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Florida's Red Tide: The Hidden Costs of Land Development in the Everglades

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Katie Outman

Abstract

How does human development of land affect the surrounding ecosystems? This paper explores the development of the Everglades throughout the 1900s, which turned much of this wetland into farmland. Rerouting and restructuring of the Everglades' remaining waterways has caused fertilizer-rich water from the farms to be dumped into the ocean. This fertilizer pollution has caused aggressive outbreaks of red tide, a toxic algal bloom which depletes the ocean's oxygen and kills aquatic ecosystems, off the coast of Southwest Florida. Chapter one presents quantitative data about land development in the Everglades, focusing mainly on the amount of wetland before the 1900s versus today, as well as data about red tide outbreaks off the southwest coast of Florida. Chapter two discusses the development of the Everglades throughout the 1900s, which turned this land from wetland to farmland. Chapter three discusses the impact of the red tide outbreaks on Florida's economy, focusing on the financial losses in the industries of tourism, health care, and fishing, as well as the loss of natural capital. Chapter four addresses the sociological side of these issues, focusing mainly on society's lack of research, knowledge, and empathy towards ecosystem degradation caused by land development. Chapter five explores government policies that have been put in place to help mitigate this issue, such as policies to limit fertilizer runoff and additional research on how to break up the algal blooms. This chapter also discusses actions being taken by community-based groups in affected counties in Florida. Finally, in chapter six, I share my policy recommendations for preventing harmful land development, limiting fertilizer runoff, and controlling ongoing red tide outbreaks.

Keywords: red tide, algal blooms, land development, wetland loss, fertilizer pollution, aquatic ecosystems, human health, Florida

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Introduction: Land Development and the Red Tide

Florida is often recognized for its agricultural prowess. With its subtropical climate and sandy soil, Florida has been able to become the United States' leading supplier of citrus and sugar cane.¹ However, this was not always the case. Before the 1800s, much of what is today Florida's farmland was wetlands. In order to create more jobs, this land was developed into farmland. However, many believe that in developing this land, humans have significantly contributed to the exacerbation of the red tide, a toxic algal bloom common in Southern Florida. Due to the changes in the natural balance of the ecosystem, this may very well be possible.

The red tide is a harmful algal bloom caused by *Karena brevis*, plant-like algae often found in the Gulf of Mexico along the western coast of Florida. It is referred to as the red tide due to the infamous rust-red coloring of the blooms themselves. Red tide outbreaks occur naturally when *Karena brevis* is exposed to pleasurable conditions, such as low salinity, slow-moving water, and long periods of sunlight. Under these conditions, the algae grow at an alarming rate, causing what is known as an algal bloom. However, red tides blooms outbreaks can also occur when the algae are exposed to fertilizer runoff. As algae is a plant, exposure to fertilizer causes these algae to grow at a much faster rate than it typically could. When this occurs, algal blooms can form more often and at any point in time, instead of having to wait for optimal conditions. Algal blooms that have exposed to fertilizer runoff are often more severe and resilient, as they are constantly receiving a flow of nutrients.

Algal blooms are a pressing environmental hazard, as they can be very harmful to aquatic ecosystems. As the bloom grows, it covers the surface of the water and depletes the oxygen in the water. In doing this, any aquatic life forms that need either light or oxygen to survive are

¹ "Facts About Florida Oranges & Citrus."

killed off. Moreover, red tide can cause greater harm to aquatic ecosystems than a typical algal bloom due to the harmful toxins that are naturally produced by *Karena brevis* cells.² These toxins, called brevetoxins, cause gastrointestinal and neurological problems in marine life,³ as well as diseases such as paralytic and amnesic shellfish poisoning in humans.⁴ As a result, beaches experiencing red tide outbreaks are often covered with hundreds to thousands of tons of fishkill.

While this may seem horrifying to some, Florida inhabitants are no stranger to the red tide. These algal blooms show up on the southern coast of Florida almost every year. In most cases, the red tide is quickly broken up by winds, strong currents, and storms.⁵ However, the more recent outbreaks of red tide have been increasingly destructive due to a steady increase in fertilizer runoff being released into the ocean. This fertilizer pollution can be attributed to the growing sugarcane industry that began in Florida in the 1900s. In order to create more agricultural land to support this growing industry, state officials developed what was once the Everglades wetlands into the Everglades Agricultural Area. In order to do this, they constructed canals from the Everglades Agricultural Area that drain into the ocean. In doing this, they created a clear passage way for fertilizer runoff to feed into these harmful algal blooms. With marine life shrinking and tourism at an all-time low, the red tide is a pressing issue within Florida that needs to be addressed.

In this paper, I will explore the connection between the land development in the Everglades and the worsening red tide algal blooms off the coast of Southern Florida. Chapter one presents quantitative data about land development in the Everglades and the subsequent red

² “Red Tide.” 2018.

³ Depp, 2018.

⁴ “Red Tide.” 2018.

⁵ Ibid.

tide outbreaks. In this chapter, I focus mainly on the wetland loss within Florida from the 1780s to today, and how this has caused many of the Everglade's natural ecosystem services to be lost. Chapter two discusses the development in the Everglades throughout the 1900s and its impacts on the surrounding ecosystems. Chapter three discusses the impact of these harmful algal blooms on Florida's economy, focusing primarily on the tourism, health care, and fishing industries. In this chapter, I will also explore the financial losses associated with the loss of natural capital within Florida. Chapter four addresses the sociological side of this issue, focusing mainly on society's lack of research, knowledge, and empathy about the negative effects of land development on the red tide. Chapter five explores government policies that have been put in place to help mitigate this issue, such as policies to limit fertilizer runoff and funding additional research on how to mitigate outbreaks. Finally, in chapter six I share my policy recommendations for preventing harmful land development, limiting fertilizer runoff, and controlling ongoing red tide outbreaks.

Chapter 1: Everglades Development and Red Tide Statistics

Although they are often not talked about or even realized, the environment provides humans with many naturally occurring services that are necessary for life to occur. These services, referred to as ecosystem services, include provisioning services, regulating services, cultural services, and supporting services. Provisioning services consist of the naturally occurring materials and other energy outputs of the environment which are needed for human survival. Examples of this would be things such as food, water, and naturally occurring fuels such as oil and coal. Regulating services refer to the environment's ability to control and regulate things such as disease and climate. The environment's cultural services have a much looser

interpretation, as they refer to the intrinsic relationship between humans and the environment. Examples of this vary from spiritual connection, aesthetic value, recreation, and the value of environmental education. Finally, supporting services are often considered the most important of all ecosystem services, as they are the basis for all of the other services. Some examples of supporting services include essential processes such as oxygen production, soil formation, and primary production.⁶

Before the rise of agriculture in the United States, most of what is Florida's farmland was wetlands, a very important, but often undervalued, ecosystem. Wetlands are characterized as "areas where water is present above or near the surface of the soil for at least a portion of the year, and the soil and vegetation present is determined by the presence of water".⁷ Combining aspects of both terrestrial and aquatic ecosystems, wetlands are very unique in that they can provide important ecosystem services to both humans and marine life. Many of the benefits that wetlands provide come in the form of regulating services, as they help to maintain and regulate natural cycles. They can do this in many ways. First of all, wetlands act a natural sponge, absorbing excess rainfall to prevent flooding within rivers. This excess water is then stored within the wetlands and can be released when water levels drop below average, in order to combat possible droughts. In addition to this, wetlands are known for their ability to purify water. Many of the plants present in wetland ecosystems can filter out harmful waste from water such as fertilizers, pesticides, and even heavy metals and toxins. As pollutants pass through wetlands, these plants trap the pollutants in the surface water. These trapped pollutants are then converted into food material which can be consumed by the organisms within the ecosystem.⁸

⁶ "Synthesis Reports."

⁷ Moseley, 2019.

⁸ "Why Florida Wetlands Are Valuable", 2015.

These filtering abilities are so strong that wetlands are sometimes used as natural sewage and industrial waste treatment plants. Through purifying water and also replenishing groundwater aquifers, wetland ecosystems can provide clean water for surrounding communities.⁹

Furthermore, peatlands- a certain type of wetland ecosystem containing high levels of decaying plant matter- are one of the world's largest natural terrestrial carbon stores.¹⁰ It has been reported that peatlands store more carbon than all other vegetation types in the world combined, with nearly 1,158,300 square miles of peatlands worldwide absorbs about 370,000,000 metric tons of carbon dioxide each year. However, since much of the world's carbon is stored within these wetlands, damaged peatlands emit high levels of their stored carbon.¹¹ Therefore, peatlands must be preserved so that they can help combat climate issues, rather than exacerbate them. Another benefit of wetlands is their ability to protect shorelines from erosion. Normally, strong currents and the force of waves causes shorelines to erode over time. However, many plants within wetlands have extensive root systems, which adds stability to the coastal soils and provides a buffer between the water's force and the shoreline.¹² Overall, one can see that wetlands provide many crucial regulating services, and therefore are necessary for the survival of both terrestrial and aquatic ecosystems.

Wetland ecosystems are also valued for their provisioning services. As wetlands have characteristics of both aquatic and terrestrial ecosystems, they can provide unique habitats for species that could not survive in other areas. Because of this, many species of birds, fish, mammals, reptiles, and amphibians rely on wetland habitats at some point in their life for breeding, foraging, or shelter. For example, nearly all waterbirds use wetlands as feeding and

⁹ Wetlands, 2015.

¹⁰ Peatlands, 2019.

¹¹ Wetlands, 2015.

¹² Functions.

breeding grounds, and many migratory species use wetlands as their resting points during their migration period. Also, wetlands house many of the plants, insects, and other smaller animals that are essential for lower levels of the food chain.¹³ Many of these smaller animals and plants also play a large role in nutrient cycling, as well as disease and pest control. Wetlands are also an important source of food for higher levels of the food chain, such as humans. Rice paddies, which are flooded fields used to grow rice, are considered wetlands. Furthermore, fisheries often obtain much of their fish from wetlands, as these ecosystems provide the shade and shelter preferred by many fish species.¹⁴ As stated, wetlands also have the ability to purify water through the removal of pollutants, toxins, and excess nutrients. However, it has been reported that any damage done to a wetland ecosystem could lead to toxins being released back into the water.¹⁵ Because of this, it is very important to minimize the destruction of these ecosystems.

