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The Disappearing Wetland Act: Climate Change, Development, and Protection

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The Disappearing Wetland Act: Climate Change, Development, and Protection

Abstract

Wetlands are the providers of ecosystem services and important local and national economic resources. Despite the services provided by these ecosystems, the importance of wetlands are often overlooked and they are filled in to make way for development, polluted, and degraded. These habitats are further damaged by the effects of climate change. This thesis focuses on wetlands in the Northeastern United States, using the Long Island Sound as a case study to explore the devastating effects of development and climate change on wetlands. In this thesis, I use environmental history, economics, and government policy to explore the importance of wetland protection. The UN IPCC, and EPA sponsored wetland monitoring and assessment reports are used to collect scientific data on the health of wetlands. The thesis explores fauna which have the ability to live only within the narrow conditions wetlands provide for them, as well as the subsequent effects destruction of wetlands have on local and national economies. All this evidence points to the need for increased protection of wetlands. Wetlands provide essential ecosystem services, economic services, and in the face of climate change serve as buffers against extreme weather. Despite the importance of wetlands there has been little increased protection for these environments. The only way to protect wetlands is to draw national attention and begin to draft and pass updated policies. Increased protection of these essential environments could lessen the effect of climate change, protect natural resources, and ensure a continually thriving ecosystems and economies.

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Introduction: The Disappearance of Wetlands

More than half of the United States population lives on or near a coast or wetland. From this information alone, it is clear that for one reason or another, wetlands are vital to life as we know it. Wetlands offer important ecological and economic services, especially in times of climate change, yet they are disappearing at an alarming rate. This thesis explores why this loss is occurring and what methods are most effective at preventing this loss and degradation.

Growing up on Long Island I was never more than 15 minutes from a body of water. Due to this I was able to observe wetlands up close and personal and marvel at all the creatures living within the ecosystem. Due to this I will focus on the Northeastern United States, and particularly the Long Island region when writing my thesis.

This thesis will take an in-depth look at the major stressors to wetlands and the effects of these stressors on the environment. I will first examine the effects of human development and climate change on wetlands and the services they provide. The first chapter explores what factors degrade wetlands and the negative effects of those damaging factors.

Then I will examine the history of wetlands. This chapter will look at the history of human degradation prior to 1970's, when attitudes towards wetland began to change and legislation began to be put into place. This paper will explore 1970 forward examining why attitudes towards wetlands changed and what this meant for the health of wetlands. This chapter will look at reports from the Fish and Wildlife Service and compare the conditions of wetlands in the past to current conditions. By comparing wetlands in history to current wetlands this chapter will highlight the importance of their unique ecosystem and the horrendous effects climate change and degradation has had on wetlands.

The next chapter will explore the ecosystem services wetlands provide for humans. An in depth look at characteristics of wetlands will show why wetlands hold such environmental, economic, political, and social importance. By looking at the benefits of wetland ecological services this chapter will explore both the environmental and economic benefits for humans and the environment, giving reasons for the protection of wetlands. Wetlands provide provisioning services in the form of fresh water, food, and medicinal resource. Wetlands also provide regulation services through local climate and air quality regulation, carbon sequestration, moderation of extreme events, and waste water treatment. Cultural and supporting services are also provided through recreation, aesthetics, tourism, habitats for species, and maintenance of diversity. By studying ecosystem services, it also offers reasons for all groups of people, environmentalist, business oriented groups, and development groups, to fight to preserve wetlands. This chapter will look at the economics effects of degradation of wetlands. Chapter 3 focuses on provisioning ecosystem services as well as economic benefits.

Next this thesis will explore, legislation and its effectiveness on the protection of wetlands. I will examine past regulations and the effects of these regulation on preventing or slowing down damage to wetlands. Regulations both revoked and still in place will be examined for their effectiveness. Legislations of wetlands began to be put in place in the 1970's in the United States so this section will focus on modern history. Chapter 4 will exemplify policies that work, policies that do not, and trends in policy.

The thesis will conclude with recommendations for policy which will be based off of what has proved to be successful in the past. The conclusion will also prove that what is good for the environment is good for economics, and therefore protective policy is beneficial to the

environment. In modern times effective policy is needed desperately and the thesis will conclude with examples of effective policy and why such policy is needed.

Chapter 1: The Effects of Development and Climate Change on Wetland Habitat Loss

In the United States over fifty percent of the country's citizens live along the coast. This is no surprise considering wetlands are biodiverse ecosystems that are vital to the health and wellbeing of the environment and of humans. Specifically, tidal wetlands are one of the most productive ecosystems in the world providing breeding and nursery grounds for species and fertile land for plants. Salt marshes, another type of tidal wetland, are vital in protecting inland areas from flooding, erosion, and are responsible for the filtration of pollutants in water. These wetlands provide necessary ecosystem services, including provisioning services, regulatory services, habitat or supporting services, and cultural services, which will be described in detail in a later section of this thesis.¹ Included in this, is resources necessary for life, such as fresh water, food and medical services, and resources that benefit the economy such as fisheries, tourism, and recreational industry.

Wetlands and Ecosystem Services. Despite this, people continue to degrade wetlands. Over recent history, wetlands across the United States have been degraded due to both increased anthropologic activity and climate change. Major stressors to wetlands are development, limitations of regulations, coastal erosion and shoreline hardening, climate change and sea-level increase, pollution, invasive species, hydraulic altercations, disturbance, and impoundments.² All of the major stressors to wetlands are human caused, and these stressors disturb the balance of

¹ Millennium Ecosystem Assessment, *Ecosystems and human well-being: Synthesis*. Washington, DC: Island Press, World Resources Institute 2005.

² S. Stedman and T.E. Dahl. *Status and Trends of Wetlands In The Coastal Watersheds Of The Eastern United States 1998 To 2004*, (Washington DC: National Oceanic And Atmospheric Administration, National Marine Fisheries Service And U.S. Department Of The Interior, Fish And Wildlife Service, 2008),1-32.

nature in wetlands causing damages to humans and the environment. When this 2008 report on the stressors to wetlands was released, it noted that 361,000 acres of wetlands were lost in the Eastern United States between 1998 and 2004.³ Eight-two percent of the loss occurred in fresh water wetlands, and 60 percent of this loss was attributed to “other development.”⁴

Development of wetlands such as filling in marshes and other wetlands destroys ecosystems and degrades water quality. This makes the services wetlands provide less efficient. It was found that development and pavement of roads negatively effects the quality of water in wetlands and aquifers. One study found that “water quality declines when built surfaces exceed 10% of a watershed⁵”. In the United States, there are more than 94,000 miles of roads along the coast⁶. In line with this finding, most of the Nation’s largest population centers have the poorest water quality. Also, development, specifically filling in tidal wetlands has led to the decreasing acreage of wetlands in the United States and to the increase in mudflats throughout the nation, which are less productive and provided less ecosystem services to humans and species.⁷

Due to pollution and development there have been mass loses of biodiversity and increases in hypoxia and dead zones, which lead to problems for the health of an area. It is known that storm water runoff carries pollutants such as pesticides, pathogens, motor oil, debris, and excess nutrients from impervious surfaces into near by water. This is caused entirety from human activity and directly related to negative health in both humans and wetland. This polluted runoff causes dead-zones and areas of hypoxia. Hypoxia is when there is a bloom in algae, which is directly related to nitrogen in the water. With increased nitrogen from farming run of

³ Stedman and Dahl, *Status And Trends*, 1-32

⁴ Stedman and Dahl, *Status and Trends*, 1-32

⁵ Long Island Sound Study Partnership, *Sound Health 2008: Status and Trends in the Health of Long Island Sound. LISS Partnership*, (Washington DC: Long Island Sound Study Partnership, 2008), 1-16.

⁶ Thomas E. Dahl, and Greogory J Allord, *Technical Aspects of Wetlands History of Wetlands in the Conterminous United States*, (Washington DC: US Geological Survey, 1997), 8.

⁷ Long Island Sound Study Partnership, “*Sound Health 2008*”

there is an increase bloom. This bloom depletes the water of oxygen making it inhabitable for all other species. These nutrients cause deformities in fishery and makes the waters unsafe to drink, swim and eat from.⁸

Climate change is one of the main stressors that has negative effects on the health and wellbeing of wetlands. According to the IPCC, scientists conclude with high confidence, that between 1992 and 2001 glaciers shrunk in size worldwide, which caused an increase in the sea level, which led to a disturbance in coastal wetlands. It is concluded that between 1901 and 2010 sea level rose by .19 meters globally, and the increase in sea level has grown more since the mid 19th century than it had during the previous two millenniums.⁹ Scientist have concluded that it is extremely likely that more than half of the observed increase in global average surface temperature, which caused the rise in sea-level from 1951 to 2010, was caused by the anthropogenic increase in GHG.¹⁰ It is likely that sea level rise has contributed to increased impact of storms, including increasingly impactful storm surges. Scientist conclude that climate change is also responsible for other extreme weather including heat waves, droughts, floods, cyclones, and wildfires all of which negatively impact wetlands. These changes in the environment allow for the “significant vulnerability and exposure of some ecosystems and many human systems.”¹¹

Due to this rise in seal level, coastal and other low lying wetlands have been susceptible to increased submergence, flooding, and erosion throughout the 21st century.¹² Also due to

⁸ New York State Department of Environmental Conservation, *DEC Releases Report on The Harmful Impacts of Nitrogen Pollution on Long Island's Coastal Marshlands*, (Washington DC: DEC, 2014), NP.

⁹ IPCC, *Climate Change 2014: Synthesis Report, Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Geneva: IPCC: 2014)

¹⁰ IPCC, *Climate Change 2014: Synthesis Report*

¹¹ IPCC “*Climate Change 2014: Synthesis Report*

¹² Jerry M. Melillo, T.C. Richmond, and Gary W. Yohe, *Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program* (Washington DC: EPA 2014), 1-841.

climate change, wetlands and coastal regions have become sensitive regions. Estuaries, a type of tidal wetland, are among the richest and most productive wetlands, and they are also the most vulnerable to climate change.¹³ In these regions, marine biodiversity has decreased significantly, which scientists have correlated, with high confidence, to climate change.¹⁴ Many plant and animal species have been unable to adapt quick enough to the change in surface and water temperatures. Climate change has also increased the growing season for many invasive plants, pest, and pathogens. The expansion of these creatures is a threat to native species, and decreases the biodiversity, function, and resistance of wetlands.

Aquifers and wetlands are also currently at risk due to increased groundwater withdrawals, surface water impoundments, and diversion.¹⁵ Due to increased withdrawal, estuaries are particularly vulnerable to salt water intrusion and freshwater inflow changes that change water salinity and subsequently make it difficult for species to survive and change the quality of water for humans. Under the influence of both heavy pumping and increased droughts and extreme storms the threat of salt water intrusion in aquifers has increased during modern time. Delaware, Susquehanna, and Potomac River deltas on the Northeast seaboard, most of Florida, the Apalachicola and Mobile River deltas and bays, the Mississippi River delta in Louisiana, and the delta of the Sacramento-San Joaquin rivers in northern California are all vulnerable to these issues¹⁶. Also, due to climate change, large proportions of the population will begin or continue to experience water scarcity.¹⁷ These problems are projected to become more common as climate warming continues to increase.

¹³ Melillo, Richmond, and Yohe, *Climate Change Impacts in the United States*, 1-841.

¹⁴ Melillo, Richmond, and Yohe, *Climate Change Impacts in the United States*, 1-846.

¹⁵ The Long Island Clean Water Partnership, *The Case for Protection And Comprehensive Management Of Long Island's Groundwater And Surface Water*, (New York: The Long Island Clean Water Partnership, 2013),np.

¹⁶ Melillo, Richmond, and Yohe, *Climate Change Impacts in the United States*, 1-846.

¹⁷ Melillo, Richmond, and Yohe, *Climate Change Impacts in the United States*, 1-846.

