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Overcoming Overexploitation of Fisheries: Creating a More Sustainable Fishing Industry Along the Gulf of Mexico Coast

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OVERCOMING OVEREXPLOITATION OF FISHERIES:
CREATING A MORE SUSTAINABLE FISHING INDUSTRY ALONG THE GULF OF MEXICO
COAST

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Abstract

With increasing global population coupled with high levels of consumption, natural resource scarcity is a vital issue in the management and restructuring of commercial industries. Resource conservation is a widely studied field to determine the current and past trends of resource availability. As oceans comprise 70 percent of our planet's surface, the study of marine ecosystems and human impacts due to fishing enterprises is becoming increasingly important, especially as fishing stocks across the world are in danger of collapse. This study focuses on the role of fishery management policies and practices in the United States and in particular, how these policies can be changed to establish industries that promote long-term sustainability. Specifically, a policy recommendation for the Gulf of Mexico fishery system is advanced, drawing from the lessons learned through examination of Alaskan and New England fisheries. This Gulf of Mexico case study is designed to produce a dialogue considering the sustainability of our fishing industries in the United States by considering biological, political, and economic factors of each region in order to create a more local and contextualized policy recommendation for the Gulf of Mexico to transition effectively and efficiently towards a more sustainable future.

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Introduction

The rapidly growing population of our planet has caused enormous strains on our natural resources as more and more of these resources are being exploited in order to meet the increasing demands. The consequences of exploitation on our resources are nowhere more evident than in the world fisheries, of which the human population has long relied upon as an important food source.

Food security is an issue that is intensified by expanding population. As it spreads throughout the globe, it will continue to create challenges for communities unless more sustainable means of food production are implemented in order to conserve the natural resources that are used to feed our increasing population, before these resources begin to collapse. However, despite Thomas Malthus's warnings of the Earth reaching a food crisis as population increases exponentially while food production grows geometrically, the advancement of new technologies, and the exploitation of our resources have allowed us to meet the needs of the population without mass starvation. Nevertheless, in the coming decades the world population is expected to reach 9 billion individuals or more and it is projected that by the year 2050 the world will need to produce “70 to 100 percent more food” (Godfrey, 2010).

With a population that greatly exceeds the planets resources, it will become imperative to support and create industries that will maintain sustainability while also providing both food and job security to the individuals dependent on these resources. In 1987 the Brundtland Commission published a report defining sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. This leads to questions concerning our abilities to provide for current economic growth to support human communities while conserving and protecting resources for future generations. This

project examines the status of current fisheries and fishery management practices and policies in the United States and applies these findings to create a proposal to establish an environmentally and economically sustainable industry for the fisheries of the Gulf of Mexico. The analysis draws on the biological, political, and economic features of two other major U.S. fishing regions- the Alaska fishing industry as well as the groundfish industry of New England- to help identify important variables of sustainable fisheries. By applying aspects of successful management and regulation policies from current sustainable programs utilized by Alaska or programs currently striving to reach sustainable levels such as in New England, the fisheries of the Gulf of Mexico can identify a path forward for achieving both environmental and economic stability over the long-term.

As American ecologist Garrett Hardin has suggested in his work *Tragedy of the Commons*, a major issue involving resource depletion is the exploitation of shared resources by individuals looking out for their own needs. Hardin's solution to this dilemma includes increasing government involvement for better management of common good resources as Hardin professes that "those who restrain their demands because of long-term bad effects lose out in competition with short-term maximizers," (Hardin, 1968). Therefore, in order to maintain an equitable system, stricter regulation is needed. However, Elinor Ostrom, an American political economist, offers an alternative solution in the regulation of these common resources. She counters Hardin's arguments focused on increased involvement of the government by arguing that, more importantly, a variety of actors on a more local context is needed to provide a more contextualized solution. This leads to a more successful solution to the conservation of resources as this goes beyond a "one-size-fits-all" approach to develop initiatives that can actually bring about both conservation, and long-term economic growth for a particular region. Both Hardin

and Ostrom identify that stricter management of these common resources is necessary to protect these resources from overuse and overexploitation.

The Gulf of Mexico's fishing industry is highly important both ecologically and economically to the region. This industry is in desperate need of a new management program in order to maintain and sustain itself for future generations. The marine resources of the Gulf of Mexico are vital for not only the commercial fishing sector, but play an integral role in the tourism industry as many flock to these waters for recreational purposes bringing in a considerable amount of income for these coastal communities.

The goal of this study is to promote sustainable development in today's industries that will support the health of our natural resources while also allowing for economic growth and job security. The Gulf of Mexico was selected for this analysis due to its abundance of natural resources, the economic importance of its fisheries, and its delicate ecosystem. The fisheries of Alaska and New England are both rich in history, as opposed to the relatively less developed fishing industry of the Gulf Coast, and therefore are important cases to consider when formulating a plan of action for the Gulf region. The industries in these regions have been in operation for over one hundred years and have both realized the importance of operating under sustainable policies in order to increase economic success and ecosystem conservation. Also considered in this study are the various fishing practices and techniques utilized in these industries alongside the policies governing the management of these industries in order to develop a more comprehensive understanding of the fisheries in question and the impact of each one on its ecosystem. By focusing on both the effects of general fishing practices as well as policy on marine conservation efforts, and the sustainable management of the ecosystems and fishing industries in the United States, a proposal can be created to reverse the current trends of

overexploitation and overfishing in the region of the Gulf of Mexico.

Section I

A Brief Background

Historical Background of Fishing

The management of common resources is an issue that is on the forefront of sustainable development projects and conservation initiatives. Fishing is an industry that humans have utilized dating back to prehistoric times, and still today many nations rely heavily upon fishing for food security. In fact, close to eight percent of the global population's livelihood is related to fishing (FAO). The global demand for fish is growing and has reached 17.1 kilograms per capita and is expected to continue to grow to 20 kilograms per capita by 2020 (FAO). However, the planet's marine resources are severely depleted as 17 of the world's major fishing areas are at or exceeding their natural limitations and this rising demand only places more strain on these overexploited fish stocks (UNEP, 2008).

A major turning point in the increase of consumption can be traced back to the industrial revolution. As human practices became progressively driven by technological advances, human's impact on the Earth and the Earth's processes and systems amplified dramatically. Such advances that contributed to the expansion of the fishing industry include the invention of the steam-powered ship. This innovation eventually led to the development of the practice of trawling as fishermen placed nets behind their boats and dragged these along the bottom of the sea floor, and although this practice allowed fishermen to increase the productivity and efficiency of their labor, trawling also caused major destruction to the environment and the marine ecosystems that these fishermen were utilizing. By the 1900s, scientists and other

ecologists began to observe the detrimental effects of these new fishing practices (Woodard, 2007). These technological innovations began to spread from the United States throughout the mid-1900s and countries such as the Soviet Union, Poland, Spain, Canada, France Japan, and Germany all began utilizing ships called freezer trawlers which were trawling ships equipped with an on board processor and freezing plant, and had the ability to operate twenty-four hours a day for several weeks leading to the expansion of distant-water fishing (Woodard, 2007).

Today, fisheries around the globe are crashing due to the overexploitation of resources. The causes have been building over centuries, but have rapidly mounted as the use of these new technologies became increasingly widespread and popular due to the increase in productivity they provided.

Overfishing is often considered the first environmentally destructive act of humans against the planet and evidence from the historical records of various disciplines indicate that over-fishing has caused major “structural and functional damages” in marine ecosystems for many centuries (Berger, 2001). Berger examines paleo-ecological and archaeological records to identify the extent of human’s exploitation of marine resources. Berger finds that current attempts to alleviate human pressure on marine resources fail due to an overemphasis on solving recent symptoms rather than historical causes of the problem (Berger, 2001). By understanding the root causes of the damage we have inflicted upon the planet, we can find and implement sustainable solutions that will benefit both the environment and the world population dependent on the Earth’s natural resources for their well-being.

Through the examination of research on modern and historical practices and policies and studying current examples of successful fishing industries, this will provide the basis for further sustainable development and begin to address the issues that are causing problems of

unsustainability.

Today's Fisheries

It is important to protect the marine resources that are becoming increasingly overexploited by the fishing industry as approximately 90 percent of the planet's living biomass exists in the oceans and about 20 percent of human's consumption of animal protein is from marine resources (Cooper, 2002). Economically, the industries centered on fishing provide hundreds of millions of individuals globally with a source of employment and livelihood. The oceans produce approximately 100 million tons of fish annually, however, due to overfishing; the overall world catch levels are dropping, creating problems for both humans and the environment (Cooper, 2002). According to the National Oceanic and Atmospheric Organization, 75 percent of global stocks today are overfished. A major issue regarding fishing regulation is the lack of understanding between the complex ecosystems that exist. Many individuals fail to understand the direct links of human well-being with the health of our environment and continue to utilize methods that are both destructive and harmful to the planet to provide for the needs of human beings.

Although much research has been conducted into the management policies and regulations that can create a more sustainable fishing industry, the continuing decrease of fish stock populations and amount of overexploitation of stocks suggests that merely increasing knowledge and understanding of this subject is not enough incentive to implement such policies. Failures in management still exist in the political sphere concerning policy and regulation as well as in the use of gears and fishing techniques that are detrimental and destructive to the marine ecosystems that fisheries are targeting. In addition, the actors in the political realm, such as

lobbyists and special interest groups, have severely limited the growth of sustainable development. These interest groups have economic incentive to promote weak regulation standards on commercial fishing enterprises and appeal to politicians to pass such policies that will benefit their agenda. Finally, political leaders typically lack the will to act when opposition is present, even on the direst issues that we face today. Modern fishing policies are centered on controlling the natural environment through human behaviors. Much of our environmental policy, in fact, concentrates on such anthropocentric ideas. Management and regulation policies are controlled by the political arena rather than science-based information and decision making. Unfortunately, in the political sphere, the politicians controlling the regulatory or management policies often operate in the short-run based on election cycles. The efforts of the government have allowed commercial interests to dominate the regulatory measures of open access spaces (Layzer, 2002). The single underlying factor that I found throughout my research on management and regulation points to the lack of defined property rights as the leading factor of management failures. According to the Food and Agricultural Organization of the United Nations the absence of property rights “discourages incentives to invest in the natural capital of the fishery to improve future returns” and exacerbates instances of overfishing and overexploitation (Shotton, 2000).

The backbone of fishing policy and regulation in the United States is the Magnuson-Stevens Fishery Conservation Act. This act is the primary domestic legislation governing the nation's fisheries. It was first enacted in 1976 and is under a constant process of revision in order to maintain effectiveness and work against overfishing of exploited stocks. At first, its goals were to rejuvenate the fishing fleets of the United States and to restore and conserve fish stock and population. In specifying these goals, the law unilaterally asserted jurisdiction from the

United States over fisheries within Exclusive Economic Zones extending 200 miles off the coastline. In 1996, the act was amended to focus on the conservation of the fishing industry including efforts to rebuild overexploited fisheries, preserve and protect marine ecosystems and reduce the amount of bycatch that occurs in commercial fishing enterprises. The act has gone further in recent years to continue to fight overfishing and create sustainable practices and emphasize management systems based on the health of the ecosystems rather than only economic growth. The act created regional councils to implement and manage these policies. These councils promote regulation through annual and individual catch quotas (ICQs), community development quotas (CDQS), marine protected areas (MPAs), and permit requirements among other regulatory measures.