Wetlands have also been able to contribute many cultural services to surrounding communities. As stated, cultural services refer to the relationship between humans and the environment and can be expressed through things such as aesthetic value, spiritual connection, and recreation. Wetland ecosystems exemplify these things in many ways. First, wetlands have been said to have a long-standing connection to cultural practices that have allowed humans to thrive. For example, communities within close proximity to wetlands have adopted tangible practices such as salt harvesting, fishing, net weaving, rice and other crop harvesting, and boat building. These practices have been engrained into these communities as a way to economically gain from these wetlands. However, many other intangible practices have sprouted in communities within that focus more on the spiritual connection to the land. These practices

¹³ Functions.

¹⁴ Wetlands, 2015.

¹⁵ Functions.

include oral literature, music, dress codes, customs, beliefs, and modes of religious expression.¹⁶ Furthermore, wetland ecosystems are often popular tourist spots due to their recreation activities such as fishing, hiking, bird watching, and hunting. Another activity that is popular in wetland ecosystems is photography, as these areas and its inhabitants can often be very aesthetically pleasing.¹⁷

As one can see, wetland ecosystems naturally provide several of the ecosystem services necessary for a community to thrive. Because of this, the communities and ecosystems surrounding the Everglades might have been naturally sustained by the wetland ecosystem alone. However, this would not have been as economically lucrative for the state. Therefore, Florida's state officials decided to drain this effective ecosystem and turn it into farmland. Before the 1780s, the United States consisted of almost 392 million acres of wetlands, 221 million acres of which were located in the 48 lower states. However, since this time, much of the wetlands have been lost to agricultural purposes. In 1980, only 104 million acres of wetland remained in the United States. This was a shocking 53 percent loss in only two hundred years. Florida was reported to have had the most wetland loss of any state, losing more than 9.3 million acres, or about 46 percent, of its 1780 total.¹⁸ However, this loss of wetland did not stop there, as Florida lost an additional 260,000 acres of its wetlands between 1986 and 1996.¹⁹ Much of this drained wetland make up the Everglades Agricultural Area, which will be discussed further in Chapter 2. Through this drainage, severe degradation was caused to these wetland ecosystems and their related ecosystem services.

¹⁶ Culture.

¹⁷ Wetlands, 2015.

¹⁸ Dahl, 1990.

¹⁹ "Why Florida Wetlands Are Valuable", 2015.

As stated, wetlands are praised for their many benefits, such as water purification, erosion control, flood protection, climate control, food production, aesthetic value, and being a suitable habitat for many species. Therefore, as these wetlands were lost, so were their ability to complete these tasks. First of all, as explained earlier, wetlands can catch high levels of rainfall. As Florida is a state with high levels of rainfall, this service was very crucial in preventing floods in downstream waterways.²⁰ Without this service, communities and farms that surround these waterways are now at a higher risk of flooding and exposure to water pollutants. These communities also no longer have the benefits of erosion control on their coasts. Another issue that has arisen from the drainage has been the decrease in biodiversity within the area. As many species inhabited the Everglades area due to its unique wetland ecosystem, the drainage of these areas has caused the number of native species of plants and animals to decrease drastically. Also, any spiritual, religious or aesthetic value associated with the land was most likely lost, as the practices-such as boat making, fishing, and hiking- that apply to wetlands do not transfer to farmland. Instead, the communities around what was once the wetlands are now engrained with practices that pertain to agriculture. Arguably the largest benefit that Florida lost through draining its wetlands was their ability to filter and remove pollutants from water. Because of this ability, Florida's wetlands were once able to filter out nutrients from things like fertilizer pollution before it reached lakes or oceans. For years, this prevented the growth of algal blooms in these areas. However, as wetlands decreased, the frequency and duration of algal blooms in Florida increased rapidly.

Typically, algae play a large role in the regulating service of waste management. Microalgae have often been recognized as a natural solution to wastewater treatment

²⁰ Moseley, 2019.

management, as it can to absorb and break down harmful chemicals, bacteria, heavy metals, and toxic organic compounds. Algae use the inorganic chemicals of nitrogen and phosphorus for their growth. Because of this, algae can break down wastewater that contains fertilizer runoff, when introduced to it in moderation. However, in situations where excess amounts of fertilizer runoff are introduced into aquatic ecosystems, the algae can no longer break down the wastewater. As algae is a plant in and of itself, the introduction of large amounts of fertilizer into the water causes the algae to grow at an alarming rate, causing an algal bloom. When this occurs, the algae lose their ability to naturally regulate the water and instead becomes harmful, as it depletes the oxygen in the water.²¹

This is what has happened in the case of the red tides algal blooms in Florida. As the wetlands were drained, the number of plant species that were able to filter out fertilizer nutrients decreased significantly. Therefore, when the increase in agriculture in the Everglades Agricultural Area began, the levels of fertilizer runoff in waterways were too high for the remaining plants to filter out. The algae were no longer able to filter out these nutrients and were instead fertilized by them, causing it to grow into large algal blooms. With the constant supply of nutrients from the fertilizer runoff, these blooms were able to become more harmful and more resilient than a typical algal bloom- causing the worsening state of the red tide over the past several decades. Although stories of the red tide in Florida were first recorded by Spanish explorers in the 16th century, the first scientifically documented episode occurred in 1844. These episodes occurred off and on for the next 100 years, with no significant outbreaks. However, in 1947, when the Everglades were being developed, a large outbreak of red tide occurred following record rainstorms in the area. This outbreak lasted nearly one year and had detrimental

²¹ "Ecosystem Services."

effects on Florida's fishing industry and caused negative health effects on local inhabitants. In the following years, red tide outbreaks continued in its aggressive nature. In 1994, the longest outbreak in history occurred, lasting a full two years. In 1996, a relapse of this two-year outbreak claimed the lives of 238 manatees, which accounted for 10 percent of the population at the time. In 2002, another severe red tide outbreak, with the algal bloom stretching over 60 miles. Only three years later in 2005, the red tide had grown to create a dead zone the size of Rhode Island.²² For scale, Rhode Island spans across about 1,045 square miles.²³ However, the red tide outbreak that occurred from 2017 to 2019 was one of the worst outbreaks to date, based on both size and the number of marine life deaths.

2017-2019 Red Tide Outbreak

"The first thing you notice is the smell. It's not a scent, exactly, but a tingling in the nose that quickly spreads to the throat and burns the lungs. But then you see the carcasses." -Maya Wei-Haas²⁴

From October of 2017 to February of 2019, Florida experienced one of the most aggressive red tide outbreaks of all time. During these sixteen months, Florida's picturesque beaches were covered with thousands of dead sea creatures. Among these creatures were different species of fish, crabs, eels, manatees, dolphins, turtles, and more.²⁵ The harmful algal bloom terrorized almost all coastal communities on the Gulf side of the state, as it spanned from Florida's Panhandle down to its southern tip. At its largest point, the algal bloom spanned an area approximately the size of the state of Connecticut.²⁶ For perspective, the state of Connecticut occupies an area of 5,018 square miles, with an average length of 90 miles and an average width

²² "Red-Tide Timeline."

²³ Bowers, 2003.

²⁴ Depp, 2018.

²⁵ Ibid.

²⁶ "The Harmful Algal Blooms in Florida," 2018.

of 55 miles.²⁷ The size and potency of this particular bloom can be linked back to Hurricane Irma, which hit Florida in September of 2017. The high levels of rainfall from this storm caused a drastic increase in runoff that was introduced into the Gulf shortly before the outbreak began.²⁸ Though the blooms occupied a large span of Florida's coast, certain counties were hit harder than others. The three counties that were most impacted by this particular red tide outbreak were Sarasota County, Manatee County, and Lee County. Throughout the course of these sixteen months, officials collected hundreds of tons of dead fish from beaches within these counties.²⁹

In August of 2018, Manatee County collected 164 tons of dead fish from its beaches and Sarasota County collected more than 149 tons. This bears no comparison to the more than 17,000 tons of dead sea life that was collected by contractors alone in Lee County over a mere three-week span that same August. This number does reflect the number of carcasses collected by the county's parks and recreation department, or those collected from the county's Boca Grande and Captiva islands. Therefore, the amount of total fishkill collected in Lee County throughout August was probably much greater than this.³⁰ The high concentration of *Karenia brevis* in these counties can be attributed to their proximity to the drainage canals from Lake Okeechobee- a lake within the Everglades Agricultural Area. Sarasota County and Manatee County are situated slightly above the end of these canals, while Lee County is located in the same area where the canals drain into the ocean. As unfiltered and fertilizer-rich water from Lake Okeechobee reached the ocean, it is likely that it came in contact with the *Karenia brevis* cells and formed the algal bloom that then spread down Florida's coast. Evidence for this theory can be seen in the levels of *Karenia brevis* cells in these counties. In 2018, it was reported that the *Karenia brevis*

²⁷ "Connecticut."

²⁸ Depp, 2018.

²⁹ Murphy, 2018.

³⁰ Ibid.

levels had reached over one million cells per liter of seawater in both Lee County and Manatee County.³¹ The map below shows the concentrations of *Karenia brevis* cells per county from the week of August 7th to August 14th of 2018. As shown, some of the highest concentrations of red tide cells were present in Lee, Manatee, and Sarasota counties.



Map of *Karenia brevis* Concentrations in August 2018.³²

The marine life deaths were not limited to these three counties. Over the course of the tide, it was reported that the algal blooms claimed the lives of about 150 dolphins,³³ over one hundred manatees, and at least one young whale shark.³⁴ One species that faced significant losses from the algal blooms was the sea turtle. It was reported that this outbreak was also responsible

³¹ "Red Tide Current Status."

³² "Gov. Scott Issues Emergency Order for Red Tide," 2018

³³ Allen, 2019.

³⁴ "The Harmful Algal Blooms in Florida," 2018.

for more turtle deaths than any other single red tide outbreak, having killed more than 350 turtles in less than ten months.³⁵ As nearly all species of sea turtles are endangered, this fact was alarming for biologists and animal activists who had been working to save the species.³⁶ Unfortunately, there is no way to know exactly how many fish and other marine life fell victim to these harmful algal blooms since many of the blooms stretched at least forty miles offshore. However, one can imagine that, based on these statistics, the amount of sea-life deaths caused by this algal bloom casualties must have been hundreds of thousands.



“Wind and currents push thousands of dead fish together in a massive fish kill during the red tide bloom off the coast of Sanibel, Florida.”³⁷

The effects of the red tide were not just limited to marine life. As red tide blooms spread across such a large area, they emit toxins into the air. Although the effects of these toxins on

³⁵ Gomez, 2018.

³⁶ Schweig, 2018.

