem and preserve our diverse, extraordinary, and life-giving earth.

STUDY OVERVIEW

RESEARCH METHODS

The goal of the study is to analyze the cause-and-effect relationship between methods of presenting facts and the willingness to take environmental action. The action, in the case of this study, is picking up pieces of trash in local communities. This section outlines the steps taken to gather research participants, present three different perspectives on facts about ocean plastics,

and collect data on their subsequent "green" actions. Our hypothesis is the following: can environmental education alter attitudes and behavior regarding plastic?

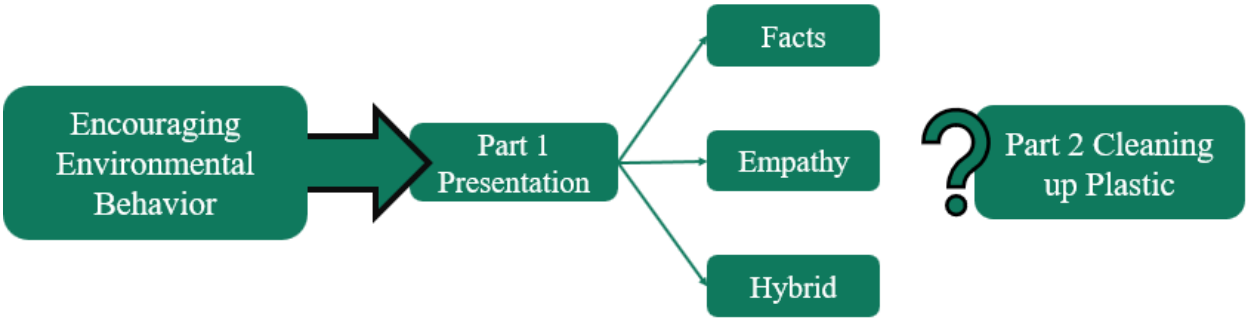
The first step to answering that questions was to gather study subjects. To do this, the team conferred with UCR's Institutional Review Board over a matter of months to gain approval to perform the study with human subjects. You may be aware that human subjects research requires very delicate handling. Due to some issues with communication with our sponsor, we were unable to secure funding to offer as compensation for our participants. This meant that we had to settle on a ninety-nine-person pool of subjects, although a greater pool of individuals would have provided more scientifically significant results. Our inclusion criteria asked for the following: undergraduate University of California, Riverside (UCR) students that speak English, are over the age of 18, and can access zoom over the internet. Access to the internet and zoom was critical, being that the entire project had to be carried out remotely (more on this predicament under "COVID-19 IMPLICATIONS"). Potential participants were sought via social media platforms, such as Instagram, with the help of University Honors at UCR. Students who were interested in the study were linked to a qualtrics survey to read more on the project, obtain informed consent, and choose meeting times for part one of the study.

Part one of the study would test if the three different viewpoints of the ocean's plastic problem might incite action among the volunteer population. Being that a planned ninety-nine students made up the entirety of the group of study subjects, each of the three groups could be divided into 33. For transparency purposes, it is notable to add that a member of the research team is particularly fond of the number 3, which largely contributes to the specificity in quantity of each study group. The first group was ordained to understand the issue of plastic pollution with the support of many scientific articles and facts. Group one participants would learn about

chemical effects of plastic leaching, the types of organisms affected by plastic obstruction, and even human-health implications in Southeast Asia. The information presented to them is not unlike the arguments presented in the "BACKGROUND RESEARCH" section of the paper. The second group would get the chance to understand the issue from an empathetic standpoint. The third and final group would learn about marine plastic both with an emphasis on the emotional reality and the scientific reality. Through the use of imagery from the media and blunt descriptions, we hoped that members of these last two groups would feel emotionally attached with marine life, and thus clean up plastic before it entered the ocean environment.

The last segment of data collection ended with part two of the study. Part one gave three subject groups thirty minutes (plus a questions and answer period) to gain a reason to pick up trash in their environment. The ninety-nine subjects would have then put their potential motivation to the test, and for the next seven days, the students would have been asked to search for a piece of trash in their communities and throw it away. The trash did not have to be plastic. The students could look for trash anywhere beyond the front doors of their homes. In addition, the students would have been asked to fill out a five-minute survey that would note if the participant searched for and threw away a piece of trash, which would tell researchers how difficult the trash was to find or, more importantly, if the student looked for rubbish in the first place. Another key aspect to note is that part two of the study would have been emphasized as completely optional. Being that we focused the research on the cause-and-effect relationship between education and environmental action, it would be important to allow students not to participate in part two of the study. If students were not motivated to pick up rubbish after learning about the ailments of plastic pollution, then that presentation viewpoint may not have been as effective. After all, the goal of this study was to find whether factual evidence, emotional

connection, or a mixture of both is a more meaningful encouragement to taking environmental action.