The Office of Sustainable Fisheries of the National Oceanic and Atmospheric Administration's National Marine Fisheries Service is the key regulatory agent behind enforcing the Magnuson-Stevens Act and the management of the nation's vital fish stocks through the support from Regional Offices and Regional Fishery Management Councils such as the New England Fishery Management Council. This office is able to assist better communication between the various parties involved at the local, state, and national levels. The OSF facilitates the implementation of the Magnuson-Stevens Reauthorization Act of 2006 and reports status updates of the nation's fisheries to Congress annually.

Unfortunately, overfishing and overexploitation of fish stocks are not the only issues that need to be accounted for when creating government policy and regulations. The environmental problems that persist today are intensifying the depletion of our natural resources even further, and it is necessary to account for these issues when formulating a plan of action. Many fishermen opposed to stricter regulatory measures argue that these concerns are impacting the quality of the

oceans and marine environments at a higher and greater rate than merely overfishing. Issues such as climate change, which is a complex process that is altering the balance of the oceans, decreasing sea ice levels, warming waters, and rising ocean acidity levels due to the increased carbon dioxide in the atmosphere cause severe implications for the marine ecosystems that we are dependent on for food and resources.

Pollution and human development are other factors that are important to consider when examining the degradation of the oceans. Marine dead zones are a significant occurrence that is taking place due to such human activity. Agricultural runoff into bodies of water surrounding farmlands consists of various discharges including fertilizers containing nitrogen and phosphorous. This runoff causes the growth of algal blooms in the waters, and as these organisms die on a mass scale, this creates a condition called hypoxia which is a lack of oxygen. This causes the deaths of much of the marine life of the area leading to dead zones, where little to no productivity can occur.

In order to implement effective policies and programs to promote sustainability, it is important to understand the history and current obstacles facing the health of our ecosystems.

Review of Literature

In order to implement policies and practices that will create a successful sustainable fishing industry in the Gulf of Mexico, it is necessary to understand the research and cases that have been previously studied. What steps are needed to transform the current fisheries of the Gulf of Mexico from single-minded maximization of profits as a driving force behind policies and practices, to systems that instead consider a wide range of factors including long-term environmental conservation? This review examines what others have found as important

variables for balancing economic and environmental considerations in sustainable fishery management.

Practices

The oceans play a key role in the regulation of Earth's climate and biological cycling of important elements; and the interconnectedness of the environmental problems that exist today are vital to consider when addressing changes in policies and practices used. Much research has been conducted regarding the fishing practices themselves and their impacts. Commercial fishing gears in general cause serious injury to coral reefs and other bottom-dwelling organisms which lead to the reduction of plankton production capacity of the ecosystem. The destruction of coral is a major issue as the significant functions they provide for the marine habitats are lost which include "provision of substrata for primary production, habitats for invertebrates and fishes, and protection of coasts from wave exposure and erosion in tropical environments" (Akpalu, 2011). According to scientists from the United Nations Environmental Program, climate change will cause the loss of more than 80 percent of the world's coral reefs. In order to maintain the delicate balance of the oceans marine ecosystems, it is necessary to consider more sustainable technological advances in regard to the techniques and gears utilized by large-scale fishing industries.

As fishing gears and nets became increasingly more efficient over the past century, these technologies began to place increasing pressure and harm on marine ecosystems. The nets and gear related to trawling, in particular, have been described as among the most destructive techniques of fishing not only in terms of immediate physical damage to the benthic habitats that these affect, but also in terms of creating imbalances in the biomass of these ecosystems as

researched by Jan Hiddinck (Hiddinck, 2011). The nets that are dragged behind fishing vessels in trawling lead to the mortality of the invertebrates of these benthic habitats which leads to a decrease in the targeted fish species not just due to overfishing, but also due to the decreased availability of the species they rely upon for prey. This in turn reduces the carrying capacity of the ecosystem leading to the further reduction of fishing yield levels (Hiddinck, 2011). Another example of how trawling intensifies environmental problems is cited by Rebekah Church as she studied the increase in commercial fishing in the Canadian Arctic due to the decreasing sea ice levels generating more areas of open water for these commercial fishing enterprises to utilize. These commercial fisheries are mainly trawling vessels as 23 percent of fishing vessels globally are trawling ships (Church, 2011). This positive feedback loop leads to further damage of these regions as more and more trawling ships enter these areas of increased open water for longer time periods intensifying the environmental concerns of the region. Church cites the practice of bottom trawling as one of “the most ecologically destructive methods of commercial fishing” to both the ecosystem as well as non-targeted marine by catch (Church 2011). Tim McClanahan agrees with these claims and states that trawling is not only harmful due to the removal of biomass and diversity and because of its effects on the habitats of marine animals but also as it is extremely wasteful as there is a high incidence of discards from these vessels (McClanahan, 2007).

Bycatch, the incidental taking of non-targeted species of fish, sharks, sea turtles, birds, marine mammals, and other animals, is another important factor to consider when looking at commercial fishing techniques. The organisms are caught in the nets, hooks, and lines of fishing vessels and are usually dead or dying upon being released back to the ocean. According to the Food and Agricultural Organization of the United Nations (FAO), approximately 25 percent of

animals that are caught in nets of commercial fishermen are bycatch. Marine mammals are at high risk of becoming caught in both nets and hooks leading to incidental mortality and injury to these creatures. According to the General Accountability Office, however, it is difficult to understand the exact amount of damage to these marine mammals because of the limitations on reliable data as much of the important information necessary for assessing damage remains unreported, particularly if the fisheries are operating under illegal practices concerning marine resource management and lack regulation (GAO, 2008). The unnecessary and unintended deaths of these animals have led to further environmental concern as the balance of the ecosystems is affected.

It is necessary to consider the fishing gear and techniques used in commercial fishing industries because these can further reduce the carrying capacity of an ecosystem, which, coupled with exploitation of these resources, results in an overall drop in fishing yields and commercial fishing production.

Policies

With our changing climate and the increase in environmental damages that humans are inflicting upon the Earth, it is becoming imperative to take into consideration the management and regulation of the planets resources that are in severe danger of collapse.

According to Sutien, much of these concerns are the result of policy failures. Jon Sutien cites the greatest threat to fish stocks as overfishing (Sutien, 2008). The amount of fishing vessels that maintain very high fishing yields in areas of collapsing fish stocks greatly exceeds the capacity of these resources as fishing capacity “is now estimated to be as much as 2.5 times that needed to harvest the sustainable yield from the world’s fisheries” (UNEP, 2008). This is a result of Total

Allowable Catch (TAC) rates being set above the rates determined by scientists as vital for sustaining these populations. Basically, science is being ignored in the policy-making decision process. Stig Gezelius describes modern fishing policies as controlling natural environment through human behavior, which places economic concerns above ecological and even social factors of consideration.

Historically, the methods of regulation of fisheries involve surveillance and penalty. However, the quotas that govern these surveillance policies are decided upon by elected officials who make decisions based on their cycles of re-election and what will maximize their potential of re-election. Therefore, the short-term sacrifice for long-term progress favored by conservation efforts is of little concern to politicians. In fishery management, another obstacle when appealing to politicians are special, private interest groups which are a serious threat to implementing policies that promote sustainable management procedures. These special interest groups often interfere in policy-making decisions in order to weaken the proposed regulations and ensure a higher productivity of the fishing vessels (Sutien, 2008).

In the policy-making process, legislation is passed into laws that identify key goals and authorize the implementation of fisheries policies and programs by fishery agencies. Then these fishery agencies establish fishery management authority in order to develop plans and regulatory measures. Stakeholders of these fisheries, which include fishing managers and producers, communities, and environmental advocates, then advise the agencies in the decision-making process in management and plan development. These resultant plans are then implemented by the fishery agencies. In this process, stakeholders have a large voice in the decision-making process and therefore have the ability to impact the formulation of policy goals as well as the adoption of regulations that are implemented according to their own needs. When the stakeholder

groups are comprised largely of private, special interest groups this leads to the passage of laws that promote weakened regulatory measures.

It is human nature to only make changes when a situation becomes dire. This is particularly true as most catch reductions are introduced far too late (Shertzer et al, 2007). Even when regulations are increased, research conducted by Christopher J. Brown suggests that to maintain higher catches, many commercial fishing industries simply delay the implementation of these regulations or, according to studies by UNEP, fishers will find new areas of less regulatory measures. Because of the political nature of fishery management and the short-term economic loss that is often accompanied by increased regulatory policies, management figures typically oppose efforts to revise management plans (Shertzer et al, 2007). These delays form through social pressure placed on the managers of the fisheries to maintain current catch levels as imposing more conservative harvest limits are highly unpopular. The uncertain nature of the fishing industry leads to managers and policy-makers to operate in the short-run to maximize profits in the present rather than make decisions that will increase economic profit in the unclear future. However, this delay in regulation enforcement and in management procedures can have significant long-term costs as stock decline becomes intensified, leading to the greater potential of a collapse of fish stocks causing a decrease in both ecological sustainability as well as economic security.

Overfishing and Overexploitation

Only in recent history has the study of the impact of overfishing and overexploitation of the natural marine resources by human's been examined. According to research conducted by Sean Pasco and Dominique Greboval, the primary issue leading to this creation and continuation

of unsustainable fisheries is overcapacity problems (Greboval, 2008). The large numbers of vessels operating in these commercial fisheries begin to deplete their resources and are forced to find new ecosystems in order to meet the growing demand of seafood in the global population.

Due to this exploitation and subsequent decline of marine resources coupled with the increase of global demand for seafood, the fishing industry has expanded to include a wider range of species. Sophie Whoriskey studied the mahi-mahi industry in order to gain perspective of the effects of this relatively new niche. Species such as mahi-mahi are important in the search for sustainable practices due to their high growth rate and early maturation making them a more durable species. However, Whoriskey discovered that the techniques used to catch this species of fish lead to high risk of by catch of unintended species such as sea turtles, sting rays, sharks and other marine mammals. These techniques include pelagic, a term indicating the upper layers of open sea, long lines to harvest this fish and the animals are caught on these shallow lines leading to high mortality rates. Therefore, although shifting the targeted catch to more sustainable species is one viable strategy; this does not fully address the root problems concerning policy failure and disregards the impact of various fishing techniques on a larger scale.

