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A Call to Action: Education Driven Strategies for Successful Implementation of Blue Economy Initiatives at Coastal Universities

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A CALL TO ACTION: EDUCATION DRIVEN STRATEGIES FOR SUCCESSFUL IMPLEMENTATION OF BLUE ECONOMY INITIATIVES AT COASTAL UNIVERSITIES

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Abstract

Microplastic pollution impacts the earth's oceans. Research at the deep sea and surface level, as well as research examining different bodies of water, indicates this problem is widespread. This research examines data from 2012 to the present to assess the impact the human stressor of microplastic has on marine ecosystems and ocean sampling and the insight that peer reviewed research on microplastics can provide as coastal universities create Blue Economy strategic action plans. Data indicates microplastics are a critical issue to the oceans overall health. The implications of the research are designed to target a variety of community members at coastal universities. The implications include a call to action for responsible landscape design and education-driven initiatives that target faculty and students.

Keywords: *Microplastics, pollution, ecosystem, human stressor, coastal universities, Blue Economy*

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Chapter 1: Introduction

Seventy five percent of the earth is covered by the ocean; therefore, human attention to the pollution within the ocean is essential. The U.S. generates the most plastic waste in the world. The U.S produces 42 million metric tons of plastic each year or 286 pounds per person. The volume of plastic produced by the U.S. is one of the major problems that leads to microplastics ending up in the ocean. If the U.S. generates the most plastic waste out of any country, plastic is bound to end up in the ocean. If plastic ending up in the ocean is not bad enough, a recent study has found the first microplastics in the human bloodstream. In an article by Damian Carrington, Environmental editor at *The Guardian*, Carrington cites new research by Leslie and Lamoree (2022). Leslie and Lamoree (2022) found microplastics in 80 percent of the 22 people tested in their study in the Netherlands. The microplastic pollution in the ocean is problematic, and this issue is now relevant to the human body as well.

While this information is relevant to countries around the world, the importance of microplastics in the ocean is necessary to examine on a smaller scale, as organizations and individuals grapple with their own personal footprint. Roger Williams University, a school of 4,844 students located along the Mt Hope Bay, has issued a strategic action plan that focuses on the Blue Economy. This initiative will provide guidance for the school seeking to reduce their impact on the ocean in 2022. Current research should be used to provide guidance to coastal universities seeking to meet the demands of these initiatives. This research aims to address the prevalence and impact of microplastics in the oceans and should be used by coastal universities to guide decisions they make regarding microplastic usage.

Statement of the Problem

Microplastics are in the ocean, which causes many issues for marine organisms and the marine ecosystems they live in. The problem is that microplastics are toxic to the oceans and cause the ocean not to function as it should. Currently, the ocean is believed to absorb “30-50% of the Co2 produced by the burning of fossil fuel” and microplastics inhibit the oceans from absorbing Co2 (UNEP, 1993). Additionally, microplastic pollution is often consumed by marine life. The cause of microplastic pollution is multifaceted. Some of this environmental pollution is from humans littering but storms, water runoff, and winds also carry microplastics into the oceans. Microplastic pollution is a major concern that causes issues for the marine ecosystems and the fish that live in them.

Most of the research that has been done on microplastics in the ocean is relatively new, so there has been limited research on this issue. Researchers often cite this gap in the literature. As the oceans are vast, researchers are challenged to provide a comprehensive and thorough view of the whole ocean. The main issue is that the human stressor of microplastics is affecting the marine ecosystems and ocean sampling throughout the world. According to the research, microplastics are in every ocean, and it affects the productivity of marine ecosystems. The research suggests that microplastics are a bigger issue than people might think because it is so new to the radars of scientists.

The problem of microplastics being in the ocean is that it affects the world's marine ecosystems. It also affects the marine life that lives in those marine ecosystems. The effect of microplastics on the oceans also affects human life because without the ocean functioning properly the world can not filter most of the carbon dioxide out of the air. The ocean helps the earth filter out most of the carbon dioxide from the air, and when the ocean has microplastics in

the water, the ocean becomes acidic, which makes it so the ocean can not do its job of filtering out carbon dioxide. The main reason why microplastics in the oceans are a big deal and should be fixed is that the ocean is a huge part of the world and proper functioning of the ocean is essential for marine and human life. As the research also shows that microplastics also could have a big impact on the world as a whole, the aim of this research is to help figure out how humankind can reduce the microplastics in the ocean moving forward.

This paper will provide a review of literature on microplastics in the oceans and rivers around the world. The literature review in chapter 2 will examine marine ecosystems as well as water composition. Based on the peer reviewed literature, this paper will conclude in chapter 3 by providing implications for practice that coastal universities should consider when working to reduce microplastics, a focus of the Blue Economy initiative.

Significance of the Research

One target audience for this research are scientists that study the ocean and microplastic pollution. Additionally, individuals and companies who want to minimize the impact of plastic pollution in the ocean should be aware of this information as well. For example, big companies located close to the ocean should consider the placement of trash and recycling receptacles, which are oftentimes located too close to the ocean. Additionally, coastal universities are a target audience for this research because they border the ocean but also should model educational best practices in their students. In a more narrow lens, this research could help improve the behavior of individuals who live in close proximity to the ocean and who use the ocean for private boating purposes. The knowledge provided through this research has the ability to alter human behavior.

Ultimately, this research has a great impact on the world because it shows the negative impact of plastic pollution on the ocean and marine ecosystems.

