The Fate of the Florida Mangroves

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As the state of Florida gears up for governor elections in the upcoming fall of 2018, many of its residents are reflecting on the last two terms served by current governor Rick Scott. A particular emphasis has been placed on the changes in environmental policy during the last decade as many Floridians are becoming aware of hydrological issues across south central Florida and the Everglades region. Gov. Scott has repeatedly shown a preference for business over the environment with actions like cutting down funding for Florida's water management districts, lowering pollution regulation enforcement, and funneling less money into land conservation programs (Rangel). He even reportedly banned the use of terms like "climate change" and "global warming" within the administration of the Department of Environmental Protection (Sherman). The stance his office has taken in environmental affairs has been made clear during his time in power which is why many residents were left confused when he proposed a one billion dollar blueprint in 2014 that would improve Florida's water flows within the Everglades. The plan would help to reverse the damage from previous canaling and river alterations that have resulted in a disturbance of natural hydrological flows into southern Florida wetlands (Turner). Many citizens summed it up to be a campaign strategy as Gov. Scott unveiled the plan a month before his re-election.

In any case, the proposed plan for the enhancement of Florida waterways was a response to the growing concerns of residents as they faced challenges of wetlands being limited by flows within the state. These are ecosystems like salt marshes, cypress forests, swamps, and in particular, the mangrove forests lining Florida coastlines. Mangroves are trees or shrubs that stand on big prop roots in or near estuarine habitats with three species of mangrove inhabiting Florida. A mangrove ecosystem provides immense ecological services to the environment and is critical

to maintaining healthy terrestrial and marine climates. Florida's mangroves face many stressors from anthropogenic influences, a problem that Floridians are beginning to realize and acknowledge (Walking Trees). Without stronger policies and mitigation efforts, mangrove ecosystems will never be properly restored or have the ability to reach their full beneficial capacity. As elections draw nearer and campaigns occur across the state, voters will get their chance to have a say in the protection and preservation of these invaluable wetlands. It is this election that has the potential to determine the fate of the Florida mangroves.

The Florida Everglades is home to some of the most significant landscapes and ecosystems on our planet. A giant preservation in Southern Florida, it is composed of 1.5 million acres of wetland with a large portion containing mangrove forests. The Everglades are the largest subtropical wilderness in the United States and as such, home to an abundance of wildlife that depends on the functions and aspects of this ecosystem to survive. The Wood Stork, for example, the only stork species to breed in the U.S., is a native to the Everglades and depends on wetlands like the mangroves for nesting and foraging. The occurrence of hydrological changes and alterations throughout Florida in the last three decades have resulted in a reduction of freshwater flowing into these wetland systems and subsequently caused problems for organisms like the Wood Stork. This bird is considered threatened and serves as an indicator species for the restoration of the Everglades because it so heavily relies on one particular ecosystem for survival (National Park Service). As mangroves and other wetlands are negatively affected by human activity, so are the many organisms that are contingent upon the services provided to them by this distinct environment.

The services provided by mangrove systems are limitless and these services are immeasurable to maintaining healthy ecosystems in Florida and all over the world. One of the most essential functions of these systems is the use of them as nesting and nursery habitats for numerous fish species and other organisms. The long prop roots of a mangrove provide protection for nesting fishes and those organisms completing the

vulnerable early stages of their lives. This function allows for the classification of mangroves as an Essential Nursery Habitat since fish species rely on the habitats they form within them for the purposes of breeding grounds and protection during the vulnerable transitioning from larval to juvenile stages (Shenker). Countless Florida fish species depend on this ecosystem for nursery grounds including mullet, snook, and a plethora of reef fish species. The roots are also an ideal spot for many small invertebrates to make their home because of factors like tide exposure, food availability, and light penetration. These are animals like crabs, snails, barnacles, oysters, tunicates, and sponges. The high density of the roots shields these small critters from waves and currents and prevents large predators from entering. The mangrove habitat is an extremely specialized ecosystem that cannot be replaced or eradicated for many marine organisms.