While Sutien states that overfishing causes the greatest impact on marine resources, Pascoe and Greboval take this theory one step further and state that the lack of alternative means of livelihood for the fishers as having the greatest impact on placing more pressure on fisheries which results in overfishing. This further exacerbates the lack of conservation based policies by politicians as their focus of reelection centers policies on maintaining employment for the fishers involved and therefore creates an increased resistance to capacity management programs. Overfishing occurs during periods when short-term catch rates exceed the levels necessary for long-term equilibrium. This is due to fishers continuing to fish as long as their costs are covered,

and the government further intensifies this issue by providing subsidies to fisherman, leading to increased fishing activity and the continuation of over-exploitation in a region (CMSF).

In addition, another barrier to exit for fishermen includes the fact that there are very few alternative uses for the capital involved such as fishing boats. Some solutions have been implemented in various nations such as France that provide monetary compensation for fishermen who change their careers. These buyback programs allow governments to buy out fishing permits to decrease the number of fishing vessels in operation in a fishing area and provide fishermen who have long histories in the fishing industry to walk away with dignity and receive compensation for their fishing vessels and gear.

However, in the United States, rather than allocating funds to buy back the capital used by fishermen to reduce the overall number of vessels in use, subsidies are being provided to offset the economic hardships of the volatile fishing industry which allows overcapacity issues to continue. Between 1996 and 2004, the United States government provided \$6.4 million in subsidies to fishermen across the nation, yet in the same time frame, there were approximately 50 percent more boats in the oceans than was necessary to bring in fish based on catch limits. In addition commercial fishing enterprises are exempt from fuel taxes imposed by the government (Sharp, 2009). This also increases the amount of fishing vessels competing for the limited resources leading to the overexploitation of these resources as fishermen are trying to make a living. Rather than addressing the root causes behind the collapsing fish stocks and the continual degradation of our nation's marine resources, the federal government is further exacerbating the strain placed on the environment.

Solutions

There are a variety of solutions that have been considered by researchers. These include stronger property rights, shifting the responsibilities and management rights to user groups involved, and removing fishery managers from the influence of political officials. Much research has also been undertaken to reverse and reduce the harmful impacts our fishing industries have on the ocean.

According to research conducted by Jeffrey Weilguis, one possible solution is to prohibit fishing in spawning areas of overexploited species in order to restore the stocks. Maintaining biodiversity is a key aspect of sustainable management of fisheries according to Wisdom Akpalu. Several changes are being made in fishery policy and practices that will create a major impact on increased conservation. Advancements in technology include input control based systems which will allow for increased awareness of the total catch by fisherman and has the potential to aid in the reduction of overfishing. However, without stronger management policies, these technological advances will be of little consequence. Currently, more attention has been given to rights based management which allows stakeholders to participate in policy-making processes limiting the influence of politicians in the direct management of these fisheries.

Marine Protected Areas (MPAs) and no-take marine reserves ban consumptive fishing activities within a specified reserve boundary. These facilitate both the recovery of marine resources while also allowing the ecosystems that are interconnected and impacted by these reserves to recover as well. In these areas, the population of a given species is able to live longer, grow larger, and develop increased reproductive potential which allows the population to recover even more. These reserves can be developed within two to five years and can then be maintained for decades to come (Weilguis, 2008). MPAs are controversial within the fishing communities as many fishermen believe that MPAs are only appropriate for certain species as most fish are

too mobile to benefit from the reserve. Also, many are concerned about the negative economic consequences with the prospect of a decreased catch and an increase in total travel time and are also cynical regarding the level of compliance of individuals refraining from fishing in restricted boundaries and abstaining from utilizing gears in these regions that have negative impacts on the habitats that the reserves are protecting and restoring. Fiona Gell and Callum Roberts address these issues concerning Marine Protected Areas and conduct a study to determine the benefits and consequences of implementing such a policy. Gell and Roberts found that MPAs do, in fact, benefit a wide variety of species and habitats and concluded that a MPA can be created for any species with careful planning and implementation. Not only do MPAs restore and regenerate fish stocks and habitats, fisheries in adjacent areas become more productive as the reproductive potential of fish stocks increase and this increase leads to the settlement of juvenile animals outside the boundaries of the marine reserve (Gell & Roberts, 2003).

One researcher believes that fishery management needs to be shared between local and government organizations (McClanahan, 2007). By doing this, the long-term interests of society can be considered alongside the short-term interests of individuals such as government officials, the fishermen themselves, and special interest groups. A holistic approach towards management creates links between nature and human needs and utilizes a localized context when discovering solutions.

On the international scale, the fishing industry is extremely important and the conservation of these marine resources is of the utmost important for providing food security at a global level. To meet sustainability measures, Hiddinck lists four necessary steps that we need to meet including a shift in perspective on resource management, objectives of fisheries expanding to include ecological considerations, involving fisher's local knowledge, and developing a

participatory government with community based institutions. By developing a participatory management program, this involves individuals whose livelihood is affected by particular decisions and allows them to participate in the policy-making process and gives them direct accountability of their own lives. Co-management programs are similar in that they share the power between the national and state governments along with local communities.

Internationally, this idea of co-management of fisheries between the national government and the communities involved is an attractive alternative to traditional management and regulatory institutions. In Bangladesh, for instance, the inland fisheries are a vital source of job and food security for the poor nation and by creating a community based system of management, the region has benefitted environmentally and economically. The fishing stocks and habitats were restored from collapse by the adoption and implementation of better fishing techniques, and fish catches were able to increase by 140 percent (WRI, 2008). This provides a cost-effective means to increase sustainable efforts by allowing the local fishermen involved to have direct accountability and responsibility over their livelihoods.

Additional considerations

Another growing concern that has been brought to light is the alienation of consumers from their food sources. A study recently conducted in New York City indicates a shocking amount of mislabeling of fish given to consumers at both supermarkets and restaurants. There are a number of instances of cheap cuts masquerading as expensive fillets and “overfished species passed off as fish whose numbers are plentiful” (Rosenthal, 2011). In fact, according to fish geneticists, close to 25 percent of the seafood products that are examined are inaccurately labeled. For instance, approximately 94 percent of fish sold as white tuna was not even tuna at all

(Rosenthal, 2011). This kind of misinformation prevents consumers from understanding the true extent of the collapse of popular fish species, as they believe these species are still readily available for purchase. This causes not only issues related to the conservation of fish species, but health issues as well. In certain cases, a fish known as snake mackerel, or escolar, which is harmful and can cause “severe diarrhea if more than a few ounces of meat are ingested” was passed off to consumers as tuna (Rosenthal, 2011). Also, for those environmentally aware consumers who are trying to do their part by purchasing sustainable species of fish, this is an injustice as they are unknowingly contributing to the decline of a species rather than consuming one of less consequence. However, there are means of regulation to ensure accurate species labeling that are becoming more widely available.

Aquaculture, genetically modified, and farm raised fish are other hot topics in relation to fish consumption in today’s society. These fish stocks are farm-raised in ponds under controlled conditions and selectively bred using a small genetic pool of stock. This small gene pool is of fish unconditioned to the natural risks and hazards that wild fish populations face, imposing ecological consequences should these individuals escape into the wild ecosystems. These problems include breeding with the wild fish population and producing offspring similarly unaccustomed to natural dangers, harming the potentially already endangered wild stocks. If the farm-raised fish are not indigenous species, this creates further ecological issues as these fish might overtake the indigenous organisms as they have no natural predators.

Aquaculture presents some of the same negative consequences of land-based agricultural industries. These include the spread of diseases among organisms living in such close quarters, as well as the production of pollution and waste. Aquaculture also places more pressure on wild fisheries, rather than alleviating the stress of overfishing as species such as shrimp and salmon

are carnivorous and require that the industries utilize wild fish stocks to feed the farm-raised species.

However, with the rapidly growing global population, aquaculture remains a viable solution to provide a source of protein to meet the expanding demands.

Summary

Taken together, these findings indicate that global marine ecosystems are vital to the health of our planetary systems as well as a crucial food source for humans. The research and studies suggest that the issues surrounding the fishing industry center on the management of these fisheries and the overwhelming occurrences of overexploitation and overcapacity by fishers. A restructuring in management techniques and fishing practices are needed to ensure the continued success and productivity of this industry. As discussed in the literature, management is increasingly dictated by political incentives as well as maximizing short-term economic profit. The practices utilized follow similar patterns as gears such as trawling vessels are utilized to increase efficiency of a fisherman regardless of environmental implications that decrease total catch in the long-run. Solutions to these problems have been studied such as implementing an ecosystem-based approach to management which would encompass the policies surrounding fisheries and also impact the gears and techniques utilized for harvesting the fish species targeted.

These previous studies provide a base to understand the current and historical trends of the fishing industry and the factors involved in the management and organization of these enterprises. This research offers the basis on which to measure the current status as well as the historical practices involved in the fisheries of New England, Alaska and the Gulf of Mexico. In these case studies, it will be beneficial to highlight the management styles such as what policies

and regulations are in place to control the overexploitation of the region, the gear and practices involved in the harvesting of the targeted species, and the associated environmental impacts in the marine ecosystems.

Section II

The Cases

New England groundfish

Background

The case of the New England fishing industry is rich in history as the development of New England is intertwined with fishing. The Georges Bank off the coast of Cape Cod in particular was one of the most prolific fishing grounds in the world due to its cold and nutrient dense waters. The collapse of the fish stocks of the Georges Bank have forced policy makers and fishing managers to implement sustainable techniques and policies in order to restore their fish populations and maintain their profitable industry. The groundfish industry of the Georges Bank became the backbone of the region and includes fish species that live on or near the bottom of the ocean floor such as cod, flounder, haddock, and yellowtail. The Georges Bank maintained stable levels for more than four centuries; however, the technological advancements of the twentieth century began to increase pressure on these popular fish stocks through the introduction of steam powered trawlers. By the 1930's, the large size of the trawling fleets resulted in the first major collapse of the groundfish stocks (Layzer, 2002).

This collapse forced fishers to shift their target to more plentiful species, which allowed the depleted stocks to rebound to a sustainable level. Yet, the mid twentieth century brought about even more advanced fishing technologies and the factory ships that became prevalent had

the ability to bring in 500 tons of fish in a single haul. The increase in total catch of groundfish from 1960 to 1965 was significant as it went from 200,000 tons to 750,000 tons, placing extreme pressure on this ecosystem. During this time, the passage of the Magnuson-Stevens Act prohibited fishing in the Georges Bank to international fleets, yet by 1974, the groundfish population had decreased by 70 percent. Fisherman began experiencing smaller catch yields in both quantity of the catch and also size of the fish despite utilizing more efficient and productive technology.

Scientists warned fishery management about the consequences of fishing beyond recommended levels and recommended that catch limits be implemented to allow stocks to replenish and recover to sustainable and healthy level. However, the managers were reluctant to follow this advice as it meant a reduction of economic gain in the short-term. By the mid-1990's, the fish populations of the groundfish of the region, particularly the cod, flounder, and haddock populations, recorded all time low numbers and the biomass of the Georges Bank plummeted. During this time the National Marine Fisheries Services implemented several year-long closures of the Georges Bank to restrict the harvest of groundfish and also control the use of commercial fishing gears that affected benthic ecosystems. These closures totaled 17,000 square kilometers and still allowed techniques such as the use of long line to harvest fish; thus it was not entirely a no-take marine reserve. However, these closures, along with a reduction in catch limits, allowed stocks to recover and benthic habitats to begin to regenerate.