Wetlands in the Northeast. There are approximately sixty-four million people living in the Northeastern United States, making the coast from D.C to Boston one of the most developed in the world¹⁸. This area is significantly ecologically and environmentally important. It is known for its coastal zones, beaches, dunes, wetlands, and freshwater biodiversity. It has large recreational and tourism industries which provide jobs for many of its citizens. These natural resources provide a long list of ecosystem services to citizens of the region including “protecting water supplies, buffering shorelines, and sequestering carbon in soils and vegetation.”¹⁹ But with this large population comes increased anthropogenic activity, as well as increased development, which decreases water quality and puts extreme pressure on wetlands. Prior to the 1970’s the United States encouraged the filling and development of wetlands. Their value was not recognized and they were thought of as places to fill in, build on and dredge²⁰. Since the early 1800’s marsh coverage on the coasts on New England has decreased by nearly 40%. In the metro area of Boston, marsh lands cover less than 20% of what they did over 300 years ago²¹.

Beginning in the 1970’s regulations began to be put into place, but at this time there was a large population increase.²² Between 1980 and 2006 the population of the New York and Connecticut watershed increased from 6.3 million to 7.2 million people.²³ So, despite the changing opinions on wetlands, the population boom of the region fostered increased development, and therefore degradation of these ecosystems. This means there is less natural filtration. In Connecticut, a survey of six wetland complexes in southwestern Connecticut

¹⁸ Melillo, Richmond, and Yohe, *Climate Change Impacts in the United States*, 1-846.

¹⁹ Dorina Frizzera, *Mitigating Shoreline Erosion along New Jersey’s Sheltered Coast: Overcoming Regulatory Obstacles to Allow for Living Shorelines*, (New Jersey: NJDEP- Office of Coastal Management, 2009), NP.

²⁰ Dahl and Allord, *Technical Aspects of Wetlands History of Wetlands in the Conterminous United States*

²¹ Melillo, Richmond, and Yohe, *Climate Change Impacts in the United States*, 1-846.

²² Long Island Sound Study Partnership, *Sound Health 2008*, 1-16.

²³ Long Island Sound Study Partnership, *Sound Health 2008*, 1-16.

revealed that the total area of salt marsh declined from 230 acres to 177 acres from 1974 to 2004²⁴. Also, due to development “Impervious urban surfaces and coastal barriers such as seawalls limit the ability of marshes to expand inland as sea levels rise.”²⁵

The Northeast’s coastal wetlands and their inhabitants are exposed to negative effects of climate change due to rising sea levels, increased temperature, increased storms, and increased precipitation. Due to these factors, there has been increased beach and dune erosions, which leaves coastal lands vulnerable to increased flooding. This further promotes erosion and decreases area of intertidal lands, which causes a population decline in the rich species that live within these areas.

The Northeast is heavily effects by extreme weather, which has escalated in the recent years, as exemplified by Superstorm Sandy and Hurricane Irene. The Northeast’s location, off of the Atlantic Ocean, leaves it and its wetlands vulnerable to ice storms, floods, droughts, heatwaves and hurricanes. With climate change and increased sea level rise there has been increasingly high storm surges. Between 1895 to 2011 temperatures in the northeast increased by 2 degrees Fahrenheit, the yearly precipitation has increased by over 5 inches, and coast flooding has increased due to sea levels in the region rising 1 foot since 1900²⁶. This combined with the decrease in the area of wetlands leads to increased damages to the environment, including further erosion of wetlands, as well as damages to infrastructure including homes and roads.

Effects to Long Island Wetlands. Specifically speaking to the Long Island region, one EPA study has found that there have been devastating effects to the Long Island Sound and its

²⁴Long Island Sound Study Partnership, *Sound Health 2008*, 1-16.

²⁵Melillo, Richmond, and Yohe, *Climate Change Impacts in the United States*, 1-846.

²⁶Melillo, Richmond, and Yohe, *Climate Change Impacts in the United States*, 1-841.

biodiversity over recent history. About 25 to 35 percent of the Sound's tidal wetlands were destroyed before federal and state legislation halted the practice in the early 1970's²⁷. It appears regulation did little to stop degradation. Research has found that marsh grass is disappearing at an alarming rate and over the past 30 years, hundreds of acres of marsh are converted to mudflats annually. On Long Island, it was found that the total area of salt marsh declined from 434 to 346 acres from 1974 to 2005²⁸. Development has also decreased the quality of the Sound's watersheds in New York and Connecticut. Areas reaching passed the 10 percent threshold increased from 278 in 1985 to 293 in 2002, and "Sub-regional watersheds exceeding the 25 percent threshold increased from 40 in 1985 to 54 in 2002²⁹,"

A study of the Long Island Sound also found that since 1987 there have been increased areas and duration of hypoxia. The study on the Sound found that the length of hypoxia was longer than average for 6 of the most recent 10 years of the study. The study also noted that the amount of nitrogen in the Sound increased by 400% due to increased anthropologic activity³⁰. Figure 1 examines areas of hypoxia throughout the Long Island Sound. The chart shows areas more heavily populated are more effected by hypoxia, proving it is related to anthropologic activity. It also shows that much of the populated areas of the Sound have experienced hypoxia for at least 50 percent of the time the study was taken.

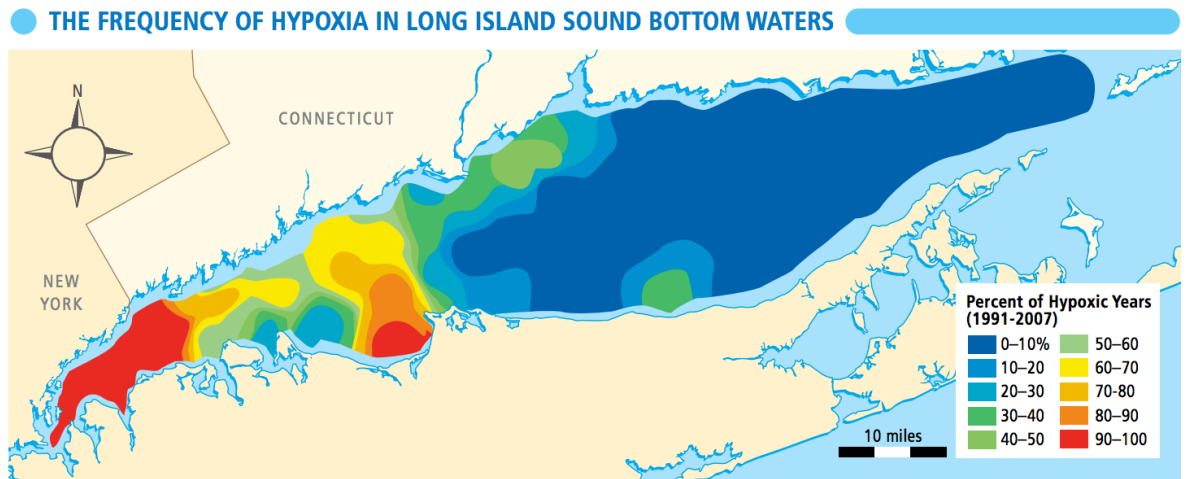
²⁷ Long Island Sound Study Partnership, *Sound Health 2008*, 1-16.

²⁸ Long Island Sound Study Partnership, *Sound Health 2008*, 1-16.

²⁹ Long Island Sound Study Partnership, *Sound Health 2008*, 1-16.

³⁰ The Long Island Clean Water Partnership, *The Case for Protection*.

Figure 1³¹



The study also noted that during the industrial revolution heavy metals started to accumulate in the sediments of the Sound. Concentrations of mercury off Norwalk Harbor in the Sound increased by more than 1,300 percent from 1820 to 1955³². Although dumping of chemicals has decreased since the 1980's, contamination has had lasting effects in species such as Striped Bass. Only in recent times are we beginning to notice a recovery of these species. Also, Pathogens, bacteria, and viruses have continued enter the Sound from inadequately treated sewage and farming waste, causing issues for the wildlife³³.

Climate change also has negative effect on the Long Island region. It has been found that rising sea levels in the Long Island Sound may increase the intensity, duration, and frequency of high water levels associated with coastal storm flooding. This flooding threatens ecosystem services and can cause increase pollution to groundwater supply³⁴. Sea level rising also effects

³¹ Long Island Sound Study Partnership, *Sound Health 2008*, 1-16.

³² Long Island Sound Study Partnership, *Sound Health 2008*, 1-16.

³³ Long Island Sound Study Partnership, *Sound Health 2008*, 1-16.

³⁴ The Long Island Clean Water Partnership, *The Case for Protection*

species who form nest in marshes. There is less marsh land around long island so researchers are beginning to see a decline in many bird species such as Saltmarsh Sharp-Tailed Sparrow³⁵.

As a result of this increased anthropologic activity combined with climate change and increasing temperature of the Long Island Sound, the population of cold water species, including lobster, winter flounder, Atlantic herring, cunner, longhorn sculpin, sea raven, ocean put, winter skate and little skate, have been declining, while the population of most warm-water species, including striped bass, weakfish, summer flounder, menhaden, scup, striped sea robin, butterfish, Atlantic moonfish, hickory shad, have been increasing. In all, 19 warm temperate species have exhibited a significant increase while the average number of cold-water species decreased over the past 23 years from about five species per tow to about four³⁶. For example, the Long Island Sound once had a booming oyster and lobster industry but this has decreased greatly due to ocean temperatures increasing³⁷. Figure 2 shows the decrease in the population of cold water species in the long island sound and the increase in warm water species from 1984 to 2007, which can be believed to only increase over the years as winter water temperatures continued to increase³⁸.

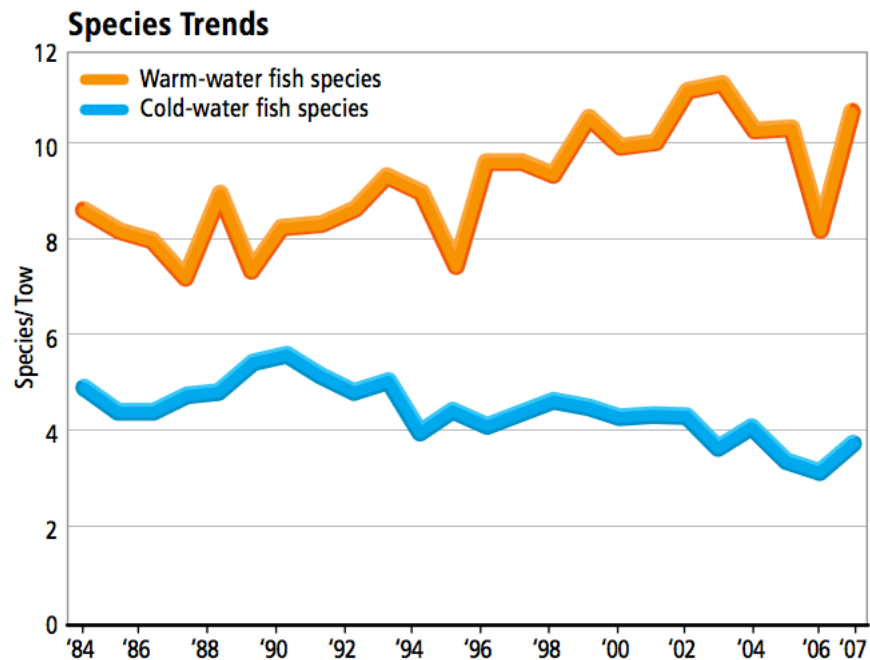
³⁵Long Island Sound Study Partnership, *Sound Health 2008*, 1-16.

³⁶Long Island Sound Study Partnership, *Sound Health 2008*, 1-16.

³⁷Long Island Sound Study Partnership, *Sound Health 2008*, 1-16.

³⁸Long Island Sound Study Partnership, *Sound Health 2008*, 1-16.