Research Problem and Research Question

The limited research available on microplastics in Atlantic Oceanic sampling as well as the impact of ocean currents on microplastic spread at the surface and deep sea level can provide coastal universities insight into their Blue Economy strategic action plans and highlight recommendations for responsible ocean sustainability. This paper will explore two questions:

- What impact does the human stressor of microplastic have on marine ecosystems and ocean sampling?
- What insight can peer reviewed research on microplastics provide as coastal universities create Blue Economy strategic action plans?

Definitions of Key Terminology:

Microplastics are tiny particles of broken down plastic that end up in the air and oceans. They are fragments of any type of plastic.

Marine Sediment is any deposit of material, rock and soil particles that settle at the bottom of the ocean.

Marine Organisms are anything that lives in the sea like fish, shellfish, or any organism that calls the ocean its home.

Marine debris is waste that has purposely or accidentally been released into the ocean.

Copepods are a group of small crustaceans found in nearly every marine habitat.

Crustaceans make up a large percent of ocean life, which includes such animals as snails and clams

Water Composition is what the water is made up of and what is in the water that is not water.

Omnivores are fish that eat both plants and other fish.

Toxicology of the ocean is the study of how toxic the sea water is to marine organisms and marine ecosystems.

Nutrient Cycles is the replenishment of the ocean nutrients in a cycle nature.

Positionality

One aspect of my identity that impacts my positionality is geographic location. I grew up in Massachusetts and spent summers on Cape Cod. Due to this, I grew up with boats. My family all my life has been on the ocean in some form or fashion. My family owns kayaks, a sailboat, and a powerboat. My geographic location impacts my view of the ocean and access to it. Another facet of my identity that impacts my positionality is education. I am getting a captain's license. I am getting my OUPV Six Pack Captain's License through the Mariners Learning System. This license puts into perspective why the ocean is important and what it does for the marine industry. Finally, my internship experience with a Massachusetts boat service that is used for transportation impacts my positionality. During my internship, I make round trips to Martha's Vineyard several times a day each week. Oftentimes I see trash near the ocean and have first-hand knowledge of what is polluting the ocean.

Due to my geographic location, education and internship experience, I hold a set of biases and beliefs about the ocean. I see that people pollute the water on a daily basis. For example, I know that freight definitely goes over the boats all the time, which pollutes the ocean with boxes and plastic. I see trash and plastics in the water from trash and recycling receptacles that are placed in close proximity to the ocean. Anything that belongs in a trashcan ends up in the ocean if it is too close to the ocean.

Additionally, I believe there are a variety of nations responsible for this problem. The U.S. produces the most trash of any nation with the exception of China. The U.S. uses plastics for many consumer items like straws, bottles, and utensils. In addition to nations that should accept responsibility for this problem, all individuals are responsible for this problem. Despite the fact that this is not done purposefully, all individuals hold responsibility for this. One way to provide a solution to this problem is to create as many nonplastic substitutes for plastic materials. This would be especially valuable for countries that have a large impact on the ocean environment.

My own positionality has changed over time because before I started learning about microplastics I had not reflected deeply on the impact or scope of microplastics in the ocean. Now that I'm on the ocean for my job all the time I see things that I would have never thought about before I was learning about microplastics. For example, I notice now whenever trash goes into the ocean more than I did before. The more that I think about plastics and the future of our oceans the more I realize when plastics go into the ocean and other debris.

Conclusion

The purpose of this research is to find what impact the human stressor of microplastics have on marine ecosystems and ocean sampling. The target audience for this research is coastal universities as well as scientists that study the ocean and microplastic pollution. Additionally, individuals and companies who want to minimize the impact of plastic pollution in the ocean should be aware of this information as well. This research is really important also for the big companies that want to cut down on their plastic waste and see why plastic waste is a great issue that needs to be dealt with. This research is important because microplastic pollution is very

toxic to the ocean and the marine life that live in it. This shows us how much microplastics actually impact the oceans.

The next section is a literature review, which will talk about the marine ecosystems, fish, marine crustacean, marine organism, sediment and beaches. Additionally, this work will focus on water composition, which occurs through samples taken by boat. The purpose of water sampling is to figure out the plastic density of the water samples from different bodies of water, which ultimately indicates how our oceans are impacted by microplastic pollution.

Chapter 2: Literature Review

The human stressor of microplastics have a big impact on the ocean's marine ecosystems and water sampling. The purpose of this senior thesis is to examine what impact microplastics have on oceans as a whole and what the future of the oceans looks like if the human stressor of microplastics continues. This senior thesis looks at water sampling and marine ecosystems and how those two topics relate. This thesis examines the different seas and looks at how much microplastics play a role in disrupting the productivity of the ocean and the marine ecosystems.

This literature review will focus on how microplastics affect the seas and marine ecosystems. The first theme will provide a background on the marine ecosystems and the marine life that lives in them like fish, marine crustaceans, marine organisms, and marine sediment. The second theme will provide background on water composition and how the water composition of the ocean is very important to the ocean's productivity. The examined research will look at water sampling via boat and plastic density in water sampling.

Marine Ecosystems

Introduction

Marine ecosystems are affected by microplastics. Microplastics harm marine ecosystems, which cause them not to function properly. This theme emerged from an examination of literature regarding how microplastics affect the productivity of marine ecosystems. Microplastics are devastating to marine ecosystems because they cause imbalance in the ocean. In addition to microplastics affecting the marine ecosystems, they also affect the fish that live there as well as marine crustaceans, marine organisms, marine sediment and the beaches.

Fish

Recent studies show that fish are very important to marine ecosystems and they are one of the most affected parts of the ocean when it comes to microplastics. Fish are one main part of marine ecosystems that are being affected by microplastics. Studies have found microplastics in most fish that live in the ocean. Fish that live in the marine ecosystems eat things that have microplastics in them and in return get microplastics inside them.