³⁷ Depp, 2018.

humans are not as serious as they are on animals, they still can cause negative health effects. Humans can be exposed to the brevetoxins produced by *Karenia brevis* through inhalation or ingestion. Once exposed, people have experienced varying degrees of eye, nose, and throat irritation.³⁸ Individuals who experience respiratory irritation after coming in contact indirectly with the red tide are advised to leave the affected area until symptoms subside. Individuals who come in direct contact with the red tide, through contact with water or sea foam, have reported skin and eye irritation, as well as rashes.³⁹ In severe cases, people living in affected communities have experienced severe coughing and shortness of breath, which have resulted in trips to the emergency room.⁴⁰ The brevetoxins can also cause serious illnesses in individuals with respiratory conditions such as asthma and emphysema, as they can trigger asthma attacks and cause symptoms of chronic pulmonary disease. These symptoms can persist even after the individual has left the affected area. Because of this, those who suffer from respiratory conditions are advised to avoid coastal areas with active red tides.⁴¹

Chapter 2. History of Land Development in the Everglades

To understand why many attribute the worsening red tide outbreaks in Florida over the past several decades to the development in the Everglades, one must first understand the complicated history behind this development. Plans for development in this area began in 1900, after William Sherman Jennings, the Governor of Florida at the time, proposed the idea of draining the Everglades as part of his efforts to create more jobs through land reform.⁴² This idea

³⁸ Burton, 2019.

³⁹ Ibid.

⁴⁰ Health Risks from Red Tide in Southwest Florida,” 2018.

⁴¹ Burton, 2019.

⁴² Clement.

was not new to the State of Florida. Previous plans to drain the Everglades to produce more agricultural land had already been proposed in Southern Florida in the 1800s. In 1847, a Harvard-educated attorney named Thomas Buckingham Smith was hired to conduct a scientific study of the Everglades on behalf of the United States Treasury, to explore the economic potential of this land. To collect all of the data they desired, Smith spent over three months on a reconnaissance through the several streams that flowed from the interior wetlands, spanning up to 6,200-square-miles at the time. After this excursion, Smith concluded that the entire region of Southern Florida could be effectively drained for anywhere from \$300,000 to \$500,000 (~\$9,386,260 to \$15,643,780 in today's currency). Smith recommended that the State of Florida go forward with this drainage project as it would create hundreds of thousands of acres of fertile soil which could be used for agricultural purposes. Despite this idea gaining much traction with politicians in state government, it was initially put on hold so that efforts could be redirected to the Civil War, which was occurring at that time.⁴³

It was not until Governor Jennings' proposal in 1900 that the plan to drain the Everglades was once again set into motion. The State of Florida began drawing up plans for draining the Everglades in 1904. In 1906, the state tasked drainage engineer James Wright with writing a report on the feasibility of draining the Everglades, as well as creating a plan for doing so. In his report, entitled the Wright Report, Wright argued that the drainage of the Everglades and its surrounding lakes would not be difficult. However, despite being very well versed in his field, Wright's report became very controversial as it contained many scientific errors. Many of these errors seemingly dismissed available scientific data to support the optimism of the politicians and the government. One example of this could be seen through his assessment of rainfall and

⁴³ Arsenault, Chapter 6.

evaporation rates in the area. In his report, Wright only accounted for a small amount of rainfall, four inches a day maximum. However, if one were to look at the weather reports from that time period, it was evident that there were days where ten to twelve inches of rainfall occurred within twenty-four hours. Wright seemingly ignored this fact as he wrote in his report that evaporation occurs in Southern Florida at a rate of nine inches per month. On the basis of this incorrect calculation, Wright reported that once the wetlands were drained, Lake Okeechobee would eventually dry up, as the rainfall would not be able to maintain its water level. This report satisfied politicians at the time, who had hoped this would be the case in order to avoid extra costs. It was not until after the development had begun that Wright's calculations were argued and dismissed.⁴⁴

When the project began in 1906, it was believed that, based on Wright's report, the drainage could be achieved solely through gravity. Under this impression, engineers and state officials began drawing up plans to drain the wetlands through the use of canals instead of pumps. They believed that the elevation of Lake Okeechobee, a lake situated in the Central Everglades, was high enough to ensure that the water drained from the lake to the Florida coast. However, this proved to be ineffective, as water still lingered in the wetlands after the digging of several ditches. Deterred and looking to fulfill their promises to the citizens, the Everglades Land Sales Company hired three well-known drainage engineers, Leonard Metcalf, Daniel W. Mead, and Allen Hazen, on July 23, 1912. These engineers were told to study the situation and make recommendations on how to improve the plans for drainage. On November 12, 1912, the three engineers issued a report which argued that the canal system which the state had built could not drain the entire region of Southern Florida. Also, they pointed out that there as a major issue with

⁴⁴ Arsenault, Chapter 6.

the canal that ran from Lake Okeechobee to the Miami river, as it lacked the smaller lateral canals needed for drainage. Because of this, the canal had been running both frontwards and backward, often draining the water back into Lake Okeechobee during times of heavy rainfall. The only solution that the engineers could reach to satisfy their employers was to drain limited areas of the wetlands and turn those into farmlands.⁴⁵

Upon hearing this news, state politicians were not pleased with their results. Many politicians and business owners had staked their reputation and invested their own money into drainage efforts. Determined to not let the drainage fail, Florida's state politicians decided to conduct their own study. These politicians hired esteemed engineers to conduct this study, in hopes of finding a reputable solution which would help in boosting their plummeting land values. Among these engineers was Isham Randolph, who was said to be the "most respected and trusted civil engineer at the time".⁴⁶ Randolph earned this title after serving as the supervising engineer on the construction of the Chicago Drainage Canal in 1900, a canal which completely reversed the flow of the Chicago River to direct the cities sewage away from Lake Michigan. The report submitted by this group of engineers, referred to as the Randolph Report, was more in line with the politicians desired outcome. This report stated that the state's plan for draining the Everglades was not only feasible but could be executed at a reasonable cost. Not only that, but the report also stated that the new farmland created from this land development would be among the nation's richest. The only major changes that the group of engineers suggested was that the existing drainage canals leading to the Atlantic Ocean be widened and deepened and that a new canal is built linking Lake Okeechobee with the Saint Lucie River. The engineers believed that this canal would keep the lake from overflowing, as it would allow

⁴⁵ Arsenault, Chapter 6.

⁴⁶ Ibid.

excess water to drain either into the river or the ocean. The total cost of this proposed venture was \$6.7 million. As the Florida legislature had already approved a \$6 million bond for this drainage program, this did not seem very out of reach. Many questioned the validity of this report, as it not only supported the state's plan but also heavily promoted the purchase of the new land. However, proponents of the drainage moved forward with these results.⁴⁷

Although the state now had a viable plan for the drainage, they were unable to move forward with the plans without additional funds. By 1920, less than 900,000 acres of Florida's wetlands had been successfully drained.⁴⁸ Plans were delayed further by the Great Depression and two massive floods in Florida caused by hurricanes in 1926 and 1928. Desperate for assistance, the state turned to the United States Army Corps of Engineers for aid. As many people had blamed the intense flooding on the poorly designed and incomplete drainage projects in the Everglades, the Army Corps agreed to help the state of Florida. The Army Corps began constructing the Herbert Hoover Dike, which was eighty-five miles long and more than three times the size of the previous dike that the state had built.⁴⁹ The Army Corps also created new control canals to accommodate heavy rainfall during hurricanes. Construction on the dike and new canals was completed in 1938 and the Everglades began to be effectively drained for the first time.⁵⁰ The total cost of the project was just over \$19 million, significantly more than the Randolph Report had estimated. However, the state of Florida only paid \$500,000 of this total, as they had endured so many financial hits in early development.⁵¹

⁴⁷ Arsenault, Chapter 6.

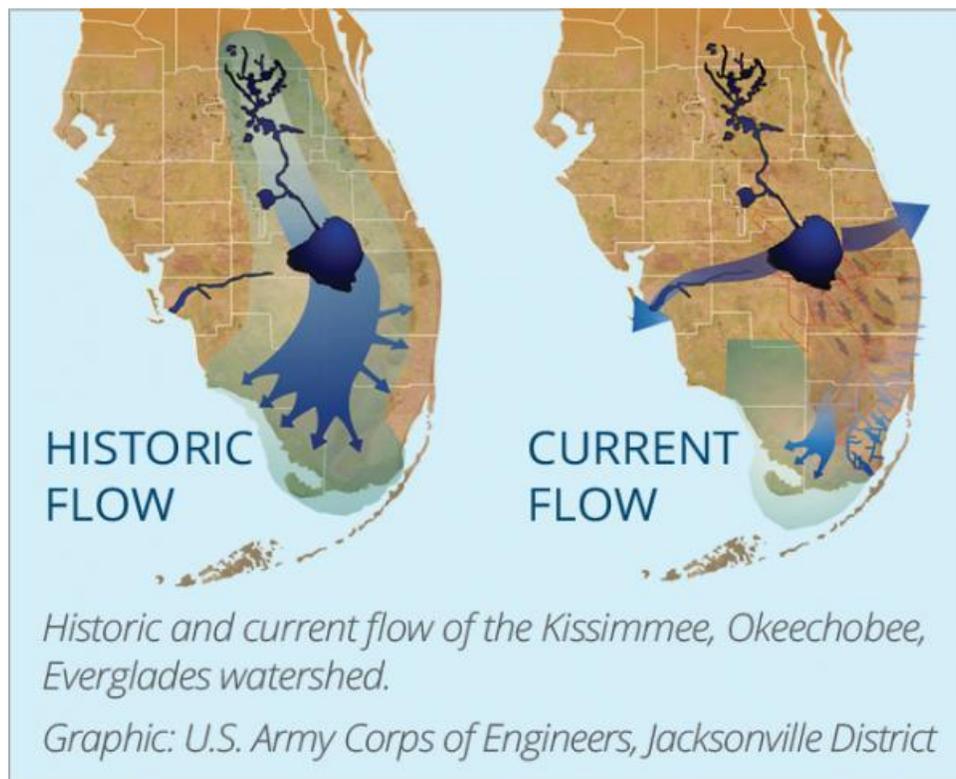
⁴⁸ "Who Drained the Everglades?" 2018

⁴⁹ Ibid.

⁵⁰ Arsenault, Chapter 6.

⁵¹ "Who Drained the Everglades?" 2018

This was not the end of the state’s assault on the Everglades. In 1947, Florida was struck by one of the largest recorded storms, flooding almost 2.5 million acres of land. In 1948, Congress passed a bill that dedicated \$208 million towards the construction of additional drainage systems to prevent further flooding. This new project, called the Central and South Florida Flood Control Project, built more than 1,700 miles of canals and sixteen major pumping stations. The project focused on draining areas south of Lake Okeechobee. Complete drainage of these areas was not complete until 1979 and cost almost \$100 million more than initially expected. These canals completely rerouted the natural flow of waterways south of the lake. These wetlands used to go south and then disperse to the east and west coasts of Florida.⁵² However, they now go directly from Lake Okeechobee to the east and west coasts, as shown below.