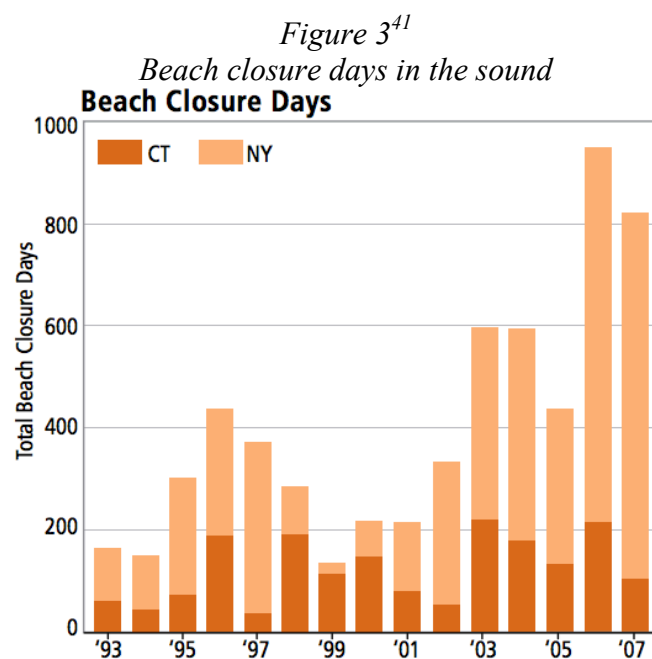
Figure 2³⁹
Trends in Wildlife in The Sound



It has also been noted that warm water invasive species have had increased population growth in the Sound, having detrimental effects on native species, especial winter species. For example, the non-native ascidians are benefiting from warmer winters, which takes away more resources from competing native species. Native species tend to benefit from cold water in the Sound while non-native benefit from warmer waters. This will affect growing seasons therefore effecting competition. If this continues it will affect the productivity of the entire ecosystem, because keystone species are becoming increasingly scarce, and therefore other species in the area will suffer. This causes a positive feedback loop in which the entire wetland ecosystem continues to decline.

³⁹ Long Island Sound Study Partnership, *Sound Health 2008*, 1-16.

This increased water temperature coupled with increased pollution from uncleansed sewage has led to the expansion of pathogens. These pathogens pose a threat to both humans and native species. Due to increased pathogen growth in the water there has been increased beach closures in the Sound, shown from figure 3 below⁴⁰. The increase pathogens also mean it is unsafe to eat oysters from the Sound, due to the damages these pathogens cause to organisms living within the Sound.



All of this leads to the fact that despite the vital role wetlands play, they are disappearing and being degraded at an alarming rate. In the United States millions of people rely on the services wetlands provided yet they continue to contribute to harmful development, pollution, and participate in activities adding to climate change. This effects the natural ecosystem of this area as well as local infrastructure and economy.

⁴⁰ Long Island Sound Study Partnership, *Sound Health 2008*, 1-16.

⁴¹ Long Island Sound Study Partnership, *Sound Health 2008*, 1-16.

To truly understand the extend of wetland damage throughout the United States. One must look at the history of damages and attitudes towards wetlands in the country.

Chapter 2: History of Wetlands

Throughout American history wetlands were viewed by people as a nuisance. Rather than acknowledge the importance of wetlands, people viewed them as obstacles in the way of development, a mentality that in part still carries on into modern times. It was not until 1953 that the United States Fish and Wildlife Service (the FWS) even termed wetland.⁴² The FWS described wetlands as “diverse environments, typically of high productivity, that share characteristics of both aquatic and terrestrial habitats,” and began to raise awareness about their importance and the importance of their protection. Attitudes towards wetlands began to change in the 1970’s and 1980’s, with the passing of Section 401 a of the Wetlands Protection Act, which changed the way wetlands were treated and regulated. Despite this, there was a significant amount of damage to wetlands prior to the passing of this law and continues to be damages into modern time.

Wetlands in the Continental United States. Wetlands began to be degraded nearly as early as the foundation of America. Wetlands began to noticeably degrade in the 1780’s. The value of wetlands was not recognized due to the government putting emphasis on settling the country from coast to coast. At this time, wetlands were also viewed as irritants because they were the breeding ground for deadly diseases, such as malaria, and often flooded ruining crops. Due to this the United States government encouraged the development of wetlands. One of the first sets of regulations regarding wetlands were the Swamp Acts of 1849, 1850 and

⁴² United States Congress, *Wetlands: Their Use and Regulation*. (WASHINGTON DC: Office of Technology, Assessment, 1984), 1-195.

1860. At the time swamps were overflowing and well known mosquito breeding grounds.⁴³ The government and people viewed this as an obstacle to maximum crop production. To counter the negative effects of swamps and encourage land development, the government allowed 15 states to reclaim 65 million acres of swamp land.⁴⁴ In doing so, there was increased urban and agricultural land but devastating effects to wildlife and the productivity of wetlands.

For the next 100 years following these acts, the government continued to push for development and encouraged the fill in of wetlands for agricultural and industrial uses. In 1954, a study was conducted by Roe and Ayres that claimed 215 million acres of wetlands in the United States were drained in order for the United States to reach optimum crop production. According to this estimate, it is believed that 24% of wetlands in this country were drained for agricultural production.⁴⁵

In the late 20th century some agencies and individuals began to recognize the vital role wetlands played and pushed for attitude and governmental changes toward wetlands. The Fish and Wildlife Service was vital in this change. In the 1950's the agency released a statements and report about the detrimental effects of the degradation and fill in of wetlands. Eventually this mentality spread, and in 1977 President Carter made a statement in favor of wetlands. In his message, President Carter said "The Nation's coastal and inland wetlands are vital natural resources of critical importance to the people of this country."⁴⁶ It was around this time that the people in American began to realize the importance of wetlands and attitudes throughout the country began to change.

⁴³ United States Congress. *Wetlands: Their Use and Regulation, 1-195* .

⁴⁴ United States Congress. *Wetlands: Their Use and Regulation, 1-195*.

⁴⁵ T.E. Dahl *Wetland Losses in The United States 1780's T0 1980's*, (Washington DC: U.S. Department of The Interior, Fish And Wildlife Service, 1990), 1-13.

⁴⁶ United States Congress, *Wetlands: Their Use and Regulation, 1-195*.

Eventually due to the support of the FWS, other organizations, and the government, bills began to be passed in favor of the protection of wetlands in the United States. One of the first bills passed was the Wetlands Land Loan Act, which was passed on October 4, 1961. The act “authorized an advance of funds against future revenues from sale of "duck stamps" as a means of accelerating the acquisition of migratory waterfowl habitat” by organizations that would promote wetland conservation.⁴⁷ The bill was extended in 1969, 1976, and 1983.

The next, and arguably the most important, wetland act passed was Section 401 a of the Emergency Wetlands Act, which was approved on November 10th, 1986 and laid the foundation for later wetland regulations. The act “authorized the purchase of wetlands from Land and Water Conservation Fund monies, removing a prior prohibition on such acquisitions.”⁴⁸ It established the National Wetlands Priority Conservation Plan, as well as required the states to include wetlands in their Comprehensive Outdoor Recreation Plans. It also ensured that migratory birds were well protected by requiring states to transfer funds equal to that from taxes on arms and ammunition to the Migratory Bird Conservation Fund. The act extended the Wetlands Loan Act through 1988. Also, the act required the secretary of the FWS to report to Congress on wetlands loss, including an analysis of the role of federal programs and policies in inducing such losses. The FSW also had to report on progress 10 years after the passing and map out wetlands loss. This was the first time a comprehensive government report on wetlands was created. It was this act that lead to increased awareness and education on wetlands and wetland loss.⁴⁹

In compliance with this act in the 1980’s and 1990’s the FWS released several reports including “Wetlands Losses in the United States 1780's to 1980's,” “Status and Trends of

⁴⁷ “Digest of Federal Resource Laws of Interest to the U.S. Fish and Wildlife Service”
<https://www.fws.gov/laws/lawsdigest/EMWET.HTML>

⁴⁸ Digest of Federal Resource Laws of Interest to the U.S. Fish and Wildlife Service”

⁴⁹United States Congress, *Wetlands: Their Use and Regulation*, 1-195.

Wetlands and Deepwater Habitats in the Conterminous United States 1950's to 1970's" and "Wetlands Status and Trends in the Conterminous United States, 1970's to 1980's." From, these reports many statistics about the historical loss of wetlands in the United States is illuminated. The reports found that the land area that then comprises the United States consisted of 392 million acres of wetlands, 221 million in the continental United States.⁵⁰ As of the 1980's it was estimated that only 5 percent of the land surfaces in the continental United States was wetlands, which amounts to a 53 percent loss since 1780.⁵¹ The reports found that Eighty percent of freshwater wetland losses occurring between the mid-1950's and the mid-1970's were attributed to agricultural conversions, but that conversion of wetlands for agricultural use was greater prior to the 1950's. Studies found that between the mid 1950's and mid 1970's there was a loss of 11 million acres of vegetated wetland. This is equivalent to a net loss each year of about 550,000 acres.⁵²

The reports noted that conversion to agricultural land almost always involved surface drainage. It is estimated that between 1955 and 1975 about 17 million acres, or about 850,000 acres per year, of surface was drained mostly from wetlands for agricultural usage. This means about 65 percent of water on the surface of the United States was drained.⁵³ The FWS reported that from 1975 to 1980 over 2 million acres, or about 426,000 acres per year were drained. This means that from 1975 to 1980 the rate of wetland conversion to agriculture land declined by at least 20 percent.⁵⁴ Despite this slowdown in wetland loss there was still a net loss yearly.

⁵⁰ Dahl, *Wetland Losses*, 1-13

⁵¹ Dahl, *Wetland Losses*, 1-13

⁵² National Fish and Wild Life Service, *Status and Trends of Wetlands and Deepwater Habitats in the Conterminous United States 1950's to 1970's*, (Washington DC: NFWS, 1983), 1-36.

⁵³ Thomas E Dahl, and Greogory J Allord, *Technical Aspects of Wetlands History of Wetlands in the Conterminous United States* (Washington DC: US Geological Survey, 1997), 1-8.

⁵⁴ United States Congress. *Wetlands: Their Use and Regulation, 1-195*

The period from 1998 to 2004 saw an increase in total wetland area, at a rate of 32,000 acres per year.⁵⁵ This trend seen is in part due to the fact that there was a sharp decline in the conversion of wetlands for agricultural uses. This coupled with the increase rules and regulations regarding wetlands both by state and federal government, which will be exemplified in the next section, lead to reclamation of many of the wetlands lost from the 1780's to the 1980's. From 1986 until 2004 the FWS measured noticeable gains in wetland acreage throughout the continental United States.⁵⁶

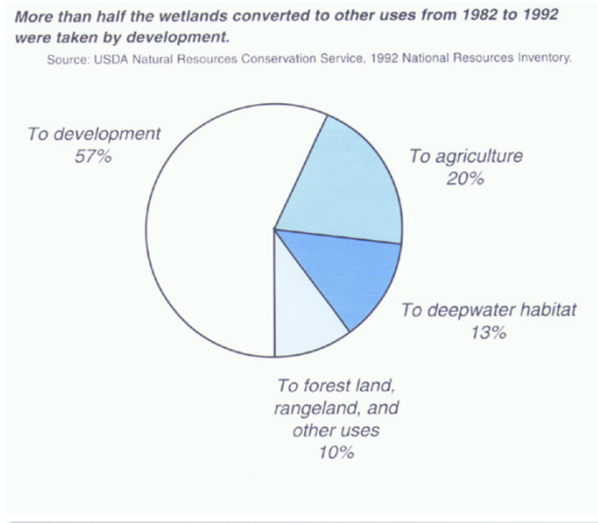
As conversion of wetlands to agricultural lands began to give away in the late 1980's development took hold in the 1990's. In this time period, there was a large spike in the conversion of wetlands for development use. Figure 3 shows the breakdown of wetland conversion to industry from 1982 to 1992 to show the growth in development.

⁵⁵ National Fish and Wildlife Service "Status and Trends of Wetlands and Deepwater Habitats in the Conterminous United States, 1950's to 1970's, 1-36

⁵⁶ National Fish and Wildlife Service, *Status and Trends of Wetlands and Deepwater Habitats in the Conterminous United States, 1986 to 1997* (Washington DC: US FWS, 2000), 1-84

- "*Status and Trends of Wetlands and Deepwater Habitats in the Conterminous United States, 1998 to 2004* (Washington DC:US FWS, 2005), 1-112.