In a quantitative study conducted by Digkaa, Tsangarisa, Torreb, Anastasopouloub, and Zeria (2018), the researchers studied fish and mussels from Corfu Island in the Northern Ionian Sea. They looked at the digestive tract of frozen fish and mussels from this region to find out if fish and mussels had microplastics in their stomachs. Microplastics (125 items in total) were found in 37 mussels, 17 sar-dines, 8 common pandoras and 8 red mullets. This study suggests that filter feeders and other similar species are more prone to microplastic pollution. This leads to more questions. In future research the researchers recommend studying a greater variety of fish species.

In a quantitative study conducted by McNeish, Kim, Barrett, Mason, Kelly, and Hoellein (2017), the researchers studied whether microplastic in riverine fish are connected to species traits. The researchers acknowledged that:

> "Microplastic abundance in fish was not significantly different among the three study sites ($P>0.05$) and ranged from 10 (±2.3) to 13 (±1.6) microplastic particles fish−1. They found that only one species of fish over all three sites was consistent. Round goby was the only fish present across all three sites, and gobies from SJ River had approximately 50% less microplastic concentration compared to those collected from the MG and MK Rivers." (McNeish, Kim, Barrett, Mason, Kelly, & Hoellein, 2017, p. 5)

This study leads to more questions. In further research they suggest researchers study different species to compare how different species are affected by microplastics.

In a quantitative study conducted by Mizraji, Ahrendt, Perez-Venegas, Vargas, Pulgar, Aldana, Patricio Ojeda, Duarte, and Galbán-Malagón (2017), the researchers studied whether the feeding was related to the content of microplastics in fish guts. In the conclusion, the researchers acknowledged that "microfibers were the more abundant class of microplastics in all the samples, representing an average abundance of 99%" (Mizraji, Ahrendt, Perez-Venegas, et. al., 2017, p. 499). The researchers found that the feeding type of omnivore had the highest concentration of microplastics in the fish's guts. In order to find out what is being affected the most by microplastics, they have to study all different species of fish.

In a quantitative study conducted by Qianga and Chenga (2019), the researchers studied whether exposure to microplastics decreased swimming competence in larval zebrafish. The purpose was to discover how microplastics affect different fish species. In conclusion the researchers acknowledge that "in this study, polystyrene microplastics were significantly taken up by zebrafish larvae at 96 hpf at the concentrations of 100 and 1000 μg/L. Exposure to microplastics significantly decreased swimming competence in zebrafish larvae not only in the free swimming test, but also in the light-to-dark alternation stimulation in dark period" (Qianga, & Chenga, 2019, p. 232). This, however, leads to more questions about which fish species is affected the most by microplastics and why. The researchers suggest that future research can examine microplastics across more species of fish to determine whether the swimming of all fish species are impacted in the same way.

In a quantitative study conducted by Phillips and Bonner (2015), the researchers studied the occurrence and amount of microplastic ingested by fishes in watersheds of the Gulf of Mexico. A total of 116 marine fishes were examined, representing eight species and five families. They found that plastics were detected in 12 individuals. The researchers found that "occurrences of microplastic ingestion was ubiquitous among all water bodies, taxonomic groups, and trophic guilds quantified in this study" (Phillips & Bonner, 2015, p. 267). The data shows that even though the occurrence of microplastics was ubiquitous that microplastics were still found in almost all of the species of fish that were tested.

Marine Crustaceans

In the oceans, fish are not the only species that are affected by this microplastic crisis. Marine crustaceans are also one of the species that are living in the ocean and being affected by microplastic pollution. Microplastics harm every living thing in the ocean, even marine crustaceans. The marine crustaceans are affected at the deep sea level when the microplastic particles sink to the bottom of the ocean.

In a quantitative study conducted by Jamieson, Brooks, Reid, Piertney, Narayanaswamy, and Linley (2018), the researchers studied "microplastics and synthetic particles ingested by deep-sea amphipods in six of the deepest marine ecosystems on Earth." In the conclusion, the researchers acknowledge that the "results of this study explain that man-made fibers including microplastics are ingested by lysianassoid amphipods at the deepest location of all the Earth's oceans." The researchers found that microplastics are being ingested by almost all the species in the ocean. This, however, leads to more questions than answers. Further research, they argue,

might consider that there are species that the researchers poorly understand and they can not observe experimentally and could not get data on prior to contamination of microplastics.

In a quantitative study conducted by Bai, Wang, and Wang (2021), the researchers studied the effects of microplastics on marine copepods. In the conclusion, “the biological effects of microplastics in marine copepods are ascribed to, but not restricted to, the microplastic properties (such as age, type, shape, and size) and tested species” (Bai, Wang, and Wang, 2021, p.230).The researchers found that the ingestion of microplastic in copepods is very common. Microplastics have a major effect on marine copepod feeding activity. The researchers also found that “phenotypic plasticity may render the copepods showing resilience in response to stressors including microplastics. Instead, if a stressor is too intense, then it may wipe out the most sensitive genotypes from the copepod population, hence resulting in genetic erosion” (Bai, Wang, & Wang, 2021, p. 10). They found that this stressor could wipe out many copepod species.

Marine Organisms

Marine organisms are also affected by the human stressor of microplastics in the ocean. Microplastics in the ocean are not just something that harms one thing. When microplastics enter the oceans, they affect every living thing in the ocean. This section shares literature on zooplankton and the toxicology effects on marine organisms.