Current Status

The groundfish industry of the Georges Bank is managed under the New England Fishery Management Council through which regulatory policies are decided upon and implemented. The

policies are then monitored by the National Marine Fisheries Services and the United States Coast Guard to ensure that fishery managers are abiding by such laws. Management of the fisheries utilizes a sector program which divides Total Allowable Catches for each stock into specific allocations which are then traded among the different stock sectors.

The commercial fisheries utilize a variety of techniques and practices on their fishing vessels. In order to harvest these bottom-dwelling species, trawling nets are the main gear. Although many of the groundfish populations of New England continue to be overfished and overexploited, after years of reduced catch limits the haddock population of Georges Bank is fully recovered. In order to ensure the sustainability for the entire region, further efforts of reduced catch for species such as cod and yellowtail are necessary as these populations are highly connected to one another. Although cod and yellowtail species have yet to recover, if a reduced catch is maintained by these fishing industries these groundfish are expected to fully rebound by 2026 (Newman, 2010).

Currently, the New England Fishery Management Council has decided to impose even stricter catch limits on the groundfish industry and could reduce these limits by “70 percent for cod on the Georges Bank fishing grounds...73 percent for Georges Bank haddock, and 51 percent for Georges Bank yellowtail” for the year 2013 (Canfield, 2012). These regulations are another step towards an overall shift in management techniques of the New England Industry as they continuously work towards creating a sustainable industry. In a statement, the Northeast Seafood Coalition industry group acknowledged this need as without these regulations and measures “there will be no groundfish fishery” (Canfield, 2012).

While the long history of these industries in New England have made it ideal for studying the impacts of industrialized fishing on stock population, it is because of this long history that

has created a resentment of increased regulation and management measures by the commercial fishermen involved. However, fishermen of the region are realizing that stricter management is essential. A group of 108 fishermen banded together to write a letter to their member of congress in order to push for more support for the stability, profitability, and flexibility of their fisheries. These individuals understand the importance of reduced harvest limits and defend that they are necessary to meet the industries goals of rebuilding stock levels. In order to do this, the fishermen demanded more funding be allocated to improve scientific assessment and monitoring and increase the frequency of such data collection which will allow the management council to set catch levels according to biological needs (Litsinger, 2011). The fishermen of the region understand the dire consequences if policy change is not realized. Following the collapse in 1990, the fishing industry along the Georges Bank took a loss in approximately 200,000 jobs and over \$340 million in revenues.

Alaska

Background

Alaska is home to some of the richest fishing waters in the world. These industries produce approximately half of all fish caught in United States waters. In the mid-1900's, Alaska's fishing industry was comparable to that of the rest of the United States in terms of over-exploitation and overfishing practices. However, unlike in the case of New England, fishermen were able to recognize the negative consequences of a potential fish population collapse and measures were taken to allow these populations to recover. However, as new technology and more efficient and productive gears were introduced, the industry appeared to be once again on the verge of a collapse. After this, the government of Alaska instituted permit systems and no-

take marine reserves in order to ensure that sustainable yields are met.

Alaska is a unique case as it is the only state whose constitution requires industries maintain sustainable operation. Alaska's commercial fishing industry is often cited as one of the premier sustainable models of not just fisheries operating under sustainable levels, but for the general management of natural resources.

Currently, according to executive director of the Marine Conservation Alliance David Benton, all of Alaska's seafood industries are being operated on a sustainable level and "there are no overfished stocks of fish" (Benton, 2007). Benton claims that Alaska is operating in the long-term rather than merely focusing on short-term economic profits. The commercial fishing sector is the largest private sector employer in the state and employs 78,500 individuals in either fishermen or fishing related positions. This industry brings in a great deal of money to Alaska. In 2010 it brought in approximately \$3.8 billion which then generated \$2 billion in indirect industries, equaling \$5.8 billion in total revenue (Alaska Department of Fish and Game, 2013).

Current Status

Fishing is an integral aspect of the state cultural identity and the ecosystem supporting the fisheries of Alaska has remained healthy due to the preservation of habitats and careful management. The fishing industry in Alaska is a model example of a sustainable industry in both the policies governing management and regulation and the practices that limit the amount of harm that is inflicted upon the ecosystem due to fishing. One major reason for this successful program is that policy-makers collaborate closely with scientists when determining factors such as appropriate levels of catch for sustainable max yields or where to implement a no-take marine reserve. This is coupled with the willingness of fishers to comply with such policies and, in fact,

encourage this conservation mindfulness as they understand the long-term economic impact if such measures are not followed. This cooperation and popularity of these regulation and management methods promote a steady source of funding to maintain these policies, and regular assessments of the health of the marine ecosystems are conducted in order to ensure that appropriate measures are being taken to conserve their valuable natural resources. The quota system in Alaska demands that once an established limit determined by scientific findings is reached for a particular species, the fisheries close down. For example, although Alaska is the world's largest producer of pollock, in the case of the pollock industry in Alaska once the annual quota is reached, it is then shut down for the remainder of the year.

Even when regulation policies are in place that meets sustainable yield levels, these will do little without adequate enforcement. The Alaska fisheries are strictly monitored and the rules strongly enforced with severe penalties for non-compliance. To do this, the National Oceanic and Atmospheric Administration along with the Coast Guard are the key agents that monitor these programs.

Alaska has also reduced the impact that its fishermen have on the oceans by restricting the use of trawling vessels in certain areas and has even closed off the entire region of the Arctic Ocean to fishing in order to better combat the impacts of climate change on the ecosystems. An important factor to consider when examining the Alaska industry is that this is a highly unique case. Compared to the rest of the continental United States, it is isolated from the greater numbers of fisherman, and is able to apply and implement these policies without the widespread opposition that is experienced in industries such as the New England groundfish.

The Gulf of Mexico

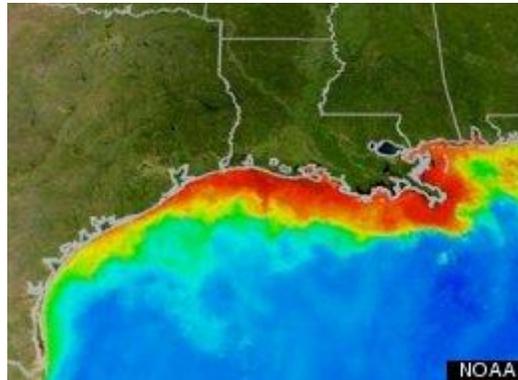
Background

Although the Gulf of Mexico does not have a fishing industry as rich in history or productivity as either New England or Alaska, it is a vital case to consider as is one of the largest industries in the Gulf region and generates a large portion of total catches in the United States.

The Gulf Coast consists of Alabama, Louisiana, Mississippi, Texas, and the Gulf coast of Florida spanning 1,631 miles of coastline. The extensive tidal shoreline and the number of inshore habitats combined with the warm sub-tropical waters create a highly productive industry second to only Alaska. The large numbers of coastal communities were founded due to the abundance of marine resources and were established in order to exploit these resources. Today, approximately 213,000 individuals of the Gulf Coast are employed in commercial fishing and fishing related positions generating \$22.6 billion in revenue for these states (NOAA, 2011). Coleman states that the population of major targeted species no longer have the ability to replace itself at a rate that supports the amount of fishing that takes place in this region as there are very few areas in the Gulf Coast that are not fished.

Another major concern of the Gulf Coast is the marine dead zones caused by eutrophication and the build-up of agricultural and human related runoff including fertilizers containing nitrogen and phosphorous. The Mississippi River accumulates runoff from approximately 41 percent of the continental United States. The fertilizers utilized on farmlands along the Mississippi River are discharged into the river, which is then transported to the Mississippi River delta which deposits 3.3 million gallons of water into the Gulf every second (Perry, 2012). As these nutrients dense waters containing excess amounts of nitrogen and phosphorous cause a huge growth of algae, leading to algal blooms. This causes a hypoxic

condition as these algal blooms die, sink, and begin to decompose, a process that consumes a large amount of oxygen. This lack of oxygen creates an uninhabitable environment for the marine organisms living in this ecosystem, causing a large amount of mortality within the area affected. Since 1984, the number of algal blooms has tripled and the Gulf Coast is has been severely impacted.



Dead zone highlighted in red along the Gulf Coast

The above image depicts the size of the dead zone along the Gulf Coast as highlighted in red. The dead zone off the coast of Louisiana and Texas is present from late spring to midsummer and has been averaging a total of 5000 square miles since being first recorded in 1985. In 2010 the area stretched to encompass 7722 square miles, one of the largest in recent history (Perry, 2012).

In the Gulf there is an extremely high rate of bycatch due to the particular techniques utilized by these industries. The Duke University Marine Laboratory compiled the first estimates of sea turtle bycatch in fisheries across the United States from 1990 to 2007. These scientists Lack of observed that although sea turtle bycatch and mortality rates decreased following implementation of mitigation efforts, the Gulf Coast Shrimp Trawl fishery accounts for up to 98 percent of the sea turtle bycatch. Even though this number is already alarmingly high, it is likely

inaccurate due to lack of coverage and reliable data (Crowder, 2010). The reduction in marine bycatch is vital as the biodiversity of the marine habitats is important in the ecological stability of the ecosystem. For instance, the Gulf is home to five sea turtle species, all of which are critically endangered. In addition, the Western Gulf of Mexico is the only location in the world that the Kemp's Ridley Sea turtle nests.

Due to the high population of humans that live along the Gulf Coast, human actions have an immediate and direct impact on the marine ecosystems. For instance, the BP oil spill of April 2010, the largest accidental oil spill in history, had major consequences on the marine life and ecosystems that it impacted. Oil flowed for three months from the damaged rig, releasing approximately 4.9 million barrels of crude oil into the sea. Over 6,800 dead animals had been collected (Raines, 2010). In order to combat the impact of such an ecological disaster, the national government closed the Gulf of Mexico from fishing activities for several months during the spring and summer following the spill. This simple act of closure resulted in an enormous increase in fish stocks and populations which were not expected after such an event. Scientists have calculated a "roughly threefold increase in what nets captured after the spill compared to before" and this increase is being seen across a wide range of species from the targeted for fishing such as shrimp and menhaden to other species that the fishing industry severely impacts such as large sharks and sea turtle populations (Raines, 2010).

The Gulf of Mexico's commercial fishing industry is managed under the Gulf of Mexico Management Council whose basis for policies derives from the Gulf of Mexico Management Plans. Currently, one of the major issues concerning the management of this region is the lack of scientific-based policies. According to the NOAA, there are 42 managed reef species, and approximately 75 percent of these species lack sufficient data to determine if these populations

are being caught at sustainable rates or whether these species are subject to overfishing. In order to create management policies that are based on scientific data, more funding is needed to improve fishery monitoring, observation and stock assessments.