Figure 3⁵⁷
Reasons for Wetland Loss 1982-1992



Development of wetlands continued to rise due to increased development and urbanization. In this time period once again wetlands began to be filled in and degraded. Due to this beginning in the early 2000's, 2004, The FSW noted a loss in acreage of wetlands from 2005 to 2008 in their report to congress, "Status and Trends of Wetlands 2004 to 2009 Report."⁵⁸ Figure 4 below exemplifies the loss and gains of wetland acreage throughout United States history by the United States Fish and Wildlife services.⁵⁹

⁵⁷ National Fish and Wildlife Service, *Status and Trends of Wetlands and Deepwater Habitats in the Conterminous United States, 1986 to 1997*, 1-84

⁵⁸ National Fish and Wildlife Service, *Status and Trends of Wetlands and Deepwater Habitats in the Conterminous United States, 1986 to 1997*, 1-84

⁵⁹ National Fish and Wildlife Service, *Status and Trends of Wetlands And Deepwater Habitats In The Conterminous United Sates 2004 To 2009*, 1-112

Figure 4
*Wetland Loss And Gain By Acreage*⁶⁰

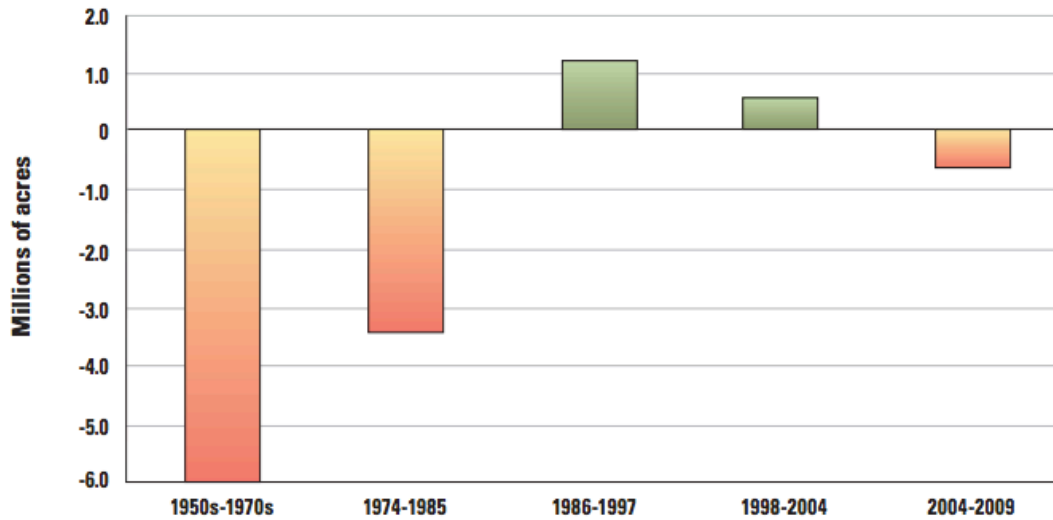


Figure 45. Long-term trends in forested wetland area as measured since the 1950s. Sources: Frayer et al. 1983; Dahl and Johnson 1991; Dahl 2000; 2006; and this study.

Regional Wetland History. The Northeast United States was heavily affected by wetland loss due to development and conversion of wetlands for urban use. The Atlantic and Gulf Coast zones lost about 17,000 acres per year, or about 0.35 percent of the combined regions’ wetlands prior to the 1980’s⁶¹. Throughout history, the Northeast experience the most loss in salt and brackish wetlands. Unlike the rest of the country the northeast lost most of its wetlands to urban use and development.⁶² The FWS found that in the 1990’s wetlands were being converted to commercial and residential lands throughout the region. In addition to this, pollution from these sites has led to a decline in wetland species and changed the landscape of the area, which further impacts the health of wetlands.⁶³

⁶⁰National Fish and Wildlife Service, *Status And Trends Of Wetlands And Deepwater Habitats In The Conterminous United States 2004 To 2009*,1-112

⁶¹ United States Congress. *Wetlands: Their Use and Regulation*, 1-195

⁶² United States Congress. *Wetlands: Their Use and Regulation*,1-195

⁶³ “Wetland Values and Trends”

<https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/rca/?cid=stelprdb1042133#losse>

New York-Long Island Region. The United States Fish and Wildlife Service reported that prior to the 1980's New York State's lost 60 percent of its wetlands⁶⁴. It is clear that a significant number of wetlands in this region were lost early on, and a significant amount continue to be lost due to development and urbanization.

Specifically speaking to the Long Island region, it is estimated that nearly half the wetlands along the Long Island Sound in New York State have disappeared in the last 130 years⁶⁵. Despite increasing legislation, acreage continues to decline. The Fish and Wildlife Service reported that from 1880-1970 there was a loss of 1,878 acres of the Sound in New York, and from 1970-2000 there was a decrease of 674 acres of the Sound in New York. Overall New York saw a 48 percent decrease, or a 2,552-acre loss, in sound land. In addition to population was increasing, along with development, and urban and suburban settlements threatening the Sound, New York choose to exclude parts the Long Island Sound from its wetland protection act from 1970 to the 2000's.⁶⁶

Following the typical trend of the Northeast, the Long Island Sound experienced most loss in its tidal wetland region. Between 1880 and 2000 there is an estimated loss of 31 percent, or 7,841 acres in in tidal wetlands. The majority of this loss took place prior to the 1970's. In the 1880's there was approximately 5,342 acreages Sound tidal wetland in New York. In 1970 that number decreased to 3,464 acres, and in the 2000's that number further decreased to 2790

⁶⁴ Dahl, *Wetland Losses in The United States 1780's to 1980's*, 1-84

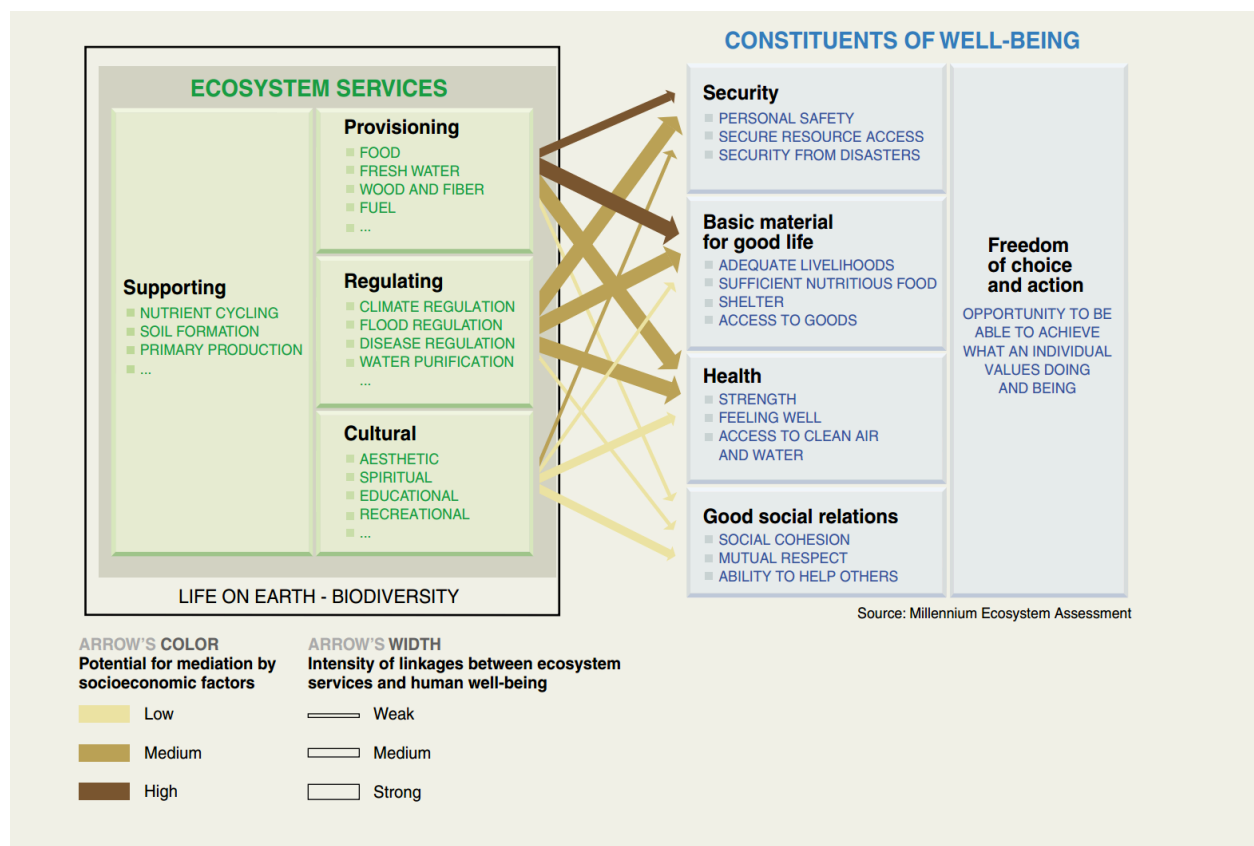
⁶⁵ Jennifer Barrios, *Study: Third of Long Island Sound wetlands lost in 130 years*" (Syosset: *Newsday*, 2016), np

⁶⁶ G. Basso, K. O'Brien, M. Albino Hegeman and V. O'Neill.. *Status and trends of wetlands in the Long Island Sound Area: 130 Year Assessment*, (Washington DC: U.S. Department of the Interior, Fish and Wildlife Service, 2015) 1-36.

acres. On the New York side of the Sound there was a 35 percent loss in tidal wetlands prior to 1970⁶⁷.

The United States has experienced tremendous wetland loss and degradation throughout its history. Despite this in the late 1900's and early 2000's the United States was able to reclaim some of the lost and degraded land. The next section of this thesis explores wetland ecosystem services that prove wetland protection is necessary. Figure 5 below exemplifies ecosystem services provided by wetlands and how the benefit people.⁶⁸

Figure 5: Ecosystem Services



⁶⁷ Basso O'Brien, Albino Hegeman and O'Neill, *Status and Trends of Wetlands in The Long Island Sound Area*, 1-36.

⁶⁸ Millennium Ecosystem Assessment, *Ecosystems and Human Well-Being: Synthesis*, np.

Chapter 3: Wetland Services

Wetlands provide invaluable ecosystem services to people, organisms, and the environment. Wetlands provide provisioning services in the form of protection of fresh water, food, and medicinal resource. Wetlands also provide regulation services through regulating local climate and air quality regulation, acting as carbon sequesters, moderating extreme weather events, and through naturally treating waste water. Wetland functions have both ecological and economical benefits. Ecological benefits include water quality control and filtration, flood protection, biodiversity, while economic benefits include revenue from fishing, hunting and recreation. Provisioning services provided are those which benefit people through direct services such as flood control water filtration, while economic benefits provide direct sources of income. Almost 124 million hectares of wetlands in 1421 different locations around the world have been designated as “Wetlands of International Importance.” Nineteen of these sites, or 1,192,730 hectares, are located within the United States, further proving the importance of wetlands throughout the United States.⁶⁹

Ecological Services. One of the most important ecological service wetlands provide to both humans and the environment is the ability of wetlands to filter polluted water and runoff therefore providing a source of clean, fresh water. Wetlands have the ability to slow down moving waters making them maneuver around and through plants, which in turn forces sediments, to drop and settle to the ground. As water moves, excess nutrients from fertilizer, manure, leaking septic tanks, municipal sewage, and polluted storm runoff can be absorbed by plant roots and microorganisms in the surrounding soil, while other pollutants stick to soil particles. Organisms living in wetlands also play a part in filtering out pollutants and toxins

⁶⁹ Joy B. Zedler and Suzanne Kercher, *Wetland Resources: Status Trends Ecosystem Services, and Restorability* (Annual Environmental Review, 2005,) 39-74

from the water. For example, filter-feeders, such as oysters and clams, filter up to 50 gallons of water a day.⁷⁰ These processes allow for human access to clean and healthy water. Wetlands are so efficient and effective at filtering and cleaning water, manmade water treatment plants are being modeled after natural systems. For example, the Congaree Bottomland Hardwood Swamp in South Carolina naturally removes the equivalent of the amount of pollutants from the watershed that would be removed by a 5-million-dollar treatment plant. Due to this towns and local governments have created artificial wetlands to filter and treat wastewater and storm water.⁷¹

Another reason wetlands are important is because they serve as carbon sequestrators. Studies have found that the ocean, and to a lesser extent wetlands, serve as the world's major Carbon sinks. Particularly coastal wetlands offer excellent environments for the sequestration of carbon, and studies have shown that over time they appear to accumulate Carbon at higher rates than other ecosystems.⁷² This means less Carbon is released back into the atmosphere which subsequently slows down climate change, and all the negative effects associated with it including global warming.