In a quantitative study conducted by Troost, Desclaux, Leslie, van Der Meulena, and Vethaak (2018), the researchers studied whether microplastics affect marine ecosystem productivity. In the conclusion, the researchers acknowledged that microplastics have a very big impact on the productivity of zooplankton and their ability to photosynthesize, which in the end

hurts the productivity of the marine ecosystem; if zooplankton can not photosynthesize, then the marine ecosystem will not function properly.

In another study done about microplastics ingested by zooplankton conducted by Cole, Lindeque, Fileman, Halsband, Goodhead, Moger, and Galloway (2013), researchers drew a similar conclusion. The conclusion of this study found that microplastics can be ingested by zooplankton when they filter feed. The researchers found that as the zooplankton grow in size so does the amount of microplastics they ingest while they are feeding. The researchers found that the more microplastics zooplankton ingest the more effect it has on their ability to digest and ingest food, which is harmful to the zooplankton.

In further research of microplastics, the researchers Ivar do Sul, Costa, and Fillmann (2014) conducted a study "in the pelagic environment around oceanic islands of the Western Tropical Atlantic Ocean." In the conclusion, the researchers acknowledge that floating microplastics are polluting the western tropical Atlantic. They also found that secondary sources of microplastics were more dominant in this region than they expected. In order to have the ocean and all its marine life functioning properly the human stressor of microplastics need to be reduced.

In a literature review conducted by Guzzetti, Sureda, Tejada, and Faggio (2014), the researchers discuss the environmental and toxicological effects of microplastics in marine organisms. In the conclusion they talk about how plastic debris is ubiquitous in the marine environment and the microplastics enter the marine environment through human activities. Microplastics are so small that they can be available to many marine organisms. The dangers of microplastic pollution on marine organisms is not just the ingestion of microplastics; it is also the

ability of the marine organisms to absorb the materials and process the microplastics to where the marine organisms can just pass the plastic particles but that is not the case. Also they talk about how the effect of microplastics on marine organisms is very important because if the marine organisms are not functioning properly then the marine ecosystem productivity is also affected. In order for the ocean to function how it should, the human stressors need to be less on the oceans.

Sediment

Marine sediment is the debris that settles to the bottom of the ocean. Marine sediment is very important in the functionality of the ocean and the marine ecosystems. It allows fish and marine organisms a place to live. Marine sediment also plays an important role in the nutrient cycle of the oceans and how the oceans function as a whole.

In a literature review conducted by You, Thrush, and Hope (2020), the researchers examined the impact of "polyethylene terephthalate microplastics (mPETs) on ecosystem functionality in marine sediment." In the conclusion, the researchers acknowledged that the function of marine sediment changed when they found microplastics in the sediment. They found that the marine sediment decreased in functionality to the ocean and marine ecosystems.

A subsequent study by Wang, Tan, Peng, Qiu, and Li (2016) talked about "the behaviors of microplastics in the marine environment." In the conclusion, the researchers found that they classified microplastics as a physical, chemical behavior toward the marine environment because microplastics have different ways of affecting the marine ecosystem.

Beaches

The effect of the human stressor of microplastics is something that humans can physically see with their eyes. They can physically see the plastic piling up on the beaches and floating in the water. Microplastics affect beaches not just in a physical way but in a chemical way also. Beaches are home to many marine creatures like sea turtles and many marine birds that are harmed by microplastic pollution. Sea turtles nest on beaches so if the beaches are polluted with microplastics then it affects the way the sea turtles lay their eggs.

In a literature review conducted by Zhang, Lin, Wu, Kong, Wang, and Shi (2021) the researchers examined the impact of microplastic on beaches and how that impacts the nesting ground for sea turtles. In the conclusion, the researchers found that microplastics have a big impact on the sea turtle's nesting grounds. The researchers found that microplastics affect the sea turtles nesting ground just from the sheer amount of microplastics on the beaches.

In a subsequent literature review by Martins, Rodríguez, and Pham (2020), the researchers examined "trace elements in microplastics stranded on beaches of remote islands in the NE Atlantic." In the conclusion, the researchers found that microplastics are so dangerous because they are available to a wide variety of organisms because of how small microplastics are.

Water Composition

Ocean water composition is affected by microplastics. Microplastics harm ocean water composition, which causes the ocean water to be imbalanced. This theme emerged from an examination of literature regarding how microplastics affect the water composition of the oceans. Microplastics are devastating to water composition because they cause imbalance in the ocean water, and if that happens then the ocean's water can not do its job filtering out toxic impurities

that humans produce. Microplastics impact the water composition, and water composition is tested through in boat sampling, allowing researchers to draw conclusions about plastic density.

Boat Sampling

Boat sampling is one method that scientists can use to observe and study the amount of microplastics that are present in our oceans. It is important to sample the ocean for microplastics because if scientists did not, people would never know how bad the pollution of microplastics in our oceans is. Boat sampling is one of the most used methods of sampling the ocean water composition because it is the easiest way to get around and have the best result.

In a quantitative study conducted by Lusher, Burke, O'Connor, and Officer (2014), the researchers studied microplastic pollution in the Northeast Atlantic Ocean through validated and opportunistic sampling. In this examination they were testing the surface water of the Northeast Atlantic with a flow through sea water system. They collected the surface of the water to see how much microplastics were on the surface of the water. In the conclusion, the researchers found that microplastics were abundant and widespread in the Northeast Atlantic. The researchers documented how the microplastic was ubiquitous in the waters around the Northeast Atlantic.