Comparison

The fisheries of New England, Alaska, and the Gulf of Mexico are unique and rely upon different factors to sustain and maintain their industries. The biological, economic, and political data collected offer insight as to these specific differences and how to determine the steps that need to be taken in order to facilitate the growth of a sustainable program in the Gulf of Mexico. Although these fisheries experience important similarities, it is the differences that provide the most useful information when creating a new policy recommendation. In this research, in order to best analyze the data, I directly compare these three regions to discover the missing pieces that exist among the industries.

Biological Data

One of the central elements to consider in the assessment of the health of a region's ecosystem, as well as in policy-making decisions, is the biological data of these fisheries. This includes the targeted species, stock assessments, total catch by fishermen, and the historical levels of fishing in a region. This allows for a direct comparison to indicate the level and impact of commercial fishing practices on these marine habitats. This scientific research is coupled with the political process as it is important in the stock assessment in order to create appropriate policies and decisions regarding the management involved.

Targeted Species by Region

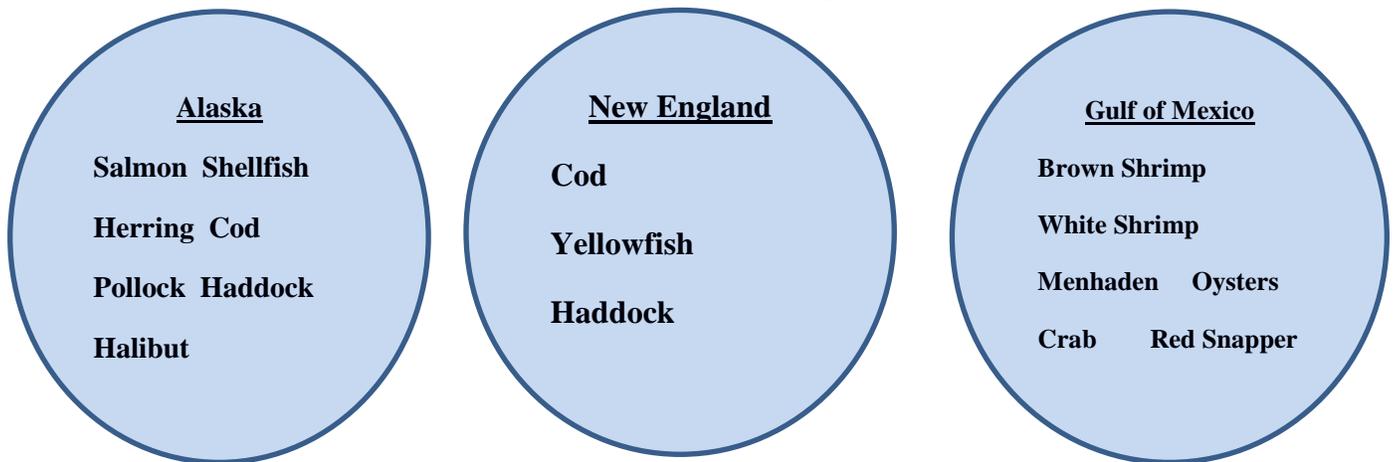


Figure 1: Key fish species targeted by each industry

Figure one depicts the fish species that these industries rely upon most heavily for the vitality of their industries. The species are important to consider as this determines the kinds of gear utilized for harvest and the amount of potential damage to the marine habitats due to the particular levels of the oceans that these species inhabit such as benthic or pelagic dwelling species. For instance, groundfish industries are more environmentally damaging than salmon fishing as the groundfish industry requires more invasive harvesting techniques such as bottom-trawling. By examining this figure, it is apparent that the species targeted have very little overlap between industry indicating that competition does not exist between these fisheries. Additionally, policies and management technique will differ due to gear differences. However, these policies will remain similar despite variances in targeted species as the policies will need to consider ecosystem-based regulations to maintain conservative efforts.

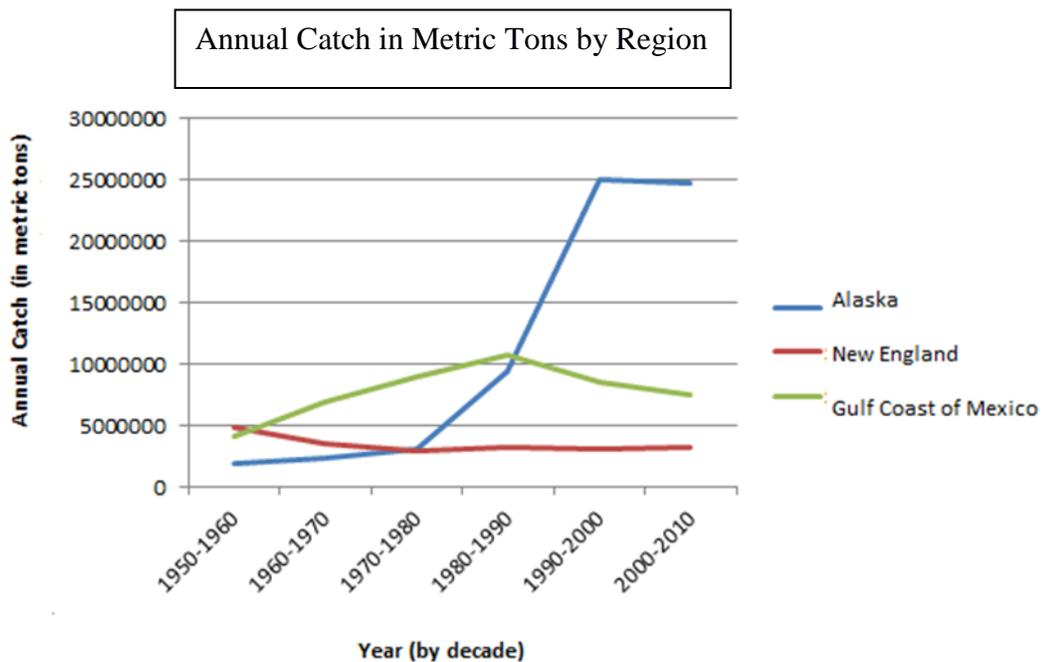


Figure 2: Annual catch in metric tons from 1950-2010 for the Alaska, New England, and Gulf of Mexico fishing industries

Figure two depicts the annual amount of catch for each region from 1950 until 2010. This figure allows scientists to observe the long-term impacts and effects of overexploitation and overfishing on the level of catch. Through this data, scientists can observe the growth or decline in catch and can then determine the possible reasons behind these changes. This graph depicts the strength and vitality of the Alaskan fishing industry, as it illustrates the near collapse that the industry faced in the late twentieth century, and the rapid growth in annual catch following implementing these policies even though the regulations are far more restrictive than any other fishing industry. It is interesting to note that although fishing techniques are becoming increasingly efficient and productivity should be at an all time high for fishermen, both the

industries of New England and the Gulf of Mexico are experiencing declines in catch levels. Although other factors may be at play, this could be the cause of these industries overfishing and creating a collapse in the ecosystem leading to a less productive industry. Therefore, by creating an institution that is sustainable and promotes conservative yields, this is actually a benefit to industries as this will increase long-run catch levels as stocks are brought back to the levels that are recommended by scientists in the field.

The collection of biological data is the basis for any industry that is to be run on a sustainable level that is based on science rather than political agendas or profit maximization. It provides unbiased information that can be used to create policies that are beneficial to the people that are involved in the fishing industry as well as the ecosystems that are impacted by these enterprises.

Economic data

Although it is important to consider the health of the ecosystem when creating policies for fishery management and practices, there are many individuals and communities who rely upon these industries for their livelihood and economic wellbeing. Today, many fishermen are losing out due to the strict catch limits imposed by regional management councils. There are simply too many fishermen to maintain sustainable catch limits while retaining a decent level of profits for all involved in the industry. Economic data also has the ability to provide further insight into the importance of these marine resources in the economies of each region.

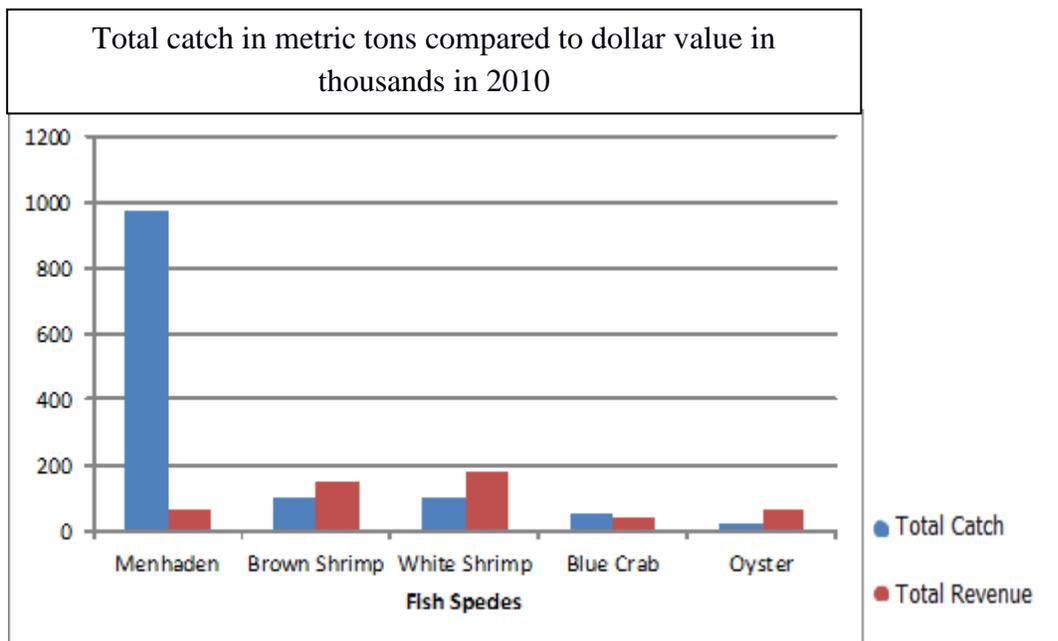


Figure 3: Total catch in both metric tons and dollars for the five largest fish species in the Gulf of Mexico in 2010

Figure three illustrates the total catch of the top five targeted species in the Gulf of Mexico as compared to respective dollar value of the catch. This indicates that the value of a species is not dependent on catch levels. For instance, menhaden generated a larger revenue than the other five species combined, yet, the total catch was approximately half that of white or brown shrimp. This suggests that in order to maximize profits, fishermen will utilize harvesting techniques to increase the efficiency and productivity of the menhaden industry.