Tropical mangrove systems are not only vital to marine organisms but also to terrestrial vertebrates who rely on the abundant resources within these systems. The uniqueness of its salt and freshwater gradient quality allows for many organisms to adapt to this particular habitat, causing them to become restricted to this specific environment. It was discovered in one study that 853 terrestrial vertebrates species worldwide are commonly found within mangrove ecosystems and that 69 of those species are limited to this environment (Luther 4-5). Few conclusions were drawn for why these vertebrates developed an exclusive dependence to mangroves, one of which is that climate change [likely] affected their original habitats and forced them to use mangrove forests as a refuge. Many of these mangrove-restricted species also rely on mangroves for food sources that are not available in inland habitats (Luther 7). Some species, like the endangered yellow-shouldered blackbird of Puerto Rico, who lost its original habitat of inland forests due to deforestation, could have possibly gone extinct had it not been for the mangrove forests that provided a suitable shelter when it was urgently needed (Luther 10).

Another fundamental role of mangroves is limiting soil erosion and reducing the impact of storm surge. Florida faces erod-

ing coastlines from high-energy waves and storm surge that often comes with the many tropical storms and hurricanes that the state experiences each year. The long prop roots that extend far into the soil of a mangrove as well as the ecosystem's ability to trap suspended sediment during incoming tides help to prevent the eroding of soil along coastlines (Willemsen 3). This action of stabilizing coastlines also assists in preventing damage to developments further inland. The dense vegetation and accreted sediments play a role in moderating storm surge and waves that can help to severely limit the damaging effects that occur to properties near or along the coasts. Mangroves both protect exposed coastal areas from soil erosion and storm surge, and serve as accumulation sites for sediment and nutrients, making them critical to the stability of coastal environments.

Climate change is currently one of the largest threats to the world's natural environments as atmospheric carbon levels increase and sea levels rise as a consequence. Fortunately, there are natural systems in place to alleviate some of these effects, and mangrove ecosystems are one of our best tools in both mitigation and preventative measures. Old-growth mangrove forests are responsible for taking much of the atmospheric carbon and storing it within their roots and biomass, thereby helping to mitigate the increasing climate change. This vital function was analyzed in a study that evaluated factors determining the value of carbon stocks within the mangrove forests of the Everglade. According to the study, between 8 and 20% of human-caused carbon dioxide emissions stem from deforestation and other changes in land use. One major example of these changes in land use is the destruction of a third of the world's mangroves in the past half century. Mangroves account for just 0.7% of global tropical forests, but their loss accounts for fully 10% of the world's deforestation-related carbon emissions (Jerath 2).

Mangroves are also responsible for partially offsetting sea level rise, an important function for a state that is dominated by coasts and therefore more vulnerable to the consequences of rising sea level. To compensate for sea level rise, mangroves increase their sediment accretion rate, which allows the ecosystem to manage higher tides and larger water influxes. Sediment

accretion is vital to the health of mangroves and is also used to help battle rising sea levels for lowland mangroves such as those existing in coastal areas (Willemsen 19-20). All of these mangrove-provided services are invaluable to the health of our environments worldwide and especially to the Florida coastline.

Unfortunately, mangroves all over the world are suffering from a plethora of hazards. In Florida, the biggest threat to the mangrove population is human activity that results in both direct and indirect change to mangrove ecosystems, leading either to their destruction or decreased functioning. One human-induced problem for the mangroves is the current rapid climate change occurring all over the planet. With the increase of greenhouse gases like carbon dioxide being released into the atmosphere from human means, average temperatures are rising and with them, sea levels and extreme weather. An increase of tropical storms like hurricanes is responsible for placing stress on mangrove ecosystems and consequently altering their productivity (Jerath 2).