In a quantitative study conducted by Tanhua, Gutekunst, and Biastoch (2019), the researchers studied "a near-synoptic survey of ocean microplastic concentration along an around-the-world sailing race." The researchers shared that "in this study we present a near-synoptic (within 9 months) study with near-global coverage of microplastic abundance, sampled and measured in a consistent manner" (Tanhua,Gutekunst, & Biastoch, 2019, p. 8). The survey confirmed that microplastics are ubiquitous in the ocean. They found that microplastics

were even abundant far away from land. The data also shows that microplastics were prominent in the Mediterranean Sea and the South China Sea.

Plastic density in water sampling

Plastic density in the water is important to study because it displays how much microplastic is actually in sections of the ocean. It is important to see what the plastic density is in the oceans so individuals can know how bad the problem is, so people can brainstorm solutions to the problem. Scientists need to know what the plastic density is in the oceans to help solve the problem. The higher the density the worse it is for the ocean and everything that lives in it because the higher the density of plastic the lower the productivity of the ocean and the marine ecosystems that call the ocean home.

In a quantitative study conducted by de Haan, Sanchez-Vidal, and Canals (2019), the researchers studied "floating microplastics and aggregate formation in the Western Mediterranean Sea." The researchers share that "interestingly, in the aggregates we found high-density microplastics during sampling. Furthermore, by using a Manta Trawl net we largely concentrated in-situ captured marine aggregates and microplastics found over 1-Km distances" (de Haan, Sanchez-Vidal, & Canals, 2019, p. 532-3). This study "provides further evidence of the high abundances of floating microplastics in the Mediterranean Sea" (de Haan, Sanchez-Vidal, & Canals, 2019, p. 533). The researchers found that the combination of tourism, marine activities and intense flash floods all have been prominent sources of microplastic pollution. They found that microplastics are abundant in many different oceans.

Summary

Microplastics are a big issue when it comes to ocean productivity. Microplastics are more abundant than people realized. They are found in most seas and not just by the shoreline. The

research found that microplastics also play a big role in the productivity of marine ecosystems. This examination showed that the human stressor of microplastic is a big issue. They found that microplastic does not just have a physical impact, and microplastics also have a chemical impact on the ocean. Scientists have found that microplastics are becoming a bigger issue than they thought because to the human eye most people can not see the microplastics because they are too small so people just do not realize how bad microplastic pollution is. This research shows people that microplastic pollution is a real issue and just because idividuals can not see it does not mean it is not there.

Chapter 3: Implications for Practice

Revisiting Problem of Practice

This paper seeks to answer the questions: (1) What impact does the human stressor of microplastic have on marine ecosystems and ocean sampling? (2)What insight can peer reviewed research on microplastics provide as coastal universities create Blue Economy strategic action plans? In doing so, the researcher hopes to shed light on the field of environmental science by blending emerging information on microplastics with the field of educational studies to consider implications for coastal universities seeking to reduce microplastic waste. Ultimately, this research will be used to shape best practices for coastal universities like RWU, a university that has shared a strategic action plan focusing on the Blue Economy. This paper will provide implications for practice with education driven recommendations designed to target all levels of the university community.

As mentioned in chapter 1, much research has been done on microplastics. The significance of this research is that microplastics cause many issues for marine life and marine ecosystems. Microplastic pollution is a very important topic to the world, as it impacts a variety of facets from sealife to human air quality. Given the vastness of the ocean, researchers contributing to knowledge in this field often focus on a small section of the ocean in order to paint a greater picture of this crisis. This research has a great impact on the world because it shows the negative impact of plastic pollution on the ocean and marine ecosystems. With increased knowledge of this crisis, organizations and individuals should feel a call to action to improve the quality of our oceans.

Current research in the field results in two key themes. First, research in the field examines marine ecosystems, which is one aspect of the ocean that is impacted by microplastic pollution. This area is multifaceted and examines a host of sea life from fish to crustaceans. Second, researchers focus on water composition, which indicates how dense the microplastic pollution is in the ocean. Together, these emerging themes illustrate the full impact of microplastic pollution, as it gives an overarching view of the full extent of this problem.

Finally, chapter three will provide three implications for practice. The three implications for practice are designed to target a variety of community members at a coastal university with the objective of reducing microplastic waste in the ocean. The reduction of microplastic waste is the responsibility of all persons, and the three implications for practice illustrate the value of community based knowledge and responsibility to target this environmental problem. Through education, a coastal university can limit their footprint.

The first implication focuses on educating individuals responsible for landscape design and university architecture on the dangers of trash near the ocean. This implication also calls for unity among coastal universities. The second implication targets faculty and staff with professional development opportunities to examine the responsibilities members of a coastal university have to the landscape. As part of this implication, faculty are called on to take initiative with Blue Economy based research. Finally, coastal universities can use core courses to provide education to students about the responsibilities humankind has to the ocean. This paper suggests the whole community be held responsible and taught environmental best practices to reduce its impact on microplastic pollution, thus each implication is titled “a call to action.”

Implications of Research

Implication 1: A Call to Action: University Design and Collaboration

The first implication for practice focuses on a call to action for those responsible for the university architecture and landscape design. For coastal universities, I suggest trash cans and recycle bins be placed more than one hundred yards from the ocean. With trash cans and recycle bins more than one hundred yards away from the water, community members can eliminate the issue of plastic waste getting blown into the ocean. This could help eliminate some of the incidental plastic pollution that happens everyday due to the trash cans and recycle bins being too close to the water's edge. With the trash and recycle bin further away from the water's edge, trash is less likely to be blown or carried into the ocean from the weather.

Additionally, universities need to make a conscious effort to ensure trash and recycling receptacles are emptied in a timely fashion, which requires maintenance and cleaning crews to play a role as well. Overflowing bins leads to incidental plastic pollution, which contributes to microplastic pollution. This, however, should not just fall to the responsibility of trash and maintenance crews. University student organizations could play a role in trash pick up, accepting responsibility for helping to empty bins, transfering recycling to recycling centers, or doing plastic pick up near the ocean. However, as will be discussed in my third implication, university students need greater awareness of this problem and their responsibility through coursework.