COVID-19 IMPLICATIONS

Of course, all honors graduates for the year of 2020-2021 have had countless setbacks and changes-of-plan due to the COVID-19 pandemic. The minor issues we have encountered constitute a drop in the ocean of the countless tragedies brought on by the disease, but it is still worth it to note the full potential of the study to understand its shortcomings.

Campus closure restricted a number of aspects to the study, one being the method of recruiting participants. Meeting individuals in person to invite their participation would be far more favorable than through the digital gap left when subjects see a flyer for the study online. The project could have increased its research pool and therefore increased the significance of its results. Part one of the study, the interaction between the students and the three viewpoints of pollution, was originally planned to take place on campus and would have allowed for a far more engaging format than a Zoom presentation. First, in-person research would have allowed for a larger research team to prepare and gather information for the study. The research team would have led participants through an interactive, thirty-minute presentation in which volunteers would explore different aspects of the factual or emotional sets of information. This could have

created a more impactful and realistic experience of how students would learn about environmental problems, which in turn would allow for more realistic data for the study. The project did not meet its potential and the results are certainly skewed by the reality of the COVID-19 pandemic (more on this under "RESULTS AND TAKEAWAYS").

BACKGROUND RESEARCH

SIMILAR STUDIES

Initial research covered projects that were similar to the vision of our project. Unfortunately, few were found, either due to a lack of effective searching or a lack of similar studies. Thomas et. al's (2019) discussion on environmental education research pointed out that "understanding and measuring actual behavior outcomes is needed" and this action is key in "assessing the extent to which program goals have been met". The topics of measurable participant behavior post-treatment discussed in the aforementioned paper was a key aspect integrated into our research in plastic pollution. In addition, our project implements the specific allocation of time for environmental action, which is similar to the model used in Sebastian Bamberg's studies in which they applied the Theory of Planned Behavior (2002). In the aforementioned study, the author found that college students that set aside time to perform an environmentally-friendly action were 20% more likely to actually enact that action. Our hope with the design of our study was that, one, we would be able to ascertain the effects of treatment and, two, we would effectively encourage measurable behavior among the students. These goals were clearly met in the two papers discussed here.

PLASTIC RESEARCH

The task of properly educating the population required for this study began with a properly-educated research team. Dr. Daniel Schlenk, an aquatic ecotoxicologist and professor at the University of California, Riverside, is extremely knowledgeable on the topic of plastic's chemical effects, which comprised a large segment of part one of the study. Through his research suggestions and topic ideas, the team was able to assimilate the materials required for the data-heavy presentations. The following section describes the information assimilated and condensed into the factual and hybrid PowerPoints that were presented during part one of the study. The conversational aspect was included to make the zoom presentation as intriguing as possible.

The presentation starts off by noting that the listeners probably lived their lives using plastic. Specifically, the speaker brings up pre-wrapped PB&J sandwiches, a lighter kept for birthday candles, or maybe produce bags at the grocery store. Living in a first world country means abundant comfort, but it also means an inescapable dependence on plastic. This trait began to develop around the time of World War II, which saw the introduction of polyethylene, nylon, and polystyrene (Admin, 2017). Plastic manufacturers of the 50s and 60s transitioned from war to the consumer industry, and from there saw the rise of number two and number five plastics. Fast forward to today, we find that the applications of synthetic polymers are boundless, but that the convenience also came with a horrible price. Humans must now face the music and consider how the infestation of plastic has affected our planet, with extra attention to our oceans, and how to begin lifting its curse, all the while conflicting with ourselves and the luxury we are trying to relinquish.

To make the first steps toward a healthy relationship with synthetic polymers, one must first understand the balance between costs and benefits. While the benefits might be more obvious, the drawbacks to depending on plastic are still coming to light and take form in the

following ways: overabundance, exploitation of impoverished communities, and as a silent curse on marine and freshwater environments. These areas were introduced and emphasized mainly in the group one and group two presentations, which highlighted the measurable effects plastics have on ecosystems.