The high productivity levels of wetlands is another reason they are such invaluable resources. Wetlands are one of the most biologically productive ecosystems in the world. Their productivity, especially that of coastal and tidal wetlands, is comparable to the productivity of rainforest and coral reefs ecosystems. Wetlands provide homes for diverse and abundant species including vegetation, aquatic plants, fish, shellfish birds and many other organisms. It has been found that up to one-half of North American bird species nest or feed in wetlands, more than

⁷⁰ Long Island Sound Study Partnership, *Sound Health 2012: Status and Trends in the Health of Long Island Sound*, (Washington DC: EPA, 2012,)1-16.

⁷¹ Environmental Protection Agency, *EPA Functions and Values of Wetlands*, (Washington DC: EPA, 2001), np; Zedler and Kercher, *Wetland Resources*, 39-74.

⁷² Environmental Protection Agency, *Economic Benefit of Wetlands*, (Washington DC, EPA, 2001), np

one- third of threatened and endangered species live only in wetlands, and an another 20 percent of the nation's threatened or endangered species use or inhabit wetlands at some time in their life.⁷³ Wetlands are also home to 31 percent of the plant species in the United States.⁷⁴

The biodiversity in wetlands also has medicinal value. Many plants and organisms living in wetlands are valuable to medical research. A good example of this is the horseshoe crabs. Horseshoe crabs are over 300 million years old. Since they have endured throughout history, their blood is used for medical research. Proteins found in horseshoe crabs' blood are extremely sensitive to bacteria and are used to screen injected drugs and implanted biomedical devices for contamination.⁷⁵ Horseshoe crabs along with many other wetland organisms have been invaluable to medical research. It is clear that wetlands are ecosystems in which life is dependent on. This high level of productivity also allows for a flourish fishing industry and other economic benefits⁷⁶.

Economic benefits of Wetlands. One of the most important economic and ecological service provided by wetlands is flood control. Flood damages in the United States average two billion dollars yearly and cause both loss of life and property.⁷⁷ Wetlands are vital because they act as natural buffers from storms, absorbing excess water and therefore decrease flooding. Wetlands hold excess water till after the flooding has began to decreased and then slowly begin to release said excess water reducing damages to property. Costal wetlands serve as storm surge protectors when hurricanes or tropical storms hit acting as wind breakers and flood barriers. An example of wetlands acting as flood barriers is the Charles River in Massachusetts. In this area,

⁷³ Zelder and Kercher, *Wetland Resources*, 39-74

⁷⁴ Zelder and Kercher, *Wetland Resources*, 39-74

⁷⁵ Long Island Sound Study Partnership, *Status and Trends: LISS Environmental Indicators*, (Washington DC: EPA, 2017), np.

⁷⁶ Environmental Protection Agency, *EPA Functions and Values of Wetlands*, np

⁷⁷ Environmental Protection Agency, *EPA Functions and Values of Wetlands*, np

there was a reclamation of 3,800 hectares of wetland along the river. The wetland along the main stream reduces flood damage by an estimated 17 million dollars each year and prevents injury to human life, proving how important wetlands are to the surrounding community.⁷⁸

One of the main economic benefits of wetlands is the fishing industry. In 2012, the fishing industry, both commercial and recreational, created 1.5 million jobs in the United States and was worth 90 billion dollars.⁷⁹ In 2004, a study found that the crab, shrimp and salmon industry in the United States, only a small portion of the fishing market, was valued at an estimated 1,167 billion dollars, while the fin fish and shellfish market was valued at an estimated 3.7 billion dollars. The same study found that consumers in the United States spent an estimated 54.4 billion dollars on products from commercial and recreational fishing trips.⁸⁰ Figure one below breaks down the profits of the 2012 United States' fishing industry⁸¹.

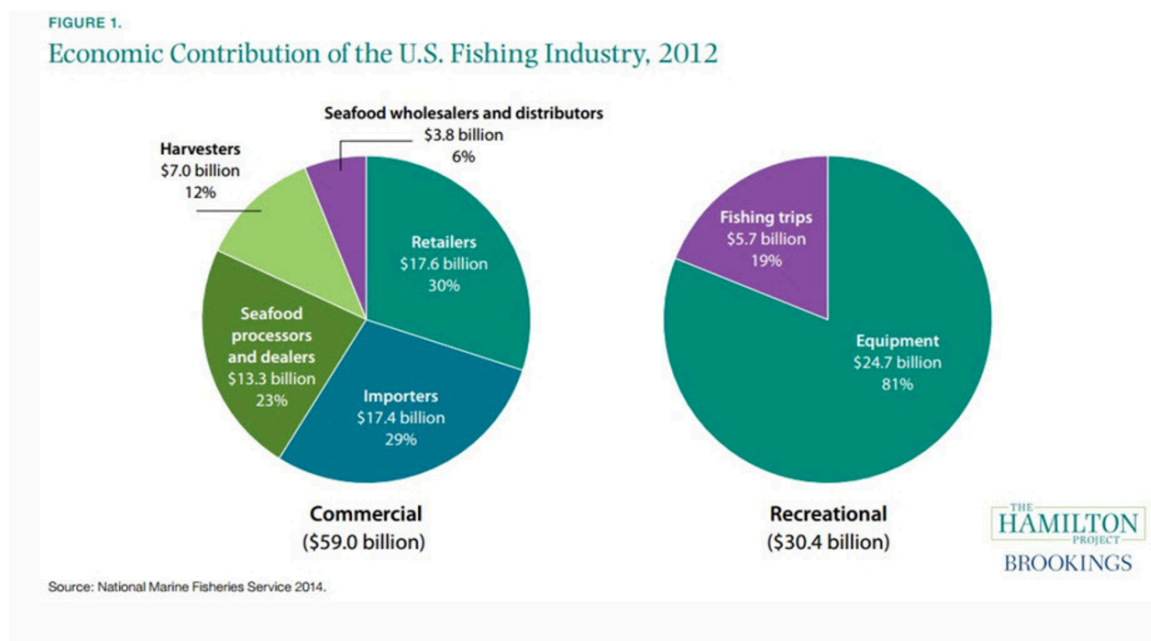
⁷⁸ Zelder and Kercher, *Wetland Resources*, 39-74

⁷⁹ Fred Dews, *The U.S. Fishing Industry Contributes Nearly \$90 Billion to U.S. Economy* (Washington DC, Brookings Institute, 2014), np.

⁸⁰ Environmental Protection Agency, *Economic Benefit of Wetlands*, np.

⁸¹ Dews, *The U.S. Fishing Industry Contributes Nearly \$90 Billion to U.S. Economy*, np.

Figure 1⁸²



In order to have such a flourish fishing industry, there must be healthy wetlands. According to a 1997 study done by the Pacific Coast Federation of Fishermen’s Associations 71 percent of the commercial and recreational fishing industry is generated from wetland-dependent species.⁸³ Studies found that “wetlands provide an essential link in the life cycle of 75 percent of the fish and shellfish commercially harvested in the U.S., and up to 90 percent of the recreational fish catch.”⁸⁴ These ecosystems provide food, shelter and nursing grounds for both marine and freshwater species. Many species which are prime catch and valuable to the fishing industry are dependent on wetlands for at least part of their life cycles and without health

⁸² Dews, *The U.S. Fishing Industry Contributes Nearly \$90 Billion to U.S. Economy*, np.

⁸³ Environmental Protection Agency, *EPA Functions and Values of Wetlands*, np

⁸⁴ Environmental Protection Agency, *EPA Functions and Values of Wetlands*, np

ecosystems species will decline along with jobs, revenue, and food supply.

The productivity of wetlands also provide space for ecotourism, bird-watching, and photography. With wetlands being one of the most diverse ecosystem in the world it is a great place to observe and interact with nature. In 1991, wetland related activities added nearly 59 billion dollars to the United States' economy, and this has continued to increase. In 2001, over 66 million Americans, 16 years old and older, fed, photographed and observed species in wetlands spending a total of 40 billion on their activities.⁸⁵

Hunting is another economic benefit of wetlands. As previously mentioned, it has been found that up to one-half of North American bird species nest or feed in wetlands. For this reason, wetlands are popular areas for hunting. It was found that in 2001, about three million people hunted migratory birds, and 6.5 million small mammals that are often found in wetlands. In 2001, wetland hunting was 2.2-billion-dollar industry. The study found that in the United States, hunters paid 111 million dollars for hunting permits and leases to hunt in wetland areas.⁸⁶ Healthy wetland ecosystems are productive environments, which attract wildlife which then attracts industry. This process provided both ecological and economic benefits to humans.

Case Study. Wetlands make up a large portion of the Northeast providing all of the above ecological and economic services. In the Long Island region, wetlands are intertwined with life and the economy. The Long Island Sound has 9 million people live in its watershed, all of whom are effected by the services the wetland provides⁸⁷.

The Long Island Sound has an estimated 12,000 acres of salt marsh.⁸⁸ Vegetation from

⁸⁵ Environmental Protection Agency, *EPA Functions and Values of Wetlands*, np.

⁸⁶ Environmental Protection Agency, *Economic Benefit of Wetlands*, np.

⁸⁷ Long Island Sound Study Partnership, *Sound Health 2012: Status and Trends in the Health of Long Island Sound*, (Washington DC: EPA, 2012)1-16.

⁸⁸ Long Island Sound Study Partnership, *Sound Health 2012*, 1-16.

the salt marsh helps protect the surrounding land from flooding and erosion. This vegetation, eelgrass in particular, also helps filter pollutants out of storm runoff and polluted water. With a constantly increasing population there is increased runoff, wastewater, and polluted storm water. Vegetation that helps filter pollutants out of water helps produce health ecosystems and water systems. These ecosystems are also vital during hurricanes and other large storms which are common in the Northeast. Storm surges and heavy winds from the hurricanes lead to loss of life, billions of dollars in property damage, wipe away dunes, alter other shoreline habitats, and led to the discharge of toxic contaminants and pathogens into the Sound. The ecosystem services wetlands provided minimize damages from such storms and help to reduce the effects by naturally filtering the water.

Another ecosystem service the Long Island Sound, an estuary wetland, provides is biodiversity. Over 1,300 species of invertebrates and finfish live in the Sound. There are over 21 species of tropic fish that seasonally visit the Sound, and atleast 50 species are known to spawn in the Sound. The Sound is also home to more than 125 species of birds. Species include plovers, terns, sandpipers, waterfowl, herons, egrets, and songbirds among others. This biodiversity of wetlands throughout Long Island, including the Long Island Sound allows for a flourishing economy in the Long Island Sound region⁸⁹.