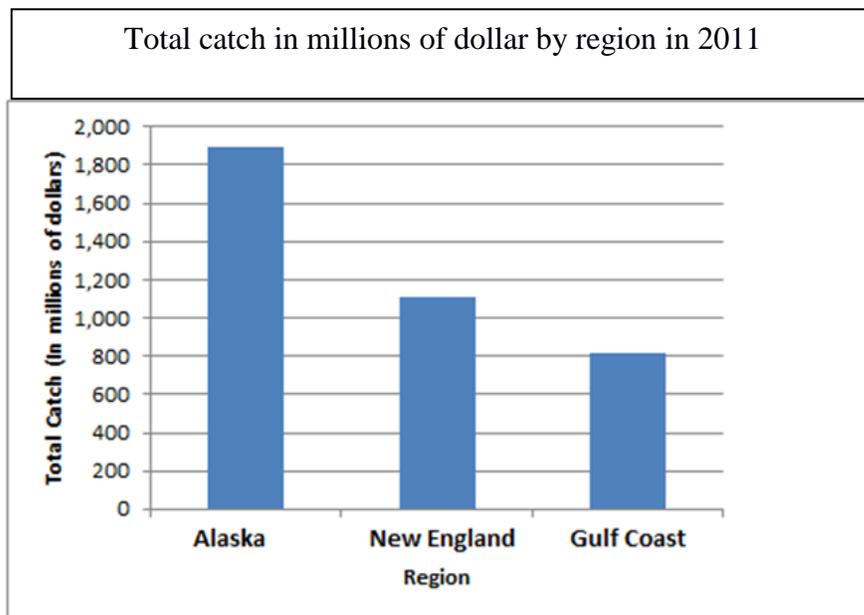


Figure 4: Total catch based on revenue generated in Alaska, New England, and the Gulf Coast in 2011

Figure four illustrates the total catch of fish in terms of dollar values for each region in the year 2011. It clearly demonstrates the strong vitality of the Alaska industry and the decreasing revenue for both New England and the Gulf Coast. In Alaska, because natural resources are so important to the national economy, the government has placed an emphasis on sustainability in all industries within the state. Fishing is a huge source of revenue and it cannot afford the threat of a collapse that is such a major concern in the New England groundfish industry.

Although the revenues generated by the New England and Gulf of Mexico fisheries are not as high as Alaska, this does not indicate that these revenues are not as important to the economy of the region. Rather, the revenue generated is similar to the rates of annual catch in each region. If productivity decreases, revenue will also continue to decline. It has been suggested recently, that the federal government should provide subsidies to fishermen in New

England because they do not generate enough income from fishing to support themselves or their families. The use of government funds to allocate this aid for the fishing communities is a misuse of government money that will decrease the funds that can be allocated for increased scientific research and data collection. This also exacerbates the problem of the presence of too many vessels in operation as it eliminates the natural selection that would normally keep these factors of overfishing in check.

In order to create a proposal that is supported by a large variety of groups involved, economic health has to be considered. A successful proposal will include factors that will both conserve these natural resources while increasing revenues generated and also increase the wages received by the fishermen involved. These industries are a business and need economic incentives to adjustment their practices to become more environmentally-friendly.

Political data

Even when armed with ample biological data to establish sustainable levels of consumption and introduce less damaging practices, without the political sector, these recommendations from scientists will be ignored by management in order to maximize profit in the short-run without taking long-term environmental or economic sustainability into consideration. Politics control the policies that are established to govern these industries. The federal government regulates certain broader aspects of commercial fishing in the United States such as the Magnuson-Stevens Act, the Marine Mammal Protection Act, and provides a source of subsidies for the fishing industry. However, the state governments and regional management councils are the key players in the majority of decision-making of fisheries. The regional councils are what dictates the management practices and policies of the fisheries in the United

States, whether by creating strict catch limits, enforcing permit systems to limit the number of fishing vessels in use, implementing marine protected areas, or allowing industries to remain unchanged in the face of increasing environmental degradation and decreasing economic profitability. It is through these state officials that policies are created. One major issue that exists within politics is a universal problem; the involvement of special interest groups in political decision-making. The elected officials in charge of rules and regulations are highly influenced by various stakeholders and special interest groups such as the fishermen themselves, lobbyists for the fishing industries, consumers, and the producers of products that rely upon a high level of yield as well as high consumption to maximize profits. The elected officials rely upon these groups for both financial support as well as political support for re-election. This indicates that policies will be implemented that do not necessarily benefit the health of the industry; rather it benefits the particular agenda of an interest group or politician.

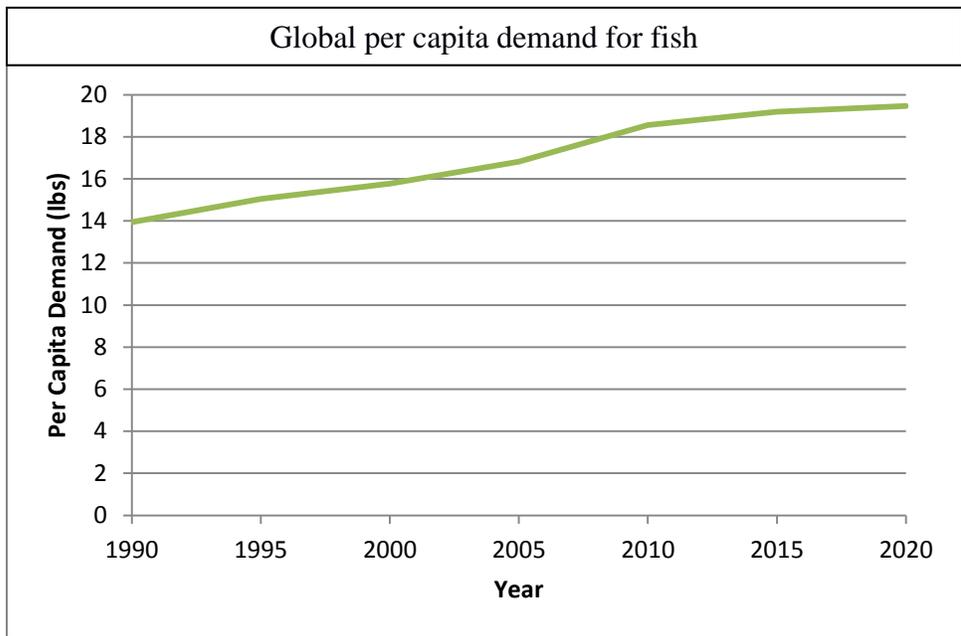


Figure 5: Per capita demand for seafood globally

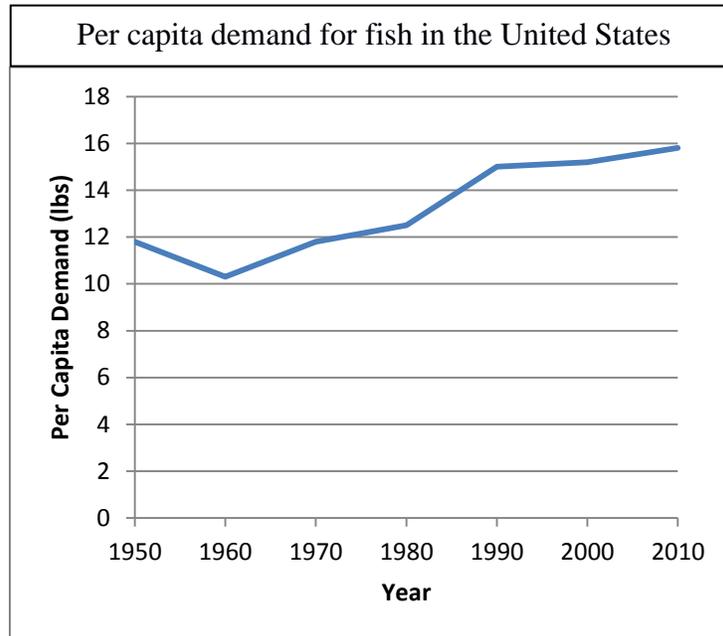


Figure 6: Per capita demand for seafood in the United States

Figures five and six illustrate the demand for fish globally and at a national level in the United States. These graphs demonstrate the increase of demand for fish. Globally, the need for fish is projected to continue to grow in the coming decade. This is expected as the global population is also rising and the fishing industry will experience a greater demand as we attempt to meet the needs of an expanding population. In the United States, demand for fish has grown steadily since the 1960s. As technology increased the amount of total catch, this allowed the supply to increase and price to decrease causing demand to rise. Per capita demand is vital as it predicts that in order to meet the need, fisheries will continue to overexploit these marine ecosystems to increase supply in the short-run. This overexploitation will eventually create shortages as fish stocks begin to collapse. Marine ecosystems are crucial in feeding the global population and this increase in demand indicates sustainable industries are necessary to maintaining high catch levels.

Although Alaska, New England, and the Gulf Coast are subjected to various stakeholder groups and political platforms, these regions have the same basic structure that governs the programs. Each location is controlled under various regional fishery management councils established through the Magnuson-Stevens Act comprised of a council, and overseeing committee, and both a planning team and advisory board. It is through these management councils that plans are created which then have to be approved and implemented by the NOAA fisheries service. Nonetheless, although this is the basic structure of policy and management implementation, it is the social differences of the regions that cause the variances between councils.

Discussion

Although it is necessary to review and research the data within separate categories in order to better organize and process the information, these factors are, in fact, highly connected and intertwined with one another. The New England groundfish industry, the fisheries of Alaska, and the industry in the Gulf of Mexico are unique with highly different variables to consider when constructing policies that will best fit the respective regions. For instance, the sustainable programs set up by the government of Alaska, while extremely effective and successful, are difficult to introduce and replicate into areas of higher development which are more difficult to regulate and control. When looking at the biological, economic, and political factors that exist between each industry, it is vital to evaluate the differences and how these differences can affect the various methods of creating a sustainable industry.

In Alaska, the issue of overfishing has been managed by effectively addressing the root cause of the problem: too many fishermen. This solution has been achieved with the use of a

permit system. This is in sharp contrast with the industries of New England, as there are far less restrictions on the amount of fishing vessels in use. Instead, the New England Fishery Management Council sets strict quota limits on the amount of catch for each vessel, but does not limit the amount of vessels, leading to overfishing in an area even when catch limits are in effect. This is due to several dynamics involved such as the fact that the New England industry is well-established and many of the fishermen have a long history in the business. There is simply a higher number of people and higher development in the Georges Bank area, making it harder to both regulate and control than the smaller population of Alaska. New England is more affected by the unemployment that is impacting the United States, and politicians are less willing to promote measures that will potentially increase the unemployment rate in a state as there are few employment alternatives for fishermen. The Gulf of Mexico is facing similar issues as the fishing industry supports a large number of coastal communities that exist within this area spanning five separate states.

These variations between regions are extremely important to consider. Although creating a program directly based off of that of the Alaskan industry at first appears ideal, it is not feasible due to these differences. Therefore, by using these successful techniques as a model and drawing from the similar and more transferable experiences of the New England industry, it is in this way that we can construct a plan of action that effectively target these issues in the Gulf of Mexico.