Since its introduction to the consumer industry in the 50s, plastic has become so abundant that countries are having trouble finding ethical ways to store the mess. For example, the United States exported 134 million pounds of plastic to Malaysia in 2019 (*Harms of Plastic Waste Exports*, n.d.). Considering that the U.S. is 28 times bigger than Malaysia, this shipment takes up massive amounts of space and, even more so, time, to rifle through in search of recyclables. In addition, North America and Asia oversaw the creation of The Great Pacific Garbage Patch, which acts as a drop-off point for trash caught in the Pacific Ocean's currents (*The Great Pacific Garbage Patch*, n.d.) and is thought to harbor about 80 thousand tons of plastic (Society, 2019). This mass is more than just an eyesore for the marine organisms of The Pacific as the plastic physically hinders life processes and distributes harmful chemicals. The versatility that synthetic polymers provide has developed into an overabundance that harms all animals (including humans), which in turn begs for a new approach to handling plastic waste.

Once first world countries distribute their pesky polymers, it's up to second and third world countries to suffer the consequences. Poor nations in the Indo-Pacific, including Malaysia, are typically on the receiving end of our plastic overabundance. Many sites that import waste in Malaysia have been found contaminated with metals (such as lead) and plastic additives (such as phthalates), which can cause intellectual disabilities and reproductive issues in humans, respectively (Haridas et al., n.d.). Being that third-world nations have little funding to properly recycle and dispose of the waste, the citizens are condemned to bear the brunt of first world

countries' extravagance. Although current research on the subject is rare, this unfair handoff and the subsequent health complications plague many third world countries that import plastic every year.

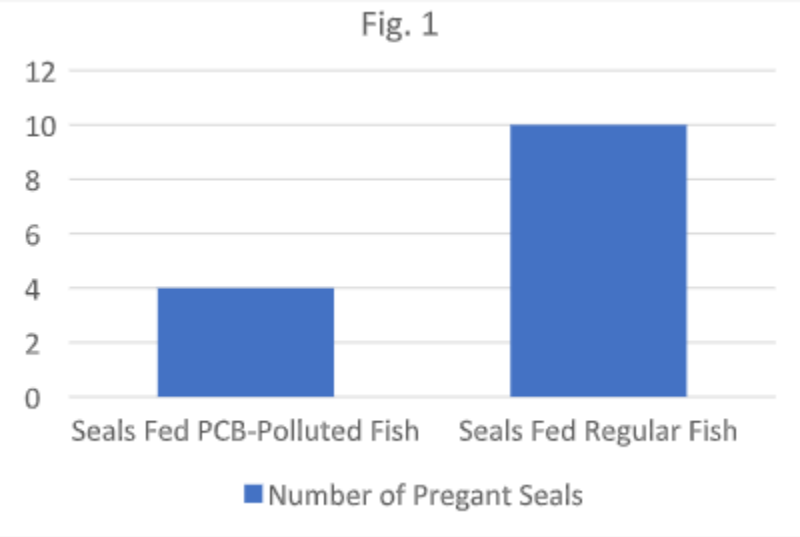
Finally, one must consider the effects of plastic on marine and freshwater life, since the ocean covers 70% of our planet, the material's introduction to aquatic organisms is inevitable. One path of impact is through obstruction by plastic, which can affect the respiratory and digestive systems of those afflicted. Seabirds are particularly prone to ingesting the material, especially pieces that float; in one study by Azzarello and Vleet (1987), researchers found that the presence of plastic in the stomach "depresses hunger" and prevents the work of digestive enzymes. The aforementioned effects are especially dangerous since, as you may know, eating is the only way large organisms gain the nutrients to survive. In another study, a sperm whale was found to have a ruptured stomach from the sheer amount of plastic it had ingested (de Stephanis et al., 2013). This means there was and might still be enough plastic mixed with the mammal's food source to cause such a gruesome fate. Finally, one might remember the uproar when scientists found an Olive Ridley sea turtle with a straw in its nose. Its rescuers concluded that the large amount of scar tissue and plastic hurt the turtle's fitness, therefore reducing its possibility to reproduce and reducing the overall number of sea turtles in that population (Robinson & Figgener, 2015). Cases like these give humanity a peek into how plastic can physically harm species, but perhaps a more alarming effect can be seen in how plastic can chemically harm species.