Comparison of the Historic Flow Versus the Current Flow of Lake Okeechobee’s Watershed.⁵³

⁵² “Who Drained the Everglades?” 2018

⁵³ Riley, 2019.

With the Everglades drained, farmers were finally allowed to purchase their land for farmland. One of the main agricultural industries which began to flourish in the Everglades was the sugarcane industry. With its subtropical climate and sandy soil, farmers deemed the land south of Lake Okeechobee suitable for this crop. This area soon became referred to as the Everglades Agricultural Area, due to the large number of farms situated in the area.⁵⁴

In 1960, before the drainage had been completed, Florida had less than 50,000 acres of sugarcane. However, the demand for sugarcane grew dramatically in 1961 due to the embargo on Cuban goods, the United States' primary source of sugar at the time. Florida, seizing the opportunity to be the county's new supplier of the crop, decided to expand its sugarcane industry. Within the next five years, an additional 150,000 acres of sugarcane was planted in Florida. Since this initial boom, sugarcane has continued to grow in Florida, taking over the majority of the Everglades Agricultural Area. Between 1996 and 2000, Florida's sugarcane acreage grew from about 200,000 acres to 454,400 acres.⁵⁵ In 2006, sugarcane acreage in Florida's Everglades Agricultural Area decreased slightly to about 440,000 acres. Currently, about 50 percent of the total cane sugar produced within the United States and about 20 percent of the sugar consumed in the country comes from these 444,000 acres in the Everglades Agricultural Area. This growing industry, commonly referred to as Big Sugar, exemplifies exactly what early politicians were hoping to gain from draining the Everglades: additional jobs and economic gain. Annually, the Florida sugar industry provides over 14,000 jobs and produces an annual income of over \$800 million. This industry is estimated to have a total economic value, considering direct and indirect effects, of over \$2 billion.⁵⁶

⁵⁴ "Sugar Cane, Rice, and Sod."

⁵⁵ Baucum.

⁵⁶ "Sugar Cane, Rice, and Sod."

However, this growth in the sugarcane industry has been linked to adverse environmental phenomena within Florida, such as the red tide. As stated earlier, the red tide is a naturally occurring phenomenon in Florida. Until about 20 to 30 years ago, these red tide outbreaks lasted only days to weeks at most. However, recent outbreaks have been lasting several months, which has raised concerns with Florida's inhabitants.⁵⁷ Many researchers have formed a connection between the worsening algal blooms and the growing sugar industry in Florida. One of these researchers is Dr. Larry Brand, professor of Marine Biology and Ecology at the University of Miami.⁵⁸ Dr. Brand has observed that the dramatic increase in humans and agriculture over the last 50 years is likely to be the cause of severe red tide outbreaks. Dr. Brand states that this started when the drainage began in the early 1900s, as humans altered the natural flow of the water in the Everglades. Prior to human intervention, water had flowed from Lake Okeechobee through the Everglades and then was drained into the Florida Bay. However, in order to make more farmland, engineers diverted excess water from Lake Okeechobee to the east and west coasts of Florida. In altering the natural flow of the wetlands, engineers also altered the wetland ecosystems and their ecosystem services. Unlike naturally occurring wetlands, these manmade canals lacked the native plants that filtered out pollutants. Therefore, the water flowing from Lake Okeechobee to Florida's coasts now contained pollutants that had been filtered out in the past.⁵⁹

This became a larger concern when the areas surrounding Lake Okeechobee became more populated, as the lake became polluted with fertilizer runoff and waste from septic tanks.⁶⁰ As this water is no longer being naturally filtered in the wetlands, the high nutrient contents of

⁵⁷ Kann, 2019.

⁵⁸ Graulau, 2018.

⁵⁹ Riley, 2019.

⁶⁰ Graulau, 2018.

the water have caused negative environmental impacts on local ecosystems. This can be detrimental to ecosystems, as it causes nonnative plant species that thrive from phosphorus to grow rapidly and crowd out native plant species. This is what researchers suspect to have happened in the case of the red tide.⁶¹ Researchers have specifically blamed two of the most common nutrients found in fertilizer- nitrogen and phosphorus- for the severity of recent red tide outbreaks. Phosphorus is a chemical that is not typically found in Florida's natural waterways. However, studies in this area have found that about 80 percent of the phosphorus used to fertilize crops in the area reaches the Everglades.⁶² Nitrogen is naturally occurring in the environment. However, excess amounts of the chemical have been introduced into waterways by fertilizer and septic tank runoff. Researchers believe that the red tide algae were exposed to additional phosphorus and nitrogen found in fertilizer. Since *Karena brevis* is a plant-like alga, this fertilizer acted as a catalyst, speeding up the growth and reproduction of the algae, ultimately resulting in significantly larger and more resistant algal blooms. This theory can be corroborated by the Environmental Protection Agency's Environmental Atlas, an interactive map that shows environmental problems around the world. In this atlas, one can see that the western coast of Florida contains some of the highest amounts of dissolved nutrients in leachate from agriculture, such as phosphorus and nitrogen. In counties where the red tide typically occurs- such as Pasco, Collier and Manatee Counties- the atlas shows anywhere from 1.6 to 1460.3 tons of phosphorus per hectare and between 0.6 to 483.3 tons of nitrogen per hectare. However, in Fort Meyer's Lee County, a county that has been experiencing particularly severe outbreaks, the map shows that its

⁶¹ "Who Drained the Everglades?" 2018.

⁶² Ibid.

coast contains a range of 53.4-1460.3 tons of phosphorus per hectare and 4.6-23.7 tons of nitrogen per hectare from agriculture runoff.⁶³

Chapter 3: Economic Impacts of Florida's Red Tide

Although the development of the Everglades was meant to boost Florida's economy, the presence of the red tide has halted the state's economic growth over the years. One of the industries that has experienced some of the most negative economic impacts has been the health care industry. It was reported that during outbreaks of red tide, the diagnoses of pneumonia increase by an average of nineteen percent, gastrointestinal illnesses by forty percent, and respiratory illnesses skyrocket by about fifty-four percent.⁶⁴ Furthermore, an average of \$22 million is lost every year during high algal bloom events due to medical expenses and lost workdays.⁶⁵ This trend of higher than average medical expenses applied to the 2017 red tide outbreak. The Florida Department of Health reported that the cost of treating red tide-related respiratory illnesses during this outbreak cost between \$500,000 and \$4 million in Sarasota County alone.⁶⁶ However, this was only a fraction of the statewide health care costs, as patients across Florida's southwest coast flooded emergency rooms complaining of irritation of the eyes, nose, or throat after coming in contact with the algal blooms.⁶⁷ Some patients experienced far more serious symptoms as well, such as trouble breathing, skin reactions that caused intense itching or burning,⁶⁸ and illnesses caused by the ingestion of contaminated shellfish. As shellfish naturally accumulate brevetoxins as they filter the algae for food, individuals who consume

⁶³ EPA.

⁶⁴ Harmful Algal Blooms- Economic Impacts," 2018.

⁶⁵ Ibid.

⁶⁶ Health Risks from Red Tide in Southwest Florida," 2018.

⁶⁷ Ibid.

⁶⁸ Sims, 2018.

shellfish tainted by *Karenia brevis* can experience severe symptoms. These symptoms include digestion issues, tingling sensations, rapid heartbeat, coordination problems, or even death if appropriate medical treatment is not sought.⁶⁹ To avoid these health risks and potential illnesses, Florida residents are instructed to keep their house and car windows closed and to not go within proximity of any beach affected by the red tide during outbreaks.⁷⁰ Despite these precautionary measures, it is often hard for individuals who live near affected beaches to escape possible illnesses. Therefore, it is likely that health care costs will continue to rise if red tide outbreaks are not mitigated in the future.

Another sector of the economy that faces serious economic impacts each year due to red tide outbreaks is the tourism industry. Tourists are often attracted to Florida for its pristine beaches and water-related activities. Therefore, mandatory beach closures due to large amounts of fishkill, swim warnings, and the overwhelming unpleasant smell of dead sea creatures often deters many of the state's usual visitors. Annually, the National Oceanic and Atmospheric Administration estimate that toxic algal blooms, including the red tide, account for an annual loss of roughly 82 million dollars in sales for restaurants, hotels, and other tourism industries across the United States.⁷¹ Once again, these statistics rang true during the 2017 red tide outbreak. In August of 2018, Visit Florida, the state's official tourism agency, surveyed business in counties the most affected by the red tide to gauge their financial losses. In July alone, Sanibel and Captiva Island's Chamber of Commerce reported that they had lost over \$4 million. Similarly, Sarasota County reported more than \$1.4 million in damages from the red tide in August. An independent study conducted by the county's travel agency, Visit Sarasota, reported the majority

⁶⁹ Hall, 2018.

⁷⁰ "Florida Red Tide FAQs."

⁷¹ Hall, 2018.

of businesses in Sarasota County had suffered significant financial hits over the last year due to the odor and appearance of the beaches. The Chamber of Commerce in Fort Myers Beach, situated in Lee County, reported \$2.7 million worth of losses in only the first three weeks of August. These losses were not only being incurred by business owners. Employees in Fort Myers Beach are estimated to have lost around \$559,770 in wages in August alone.⁷² Another survey conducted in August 2018 found that forty-six percent of coastal business owners reported that their business had been down by at least fifty percent. Hotels in Sarasota County also reported financial struggles during this time. Many of the hotels in the area reported that they had had several reservations canceled due to concerns about the red tide.⁷³ This was not the first time that hotels had suffered significant losses due to the algal blooms. Nearly \$6.5 million was lost by hotels and restaurants alone in Okaloosa County during the yearly outbreaks from 1995 to 2000- which were far less severe than the 2017 outbreak.⁷⁴

In order to fully understand the extent of the loss of tourism in the area, a New York Times reporter visited the southwest coast of Florida during Labor Day weekend of 2018 to talk to business owners in the area. This reporter began by interviewing John Fabien, the captain of a charter boat in Siesta Key, a key that borders Florida's Sarasota County. In this interview, Fabien explained that he typically brings in about \$15,000 during Labor Day weekend from his tours and books up far in advance. However, during the 2018 year, he had only had one booking- the one made by the reporter herself. Throughout the course of this interview, Fabien described the severe financial hit that his water-based tours and excursions business had taken because of the algal blooms. He went on to explain that he had canceled any tours that had been booked, as he

⁷² Florida's, 2018.