Another anthropogenic intervention faced by mangroves is the development of coastlines that results in either their destruction or a coastal squeeze that limits their landward movement from sea level rise. The latter problem also occurs alongside a decreased sediment supply for many reasons related to human intervention, which is explained by Professor Willemsen in his study analyzing the sensitivity of a mangrove's sediment-capturing abilities. Willemsen describes how the blocking of tidal patterns or sediment river flow, from actions like damming or creating reservoirs, limits the amount of sediment able to reach and accumulate in mangrove ecosystems. In fact, reservoirs trap 26% of total terrestrial sediment discharge globally, critically affecting sediment deposition in wetlands (Willemsen 3). However, the sediment trapping capacity of mangroves is severely limited by hydrological changes from humans such as those mentioned above. In response to this, mangrove forests begin to move landward and away from the rising sea. This plan fails, though, when coastal developments restrict the accommodation space for landward-migrating mangroves, a process called

a coastal squeeze. This ultimately creates wetland degradation and the drowning of the mangrove ecosystems that harms their survival (Willemsen 19-20). As mangroves disappear, so do the ecosystems that they belong to, as well as the benefits that they provide.

Rising sea levels pose other problems such as the potential drowning of entire ecosystems if the mangroves do not respond sufficiently to longer and higher tide influxes. The placement of dams and canals has produced the issue of decreased sediment input so the mangrove's solution is to move inland; this plan, however, leads to the aforementioned coastal squeeze (Willemsen 3). Coastal development also creates another dilemma of the complete deforestation of mangroves for space and aesthetic purposes. Coastal properties are often worth much more than their inland counterparts, which has led to the clearing of much of the mangrove forest population along coastlines for the sake of monetary profit. The belief that mangroves decrease aesthetic value as well has also led to their decline in Florida, with areas like Tampa Bay losing 44% of its coastal wetlands acreage and West Palm Beach experiencing 87% decrease of mangrove acreage in the past century (Walking Trees). However, to clear mangroves from coastlines is to eradicate a natural storm buffering system leading to a higher possibility of damage from large storms for residential and commercial areas (Yespelkis 1).

Mangroves suffer from a variety of other forms of human interaction including hydrological changes that affect drainage and fresh water flow. Professor Meenakshi Jerath notes in the study he co-authored that when mangrove forest water patterns are changed, the nutrient and salinity levels are altered and the forest's structure and productivity are hindered. Jerath provides an example of this with the Mangrove Ecotone Region in the Everglades of South Florida, which is experiencing those very problems. These old-growth forests are found to have a considerable stored amount of carbon within their biomass and roots that is sequestered from their surrounding environment. When these forests are altered or deforested, they lose their carbon-trapping abilities and their stored carbon is released back into the atmosphere. This means that besides losing a natural

climate change mitigation system when altering mangroves, climate change is also exacerbated by the loss all of the stored carbon in the system. The Everglades area is now protected but even with this status the Mangrove Ecotone Region still faces challenges and stressors from the alterations to unprotected mangroves on the outskirts of the protected region; these alterations are negatively impacting the functioning and hydrological processes of the forests within this area (Jerath 2).

Damaging mangrove ecosystems through physical destruction and alteration of hydrological processes also has adverse effects on fishery species. Many fisheries rely on certain fish species to support their businesses, which can be harmed if there is a decline in these species. Mangroves are a vital habitat to marine fishes that support healthy and abundant populations. Even with these benefits, mangroves still face many of the aforementioned challenges from human activities and 25-30% of mangroves within Florida's Indian River Lagoon has been estimated to have been lost in the last 60 years (Shenker 5). Much of this loss was due the incorporation of these areas into mosquito control impoundments that have since been reconnected to the Lagoon. However, these areas still face difficulties of reduced water flow from the previous alterations, limiting their usefulness as an Essential Nursery Habitat (Shenker 5-6). As certain marine species and organisms are negatively impacted by changes, food chains in mangrove ecosystems become altered. This creates consequences for fisheries and any aspect of the ecosystem reliant upon the functions of these impacted species.