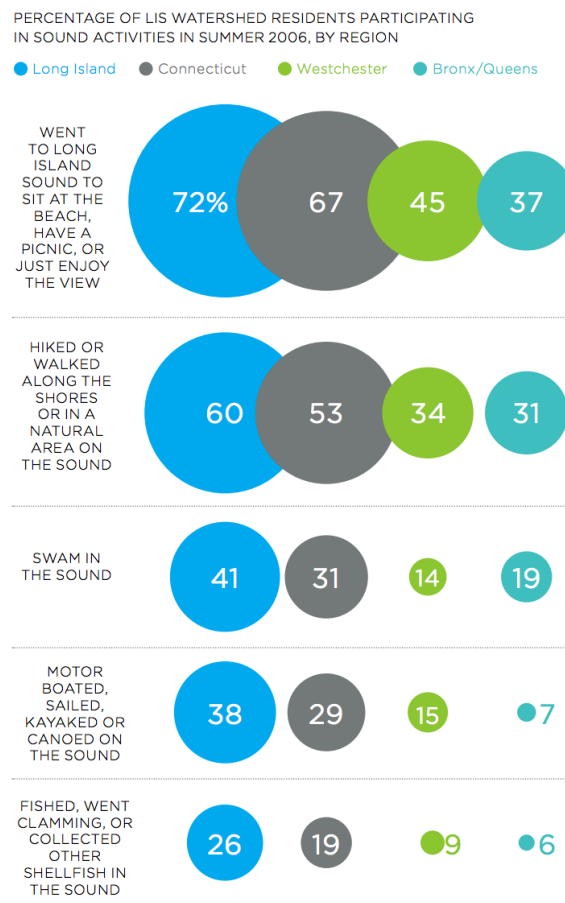
In 2015, the Long Island Sound was responsible for adding 9.4 million dollars to the local economy.⁹⁰ One of the main economic profits of the Sound is from recreational activities. The Sound is used for boating, swimming, beach going and animal watching. The Sound is home to 210 different beach spots that attract people from all over the region. One study found

⁸⁹ Long Island Sound Study Partnership, *Long Island Sound by the Numbers*, (Washington DC: EPA, 2017), np

⁹⁰ Long Island Sound Study Partnership, *Long Island Sound by the Numbers*, np.

that beach attendance at the six top beaches in the watershed totaled 6.4 million people in 2010. The highest attended beach was located in New York with 1.6 million visitors⁹¹. All this beach going leads to permit sales, seasonal parking and pass sales, boating revenues, and concession profits. It also creates thousands of jobs throughout the region. Figure 2, below exemplifies the percentage of people who participated in recreational activities related to the Sound⁹². The graph shows how wetlands are used for recreational activities by many add to its value.

*Figure 2:
Percentage of NY residents Participating in recreational Activities throughout the Long Island Sound⁹³*



⁹¹ Long Island Sound Study Partnership, *Sound Health 2012*, 10-15.

⁹² Long Island Sound Study Partnership, *Sound Health 2012*, 15.

⁹³ Long Island Sound Study Partnership, *Sound Health 2012*, 15.

The main economic benefit of the Long Island Sound is the fishing industry. Due to the biodiversity of the Sound there is a thriving fishing industry. In 2011, an estimated 7.4 million fish were caught by recreational anglers in the Sound. Included in this were 2.3 million scup and 2 million bluefish. NOAA found that these fishers took an estimated 2.15 million boat trips. In addition to this in 2007, 7.4 million dollars worth of oysters were caught. In that same year 600,000 bushels of clams were harvested⁹⁴.

It is clear that wetlands provide important ecological services and hold important economic value. These are only some of the reasons there is need for increased effective protection for wetlands. Continuing with the case study, about 35 percent of tidal wetlands in the Long Island Sound were lost before federal regulations were put into place. After regulations was put into place wetland continued to decline. From 1974 to 2005, between 434 to 346 acres of salt marsh was lost⁹⁵. Along with this came significant decline in eelgrass and loss of protections from flood and loss of efficient water purification. These ecological services are important now more than ever. In 2012, Hurricane Sandy caused increased flooding, millions of dollars in property loss, and the discharge. Scientist predict that extreme weather such as this is likely to continue⁹⁶. If this is the case, it is extremely important that we protect our wetlands to ensure the serves they provide continue.

Another reason it is important to protect wetlands is due to protect economic growth. According to a 1990's study activities in the Sound that depend on clean water was equal to 8.91 billion dollars yearly. In the Long Island Sound there was both an oyster and lobster collapse, due to disease and pathogens in the water. The lobster population was never able to recover.

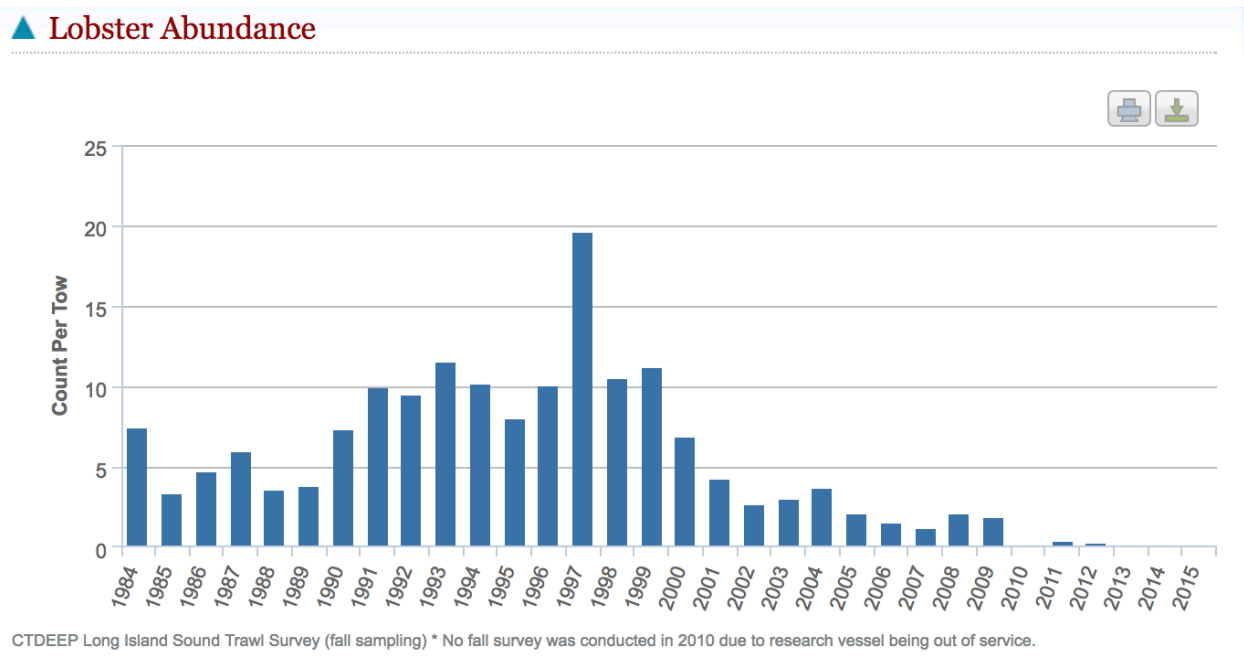
⁹⁴ Long Island Sound Study Partnership, *Sound Health 2012*, 1-16.

⁹⁵ Long Island Sound Study Partnership, *Sound Health 2012*, 1-16.

⁹⁶ Long Island Sound Study Partnership, *Sound Health 2012*, 1-16.

The oyster population was able to recover but never reached its peak economic profit, which was worth 48 million in 1992. The Below chart, figure 3⁹⁷ chart exemplifies the lobster population in the Sound over time.

Figure 3: Lobster Population In the Long Island Sound⁹⁸



From this information it is clear that regulation and protections of wetlands is needed.

Chapter 4: Wetland Government Policy

The last section exemplifies how wetlands provide essential ecosystem services and have important economic benefits for people. Due to this, it is vital that the government creates regulations and laws that protect wetlands. Regulations prior to the 1970's encouraged degradation and destruction of wetlands. Beginning in the 1970's the National Fish and Wildlife Services Agency began to exemplify the importance of wetlands and began to push for more

⁹⁷ Long Island Sound Study Partnership, *Status and Trends: LISS Environmental Indicators*, (Washington DC: EPA, 2017), np.

⁹⁸ Long Island Sound Study Partnership, *Status and Trends*, np.

protective regulation. Encouraged by this agency, the United States government began to put regulation into place, one of the most important being Section 404 of the Clean Water Act. Some of these regulations have been proven to be effective while others have not and since been revoked. This section focuses on laws, regulations, and executive orders which have been arguable successful.

Regulations Prior to the 1970's. In the early history of the United States the government's focus was on settling the country coast to coast, expanding agriculture and developing industry. In order to do so, suitable land was needed, and because of this the United States' government encouraged the development of wetlands.

The Swamp Acts of 1849, 1850 and 1860 were among the earliest set of regulations regarding wetlands. The purpose of the Swamp Acts was to reclaim "worthless" wetland and fill these lands in to allow for cultivation, to eliminate water born illnesses, to improve sanitary issues, and to increase the value of adjacent government property.⁹⁹ The Swamp Acts paved the way for 15 states to reclaim 65 million acres of swamp land.¹⁰⁰ In doing so, there was increased urban and agricultural land but devastating effects to wildlife and the productivity of wetlands.

Also in the 1800's, state courts began to rule against the protection of wetlands by individuals. For example, in 1870 the New York State Court ruled on a case involving the right of people to drain wetlands on private property. The Court ruled in favor of those wishing to drain wetlands that were on their private property. The Court's decision stated that draining wetlands would allow the land to be more wholesome, useful, and productive. Various decisions

⁹⁹ Nagle, John Copeland, "From Swamp Drainage to Wetlands Regulation to Ecological Nuisances to Environmental Ethics," *Notre Dame Law School Legal Studies Paper*, No.09-05 (2009) 787-80 .

¹⁰⁰ United States Congress, *Wetlands: Their Use and Regulation*, 1-195.

by the Court show that it was the general belief of citizens at the time that draining wetlands would improve the land.¹⁰¹

After numerous state court cases, in 1900 the Supreme Court took on *Leovy v. the United States*. In this case, the Supreme Court ruled in favor of an individual's right to drain wetlands on their property. This case is often used to exemplify the general feelings of disdain towards wetlands throughout the United States in the 1800 and 1900's. The Court's decision stated that it is a common known fact that "that swamps and stagnant waters are the cause of malarial and malignant fevers, and that the police power is never more legitimately exercised than in removing such nuisances."¹⁰² The Court's explanation of its ruling shows that the general consensus among people and the government was that wetlands were nuisances. The focus at this time in United States' history was on the negatives of wetlands while the ecosystem services and economic benefits were ignored. Prior to the 1980's, it was found that there was a 53 percent loss in wetlands in the United States.¹⁰³

Regulations 1970's After. Attitudes towards wetlands began to change in the 1970's with a push from the Fish and Wildlife Service Agency. In the 1950's the agency officially defined wetlands, which led to regulations being put into place.¹⁰⁴

An early protective wetland act is the Land and Water Conservation Fund Act of 1965. The act funded the government purchase of lands, including wetlands, to protect endangered species and natural resources. Between 1967 and 1982 the National Fish and Wildlife Service spent 182 million dollars preserving 221,000 acres of lands. The National Park Service utilized

¹⁰¹ Nagle, John Copeland, "From Swamp Drainage to Wetlands Regulation to Ecological Nuisances to Environmental Ethics", np.

¹⁰² United States Congress, *Wetlands: Their Use and Regulation*, 1-195.

¹⁰³ Dahl, *Wetland Losses*, 1-13.

¹⁰⁴ United States Congress, *Wetlands: Their Use and Regulation*, 1-195.

the act and spent 1.7 billion dollars preserving 1.4 million acres of land. An unknown portion of this land was wetland.

Another important early act is the Water Bank Program. The Water Bank Program was put in place in 1970 by the Agriculture Stabilization and Conservation Service of the U.S. Department of Agriculture, the USDA. The program worked to preserve the nation's wetlands by conserving surface water, preserving and improving habitats for migratory animals, reducing runoff and soil erosion, contributing to flood control, contributing to improved water quality, reducing stream sedimentation, contributing to improved subsurface moisture, reducing acres of new land coming into production, restoring lands now in agricultural production, enhancing the natural beauty of the landscape, and promoting comprehensive and total water management planning. The program did so by paying land owners not to draining or degrading wetlands on their private property. Payment for the protection of land was based on area and the importance of the wetland. Payments typically ranged from 5 to 10 dollars per acre, but could be higher depending on the location. For example, average payments in California were 22 dollars per acre.¹⁰⁵

The first major piece of regulation regarding wetlands was the Clean Water Act passed in 1972. The Clean Water Act was the original piece of legislation that regulated discharge of pollutants into United States' waterways. The act regulates ocean discharge, pollution, as well as state and federal monitoring and enforcement of the law. Arguably the most important section of the Clean Water Act is Section 404. Section 404, passed in 1977, is an amendment to the Clean

¹⁰⁵ Environmental Protection Agency, "Clean Water Laws, Regulations, Executive Orders" United States Government January 19, 2017, <https://www.epa.gov/cwa-404/clean-water-laws-regulations-executive-orders>.