⁷³ Carter, 2018.

⁷⁴ "Harmful Algal Blooms- Economic Impacts."

did not want to risk customers getting sick or leaving him negative reviews. This same New York Times reporter also spoke to Brittney Dolman, a full-time waitress at a popular beachfront bar and grill in Longboat Key, a popular tourist spot. Dolman spoke of similar financial hits since the red tide outbreak began, stating, “Normally I’ve got 200 customers in a shift, but some shifts I’ve been leaving work with zero customers and zero dollars... We’re normally one of the busiest places in town, so I can’t imagine how the smaller places are coping.”⁷⁵ Kurt Daisy, the restaurant’s manager, told the reporter that their business was down by an estimated 50 to 75 percent.⁷⁶

As these businesses continue to lose money, the government is responsible for paying some form of mitigation costs. The University of Florida surveyed the city and county government administrators that were in charge of red tide mitigation efforts. Respondents from Sarasota County estimated that the government spent nearly \$52,000 between the years of 2006 to 2007 as mitigation for six separate red tide events. In Lee County, it was estimated that they spent \$250,000 for a single event in 2004 and that the same amount was paid to Collier County for their damages in 2005. Along with the mitigation costs that are paid out to affected businesses, Florida’s government also has to spend large amounts of money each year to clean up the dead marine life that collects on its beaches. From 2004 to 2007, it was reported that the state spent \$653,890 in Pinellas, Sarasota, Lee, Collier, Longboat Key, and Naples alone on clean-up activities, such as equipment and labor wages.⁷⁷ State officials, knowing that this outbreak was going to require significant cleanup, announced in August of 2018 that they would be allocating \$3 million to aid affected counties with clean up.⁷⁸ After the bloom finally subsided

⁷⁵ Sims, 2018.

⁷⁶ Ibid.

⁷⁷ “Harmful Algal Blooms- Economic Impacts.” Carter, 2018.

⁷⁸ Carter, 2018.

in February of 2019, the research group Florida Sea Grant was able to estimate that Florida suffered \$20 million in tourism-related losses over the sixteen-month period.⁷⁹

Harmful algal blooms have also had negative impacts on the fishing industry, which is fairly large in Southern Florida. Annually, it is estimated that the red tide results in anywhere from \$13 million to \$25 million of lost revenue from the fishing industry.⁸⁰ During the 2015 to 2016 red tide event, it was reported that clam farmers alone lost \$1.3 million.⁸¹ These losses can be attributed to the fact that many of the eligible fish are killed by lack of oxygen or neurological defects from the brevetoxins emitted by the red tide. Many of the fish and shellfish that are not initially killed from toxin exposure are still contaminated and therefore are not safe to eat. This is often not a problem for commercial fishermen, as they can go far off the coast in order to avoid the blooms. However, many local charter captains do not have this luxury and therefore are gravely impacted by financial losses.⁸² Nevertheless, people within Florida are often wary of eating any seafood caught during a red tide outbreak due to the possible health risks associated with the tide. As previously stated, these risks include severe digestion issues, tingling sensations, rapid heartbeat, coordination problems, or possible death. Therefore, even those fishermen who are able to catch noncontaminated fish have trouble selling their products due to fear of contamination.

The loss of wetlands has also caused Florida to lose much of its natural capital. Natural capital refers to “resources and services produced by the earth’s natural processes, which support all economies and all life.”⁸³ For years, groups have argued about how humans should treat

⁷⁹ Riley, 2019.

⁸⁰ “Harmful Algal Blooms- Economic Impacts.”

⁸¹ Riley, 2019.

⁸² “Red Tide Hurting Local Fishing Industry,” 2017.

⁸³ Miller, 2011, 612.

natural capital. Two of the most well-known arguments come from neoclassical economists and ecological economists. On one hand, the neoclassical economist group argues that the earth's natural capital is a crucial part of the anthropocentric economic system. Because of this, they believe that nature exists to be depleted and manipulated to achieve economic gain for humans. In short, neoclassical economists believe that humans should take advantage of whatever natural capital we have- ignoring any negative effects that our actions may have on the future- and make a financial profit from it.⁸⁴ On the other hand, ecological economists believe that the economy relies heavily on the health and preservation of earth's natural capital. These economists build economic models based on three basic assumptions. First, natural resources are limited and therefore should not be wasted, as there are often no substitutes for forms of natural capital. Second, we as humans should be encouraging forms of environmentally beneficial or sustainable forms of economic development, rather than focusing on economic growth that relies on the degradation of the environment. Finally, the negative effects on the environmental or on human health when producing an economic good should be factored into the good's market price. In doing this, consumers would be able to properly gauge the ecological impacts of the products they purchase.⁸⁵

Despite these differing opinions, it is clear that natural capital plays a crucial role in economic growth. In the case of the drainage of the wetlands in the Everglades, it can be argued that the negative effects associated with the loss of natural resources will stunt economic growth over time. First of all, there are many hidden costs associated with the drainage project. As spoken about in Chapter 1, the loss of wetlands has left many communities surrounding the Everglades to be more susceptible to flooding and exposure to water pollutants. This could cause

⁸⁴ Miller, 2011, 612.

⁸⁵ Ibid, 614-615.

financial losses in the future if these communities face serious damages due to flooding or are exposed to illnesses from unfiltered water. Furthermore, these communities are also more likely to face shoreline erosion now due to the lack of buffer from wetlands. Once again, this could cause significant financial losses as these communities begin to physically shrink in size. Finally, the loss of the wetlands also redirected tourists to the coastline, minimizing tourism opportunities inland. As stated in Chapter 1, wetlands are often recognized for their aesthetic value, making them optimal locations for recreational activities such as hiking, fishing, bird watching, hunting, and photography. However, as these wetlands were turned into farmland, they lost most of their value in the eyes of tourists. Furthermore, the worsening algal blooms that arose as a result of this drainage have also had negative impacts on Florida's natural capital. As stated earlier, Florida's economy is heavily reliant on the fishing industry, making the ocean one of its greatest natural resources. As these red tide algal blooms are threatening marine life by contaminating and killing off several species with their toxins, it is clear that they are a threat to Florida's natural capital and are limiting the economic growth within the state.

Chapter 4: Sociological Road Block Against Red Tide Prevention

Despite the ecological and economic effects of these harmful algal blooms, there has been little political action taken to limit the amount of fertilizer pollution being released into the ocean. This exemplifies Luiz Barbosa's theory of "risk society" which he explains in his work, *Theories in Environmental Sociology*. This theory was initially introduced by Ulrich Beck, a famous German sociologist. In the context of this theory, "risk" refers to the way in which humans deal with hazards that are created by modernization. Therefore, risk society refers to the idea that "modern societies differ from other forms of society in the sense that risks are created

by decisions, instead of naturally occurring hazards such as famines, floods, and so on, which plague other societies".⁸⁶ In short, the risk society theory states that whereas past societies were afflicted by or suffered from naturally occurring phenomena, modern societies create their own threats by choosing to take deliberate risks. One example of this that Barbosa gave to further explain this theory was nuclear energy. Although we as humans know that there are risks associated with nuclear energy, such as nuclear disasters, radiation, and toxic waste, we continue to use it because scientists believe that the benefits outweigh the risks.⁸⁷

The idea of risk society can be seen in the case of the land development in the Everglades and its subsequent effects on the Red Tide. First of all, it is nearly impossible to believe that the individuals who worked on these drainage projects did not think that altering an existing ecosystem so drastically could have negative effects in the future. Although it might not have been at the forefront of their minds, it is very clear that draining an entire wetland ecosystem and turning it into farmland could have negatively impacted the ecological health of the area. However, there were no accounts of research being done surrounding the possible effects on the environment. In fact, there was little research conducted at all. As stated before, the drainage projects were based on Wright's report alone, with no additional research. Soon after, it was soon found that Wright had falsified his reports to support the plans set forth by state officials. After this, the Everglades Land Sales Company hired the group of three well-known drainage engineers to replace Wright after it was made public that his report had been altered to reflect the plans of state officials. All of these engineers voiced their concerns about the drainage project, however, they were quickly shut down and replaced by engineers selected by the state officials. This new group of engineers dispelled the previous concerns and also agreed with the plans of

⁸⁶ Barbosa, 2009.

⁸⁷ Ibid.

the state officials. State officials moved forward based on the information from their engineers, rather than those hired by the Everglades Land Sales Company.

Overall, the state official's constant switching between engineers calls attention to their ultimate goal: to find an engineer that was willing to create a drainage plan for them despite any perceived environmental threats or negative impacts. This, in combination with the lack of focus on gaining sufficient and verified research, highlights the presence of a risk society mentality among Florida's state officials at the time. Despite the environmental risks associated with draining the Everglades and turning it into farmland, state officials continued with drainage plans because they felt as though the economic gain from increased jobs and more agriculture outweighed the environmental risks. Instead, they chose to work engineers and groups, such as Wright, who went as far as to falsify reports to support their plans. This demonstrates the complete willingness of these individuals to ignore pressing risks in order to achieve their desired outcome.

The risk society mindset is also present in the actions of Florida's current state officials, as they have failed to create any solid policies to address this issue. As stated, scientists have found clear correlations between the rise in agriculture and the increase in fertilizer pollution being released into the ocean from sugarcane farms. Despite this, there has been very little political intervention. Instead, any policies that have been proposed surrounding the Red Tide are focused on funding additional research on how to mitigate ongoing outbreaks, rather than addressing humanity's role in the exacerbation of the algal blooms.⁸⁸ As politicians have been avoiding suggesting any policies that limit agriculture or fertilizer use- despite the scientific evidence that shows that it is responsible for the more severe outbreaks- it is clear that they have

⁸⁸ Callihan, 2018.

chosen to take this deliberate risk because they believe that economic gains from the agricultural land outweigh the negative effects on the aquatic ecosystems

The lack of concern for the environmental risks in this situation also highlights the disconnect that now exists between nature and humanity. This separation is further explored in Raymond Williams' writing, "Ideas of Nature". In this writing, Williams states that "in the orthodox medieval concept of nature, man was, of course, included."⁸⁹ From this, one can see that there was a point in time where humans were considered to be an intricate part of nature. However, Williams goes on to explain that over time, a clear separation between humans and nature began. This started originally with the small instances of humans controlling nature, through the domestication of animals and the use of land for agriculture. At this point, humans still thought of themselves as somewhat included in the idea of nature, but still separate enough that it allows us to view nature as a separate entity that could be controlled. However, as humans began to understand more aspects of nature, they also began altering and controlling it for things such as fuel and resources. When this happened, humans completely stopped viewing themselves as part of nature. Instead, they began to think of nature as anything other than man, as well as anything that hadn't been touched by man. The idea of nature being something that had yet to be touched by humans perpetuated the idea that nature was something that was meant to be exploited by humans for their benefit. Because of this, humans reached the point where they no longer viewed themselves as being intrinsically connected with nature and instead saw themselves as the producers and consumers of nature. As more humans began to buy into this idea, it became easier for them to feel morally right when thinking of nature as merely a resource that exists for the exploitation of man.