Currently, I hold an internship with a boat company that transports goods and individuals from Cape Cod to one of the islands off the coast of Massachusetts. As we depart from Cape Cod, there is a big dumpster that sits no more than 30 ft from the water's edge, and when there is a big storm or just wind, the trash just gets whipped around and most of it ends up in the ocean. The weather is one of the major factors on why oceans are getting polluted with plastics because

of rain and flooding and wind, which all carry plastics from land into the ocean. Trash cans and recycle bins need to be more than one hundred yards from the ocean is an implication because it can help stop incidental plastic pollution in the ocean by just moving trash cans and recycle bins away from the oceans edge. However, placing the dumpster further away from the water's edge decreases the likelihood of the trash ending up in the ocean. As this is a problem that coastal towns grapple with, coastal universities can learn from these errors and employ safer ocean practices.

Additionally, increased signage near the ocean's edge can increase awareness for the university community and counter the high traffic associated with university life. There are a variety of individuals who regularly are near the water's edge. In some cases, students may be traveling to class; prospective students may tour the campus; individuals may be seeking water activities; professors may hold class outside; organizations may be running activities near the water's edge. The volume of traffic within yards of the ocean occurs daily, and being a coastal university is often an allure for prospective students. Therefore, it is essential universities care for the ocean and hold all community members responsible for proper ocean practice. Ultimately, increasing signage about the dangers of plastic pollution and trash pollution could help remind these individuals about their personal responsibility to use best practices near the water.

Coastal universities should consider the design of their dining halls and the materials they provide to their students in dining rooms. One thing that could help is getting rid of the single use plastics that are in the dining halls. Salads and fruit are some examples of things in the dining hall that have single use plastic containers that could be subbed out for non plastic or more than one use plastic containers. Additionally, suggestions for plastic silverware and plastic cups

should be examined. Coastal universities should aim to design their dining halls to reduce microplastic waste.

I suggest that coastal universities unite under a Blue Economy Initiative for Coastal Universities Association to share ideas and research to target the reduction of microplastic waste in the ocean. Through the unity of U.S. and potentially international colleges and universities, coastal universities can begin a broader discussion on problems they face and solutions they are working on. This will provide an outlet for staff, professors, and students to share ideas. The idea of a Blue Economy Initiative for Coastal Universities Association would signal the seriousness of the problem to the student body, provide an outlet for united research, and allow for greater dialogue in the field.

Individuals at coastal universities can limit their plastic footprint through the design of their landscapes, collecting trash in a timely manner, using signage, and uniting as a Blue Economy Initiative for Coastal Universities Association. This first implication provides small and large-scale suggestions that help increase a sense of community among coastal universities and takes small but worthwhile steps to limit microplastic pollution.

Implication 2: A call to action: Faculty Based Knowledge and Research

Coastal universities should use ongoing professional development to increase awareness for staff and professors of the repercussions of using items that are not biodegradable. Additionally, coastal universities can encourage research by providing the resources to examine the university footprint on their local stretch of ocean. Finally, coastal universities can provide an open dialogue regarding Blue Economy Initiatives and be open to constructive ideas regarding the university's reduction of plastic waste.

Professional development can take many forms. First, everyone should be educated on what is happening to the ocean when plastics are put in it. By making everyone aware of the issue of microplastic pollution and informing everyone just how much it hurts the oceans and even the earth as a whole is a worthwhile endeavor. Typically, colleges and universities offer professional development to staff and faculty; however, this platform should be used to promote the Blue Economy ideals of the university. The way universities could implement this would be to teach how individuals within the community use plastics and what could be done to help reduce plastic waste.

Additional areas for exploration include how the non biodegradable material impact the ocean when the ocean is polluted with plastics. This will allow members of the community to see the greater impact of their plastic usage. Another area for professional development is to help the community learn about the overall concern and how people can do their part. For example, professional development can inform faculty what sea life is impacted and what sealife is local to the waters around the coastal university. Recent knowledge and developments within the field of ocean sustainability show that more people need to be educated on the matter to help. Coastal universities should promote events that focus on ocean sustainability by explaining what could happen if nothing is done.

Additionally, coastal universities can call upon their professors to include Blue Economy research in their courses. For example, professors could lead students in sampling water or provide evaluations of the health of the waters around the coastal university campuses. Understanding which community organizations the faculty is associated with and integrating

community based, experiential learning into coursework is another way to target this problem. Universities can encourage professors to help students connect with the greater community hoping to impact ocean sustainability.

Finally, the university can allow for open dialogue regarding the goals of the Blue Economy Initiative and seek ongoing suggestions and create an ongoing dialogue with staff. This could be done through an email account where individuals send suggestions about plastic waste reduction or through roundtables or post-professional development surveys.

Some of the students and staff at coastal universities really do not know what the impact of non-biodegradable materials do to the environment, especially the ocean and marine ecosystems and how much it really does impact the ocean. Individuals working at a coastal university need awareness of the responsibility of the university and themselves. Universities can use professional development, research, and local connections to increase awareness of microplastic pollution.

Implication 3: A call to action: University Students

Coastal universities should implement environmental issues into course structures to support student understanding of microplastics and the need to be environmentally conscious. Implementing environmental issues into course structures is a good way for students to learn why microplastics are a big issue for the ocean and how they can be environmentally conscious so that they can understand what should be done and continue to make sure our ocean thrives.