Water Act. This amendment marked the primary way the federal government got involved in controlling the use of wetlands. The act punishes those who wish to discharge, dredge or fill in wetlands without a proper permit from the Army Corporation of Engineers. The Environmental Protection Agency, the NMFS, and the FWS review permit applications and provide comments and recommendations. The EPA has the authority to veto any application as well as to veto any disposal site designated on a permit if the agency finds the project impacts unacceptable. The act also develops criteria for discharges and State assumption of responsibilities of environmental issues.¹⁰⁶

The Clean Water Act has been continually updated and changed along with the times. The act was updated for the first time in 1977 and has been updated as recent as 2012. Since its original passing, amendments have been added to police activities in regards to wetlands. Included in these updates are EPA revised definitions of fill rules, permit regulations, program definitions and permit exemptions, updated dredging and discharge rules, nationwide permit programs, enforcement rules, state assumption regulations, and tribal assumption regulations. The goal of these updates is to restore lost aquatic resource functions and area, increase both state and federal participation, and still allow for growth and development.¹⁰⁷ For example, in 2000 the EPA added an amendment to expand the definition of fill material to combat wetland degradation that was being reported by monitoring agencies. Traditionally fill material was referred to as rock, sand, soil, clay, plastics, construction debris, wood chips, overburden from mining or other excavation activities, and materials used to create any structure or infrastructure

¹⁰⁶ Environmental Protection Agency, “Clean Water Laws, Regulations, Executive Orders”

¹⁰⁷ Environmental Protection Agency, “Clean Water Laws, Regulations, Executive Orders”

in waters. In 2000, this definition was expanded to include trash or garbage.¹⁰⁸ The below tables exemplify the current rules for fill material.

Figure 1: Fill Definition

Category	Examples of potentially regulated entities	Category	Examples of potentially regulated entities
Industrial, commercial, or agricultural entities.	Industrial, commercial, or agricultural entities that discharge material that has the effect of replacing any portion of a water of the U.S. with dry land or changing the bottom elevation of a water of the U.S.	State/Tribal governments or instrumentalities.	State/Tribal agencies or instrumentalities that discharge material that has the effect of replacing any portion of a water of the U.S. with dry land or changing the bottom elevation of a water of the U.S.
Land developers and landowners.	Land developers and landowners that discharge material that has the effect of replacing any portion of a water of the U.S. with dry land or changing the bottom elevation of a water of the U.S.	Local governments or instrumentalities.	Local governments or instrumentalities that discharge material that has the effect of replacing any portion of a water of the U.S. with dry land or changing the bottom elevation of a water of the U.S.
		Federal government agencies or instrumentalities.	Federal government agencies or instrumentalities that discharge material that has the effect of replacing any portion of a water of the U.S. with dry land or changing the bottom elevation of a water of the U.S.

Around this time new permit rules were also put into place to allow economic growth, as well as more state and federal participation in the act through monitoring and permits. The Clean Water Act is arguable so successful because it allows for growth and change.

Another notable act is the Coastal Wetlands Planning, Protection and Restoration Act passed in 1989. The act provides funding and administrative direction for the implementation of the North American Waterfowl Management. The act also created the North American Wetlands Conservation Council which recommends wetland projects. The council is composed of the Director of the Service, the Secretary of the National Fish and Wildlife Foundation, a State fish

¹⁰⁸ EPA, "Rules and Regulation," *Federal Register* 67, No. 9 (2002):31129

and game agency director from each Flyway, and three representatives of different non-profit organizations participating in projects under the plan or the act¹⁰⁹. The Commission must justify in writing its decisions to the council, and annually to Congress any decisions not to accept Council recommendations. The law has been renewed and updated every three years.¹¹⁰

Another important act is Federal Agriculture Improvement and Reform Act of 1996. The act also known as the Farm Bills builds off of four previous programs. The bill punishes those who plant on wetlands. The bill penalized those who planted and converted wetlands between December 23, 1985 and November 28, 1990 by making them ineligible for agricultural program benefits in any year an agricultural commodity is planted, unless an exemption applies.¹¹¹ Those who converted wetlands after November 28, 1990, were ineligible for program benefits until the functions of the wetland that was converted is mitigated, unless an exemption applies. The act sharply reduced wetland conversions for agricultural use. Before 1985 there was a conversion of 235,000 acres per year and after the act there was a conversion of 27,000 acres per year. The act worked to preserve the ecosystem services of wetlands, such as flood control, sediment control, groundwater recharge, water quality, wildlife habitat, recreation, and esthetics.¹¹²

Other important regulations were Executive Orders 11990 and 11988. Executive Order 11990 passed in 1977 by President Carter, mandated that Federal agencies minimize destruction and degradation to wetlands. The order mandated that agencies avoid taking on construction projects on wetlands. Executive Order 11988 deals with flood plain management. The order

¹⁰⁹ Environmental Protection Agency, “Clean Water Laws, Regulations, Executive Orders”

¹¹⁰ US Fish and Wildlife Services, “Digest of Federal Resource Laws of Interest to the U.S. Fish and Wildlife Service” United States Government, 2017, <https://www.fws.gov/laws/lawsdigest/NAWCACT.HTML>

¹¹¹ USDA, “Wetland Conservation Provisions (Swampbuster)”, United States Government, 2017, <https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/water/wetlands/?cid=stelprdb1043554>

¹¹² Environmental Protection Agency, “Clean Water Laws, Regulations, Executive Orders”

mandates Federal agencies to avoid direct or indirect support of the development of flood plains¹¹³.

President Clinton also passed important executive orders in regards to the protection of wetlands. In 1995 Executive Order 12962 was put into place. The order dealt with recreational fisheries. The goal of the order was to conserve, restore, and enhance aquatic systems in order to provide increased recreational fishing opportunities nationwide. In 2001, President Clinton signed executive order 13186 into action which dealt with federal agencies protecting migratory birds. The order directed executive departments and agencies to take certain actions to further implement the Migratory Bird Treaty Act, which intern meant protecting their wetland habitats.¹¹⁴

Case Study. The policies mentioned help improve the health of wetland systems throughout the country. To exemplify this the Long Island Sound and the Long Island Sound Study will be used. The Sound Study, a group created by the federal government to monitor and implement policies to improve the health of the Long Island Sound was created in 1985 as a result of the implementation of the Clean Water Act of 1972. The EPA, New York, and Connecticut came together to form the Long Island Sound Study. The study is a bi-state partnership consisting of federal and state agencies, user groups, concerned organizations, and individuals dedicated to restoring and protecting the Sound.¹¹⁵ Since the federal Clean Water Act became a law in 1972, investments in water pollution control programs have led to measurable improvements in the water quality of Long Island Sound. Obvious sources of pollution were controlled through permit programs. Tidal wetlands were protected, wastewater treatment plants

¹¹³ Environmental Protection Agency, "Clean Water Laws, Regulations, Executive Orders"

¹¹⁴ Environmental Protection Agency, "Clean Water Laws, Regulations, Executive Orders"

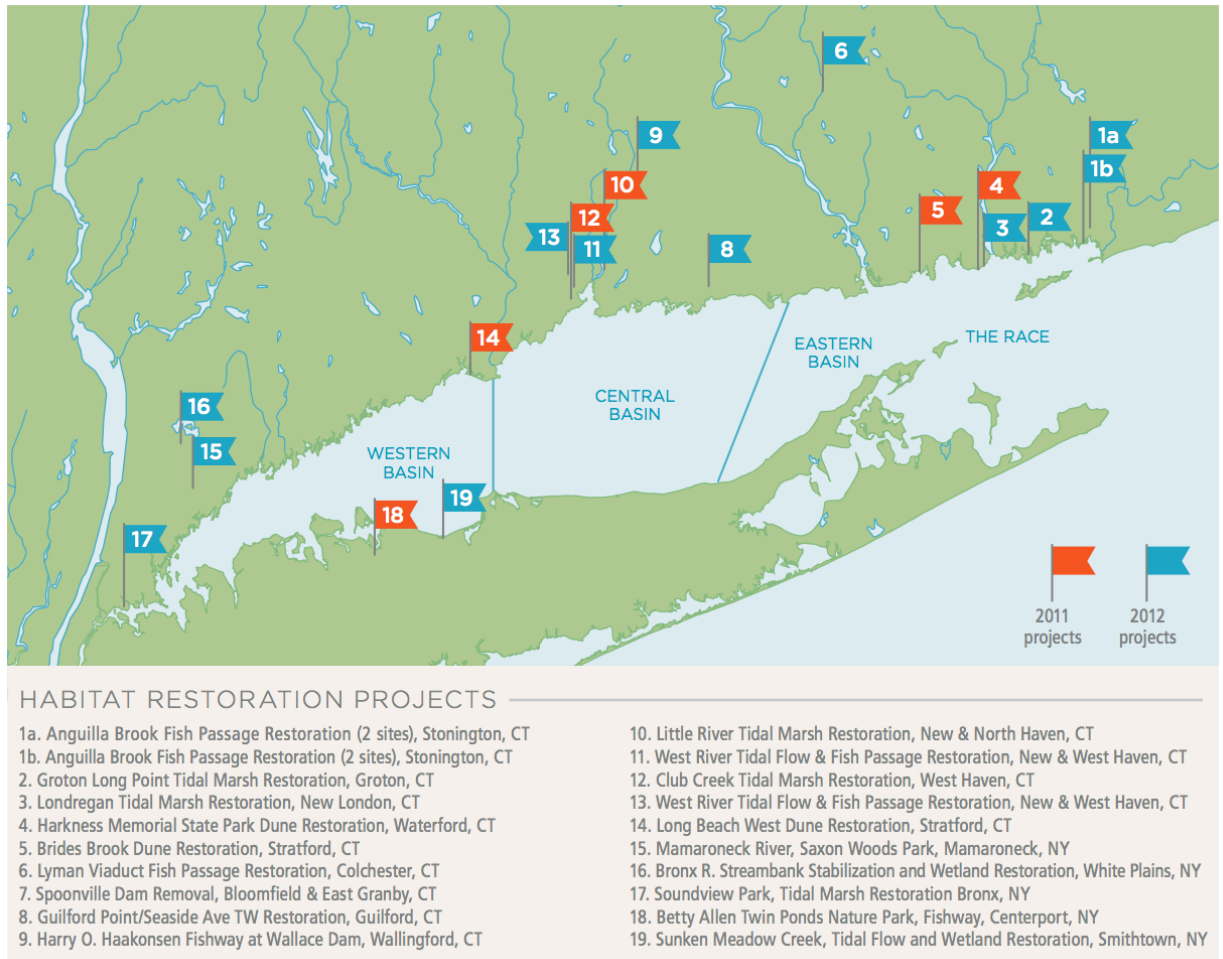
¹¹⁵ Environmental Protection Agency, "Clean Water Laws, Regulations, Executive Orders"

improved, and industrial discharges were controlled. The Study creates Comprehensive Conservation and Management Plans, which include EPA approval of New York and Connecticut goals to reduce pollution in the Sound and restore wetland. The study conducts water quality monitoring, habitat restoration, and nitrogen management.¹¹⁶

The cooperation between states, the federal government, and interest groups have allowed the enforcement of the Clean Water Act's policies as well as set regulations that reduce hypoxia, restore wetlands and improve water quality. Improvements in the Sound have been vast and without regulation the condition of the Sound would most likely have continued to decline. For example, from 1998 to 2015, 1,750 acres of habitat, including tidal wetlands and forest, have been restored in Connecticut and New York in the Long Island Sound watershed. From 1998 to 2015, 335 miles of river migratory corridors have been restored and as of 2015, the Long Island Sound Futures Fund has funded 31 habitat restoration projects. The below charts exemplify the effectiveness of well planned adaptive cooperative wetland regulation.