⁸⁹ Williams, 1980.

Williams' ideas can also be seen in the case of the Red Tide. The idea of the separation between humans and nature can primarily be seen through the lack of empathy towards the aquatic ecosystems in Southern Florida. Even though there were tens of thousands of tons of fishkill washing up on the beaches of Southern Florida, much of the media surrounding the 2017 to 2019 Red Tide outbreak focused on the loss of profits for fisheries and tourism-based businesses in the area. This showed a clear dissociation between humans and nature, as entire ecosystems were being destroyed due to these algal blooms and the public was mainly concerned with the economic loss. Also, many of these articles did not mention that the length and severity of this specific outbreak were connected to fertilizer pollution, and instead repeatedly stated that the fact that these blooms are naturally occurring in Southern Florida.⁹⁰ Although this statement is technically true, it shows the reluctance of humans to take responsibility or feel empathetic about our effects on the environment.

After the outbreak, more articles were published blaming fertilizer runoff for the exacerbation of the Red Tide. Despite the widespread publication of this knowledge, no drastic changes have been made. Some counties in Southern Florida banning fertilizer use in personal lawns and golf courses on rainy days to minimize the chances of fertilizer runoff reaching waterways. However, this ban does not apply to farmland, the main contributor to the fertilizer runoff.⁹¹ Although this fertilizer ban was created to mitigate this issue, it is clear that policymakers are once again unwilling to address the root of this issue: agricultural runoff. This shows humanity's inability to compromise their economic greed for the benefit of the environment, as they have bought into the idea that nature is a completely separate entity from us and therefore humans should be able to exploit it however they want. This mindset allows

⁹⁰ Hall, 2018.

⁹¹ Riley, 2019.

humans to validate the destruction of nature to themselves, as they have been taught to believe that humans are superior to nature. Because of this, it is once again clear that the redevelopment of the Everglades was going to happen regardless of any perceived environmental degradation because humans will not let potential threats to nature impede on their potential financial gain.

Overall, it is clear that the development of the Everglades, and the subsequent Red Tide outbreaks, were a result of human's inherent economic greed and lack of research into long-term environmental dangers. Despite the warnings from early engineers and the obvious environmental implications associated with converting wetlands into farmland, Florida's state officials chose to move forward with their plans to develop the Everglades. This decision- coupled with the refusal to take responsibility for the fertilizer pollution which has led to aggressive and destructive outbreaks of Red Tide- highlights humanity's inclination to put their desires above the needs of the environment. Because of this, humans are willing to take deliberate risks, such as develop large spans of land, in order to benefit themselves. Furthermore, the dissociation that humans now feel between themselves and nature allows them to justify their actions, as nature is viewed as a resource that should be exploited for human benefit.

In the case of the Red Tide, it seems as though state officials have chosen to ignore this pressing environmental issue because the solutions would most likely interfere with the economic growth of Florida's agricultural industry. This demonstrates state officials choosing to think like neoclassical economists, meaning that they believe that humans should take advantage of whatever natural capital we have- despite any negative effects on the environment- in order to financially profit from them. However, Florida's aquatic ecosystems cannot continue to survive if they are exposed to aggressive outbreaks of these harmful algal blooms each year. As the health of Florida's aquatic ecosystems is essential for their tourism and fisheries, it is clear that

state officials in Florida must accept that humans and nature are intrinsically linked and begin adopting the mindset of the ecological economist. As stated in the previous chapter, ecological economists believe that the economy relies heavily on the health and preservation of the earth's natural capital. Therefore, they encourage forms of environmentally beneficial or sustainable economic development. In adopting policies that regulate fertilizer runoff into the ocean, Florida officials will be able to both protect and preserve their natural capital, while at the same time allowing aspects of their economy, such as the fishing and tourism industry, to prosper.

Chapter 5: Experiments and Policies to Combat the Red Tide

As previously stated, red tide algal blooms occur naturally almost every year in Florida. Therefore, many different groups have been affected by or been made aware of these harmful algal blooms at one point- including state politicians, fisheries, the Fish and Wildlife Service, Everglades-based restoration groups, the Sierra Club, and even community-based groups. Over the years, these groups have made several attempts at combatting these algal blooms issue and mitigating its effects. One of the first major attempts occurred during the 1957 outbreak, the first outbreak which was bad enough to warrant a large-scale attempt of controlling the algal blooms. During this outbreak, experiments were conducted by members of the Gulf Fishery Investigations, a group that was created by the Fish and Wildlife Service in 1950. This group consisted of many organizations and fisheries that had a stake in the fishing industry within the Gulf of Mexico. The primary purpose of this group was to act as a research vessel, conducting experiments and gaining information that could then be relayed within the group and to the Fish and Wildlife Service.⁹² Many factors had to be considered when scientists began experimenting

⁹² Arnold, 1958.

with the algal blooms, namely the cost of controlling the blooms, how long they could control them, and whether or not these attempts would harm marine life in the area. As a collective team, the members of the Gulf Fishery Investigations group decided that the best way of containing and controlling these algal blooms at an affordable and relatively harmless way would be to employ the use of copper sulfate. Copper sulfate is often used to fight algal blooms in smaller bodies of water, such as lakes or canals. However, it had never been used in the ocean. Previous laboratory experiments had proved that *Karenia brevis*, the organism that causes the red tide, could be effectively killed by copper concentrations within 1 to 3 hours. At the time of this experiment, copper sulfate cost only \$215 a ton, making it a relatively cheap alternative. The proposed plan was simple: purchase copper sulfate in crystallized form and sprinkle it over the areas affected by the red tide. However, the execution of this plan did not go over as easy as it was planned for many reasons. First of all, scientists struggled to find a way to evenly disperse the crystals in the correct area, as they were dropping it from a plane. Also, as the ocean is very large, the copper was bound to disperse. Therefore, it was difficult for the scientists to determine how much copper sulfate to drop at a specific time. Scientists were wary about introducing too much copper sulfate into the ecosystem, as they were worried about it dispersing and harming other organisms in the area. Overall, plans to use copper sulfate to eliminate the red tide were later dismissed after only a few attempts. During their experiments, the scientists found that the copper sulfate did not kill all of the *Karenia brevis* cells and that it released the brevetoxins from the cells that it did kill. Besides, introducing such large amounts of copper sulfate into the ocean ended up killing off many of the other aquatic organisms within the area. Due to these failures, this plan was abandoned.⁹³

⁹³ Rounsefell, 2016, 1-2.

As of today, scientists are still avidly searching for a way to effectively control or eliminate these harmful algal blooms, however, they have been unsuccessful thus far. Because of this, many scientists have begun to shift their goal away from trying to control active algal blooms, and instead are focusing on trying to stop the blooms from occurring in the first place. In doing, scientists have brought attention to the biggest factor contributing to the growth of these algal blooms: the increase of fertilizer runoff within the ocean. As discussed earlier, fertilizer runoff from agricultural farmland has been fueling these blooms and causing them to be more resilient than ever before. Two of the most popular agricultural goods produced in Florida are citrus and sugarcane. As native oranges are one of Florida's most well-known goods, the citrus industry consumes a large amount of fertilizer. The University of Florida's Institute of Food and Agriculture Services has recommended that there be 200 pounds of nitrogen and 40 pounds of phosphorus per acre of citrus grove⁹⁴. Because of this, up to 89 million pounds of nitrogen and 18 million pounds of phosphorus are being used per year throughout the 447,012 acres of citrus groves in Florida. Although most citrus groves are located north of Lake Okeechobee, there are still several groves that are situated close to the manmade canals, leaving the potential for excess fertilizer runoff to leech into the waterways. Sugarcane crops are also known to consume a large amount of fertilizer. However, the exact amount of fertilizer used in the Everglades Agricultural Area is unknown as Big Sugar leaders refuse to disclose their fertilizer use to the public.⁹⁵ However, as about 440,000 acres of the Everglades Agricultural Area are devoted solely to sugarcane, one can imagine that this area requires a large amount of fertilizer. However, farmland is not the only culprit. Annually, Lee County, a county of the southwest tip of Florida, reports spreading 780,000 pounds of fertilizer on its athletic fields, and Fort Meyers, a city

⁹⁴ Dorsey, 2018.

⁹⁵ Ibid.

within Lee County, has reported spreading 202,000 pounds of fertilizer and 17,200 pounds of phosphorus on its two golf courses alone.⁹⁶ Another big factor has been the redirection of water from Lake Okeechobee. Naturally, the overflow from this lake flows south to the Florida Bay, however, the creation of the Herbert Hoover Dike has redirected the water to the East and West coasts of Florida. As the water builds up in the canals, the US Army Corps has been releasing water from a nearby lake, Lake Okeechobee, into the ocean, along with water from its basin. This water is mostly freshwater, and therefore is diluting the salinity of the Gulf Coast. As many of the microorganisms associated with the red tide thrive in freshwater, this release of water has worsened the algal blooms over time.⁹⁷

Although scientists have been able to trace a large percentage of the fertilizer pollution back to sugarcane farms, they have been unable to combat this issue on their own. Instead, they have supplied their research to other groups that are better suited to combat this issue. One possible solution that has come from this research has been Senate Bill 10, otherwise known as the Now or Neverglades Declaration. Since its introduction, this declaration has gained significant backing from organizations such as the Sierra Club and the Everglades Trust. The Sierra Club is a well-known environmental group that was founded in the United States in 1892. The Everglades Trust is a subsection of the Everglades Foundation, which was created in 1994. The goal of the organization is to act as the political voice of the Everglades. The organization calls for local, state, and federal lawmakers to take meaningful action to restore and preserve the Everglades and ensures that lawmakers who do not do so are held accountable.⁹⁸

⁹⁶ Dorsey, 2018.

⁹⁷ Renner, 2018.

⁹⁸ Everglades Trust.