Typically, university students are provided a core curriculum, which includes the sciences. One suggestion is to implement the topic of ocean sustainability into a core science

class because it already is talking about science. Therefore, the course could include a section on why microplastics and plastic in general is a big issue when it comes to the ocean and how it functions. This information is relevant to the students' lives, as they will be a part of the campus for four years. Additionally, the opportunity to learn about the local marine ecosystem is valuable knowledge. This will help students better understand their campus. Another way this could be implemented into a core science class is one could make up a little section in the class dedicated to learning about the impact of plastics in the ocean, which would allow students to understand the big issue of plastics in the ocean and what they could be doing to help this issue. For an example you could talk about how using single use plastics is one of the big issues when it comes to microplastic pollution. Again, this would provide students the opportunity to learn about their environment.

This is important because teaching young adults about this issue is one way that this issue could be delayed. The more people talk about this issue the better off we will be. Incorporating an addition to a course that already exists but just adding a little extra to it by talking about microplastics and the need to be environmentally conscious would be a helpful addition to the curriculum and have a big impact. Just by talking about those two topics in a classroom setting could be the way you could get through to people that these topics are important to think about and try to incorporate them into your daily lives. This is a key factor in getting the younger generation to think about what is going on with plastic pollution.

As coastal universities often offer recreational water activities like swimming, sailing teams, or kayaks, these organizations that use the water should have training and awareness of what the effects of polluting the water around the school have on the ocean. Additionally, students using the water for recreational practices should sign a Blue Economy waver as part of

their liability form reminding them of the dangers of plastic pollution to the local marine ecosystem, the water quality, and the health of the earth.

Finally, student awareness of their footprint should be made a priority. For example, student groups or particular disciplines could create posters or hold some small seminars that tell students the negative impact of using non-biodegradable materials and how those materials hurt the ocean. Additionally, student groups like Save the Bay can continue to accept responsibility for trash pick up. Through using core courses that discuss microplastics and environmental science, coastal universities can promote their cause and strengthen the students' understanding and response to the Blue Economy initiative.

Future Research

One area future research should examine is which places in the world are the biggest contributors of plastic pollution and which places in the world have the most single use plastic. Another area future research should examine is the impact of microplastics on different marine life. For example, research could focus on which marine organisms or marine animals are impacted the most as well as how microplastics impact the ocean as a whole. Current research focuses only on small sections of the ocean. Research should continue to examine the plastic density of water sampling because it is very important to see the rate that plastic pollution increases. Without testing the density of plastic in different parts of the ocean, we would not have that data to compare to earlier data. Research should be done within individual coastal universities to consider their footprint on the local ocean. Researchers Lusher, Burke, O'Connor, and Officer (2014) suggest further research is needed in "regional variation and to characterize

the spatial distribution, pathways and fate of microplastics around the globe" (p. 332). This is a valid claim as this kind of sampling has only been done in a couple parts of the ocean. The particular method used by Lusher, Burke, O'Conner, and Officer (2014) is a very accurate way of testing water in the ocean for microplastics. If research continued to collect water samples from all over the world at both the surface and deep sea level, then the researchers could have a very accurate view on just how much microplastic is in the ocean. But right now without them implementing this method all over the world, they only have a small speck of actually how much microplatic is in the ocean.

References

Bai, Z., Wang, N., & Wang, M. (2021). Effects of microplastics on marine copepods. *Ecotoxicology and Environmental Safety, 217*, 112243. doi:10.1016/j.ecoenv.2021.112243

Castaneda, R. A., Avlijas, S., Anouk Simrad, M., & Ricciardi, A. (2014). Microplastic pollution in St. Lawrence River sediments. *Canadian Journal of Fisheries and Aquatic Sciences, 71*(12), 1767-1771. doi:10.1139/cjfas-2014-0281

Cunningham, E. M., Ehlers, S. M., Dick, J. T. A., Sigwart, J. D., Linse, K., Dick, J. J., & Kiriakoulakis, K. (2020). High abundances of microplastic pollution in deep-sea sediments: Evidence from Antarctica and the Southern Ocean. *Environmental Science & Technology,* (21), 13661-13671. doi:10.1021/acs.est.0c03441

de Haan, W. P., Sanchez-Vidal, A., & Canals, M. (2019). Floating microplastics and aggregate formation in the Western Mediterranean Sea. *Marine Pollution Bulletin, 140*, 523-535. doi:https://doi.org/10.1016/j.marpolbul.2019.01.053

Digka, N., Tsangaris, C., Torre, M., Anastasopoulou, A., & Zeri, C. (2018). Microplastics in mussels and fish from the Northern Ionian Sea. *Marine Pollution Bulletin, 135*, 30-40. doi:https://doi.org/10.1016/j.marpolbul.2018.06.063

Galloway, T. S., Cole, M., & Lewis, C. (2017). Interactions of microplastic debris throughout the marine ecosystem. *Nature Ecology & Evolution,* (5), 116. doi:10.1038/s41559-017-0116

Green, D. S., Boots, B., Sigwart, J., Jiang, S., & Rocha, C. (2016). Effects of conventional and biodegradable microplastics on a marine ecosystem engineer (arenicola marina) and sediment nutrient cycling. *Environmental Pollution, 208*, 426-434. doi:10.1016/2015.10.010

Guzzetti, E., Sureda, A., Tejada, S., & Faggio, C. (2018). Microplastic in marine organisms: Environmental and toxicological effects. *Environmental Toxicology and Pharmacology, 64*, 164-171. doi:10.1016/j.etap.2018.10.009