Synthetic polymers can further plague marine and freshwater animals by adsorbing (holding molecules on its surface) and releasing chemicals gained when manufactured or even gained on its way to the ocean. One group of additives (chemicals used to alter plastic's

properties) that companies use to make plastics strong and malleable are called phthalates. DEHP is a member of this group and can comprise up to 60% of PVC (number 3 plastics), which is often used to make blood bags, cable insulation, and even pipes that carry drinking water (Kim et al., 2002). While these applications make the material seem safe and stable, once exposed to the corrosive effects of saltwater and UV rays, the additive DEHP is released and wreaks its havoc, especially to organisms in shallow bodies of water. In one study using the popular model organism Japanese Medaka, 54% of the group not exposed to DEHP grew mature sexual organs; in another group, 10 µg/l of DEHP exposure was enough to prevent the maturation of sexual organs completely (Kim et al., 2002). To put it in perspective, this concentration of the phthalate is comparable to one drop of DEHP to four cups of water. This light level of exposure has great health effects on fish, and its strength will grow even more apparent as humans continue to allow number three plastic to accumulate in the ocean.

Plastic can also spread toxicants through adsorption, as one can see in the case of PCBs. Polychlorinated Biphenyls, or PCBs, are a sect of chemicals that were used (they are now banned to manufacture in the U.S.) in making plastic more flexible, in electrical insulation, and in adhesives (US EPA, 2015). Because of improper disposal into landfills, dumping, or leakage, these chemicals are now found in marine and freshwater environments and bind specifically to numbers two, three, and five plastics (Rochman et al., 2013). Here is an example: In the Netherlands, across a span of twenty-five years, people found that the seal population had dropped from 3,000 to less than 500 (Reijnders, 1986). It is also interesting to note that this large decline happened before the Dutch began ditching the use of PCBs. In one study on the effects of PCBs on the Dutch seal population, researchers compared two groups of twelve seals and fed the first group fish from the seal's typical habitat in the Netherlands and fed the second group fish

from a less-polluted area in the Atlantic Ocean. The group eating fish from the PCB-polluted waters had only four seals get pregnant while the group eating unpolluted fish had ten seals get pregnant (Fig. 1). This massive difference is attributed to the negative endocrine effects ingesting these chemicals has on marine animals. Who is to say what other chemicals can be adsorbed and leached into marine organisms through plastic abundance? While there are a myriad ways plastic can physically and chemically harm aquatic organisms, it only takes a few to convince one that the problem needs to be addressed as soon as possible.



The next steps down this path to a healthy relationship with plastic include lifestyle changes that overall reduce the amount of plastic an individual uses. Despite what we are taught, today's methods of recycling are not as important as originally thought. Popular Mechanics mentions that recycling plastic itself is not really profitable: "the apparent cost to you of throwing out the empty [bottle] or recycling it are identical: zero" (Hutchinson, 2017). Focusing on clean number one and two plastics, aluminum, and glass is a more environmentally friendly way of recycling as humanity develops better ways to reuse polymers. It is always key, however, to ensure that your trash (especially plastic) makes it into some sort of waste receptacle. Marine

and freshwater organisms have no ways to protect themselves from the polymer menace, and plastic left out in the open can travel to their habitats through rivers, gutters, and even on wind. Another way to decrease the material's use is to stop using plastic in general: wood, glass, porcelain, or stainless steel are all viable options. One might find that multi-use alternatives are particularly popular right now, especially in the realms of takeout, grocery shopping, and personal care. Minimizing plastic use is no easy task today in the United States, but soon everyone will start facing the repercussions, and today is the day we must decide to stop plastic in its tracks.

RESULTS AND TAKEAWAYS

The results of the study were, unfortunately, inconclusive. There was a gross lack of participation for the study and only two of the planned ninety-nine students were recruited from the subject population. This could have been another COVID-19 implication, a result of student exhaustion after two quarters of university, a recruitment method that presented the study as arduous and undesirable, or a lack of compensation. Whatever the case, parts one and two of the study never came into effect.

RECOMMENDATIONS MOVING FORWARD

The results obviously left something to be desired, being that we will never know exactly how this method of environmental encouragement would apply in the field. Recommendations moving forward with the study can only include what will be performed differently if the study were to be polished and revamped.