The Now or Neverglades Declaration is a land buyback scheme which was introduced in January of 2017. This declaration calls for the construction of a reservoir in the Everglades Agricultural Area, just south of Lake Okeechobee.⁹⁹ If this reservoir was to be created, water would be able to resume its natural flow southwards, hopefully alleviating the algal blooms. Though this declaration was initially created to prevent algal blooms within Lake Okeechobee, restoring the natural flow of water within the Everglades could significantly mitigate red tide outbreaks in the future as the water would not be flowing directly into the ocean. In tandem with this bill, politicians have also suggested other methods of alleviating the stress on the aquatic ecosystems, such as increasing the salinity of the water in areas plagued with the red tides. Although this would be effective, many argue that this would be a method of controlling the issue, rather than getting rid of the root of the problem.¹⁰⁰ Also, it is hard to tell the impact that further manipulation of the ecosystem would have on the surrounding marine life.

Over the years, there has also been an increase in the number of community-based organizations with the goal of mitigating the effects of the red tide. One organization that was formed after the 2017 to 2019 outbreak was the Florida Commercial Watermen's Conservation (FCWC). This nonprofit, science-based organization was created by a commercial fisherman in Pine Island, Florida who faced significant financial losses to his commercial fishing and fish market business after the particularly aggressive outbreak. The goal of this organization is to create a network of local fishermen from across the coast of Florida who are willing to work with federal and state scientists to help water samples from offshore Florida waters. These water samples, collected from Venice to Marco Island, will then be tested for red tide and other water quality indicators. Casey Streeter, the founder of FCWC, explained that he knew that scientists

⁹⁹ Everglades Trust.

¹⁰⁰ Renner, 2018.

were getting better at recognizing early indicators of algal blooms, however, it is often hard for them to get samples from different areas around the Florida coast. As the group of fishermen who have joined the FCWC spend much of their time on the water, they can provide scientists access to constant samples of waters from areas of the ocean that they may otherwise not have tested.¹⁰¹

Another community-based organization that was started after the 2017 to 2019 outbreak is Hands Along the Water. Hands Along the Water is a volunteer-driven group that is based in Sarasota County, one of the several counties that were affected the most by the aggressive red tide outbreak. Since its founding in August of 2018, the organization has spread into several other nearby counties. The organization's mission is to protect the ocean and its marine life by involving shoreline communities in education and activism. They have achieved this mainly through organizing beach cleanups and shoreline restoration projects. They have also held several educational seminars for community members, educating them about the root causes of the algal blooms. The group is mainly known for their peaceful protests, which are aimed to show politicians that they will no longer sit idly by while their communities, beaches, and wildlife are terrorized by these toxic algal blooms. Although they are doing little to solve the root cause of the problem, the organization has been successful at garnering media attention and community backing. In doing this, they are putting additional pressure on state officials to create policies to address these red tide outbreaks.¹⁰²

However, despite the work done by these organizations, there has been little political action. The Now or Neverglades Declaration was signed by the Florida State Governor, Rick Scott, in May of 2017. However, little progress has been made in creating the reservoir as the

¹⁰¹ Slimak, 2019.

¹⁰² Chaney, 2019.

state must wait to gain the appropriate permits and property deeds before they can start construction. Furthermore, political action has been halted due to budget cuts within Florida's environmental agencies. Although the problem of the red tide within Florida has been a growing issue for decades, the state has cut many of its organizations that focus on managing water quality. Recent state and federal budget cuts have resulted in the remainder of only 115 of the 350 water management stations within Florida.¹⁰³ With these drastic cuts in the budgets of environmental agencies, it has been increasingly difficult to get the ball running on any form of solid action. Many of these budget cuts were either called for or approved by Governor Scott. Therefore, it came as a shock to many when Governor Scott made a public call for Florida's Fish and Wildlife Conservation Commission to take additional action against combatting the red tide in 2018. Although Scott thanked the organization for its successes in monitoring, reporting, and responding to the harmful algal bloom, he asked them to do more. In a letter to the chairman of the Fish and Wildlife Conservation Commission, Governor Scott urged the organization to create a Florida Center for Red Tide Research, as well as to re-establish the Florida Harmful Algal Bloom Task Force. Scott also allocated \$1.2 million to the agency's redfish research and hatching facility at Port Manatee, as redfish populations were severely depleted due to the red tide outbreak. To make further amends for his previous budget cuts, Scott proposed that he would fight increase environmental spending by \$220 million if he were to be reelected.¹⁰⁴

This additional funding would most likely be going towards researching methods of controlling the red tide using clays. In 2018, Governor Scott announced a partnership between Florida Fish and Wildlife and several researchers across the world that focused on exploring the possibility of using clay to get rid of the toxic algal blooms. This approach is based on research

¹⁰³ Callihan, 2018.

¹⁰⁴ Ibid.

and experiments done in Asia, namely Japan, China, and Korea, where they have used certain clays that attach to the algal particles and carry them to the bottom of the ocean. Once at the bottom of the ocean, the clay buries and decomposes the harmful particles.¹⁰⁵ Although this method seems very promising, this approach has received significant backlash because the clay used in past experiments was purchased from the phosphate industry, the chemical compound which is contributing to the accelerated growth of these algal blooms. Because of this, many argue that this is simply allowing the phosphate industry to profit off solving a problem they created.¹⁰⁶ Regardless, further testing is still needed to determine whether or not this method would even be viable within the state of Florida, due to the amount of clay that would be needed, the availability of these clays within the United States, and the possible effects of these clays on the aquatic ecosystem.

Although it is widely believed that the money for additional research would be beneficial in the long run, many individuals and organizations still believe that policies and solutions should focus on the root of the problem: fertilizer pollution. One of the leaders of this opposition has been the Sierra Club. In 2018, the Sierra Club's Florida Chapter Director, Frank Jackalone, released a statement criticizing Governor Rick Scott. In this statement, Jackalone states, "Rick Scott's call for the creation of a Center for Red Tide Research is nothing more than a self-serving publicity stunt. He is desperately diverting attention from his failure over his two terms as Governor to address the pollution problems which have fueled massive [toxic red tide] across the State... The only way to reduce the occurrence, size, and severity of harmful algal blooms is to stop the pollution that is feeding it at its source. We need prevention, not more studies."¹⁰⁷

¹⁰⁵ "ECOHAB: Control of Harmful Algal Blooms Using Clay," 2018.

¹⁰⁶ YouTube, 2018.

¹⁰⁷ "Sierra Club Florida News," 2018.

Through this statement, one can see that the Sierra Club and other grassroots organizations believe that additional funding should be put towards prevention of future fertilizer pollution, instead of dealing with its consequences. Following in the footsteps of the Sierra Club, other grassroots movements have also voiced their concerns about the lack of political action concerning the red tide. For example, local fisherman Rob Merlino started a petition to create a constitutional amendment banning the use of fertilizers and glyphosate herbicides on the ballot for the 2020 election. Although this petition gained a lot of local publicity, it did not gain significant political footing.¹⁰⁸

Chapter 6: Policy Recommendations

For policy recommendations, it is important to create policies that deal with the prevention of harmful land development, the prevention of excessive fertilizer runoff, and the mitigation of ongoing red tide outbreaks. In order to address these things, this chapter will be broken down into 3 subsections: Land Development Policies, Runoff Prevention Policies, and Red Tide Control Policies.

Land Development Policies

First of all, policies need to address the root of this environmental issue: under-researched land development programs. As stated before, the Everglades drainage project began based on very little research- much of which was found to be falsified. Because of this, the state of Florida is now dealing with severe threats to their ecosystems and communities. If state officials had set requirements for adequate research in the first place, Florida would not be facing the severe algal blooms that they are today. Therefore, first and foremost, Florida's officials should begin

¹⁰⁸ Kimel, 2018.

drafting policies that require a certain amount of research to be done before any construction or ecosystem-altering programs be approved. These policies should require that the research be funded and conducted by the company itself, but that it be reviewed and approved by qualified engineers and scientists appointment by the state's government and environmental groups. This will hopefully deter organizations who do not want to invest in proper research or who know that their proposed projects will have negative effects on the environment. Also, by requiring that projects are approved by qualified engineers and scientists, it will make it harder for organizations to falsify reports or create false calculations to have their projects passed, as was done in the case of the Everglades drainage. Through this policy, it is more likely that reports would reflect the true consequences or impacts of the construction, rather than simply stating what the organization funding the project wants to hear.

Furthermore, policies like these would help organizations and state officials move away from policies that promote the idea of "risk society" which was discussed in Chapter 4. As stated, risk society refers to the idea that modern societies create their own threats by choosing to take deliberate risks.¹⁰⁹ As seen through the case of the Everglades drainage, state officials have often chosen to disregard possible threats to the health of ecosystems in order to benefit themselves financially- demonstrating their risk society mindset. However, by requiring extensive research into land development projects there will be little way for officials and organizations to perpetuate the idea of risk society as they will be required to dismiss any projects that could pose a potential threat to the environment.

It is also important to factor in natural capital into assessments of potential risks associated with land development projects. In the case of the Everglades, the state of Florida lost

¹⁰⁹ Barbosa, 2009.

much of the natural capital and natural resources that wetlands provide. As mentioned in Chapter 3, the loss of wetlands caused some of Florida's communities to be more susceptible to flooding, exposure to water pollutants, and shoreline erosion. Also, the loss of the wetlands caused a significant decrease in this region's value to tourists and fisheries, stunting certain areas of potential for economic growth for these communities. Because of the potential financial losses that could result from these issues, state officials should also consider the unseen costs of land development before deciding whether the economic benefits outweigh possible environmental risks.

If policies like these were to have been put in place before the drainage plans in the Everglades began, the project would most likely not have been approved. Not only would the problems with Wright's report been recognized sooner, but also state officials would have had to consider the contributions from the other engineers who advised against draining the entire Everglades in fear of environmental degradation. At the beginning of the drainage, state officials believed that the economic gains associated with the increase in agricultural land severely outweighed the potential environmental risks at the time. However, if they were to have taken into the account the loss of natural capital that would result from it, they would have been able to predict the possible financial losses in the long run associated with the need for additional flood protection and the loss of tourism and fishing industries.

Fertilizer Runoff Mitigation Policies

Shifting attention to the issue of the red tide, it is first important for policymakers to create policies that deal with the root of the problem: fertilizer runoff. As the increase in the severity and aggressive nature of the red tide algal blooms has been scientifically linked to the

increase in fertilizer runoff, it is clear that policymakers within the state of Florida must start creating policies that deal with lowering the amount of fertilizer runoff being released into the ocean. Although the algal blooms will most likely still naturally occur in Florida every year as they have for decades, limiting the amount of fertilizer runoff will lessen the duration and intensity of future blooms.