Jakubowska, M., Białowąs, M., Stankevičiūtė, M., Chomiczewska, A., Pažusienė, J., Jonko-Sobuś, K., . . . Urban-Malinga, B. (2020). Effects of chronic exposure to microplastics of different polymer types on early life stages of sea trout Salmo Trutta. *The Science of the Total Environment, 740*, 139922. doi:10.1016/j.scitotenv.2020.139922

Labbe, B., Bagshaw, C. R., & Uttal, L. (2020a). Inexpensive adaptations of basic microscopes for the identification of microplastic contamination using polarization and nile red fluorescence detection. *Journal of Chemical Education, 97*(11), 4026-4032. Retrieved from 10.1021/0c00518

Lusher, A. L., Burke, A., O'Connor, I., & Officer, R. (2014). Microplastic pollution in the northeast Atlantic Ocean: Validated and opportunistic sampling, (1), 325-333. doi:10.1016/2014.08.023

Martins, I., Rodríguez, Y., & Pham, C. K. (2020). Trace elements in microplastics stranded on beaches of remote islands in the NE Atlantic. *Marine Pollution Bulletin, 156*, 111270. doi:10.1016/2020.111270

Microplastics from ocean fishing can 'hide' in deep sediments. (2020). *Marine Pollution Bulletin, 152.*

Miller, M. E., Hamann, M., & Kroon, F. J. (2020). Bioaccumulation and biomagnification of microplastics in marine organisms: A review and meta-analysis of current data. *PloS One, 15*(10). doi:10.1371/journal.pone.0240792

Mizraji, R., Ahrendt, C., Perez-Venegas, D., Vargas, J., Pulgar, J., Aldana, M., .Galbán-Malagón, C. (2017). Is the feeding type related with the content of microplastics in intertidal fish gut? *Marine Pollution Bulletin, 116*(2), 498-500. doi:10.1016/j.marpolbul.2017.01.008

Mohamed Nor, N. H., & Obbard, J. P. (2014). Microplastics in Singapore's coastal mangrove ecosystems. *Marine Pollution Bulletin, 79*(2), 278-283. doi:10.1016/j.marpolbul.2013.11.025

Mohrig, D. (2020). Deep-ocean seafloor islands of plastics: The processes controlling sediment transport also concentrate microplastics. *Science, 368*(6495), 1055. doi:10.1126/science.abcl510

Monteiro, R. C. P., Ivar do Sul, Juliana A., & Costa, M. F. (2018). Plastic pollution in islands of the Atlantic Ocean. *Environmental Pollution, 238*, 103-110. doi:10.1016/j.envpol.2018.01.096

Mu, J., Qu, L., Jin, F., Zhang, S., Fang, C., Ma, X., . . . Wang, J. (2019). Abundance and distribution of microplastics in the surface sediments from the Northern Bering and Chukchi Seas. *Environmental Pollution, 245*, 122-130. doi:10.1016/j.envpol.2018.10.097

Pauna, V. H., Buonocore, E., Renzi, M., Russo, G. F., & Franzese, P. P. (2019). The issue of microplastics in marine ecosystems: A bibliometric network analysis. *Marine Pollution Bulletin, 149*, 110612. doi:10.1016/j.marpolbul.2019.110612

Phillips, M. B., & Bonner, T. H. (2015). Occurrence and amount of microplastic ingested by fishes in watersheds of the Gulf of Mexico. *Marine Pollution Bulletin, 100*(1), 264-269. doi:10.1016/j.marpolbul.2015.08.041

Qiang, L., & Cheng, J. (2019). Exposure to microplastics decreases swimming competence in Larval Zebrafish (danio rerio). *Ecotoxicology and Environmental Safety, 176*, 226-233. doi:10.1016/j.ecoenv.2019.03.088

Rowe, L., Kubalewski, M., Clark, R., Statza, E., Goyne, T., Leach, K., & Peller, J. (2019). Detecting microplastics in soil and sediment in an undergraduate environmental chemistry laboratory experiment that promotes skill building and encourages environmental awareness. *Journal of Chemical Education, 96*(2), 323-328.

Scircle, A., & Cizdziel, J. V. (2020). Detecting and quantifying microplastics in bottled water using fluorescence microscopy: A new experiment for instrumental analysis and environmental chemistry courses. *Journal of Chemical Education, 97*(1), 234-238.

Troost, T. A., Desclaux, T., Leslie, H. A., van Der Meulen, Myra D., & Vethaak, A. D. (2018). Do microplastics affect marine ecosystem productivity? *Marine Pollution Bulletin, 135*, 17-29. doi:10.1016/j.marpolbul.2018.05.067

Wang, J., Tan, Z., Peng, J., Qiu, Q., & Li, M. (2016). The behaviors of microplastics in the marine environment. *Marine Environmental Research, 113*, 7-17. doi:10.1016/j.marenvres.2015.10.014

Wright, S. L., Thompson, R. C., & Galloway, T. S. (2013). The physical impacts of microplastics on marine organisms: A review. *Environmental Pollution, 178*, 483-492. doi:10.1016/j.envpol.2013.02.031

You, Y., Thrush, S. F., & Hope, J. A. (2020). The impacts of polyethylene terephthalate microplastics (mPETs) on ecosystem functionality in marine sediment. *Marine Pollution Bulletin, 160*, 111624. doi:https://doi.org/10.1016/j.marpolbul.2020.111624

Zhang, T., Lin, L., Li, D., Wu, S., Kong, L., Wang, J., & Shi, H. (2021). The microplastic pollution in beaches that served as historical nesting grounds for green turtles on Hainan Island, China. *Marine Pollution Bulletin, 173*, 113069. doi:10.1016/j.marpolbul.2021.113069