Key findings

When researching the data for each individual industry, there were several areas that became apparent as important factors to address when creating a policy for the Gulf of Mexico. After reviewing the success and failures that have been observed throughout the history of the

well-established industries of New England and Alaska that continue today, I have identified three key findings involving the management techniques, practices, and policies that can most effectively and efficiently help lead the Gulf Coast to a more sustainable and healthy future.

Management

In the cases of Alaska and New England, there is ample scientific data and research concerning stock levels and the health of the ecosystem. This data collection is vital in order to set appropriate catch limits and quotas as well as for establishing and maintaining marine protected areas. Science needs to be directly involved in the policy-making process in order for success to be achieved. In Alaska, management techniques are centered on ecosystem-based approaches and are driven by science. In the history of New England, this has not been the case as the collapse of the cod industry in the 1990s reflects the management's refusal to consider the warnings of the scientific community who cautioned against the severe overfishing that was observed. Today, fishermen in New England have come to realize the importance of such scientific recommendations when creating sustainable catch limits. There has even been a recent push towards gathering more scientific data despite the already strong presence of data and studies being conducted with the groundfish industry to discover the most appropriate plan of action. In my research, I found abundant scientific assessment and information for both Alaskan and New England biological factors. However, there was little scientific data concerning the biological assessments of the ecosystem in the Gulf of Mexico in comparison. The majority of research I did find concerning the Gulf Coast was conducted following the BP oil spill in April 2011 specifically to obtain the impact of this oil spill on the environment. This indicates that science is not an as significant an indicator for these policy-decisions as in other industries, and

rather than an ecosystem-based management system, it is centered on economic profitability. Due to this lack of such vital indicators, the Gulf of Mexico has ignored the telling signs of environmental degradation that is associated with overexploitation in commercial fishing practices. Increasing the volume of data concerning stock assessments and the health of the ecosystem as a whole is necessary for a solid base to build a sustainable industry.

Practices

Another key difference between the management of Alaska and New England and that of the Gulf is that of the general practices involved. The gears and techniques utilized by fishermen in these industries greatly impact the overall health of the region. For instance, Alaska has enforced strict limits on the use of trawling vessels. In many cases in Alaska, rather than using the highly damaging method of bottom-trawling, fishermen use their trawling nets at a pelagic level thereby increasing control while minimizing damage to benthic habitats. On addition, this practice also reduces the incidence of bycatch strengthening the overall condition of the marine habitats involved. Groundfish are the most common species to harvest using this method of trawling nets, as well as shellfish and shrimp, and New England has yet to establish such limits. This can be witnessed in their inability to maintain healthy cod stocks despite stronger catch limits based on scientific recommendation.



Figure 7: Impact of trawling vessels Louisiana, Gulf of Mexico

Figure seven shows the damaging effects of trawling on the ocean floor as it depicts a shrimp trawler off the coast of Louisiana. This image captures the direct disturbances caused by these vessels to benthic habitats as you can clearly see the bottom soils churned up and visible from the surface waters. This mud can negatively harm fish health and result in algal blooms furthering the already present concern of dead zones in the Gulf. The trawling industry is the largest in the Gulf of Mexico as bottom-trawling is used in large numbers and is key to the industries short-term profitability. However, as seen in New England, this is not sustainable as trawling creates a high risk of fishery collapses as it is the cause of both the overexploitation of species as well as damaging to the ocean's benthic habitats which impacts the ecosystem as a whole by further exacerbating the risk of collapse.

Policies

Both the management and common practices of these regions are the basis of policy differences of the respective industries. The particular management techniques, whether ecosystem based or geared toward economic profitability, and the prevalence of certain harvesting practices create the foundation for policy design. These factors dictate the support and popularity of certain policies that are available to be implemented.

In Alaska, the policies in operation focus on maintaining the strength of the industry into the future. This is achieved by using a strict permit system that is carefully monitored and regulated, as well as through the implementation of a quota system, and through large zones of marine protected areas (MPAs) in order to minimize or avoid the damaging impacts of commercial fishing on marine habitats. All of these have led to a strong industry that is both environmentally sustainable as well as one of the most economically profitable industries in the world.

New England has enacted several of these techniques on a smaller level. Although there is only minimal regulation on the amount of vessels that are in operations, catch limits have been implemented and continually assessed to ensure that an appropriate catch level is sustained. This is coupled with the use of MPAs to restore the environments to promote the growth in stocks. The fact that both quotas and MPAs have been implemented yet species such as cod have still not reached healthy stock levels indicates that the major issue facing the overexploitation of fisheries is the sheer number of fishing vessels in operation.

The Gulf of Mexico does have catch limits set to promote sustainable yields; however, the use of MPAs is limited as well as the lack of restrictions on number of fishing vessels and fishing gears used. The policies that govern regional fisheries are based on the recommendations

of policy-makers and are strongly influenced by majority opinions. Without the desire to become more sustainable, the necessary policies will not be employed.

Section III

Policy Recommendation

When beginning to restructure an already established industry into a more conservation-focused enterprise, it is necessary to consider the appropriate procedures to make the transition smooth and successful while minimizing short-term economic loss for the individuals involved. However, although there will be some economic loss in the short-run from shifting the fishing industries of the Gulf of Mexico to more sustainable policies and practices, in the long-run, these minute economic losses will turn into increased job security and a more steady industry as the fish stocks become stabilized and the ecosystems return to a state of equilibrium. In this section, based on the data discussed in the key findings, I will propose a plan of action that the fisheries of the Gulf of Mexico can implement that may serve as an effective means of driving the industry towards a more ecosystem based approach established on scientific studies and data concerning various practices that will aid in the long-term conservation of the regions important natural resources, and successful policy implementation from the fishing industries in the United States that are currently pursuing similar goals of sustainability.

Proposal for the Gulf of Mexico

Management

A continual monitoring of the impacts on the ecosystem is vital in order to ensure the health and preservation of the ecosystems impacted by the fishing industry. To achieve this goal,

a greater funding needs to be allocated for scientific research and studies to be conducted throughout the Gulf Coast. Studies and data collection should be conducted on a regular basis to monitor the various stock levels of species in the Gulf. This includes targeted species for commercial purposes as well as non-commercial species such as sea turtles and shark populations. This will allow scientists to construct appropriate levels of catch that will benefit both the fishermen as well as the ecosystem as a whole. These studies will ensure that sustainable levels of catch are maintained to restore these damaged ecosystems back to equilibrium. The funding for such research should be given to scientists who have no affiliation to a particular interest or stakeholder group whose research may be biased towards a particular conclusion. For instance, the minimal stock assessments that are currently undertaken in the Gulf are funded by oil companies or other special interest groups who need healthy assessments in order to promote their businesses and avoid possible limitations that will be imposed to increase the health of these habitats. Rather, scientists with unbiased interests are needed to best provide the most appropriate recommendations regardless of economic factors. These findings need to be taken into consideration by regional councils and state governments.

Practices:

Following the technological advancements that made the oceans and its natural resources more easily accessible to human beings, overexploitation problems began to occur. Although techniques such as trawling greatly increase the productivity and efficiency of a fisherman's efforts in the short-run, this same practice leads to the volatile and uncertain future that encompasses the industry. In order to reduce human impact on marine ecosystems, it is necessary to reduce destructive habits such as trawling by creating trawling lanes or only using

pelagic trawling nets as to minimize the impacts on the benthic habitats that are so vital to the overall health and productivity of the ecosystem. Trawling lanes are a practice that restricts the use of trawling ships to certain designated areas to further minimize its negative impact on benthic habitats.

Other harmful practices that lead to the increased incidence of bycatch can be avoided as well through the use of safe gears such as larger mesh nets and turtle excluder devices which allow non-targeted marine animals to escape without harm, significantly reducing the mortality rate of these marine creatures. Marine ecosystems are intertwined and can be subject to collapse if all factors are not considered. High amounts of bycatch can impact other aspects of ecosystem health by reducing populations of keystone species and damaging productivity levels necessary to maintain healthy stock populations.

The numerous practices that fishermen employ have major consequences on the productivity of their industry. In the Gulf of Mexico, a system of restricted use of trawling vessels through trawling lanes and pelagic trawling nets will allow fishermen to continue harvesting the targeted species that are reaped with trawling gears, maintaining economic success, while also decreasing the damage done to these marine habitats which ensures the continued health and future success of the industry.

By providing incentive such as tax deductions, or offering other monetary compensation for these fishermen to change simple measures such as adding turtle excluder devices and using mesh nets with larger holes, it will greatly improve the environmental degradation that is so prevalent in the region.

Policies

It is not enough to incorporate sustainable measures such as increasing scientific assessments or shifting practice techniques without also addressing the underlying issues of unsustainability, such as overcapacity and overexploitation of marine resources. Although such policies such as MPAs have the potential to allow fish populations and habitats within and around the reserve to recover, if conservative catch limits and permit systems are not imposed, the surrounding areas will fail to provide any long-term sustainability or security to the fishing industry as it continues to maximize the short-term profitability of harvest levels that are set above scientific recommendation.

To ensure that the fisheries comply by these ecosystems-based approaches, limits on the amount of catch and harvest levels is an important component. This will require that fishing management work more closely with scientists. In order to maintain Annual Catch Limits (ACLs) and Individual Quotas (IQs) that remain below sustainable levels, an increase in the rate and amount of fish assessments and data collecting is necessary

On the implementation level, it is important to involve the communities that rely heavily upon the fishing industry to participate in policy-making decisions rather than relying on inputs by special interest groups whose interest is not necessarily in the well-being of these fishing communities. This will give the individuals a higher sense of responsibility and accountability as they have more control over their livelihood. This will also encourage fishermen to comply by regulations and utilize safer practices as they have more responsibility over maintaining a healthy stock for long-term sustainability.

Overfishing is largely due to a large volume of fishing vessels in operation. This particular problem can only effectively be eradicated in one way: by reducing the amount of

fishermen in a region by introducing a strong permit system. In order for this particular program to be effectively implemented, the government needs to also introduce programs to aid fishermen in finding alternative means of livelihood or provide monetary compensation through a vessel and gear buyback program to those close to retirement. This program can replace the subsidies provided to fishing industries that currently have too many fishermen who are unable to maintain a comfortable lifestyle due to increased competition with the rise in catch limits. With a permit system, only a sustainable number of vessels will be allowed in operation which will eradicate the need for such government aid, which can then be utilized in the short-run to provide for the fishermen who have been pushed out of the industry. By reducing the number of fishermen involved, individual profits will begin to increase as catch limits and quotas will be divided and shared between smaller amounts of vessels in operation. In the long-run, these programs will become less necessary, cutting government costs even further.