Mangroves trees provide insurmountable value to humans and therefore there should be more regulations in place to protect them and their ecosystems. Without mangroves, certain negative impacts would arise, such as less climate change mitigation, higher vulnerability to storm surge for developments, increased change of coastal soil erosion, and a decrease of species that rely on these ecosystems. These are all effects that have the potential to create severe consequences for people in Florida and all over the world. Mangroves need laws and regulations that protect their existence, minimize human impact on their

ecosystems, and support their reforestation. The impact of advancing mangroves in both population numbers and productivity will have both short-term and long-term effects. More immediate change would be higher fishery species yield, while climate change mitigation would be a more gradual change over many decades. It is this latter result that many would consider to be its most significant influence to people, but often the results are not tangible or rapid enough for society to realize what's truly at stake when mangroves are lost. John Pethick, author of "Marshes, Mangroves and Sea-level Rise," notes in his study evaluating the threat of sea-level rise on wetlands that as mangroves disappear the "failure to establish adequate coastal wetlands will lead to both economic and ecological penalties over the years ahead." It is for these reasons that laws governing mangroves should be more strictly enforced and should strive to create a unified effort to protect mangroves across Florida.

Currently, Florida does have a set of regulations regarding the preservation of mangroves, though many environmentalists would agree that they are not sufficient enough in protecting and restoring mangrove ecosystems. The Florida Legislature passed the 1996 Mangrove Trimming and Preservation Act after many efforts by lobbyists to bring attention to the growing mangrove destruction in Florida (Fisher). The Act includes important rules like obtaining permits to trim or clear mangroves and fines for any "unregulated removal, defoliation, and destruction" of mangrove trees. However, permits are not required to trim mangroves on a riparian mangrove fringe (shoreline mangroves containing a set of specific qualities) and a professional trimmer is only required if the mangroves exceed 10ft (1996 Mangrove). The Act also allows for counties to regulate permits for mangrove alterations and trimming, which can allow for stricter enforcement but it can also allow for more lax stances on counties wishing to profit indirectly from mangrove removal or alteration. Preserving mangroves requires that everyone in Florida have strict, unified laws in regard to how they can affect mangroves. Compensation is accounted for in the Act in that the removal of any mangrove must be replaced with another mangrove being replanted, but there is no compensa-

tion for damage already done to mangroves. Restoration efforts should be put into place as lawyer Kellyalexis Fisher makes note of in her article "Man Let'em Grow: The State of Florida Mangrove Laws." She proposes that those areas not likely to be used for real estate be converted into mangrove swamps to "help compensate for past losses of mangroves in the bays and coastlines." To restore mangroves back to proper functioning and usefulness to both Florida residents and to the world, a long-term united effort is needed to both preserve and reestablish these vital ecosystems.

Florida has the opportunity to use the upcoming gubernatorial election to take a stance on the importance of the wetlands within their state. The peoples' voices on environmental policy need to be heard so the fate of the mangroves and the Everglades overall can have a chance at recovery and restoration. It is crucial that attention is given to the destruction that humans are having on these ecosystems in Florida and its detrimental results. The importance of mangroves' needs to be realized because of their significance for climate change mitigation and storm surge protection. We must also grasp that when we perform harmful activities like developing coastlines and generating greenhouse gases we are affecting those very services the mangroves provide to people. Ultimately, the price of exacerbating the decline of Florida's mangroves is too high to justify the short-term benefits from their destruction. Stricter regulations and strategies for mangrove restoration need to be put into place immediately to help stabilize and reverse the problem so that we can start appreciating all the benefits mangroves provide. There is also a need for exploration of questions like "what is the best strategy for implementing mitigation efforts to restore mangrove populations?" as well as "how do we make people comprehend that the harm they're inflicting on mangroves is harming their own welfare?" When we start fixing the problems mangroves face through stricter control on regulations and more efforts towards restoration, we allow ourselves to experience the full potential mangrove ecosystems can have on the environment. All it takes is for people to care and as a result, to take a stand for their rights to a life that experiences

all the magnificence of living in a healthy environment.

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