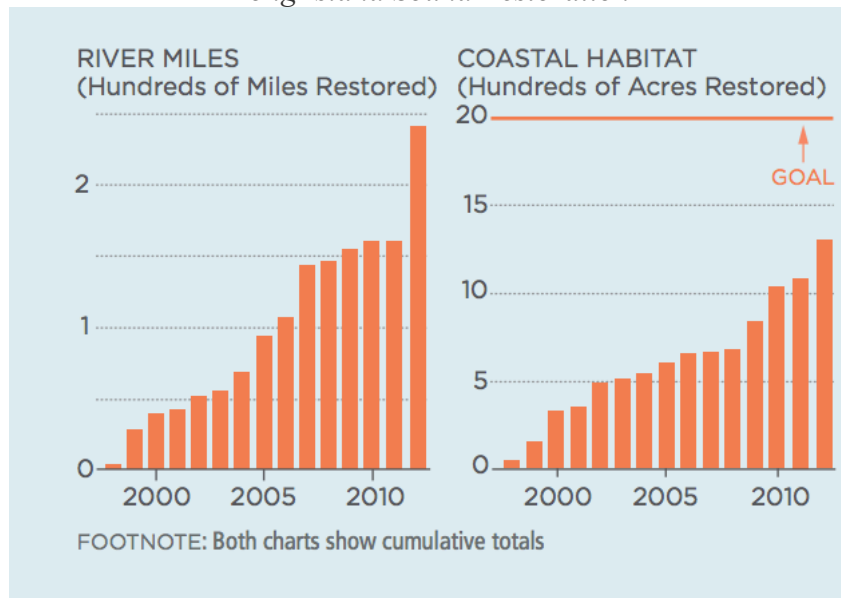
¹¹⁶ Long Island Sound Study, "History", EPA, 2017 <http://longislandsoundstudy.net/about-the-sound/history/>

Figure 2¹¹⁷
Long Island Sound Restoration Projects



¹¹⁷ Long Island Sound Study, *LISS Biennial Report 2011–2012*, (New York, NY EPA 2013) 1-22.

Figure 3
Long Island Sound Restoration



Obstructionism. Despite the success of well thought-out regulation throughout history different administrations in the United States’ government have tried to limit such regulation and protection. In 1988, President Regan signed Executive Order 12630 into effect. The order directed government agencies to limit their policy interaction with the environment to protect individual property rights. The act limited the effectiveness of the EPA, the FWS, and similar agencies, as well as limited resources for restorative wetland acts. At this time there was little progress made in the protection and restoration of wetlands.¹¹⁸ Regan used the fifth amendment to rationalize his executive order. In the order Regan noted that policies that have “taking implications including “Communications between Federal agencies or departments and State or local land-use planning agencies regarding planned or proposed State or local actions regulating private property regardless of whether such communications are initiated by a Federal agency or

¹¹⁸ Environmental Protection Agency, “Clean Water Laws, Regulations, Executive Orders”

department or are undertaken in response to an invitation by the State or local authority,” should be used sparingly.¹¹⁹ This specifically limited many regulations that regarded sought to restore wetlands that were then in use for agricultural purposes. The executive order also made it difficult for actions to be taken by the EPA and other similar agencies because now all actions taken had to be done through Office of Budget Management.

In this executive order, Regan also made it difficult for environmental agencies to act on behave of public health and safety. Executive Order 12630 is quoted as stating, “the mere assertion of a public health and safety purpose is insufficient to avoid a taking. Actions to which this Order applies asserted to be for the protection of public health and safety, therefore, should be undertaken only in response to real and substantial threats to public health and safety, be designed to advance significantly the health and safety purpose, and be no greater than is necessary to achieve the health and safety purpose.”¹²⁰ Agencies now had to excessively prove there were self and safety hazards before acting. This limited the effectiveness of acts such as the Clean Water Act which dealt with the public safety of dredging and filling in wetlands. Overall, the executive order severely limited the effectiveness of legislation in place.

The United States has currently entered into a similar administration in regards to environmental and wetland protection. Current Director of the EPA, Scott Pruitt, has released a plan to rescind or revise the Clean Water Act. In reviewing the act, the agency will be re-defining certain terms, reexamining court decisions and plans to replace or repeal the law.¹²¹ The agency will specifically be focusing on defining “waterway” as to severely limit what wetlands are protected under the Clean Water Act to allow for unmonitored, environmentally

¹¹⁹ Environmental Protection Agency, “Clean Water Laws, Regulations, Executive Orders”

¹²⁰ Environmental Protection Agency, “Clean Water Laws, Regulations, Executive Orders”

¹²¹ United States Government, “Proposed Rules,” *Federal Register* 82, No. 42 (2017):31129

damaging economic development. As mentioned, this is one of the most important laws relating to wetlands, so it is more important now than ever to push for effective regulations and to keep working regulation in place.

Chapter 5: Policy Recommendations

The prior chapters identify the importance of wetlands as well as the long rocky history of wetland protection in the United States to identify the importance of these keystone ecosystems and their protection. As mentioned, currently the Director of the EPA is trying to revoke many of the executive orders and legislations in place that protect wetlands. Because of this, it is now more important than ever to protect wetlands and increase the number of effective pieces of legislation in place. For wetland legislation to be effective there needs to be cooperation between the national, state, and local governments, legislation must be adaptable and advisable, and legislation must take into account the need and importance of economic growth.

One of the most important and necessary things for wetland legislation to be effective is the need for cooperation between the national and local levels of government. If all levels of government are not on the same page it is likely that legislation protecting wetlands will not succeed and wetlands will not be protected. It is extremely important for the federal government to be in support of protective wetland regulation. The federal government sets the agenda for the country and the atmosphere for the attitudes towards the protection of wetlands. As previously noted, prior to the 1970's the United States' government supported the destruction of wetlands. Due to this, there was a general attitude of disdain towards wetlands throughout the country that led to their further destruction. Also, as the previous chapters illuminate executive orders are one of the main tools used to regulate the protection or destruction of wetlands. When the

federal government is not on board with wetland protection legislation such as Executive Order 12630, which directed government agencies, such as the EPA and FWS, to limit their policy interaction with the environment, are signed into place.¹²² A current example of this is Director Pruitt of the EPA planning to rescind the Clean Water Act.¹²³ When the federal government is on board, executive orders such as those passed by President Carter and President Clinton are put into place. These executive orders mandated federal and local protection of wetlands and minimal destruction to wetland habitats.

It is equally important that state and local governments support protective wetland legislation. When local governments do not support legislation there is increased degradation, development, and destruction of wetlands. When local or state governments support wetlands, local wetlands thrive. For example, since the creation of the Long Island Sound Study, a collaboration between local agencies in Connecticut and New York, the Long Island Sound is monitored, protected, and when problems that arise in the Sound are noted they can be addressed more thoroughly. As mentioned in chapter 1, the Long Island Sound Study has noticed increasing periods of hypoxia and through state cooperation can monitor it, find the source or sources of it, and then fix or alleviate the issue of hypoxia in the Sound.¹²⁴

With all of this in mind, legislation is most effective when there is support and cooperation between federal and local levels of government. It is important to have federal support, because it is federal agencies that set the agenda for wetland regulations and it is these agencies that put out the major pieces of legislation. Local governments are the ones who carry out the legislation and are responsible for effectively implementing them. Without cooperation

¹²² Environmental Protection Agency, “Clean Water Laws, Regulations, Executive Orders”

¹²³ United States Government, “Proposed Rules”

¹²⁴ Long Island Sound Study Partnership, *Sound Health 2008*, 1-16

from both levels of government legislation is weak. When there is cooperation from both there can be extremely positive results in regards to wetland protection and rehabilitation. For example, as mentioned in chapter 4, the Clean Water Act puts in place regulations that are meant to reduce hypoxia, restore wetlands and improve water quality. The Long Island Sound Study, bases its management plan for the Sound off of this regulation, and gets its plan approved by the EPA. The results of this system have been very effective. From 1998 to 2015, 1,750 acres of habitat, including tidal wetlands and forest, have been restored in Connecticut and New York in the watershed, and 335 miles of river migratory corridors have been restored. Without cooperation of local and federal government agencies this would not have been possible.

Another important aspect to wetland regulation is that regulation must be adaptable and advisable. The needs of wetland ecosystems change over time and new issues arise and need to be taken care of. For this reason, legislation that regulates and protects wetlands must be able to be advised and adapted to keep up with ever changing needs of the environment. One of the most effective legislations in regards to the protection of wetlands, the Clean Water Act, is an example of this. The Clean Water Act was originally created in 1942, but was updated in 1972, 1973, 1977, 2002, and as recently as 2012. Since its creation there have been hundreds of amendments added to the act. The act monitors the condition and health of wetlands and when it needs to adapt its statement of purpose and the areas it regulated over. For example, the act created task forces to deal with prominent issues that arose such as hypoxia. Overtime the Clean Water Act has expanded its definition of what a wetland is as well as expanded protection. It has put in a regulation system that is flexible enough to deal with new issues as they arise as well as strong enough to enforce its rules by taking violators to courts. This regulation which to date, is over 60 years old is still considered the most important piece of wetland legislation and arguable

still the most effective. It would be helpful for future policy to be modeled after the Clean Water Act. The ability of this act to adapt and expand with the times is why it remains in place and so effective. Creating legislation that is able to deal with new issues as they arise as well as expand coverage when needed is essential to the effectiveness of wetland regulation.

Another important thing to note is that as chapter 1 mentions, wetlands are becoming increasingly vulnerable due to climate change. Scientist have proven that between 1992 and 2001 glaciers shrunk in size worldwide, which caused an increase in the sea level, which led to a disturbance in coastal wetlands. It has also been proven that between 1901 and 2010 sea level rose by .19 meters globally, and that sea level has rose more since the mid 19th century than it had during the previous two millennia.¹²⁵ It is likely that sea level rise has contributed to increased impact of storms, including increasingly impactful storm surges. Climate change has also been found to be responsible for extreme weather including heat waves, droughts, floods, cyclones, and wildfires, all of which negatively impact wetlands. All of this combined has led to the significant vulnerability and exposure of some ecosystems and many human systems.”¹²⁶ This makes it increasingly important that regulation regarding wetlands is adaptable. Unless humans can change their lifestyles quickly new issues related to wetlands will continue to pop-up as a result of climate change and it is essential that regulation is able to deal with these problems as they arise.

Another important thing in regards to the effectiveness of regulation is that regulation must take into account economic factors when promoting and crafting said regulation. Society is extremely material focused, and without keeping this in mind when creating and promoting regulation there is bound to be extreme pushback from the community. As chapter 3 mentions,

¹²⁵ IPCC, *Climate Change 2014: Synthesis Report*

¹²⁶ IPCC, *Climate Change 2014: Synthesis Report*

wetlands provide many essential ecosystem services, including many that boost the economy. For example, wetlands provided flood damage control, as well as add to the economy through the fishing, hunting and recreation industry. If wetland regulations take into account these services and emphasizes them when promoting legislation, there is likely to be more cooperation, compliance, and support for regulation therefore making the piece of legislation more effective.

For example, as chapter 3 mentions, in 2012, the fishing industry, both commercial and recreational, created 1.5 million jobs in the United States and was worth 90 billion dollars.¹²⁷ If legislation protecting wetlands is promoted as also protecting these jobs it would gain the support of millions of Americans and have a better chance of being complied with. In 2004, consumers spent 3.7 billion dollars on the fin fish and shellfish market. If they are given a choice between increasingly expensive products or complying with a few regulations, such as less development it is likely many who revel in these products will begin to support the legislation. The promotion of legislation is in part a large part of its support and compliance. If legislation is able to emphasize industry, job creation, as well as the stable price of goods it will gain the support of millions of Americans. This will lead to the formation of interest groups by fishermen, hunters and others, and inevitably lead to legislation being put into place.

In the face of climate change and a presidential administration opposed to wetland protection, it is essential now more than ever effective policy is put into place. Wetlands provide health services, such as medicinal study and use, cultural services, provisionary services, such as fresh water, and are vital to the economy of the United States. For this reason, it is essential that citizens and elected officials push for proposal that protects wetlands and is effective. Wetlands are essential to the functioning of this country and it is essential that we move forwards in our

¹²⁷ Dews, *The U.S. Fishing Industry Contributes Nearly \$90 Billion to U.S. Economy*

relationship with wetlands and not backwards.

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