As discussed, the southwest coast of Florida contains some of the highest numbers of phosphorus and nitrogen runoff in the United States, with anywhere from 1.6 to 1460.3 tons of phosphorus per hectare and between 0.6 to 483.3 tons of nitrogen per hectare.¹¹⁰ This has been caused by the significant increase in the sugarcane and citrus industries within the Everglades Agricultural Area. As the agricultural industry has become a large source of economic growth within Florida, it will be difficult to convince politicians to ban the use of fertilizer altogether. Therefore, policies that deal with mitigating fertilizer runoff within Florida must instead deal with both educating farmers on how to reduce fertilizer runoff, as well as limiting the overall amount of fertilizer used within the state. Through policies like this, the agricultural industry would still be able to thrive, but the amount of fertilizer nutrients released into the ocean would drop significantly.

First of all, policies should be put into place to hold farmers accountable for their irresponsible use of fertilizer. For instance, a regulation should be put into place that prevents farmers from using fertilizer within a certain distance of storm drains, rivers, and larger bodies of water. As fertilizer is often leached into the ocean through these waterways, farmers need to release as little fertilizer into them as possible. Furthermore, farmers should be required to follow similar bans and policies concerning fertilizer use that have been put in place throughout the

¹¹⁰ EPA.

state of Florida. For example, some counties in Southern Florida have already banned fertilizer use in personal lawns and golf courses on rainy days to minimize the chances of fertilizer runoff reaching waterways. Also, Sarasota County recently prohibited the use of all fertilizers that contain nitrogen from during Florida's rainiest period- June 1 to September 30.¹¹¹ The county also advises against using fertilizers that are high in phosphorus during this period. Some of these regulations may be hard to implement into agricultural land, as they are heavily reliant on fertilizer for their crop growth. However, it can be argued that a slight loss in profits for farmers is a small price to pay for an overall increase in economic and environmental health of the state. Furthermore, it seems only fair that farms- the leading source of fertilizer runoff- should be forced to follow similar regulations to mitigate this issue as the communities affected by the consequences of this runoff.

One way that fertilizer use could be reduced across the entire state would be through the incentivization of households and green spaces, especially those near bodies of water, to limit their fertilizer use. Although agricultural land is the main source of fertilizer runoff within Florida, it has been reported that households, golf courses, and athletic fields also contribute to the issue. Therefore, a policy could be put into place that offers tax breaks to any household, golf course, or athletic field that agrees to lower or completely stop their use of fertilizer. As stated before, it was reported that Lee County alone uses 780,00 pounds of fertilizer for their athletic field, as well as 202,000 pounds of fertilizer and 17,200 pounds of phosphorus on their golf courses each year.¹¹² Therefore, decreasing the amount of fertilizer used in these areas would be a great start in lowering the amount of nitrogen and phosphorus being released into the ocean. This can be done through the introduction of turf fields into athletic fields. Although turf is more

¹¹¹ Red Tide Fact.

¹¹² Dorsey, 2018.

expensive than install than a typical grass field, it requires little to no fertilization. Therefore, investing in turf fields would be a relatively easy switch for communities that could help significantly decrease the amount of fertilizer runoff in the long run. In addition, state officials could promote and incentive xeriscape landscaping for household lawns and golf courses. Xeriscaping is a landscaping style that has been growing in popularity over the years due to its ability to save water. Xeriscape landscape designs use mainly native and drought-resistant plants and arrange them in ways that save as much water as possible.¹¹³ As xeriscape landscapes use mostly native plants, they rarely require fertilizer- as native plants are adapted to the natural soil conditions in the area.¹¹⁴ Therefore, by incentivizing xeriscaping over traditional landscaping, state officials would be able to help further cut down on possible sources of fertilizer pollution.

These incentivization policies will not only help to cut down on fertilizer pollution but will also help to educate Florida's population about the root cause of the red tides. In a 2014 study of educated adults within Florida, it was found that the majority of the participants had little to no knowledge of the fertilizer runoff alone, nonetheless its effects on the red tide.¹¹⁵ Although the knowledge of this issue has slightly risen over the past few years, many Florida residents are still unaware of the correlation between fertilizer runoff and the algal blooms. Therefore, these incentivization policies serve a dual purpose of increasing knowledge about this issue, which would hopefully allow any future policies concerning limiting fertilizer runoff to obtain more public backing. Furthermore, recent studies found that forty-six percent of business owners in Sarasota county reported that their business has been down by at least fifty percent this year due to the algal blooms.¹¹⁶ Although statistics have not been collected in other counties,

¹¹³ Fuller, 2008.

¹¹⁴ Xeriscape.

¹¹⁵ Kirkpatrick, 2014.

¹¹⁶ Carter, 2018.

business owners across the coast are likely experiencing similar losses. If these algal blooms persist, it is apparent that many businesses will suffer in the long run. Therefore, as many residents of the southwest coast Florida are likely struggling due to the red tide, there is a high potential that they would support a policy to limit the use of nitrogen and phosphorus-rich fertilizers if they were made aware that fertilizer runoff plays a large part in exacerbating the red tide. Therefore, through incentivizing alternatives to fertilizer use, policymakers will not only be decreasing the amount of nutrient runoff but will also be helping to obtain substantial public backing for any further policies.

Red Tide Policies

Finally, policymakers should create policies that are focused on preventing and mitigating the red tide itself. As seen throughout this paper, the Florida red tide is a significant environmental issue that affects the overall health of Florida's aquatic ecosystems, residents, and economy. Although, policymakers must continue to push for policies to prevent fertilizer pollution that will be beneficial in the long run, they must also focus some of their energy on creating short-term solutions. One of the previously proposed solutions that state officials should continue to focus on would be the Now or Neverglades Declaration. This declaration calls for the construction of a reservoir within the Everglades Agricultural Area, just south of Lake Okeechobee. This reservoir would stimulate the natural flow of the water from Lake Okeechobee into the Everglades, rather than forcing it to go into the canals created by the United States Army Corps of Engineers. This would allow the water to once again be naturally filtered through the Everglades, rather than being released directly into the ocean. In doing this, less fertilizer pollution be released into the ocean and some of the wetland ecosystems would be partially restored. This would provide multiple benefits to the state of Florida, such as protection against

flooding and shoreline erosion, natural filtration of fertilizer nutrients out of the water, and an increase in biodiversity. The possible benefits of this plan were recognized by state officials, as the Now or Neverglades Declaration was signed by Governor Scott in May of 2017. However, as previously stated, progress has been halted as the appropriate deeds and permits are received. This delay has largely been due to Big Sugar's reluctance to give up their farmland.¹¹⁷ Although the state has raised the money to buy back the land from Big Sugar, the land technically still belongs to them. Nonetheless, politicians should continue to put pressure on Big Sugar and sugarcane farmers to sell their land, as it is apparent that this plan could help to alleviate a lot of the current problems affecting the state of Florida and its inhabitants.

Although the Now or Neverglades Declaration would improve the health of the marine life, Florida residents, and the Florida economy during future outbreaks of the red tide, it would not get rid of the problem entirely. Therefore, politicians must also put any leftover money and resources they have into researching methods of mitigating ongoing red tide outbreaks. For example, politicians should be continuing to fund the international research partnership that was put in place by Governor Scott. This partnership between Florida Fish and Wildlife and several researchers across the world- including Woods Hole Oceanographic Institution, The University of South Florida, Mote Marine Laboratory, and the Florida Department of Environmental Protection- is focused on researching clay as a possible solution to mitigating toxic algal blooms.¹¹⁸ This method has resulted in the mitigation of algal blooms across Asia, namely Japan, China, and Korea. However, as previously mentioned in Chapter 5, this method has received a lot of opposition within Florida, as the clay used in previous experiments within Florida was obtained from phosphorus companies- the same nutrient which has found to be causing the red

¹¹⁷ Graulau, 2018.

¹¹⁸ YouTube, 2018.

tide to grow. To deal with this criticism, the research group has obtained a new type of clay from China which they hope to use in future experiments. If these experiments are successful, red tide blooms could hopefully be controlled until further policies are created.

Once again, this is only a short-term solution and does not combat the root of the issue, which is fertilizer pollution. Therefore, further research on clay to control red tide blooms should only be funded with money left over from the Now or Neverglades Declaration, as well as any policies that deal with limiting fertilizer pollution. However, as it appears that it may take longer than expected for these things to fully come into fruition, it is necessary for politicians to allocate some funding towards researching methods of controlling the red tide in the meantime. These methods should only be used to mitigate the effects of the red tide-such as health risks and financial losses- and protect aquatic ecosystems until permanent policies that address fertilizer pollution are put in place.

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EDUCATION

- Fordham University**, Bronx, NY May 2020
Bachelor of Arts in Environmental Studies, Minors in Business Administration and Business Law and Ethics,
 GPA: 3.67, Major GPA: 3.87
- Notre Dame Academy**, Hingham, MA May 2016
National Honors Society, National French Honor Society, Notre Dame Academy Scholar, GPA: 3.9

RELEVANT EXPERIENCE

- The Bronx is Blooming**, Social Media and Outreach Coordinator January 2019-Present
- Managed the social media accounts for a nonprofit organization, gaining 100+ new followers
 - Organized outreach programs within the Bronx community
 - Facilitated volunteer events within Bronx parks
 - Wrote and submitted environmental justice and sustainability grant applications
- Gibney, Anthony & Flaherty LLP**, Internet Researcher June 2019-August 2019
- Searched, identified, and reported counterfeit items
 - Compiled reports and paperwork to report sellers
- The Pooped Pooch**, Pet Care Provider, Dorchester, MA June 2017-November 2018
- Walked up to 15 dogs per day
 - Managed 15-35 dogs per day in our day care facility
 - Took care of various pets to ensure their health and safety while owners were away
- Sweet Frog**, Sales Associate, Quincy, MA November 2014-December 2016
- Worked as a cashier 3-5 days a week
 - Organized and facilitated fundraisers and events within the store
 - Dealt with customers' questions and complaints

ADDITIONAL EXPERIENCE

- Sustainability Club**, Member, Bronx, NY January 2018-Present
- Attended meetings and contributed to discussions about our school's sustainability policy
 - Brainstormed ways in which we could implement composting within our community
- Boston Rugby Camp**, Administrator, Milton, MA June 2014-August 2015
- Handled paperwork and important documents
 - Assisted in camp activities with children ages 7-13
- The Children's Chef**, Chef, Quincy, MA June 2011-August 2014
- Prepared food for local summer schools and campus
 - Taking stock inventory

ADDITIONAL SKILLS

Microsoft Word, Excel, PowerPoint, Customer Service, Social Media
 Conversational French

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