The small volunteer pool could indicate that UCR undergraduates do not feel plastics are an issue or feel that the subject is not interesting enough to engage them. First, those considering reapplication of the project should incorporate compensation into the study. With no benefits other than knowledge, students likely did not feel that spending a week involved in voluntary research was very productive; adding a gift card or physical prize would be an excellent way to gain participants. If the study were to be continued on its home campus of the University of California, Riverside, the funding for this aspect of the study can be obtained through Green Grants offered by the Green Campus Action Plan.

Also, the study should take place at a certain point in a college academic year when students feel inclined to participate in extracurriculars or activities. This period should be as close to the start of the school year as possible, since students will then have more time to dedicate to opportunities. Another suggestion would be to take an active approach to advertising. This past unsuccessful trial of the study was conducted completely online and students were only passively subjected to flyers regarding the study when scrolling through emails or social media. To recruit for this study, one must be on the subject college campus with flyers for students and a willingness to engage in conversation. Students were very dissuaded to participate because there was a digital barrier up during the remote academic year, but meeting in person will allow for more personal interaction and will encourage more students to volunteer in the research.

In addition, part one of the study could be reimagined to be more engaging than a thirty-minute, uninterrupted presentation. As was mentioned in “COVID-19 IMPLICATIONS”, the portion of the study dedicated to educating participants could have supported an interactive aspect in which subjects could talk with volunteers who specialize in the various aspects of the study. This would allow for more questions answered, more complex concepts to be internalized,

and more human connections formed. This would likely affect the results for part two of the study by inciting more students to actively search for waste to throw away in their communities.

Part two of the study could be enhanced through the use of the free app, Literatti. The app is similar to iNaturalist in that students can take their phones and snap a quick picture of any litter they encounter while searching for those five minutes each day. The photo would automatically be geotagged and uploaded to a shared project database. The integration of this software would be extremely beneficial, since researchers would not need the five-minute survey included in this version of the study. It would promote a more natural response to the presentation, since the students would not be searching for plastic simply to respond to the five-minute form, but to capture a picture of refuse to prove they made a commitment to ending the abundance of plastic waste in their community. Implications of this aspect would include additional scrutiny from the Institutional Review Board, since researchers would have to be extremely careful with the data surrounding participants geographic location.

Finally, those contemplating continuing research on this topic should consider fundamentally changing the criteria for part two of the study. A goal of this project is to prepare individuals to make a difference in the plastic problem the world faces. In complete honesty, there are more helpful alternatives to picking up small bits of trash that could better combat our reliance on plastic, such as completely halting the use of plastic altogether. Researchers could instead monitor the number of environmentally-friendly decisions that the participants actively make throughout the week using the survey in part two of the study. Changes such as these could allow for more impactful, universal, and significant research in the field of environmental behavior.

CONCLUSION

To revert back to the first person, hello, my name is Laura, and I began this project in October of 2019. The thought originated in the mind of an environmentally-illiterate individual who wanted some form of pressure to instill imperative information about our planet into herself. As mentioned in the introduction, the study was truly sparked by a distaste for misinformation and a hope that we as individuals could take environmental action based on research-backed problems and not issues that the media emphasized for their own gain.

The project was at first centered around sustainable actions with money: the research team would speak with students in person about the scientific plastic problems (with only one lens rather than three) and the students would then be prompted to buy stickers knowing that 100% of the proceeds would go toward a respectable organization centered on keeping oceans clean. This seemed to be too much of a slimy gambit, so the project turned its focus onto environmental action specifically in the subjects' neighborhoods, and the rest is history. Thankfully, Dr. Daniel Schlenk agreed to oversee the study early in its creation, which is why you are able to read a completed paper at this very moment!

My main takeaway from this almost-two-year experience is that research is very difficult and I commend every student, professor, and researcher who has managed to earn their name under the title of a published work. Gaining Institutional Review Board approval and collaborating with my mentor taught me to have productive conversations; designing the presentations and flyers for the study taught me about art and advertising; finally and most importantly, learning about the multiple avenues of harm that plastic can bring to marine organisms and humans brought the project full circle and taught me why everyone needs to adopt

a heart of environmentalism. I live every day in our polymer-filled world thinking about the truths gained from this study and do my best to act on our reality that threatens the health of tomorrow's oceans. If we as individuals finally make the decision to take responsibility for our one and only planet, green actions can turn the tides.

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APPROVED IRB APPLICATION AND PRESENTATIONS

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