Marine Protected Area's

An important practice that is currently being utilized in both the waters surrounding Alaska's fisheries as well as off the shores of the New England coastline to allow fish stocks to rehabilitate and stabilize is Marine Protected Areas. In the Gulf of Mexico in particular, the utilization of MPAs has the potential to dramatically improve the health of the ecosystem as a whole. Due to the fishing closures following the catastrophic oil spill, we have witnessed the amazing ability of the marine habitats to regenerate when given protection from the overexploitation of human interaction including fishing practices. In order to continue to maintain economic profitability, the use of MPAs will need to be based on scientific findings and data in order to most efficiently create reserves as to both aid in the protection of the natural

resources while minimizing the economic impact on the fishing industry and the communities it supports throughout the Gulf. By using scientific research and data, the use of MPAs can create positive economic outcomes by increasing the productivity of the surrounding areas

Conclusion

As of today, the majority of the world's fisheries are either overexploited or in serious threat of overexploitation. By examining the historical context of fishing and the current status of its impact on the environment, we can begin to understand the necessary steps to take in order to minimize the damaging affects it has on the health of the planet. By comparing industries that have either reached sustainable practices or are striving for sustainability, such as in the cases of Alaska and New England, we can apply these findings along with careful examination of the factors that are the biggest players in the Gulf of Mexico to create a more contextualized plan of action for a sustainable industry. Although the conservation efforts of one region appear to have little impact on a global scale, these changes will lead to the further expansion of industries concerned with environmental health and long-term preservation.

Through this research, we can generate an increased understanding of the current status of fisheries and what steps must be undertaken to achieve sustainability in the fisheries of the United States. Although topics such as climate change and environmental conservation continue to remain a controversial subject to the American people, it is one that is essential to our continued success as a nation. Our natural resources are an integral aspect of our economy and well-being of our citizens and need to be protected. The solutions that have been outlined through this study have the potential to aid in the recovery of the ecosystems involved, as well as support the well-being of a region highly dependent on its waters for economic prosperity.

Areas of Further Research

In order to continue to create industries to promote sustainable practices in the existing framework of our society today, further and more extensive research needs to be conducted into this broad field of study. Despite vast knowledge and scientific data concerning how depletion of the planet's natural resources is impacting planetary systems, this data is not always taken into consideration by policy-makers. Studies in how these changes will affect human populations are also necessary as is making this information more accessible to the general public. By generating public interest and popularity in these issues, the support will lead to further funding and bring these ideas into the forefront of the political agenda. According to economic theories, humans are driven by incentives, and without appealing to communities, nothing will change until it is too late.

Although local changes are the basis for creating larger modifications, research concerning global fishing industries is also essential. These changes need implementation at a global level in order to provide for the demands of our growing population; therefore, this research needs to be directed in the area of sustainable practices in nations of extreme poverty. The incentives and goals in these areas are not the same as in nations such as the United States or other developed nations, and although the general goals of promoting a healthy ecosystem while maintaining the livelihoods of fishermen will be the same, the methods of implementation will need to be adjusted.

Oceans make up 70 percent of our planet's surface and are an essential player in our planetary systems. Maintaining the health and balance of these marine ecosystems are of the utmost importance in collaborating to reduce the impact and effects that human beings have inflicted to the Earth.

Bibliography

- Alaska Seafood Marketing Institute. "About the Fisheries: Harvesting Alaska Fish." AlaskaSeafood.org., accessed 2/6/2013, <http://www.alaskaseafood.org/information/fisheries/pages/harvest-whitefish.html>.
- Brown, Christopher J., Elizabeth A. Fulton, Hugh P. Possingham, and Anthony J. Richardson. 2012. "How Long can Fisheries Management Delay Action in Response to Ecosystem and Climate Change?" *Ecological Applications* 22 (1): 298-310.
- Canfield, Clarke. 2012. "New England Fishing Cuts Looming for 2013." *The Boston Globe*, August 2.
- "Catch Shares Save Commercial Fishing Jobs." Edf.org. Environmental Defense Fund, accessed 1/13/2013, <http://www.edf.org/oceans/catch-shares-save-commercial-fishing-jobs>.
- Church, Rebekah. 2011. "Arctic Bottom Trawling in Canadian Waters: Exploring the Possibilities for Legal Action Against Unsustainable Fishing." *Review of European Community & International Environmental Law* 20 (1): 11-18.
- Coleman, Felicia C. and Christopher Koenig C. 2010. "The Effects of Fishing, Climate Change, and Other Anthropogenic Disturbances on Red Grouper and Other Reef Fishes in the Gulf of Mexico." *Integrative and Comparative Biology* 50 (2): 201-212.
- Cook, Gareth and Beth Daley. 2003. "A Once Great Industry on the Brink: After Tough Choices Avoided, Future Bleak." *The Boston Globe*, October 26, 2003.
- Cooper, Mary H. "Threatened Fisheries." *CQ Researcher* 12 (27): 617-648.
- Fisheries and Aquaculture Department. "Fisheries and Aquaculture." FAO.org. Food and Agriculture Organization of the United Nations, accessed 10/25/2012, 2012, <http://www.fao.org/fishery/en>.
- "Fisheries." OECD.org. Organisation for Economic Cooperation and Development, accessed 10/28/2012, <http://www.oecd.org/agriculture/fisheries/>.
- Gell, Fiona R. and Callum M. Roberts. 2003. "Benefits Beyond Boundaries: The Fishery Effects of Marine Reserves " *Trends in Ecology & Evolution* 18 (9): 448-455.
- Gezelius, Stig S. and Jesper Raakjaer. 2008. "Making Fisheries Management Work; the Problem of Implementing Policies for Sustainable Fishing." Vol. 8. New York, NY: Springer.

- Godfray, H. Charles J., John R. Beddington, Ian R. Crute, Lawrence Haddad, David Lawrence, James F. Muir, Jules Pretty, Sherman Robinson, Sandy M. Thomas, and Camilla Toulmin. 2010. "Food Security: The Challenge of Feeding 9 Billion People." *Science* 327 (5967): 812-818.
- Greboval, Dominique and Sean Pascoe. 2004. "Overcoming Factors of Unsustainability and Overexploitation in Fisheries: Selected Papers on Issues and Approaches." FAO, Japan Government Cooperative Program.
- Gulf of Mexico Program Office. "General Facts about the Gulf of Mexico." Epa.gov. United States Environmental Protection Agency, last modified October 26, accessed 1/13/2013, <http://www.epa.gov/gmpo/about/facts.html#tourism>.
- Hardin, Garrett. 1968. The Tragedy of the Commons. *Science* 162.
- Hesselgrave, Taylor, Sarah Kruse, and Kristen A. Sheeran. 2011. "The Hidden Cost of Overfishing to Commercial Fishermen: A 2009 Snapshot of Lost Revenue." Portland, OR: Ecotrust.
- Hiddink, Jan G., Andrew F. Johnson, Rachel Kingham, and Hilmar Hinz. 2011. "Could our Fisheries be More Productive? Indirect Negative Effects of Bottom Trawl Fisheries on Fish Condition " *Journal of Applied Ecology* 48 (6): 1441-1449.
- Jackson, Jeremy B. C., Michael X. Kirby, Wolfgang H. Berger, Karen A. Bjorndal, Louis W. Botsford, Bruce J. Bourque, Roger H. Bradbury, et al. 2001. "Historical Overfishing and the Recent Collapse of Coastal Ecosystems " *Science* 27 293 (5530): 629-637.
- Kubasek, Nancy and Gary Silverman. 2010. 7th ed. New Jersey, USA: Prentice Hall, Inc.
- Layzer, Judith A. 2002. *The Environmental Case: Translating Values into Policy* Cq Press.
- Litsinger, Emilie. 2011. "108 New England Fishermen Stand Up for Sector Management." Environmental Defense Fund. Edf.org. <<http://blogs.edf.org/edfish/2011/11/15/108ne-fishermen-stand-up-for-sector-management/>>.
- Lubchenko, Jane. 2011. "New England Groundfish Management Testimony." Boston, MA: National Oceanic and Atmospheric Administration.
- McClanahan, Tim and Juan Carlos Castilla, eds. 2007. *Fisheries Management: Progress Toward Sustainability*. Oxford, UK: Blackwell Publishing Ltd.
- National Ocean Services, NOAA. 2011. "The Gulf of Mexico at a Glance: A Second Glance." Washington, D.C.: U.S. Department of Commerce.

- National Oceanic and Atmospheric Administration. "NOAA Fisheries." NOAA.gov. United States Department of Commerce, accessed 1/10/2013, , <http://www.nmfs.noaa.gov/>.
- Ommer, Rosemary E., R. Ian Perry, Keven Cochrane, and Philippe Cury, eds. 2011. *World Fisheries: A Social-Ecological Analysis*. Fish and Aquatic Resources Series. Vol. 14. Oxford, UK: Wiley-Blackwell Publishing Ltd.
- Ostrom, Elinor. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge, U.K.: Cambridge University Press.
- Pauly, Daniel and Kyle Van Houtan. 2004. *Research on Fishing Trawler Mudtrails*.
- Perry, Wynne. 2012. "Gulf 'Dead Zone' Size in 2012 is A Point of Debate for Scientists " *Huffington Post*, 6/22/12.
- Raines, Ben. 2010. "Researcher: Fish Numbers Triple After Oil Spill Fishing Closures." *Alabama News*.
- "Restoring the Gulf of Mexico: A Framework for Ecosystem Restoration in the Gulf of Mexico." 2011. New Orleans, LA: Ocean Conservancy.
- Rosenthal, Elizabeth. 2012. "Tests Call Mislabeled Fish a Widespread Problem." *The New York Times*, December 11.
- Sharp, Renee and U. Rashid Sumaila. 2009. "Quantification of U.S. Marine Subsidies." *North American Journal of Fisheries Management* 29: 18-19-32.
- Shotton, Ross. 2000. "Use of Property Rights in Fisheries Management." Fremantle, Western Australia, FAO Fisheries Department, 11-19 November 1999.
- Sutinen, J. G. "Major Challenges for Fishery Policy Reform: A Political Economy Perspective", *OECD Food, Agriculture and Fisheries Papers*, No. 8. 2008. OECD Publishing.
- "Toward Sustainable Fisheries." 2007. *Science* 316 (55832): 1665.
- United States Government Accountability Office. 2008. "National Marine Fisheries Service: Improvements are Needed in the Federal Process used to Protect Marine Mammals from Commercial Fishing." Washington, D.C.: General Accounting Office.
- Wells, R. J. D., James H. Cowan Jr., Patterson, William F., I, II, and Carl J. Walters. 2008. "Effect of Trawling on Juvenile Red Snapper (*Lutjanus Campechanus*) Habitat Selection and Life History Parameters." *Canadian Journal of Fisheries & Aquatic Sciences* 65 (11).
- Wielgus, Jeffrey, Enric Sala, and Leah R. Gerber. 2008. "Assessing the Ecological and Economic Benefits of a no-Take Marine Reserve." *Ecological Economics* 67 (1): 32-40.

Williams, Margot; Zwerdling, Daniel “For A Florida Fishery, 'Sustainable' Success After Complex Process.” Under the Label: Sustainable Seafood. NPR. National Public Radio. Web. 11 February 2013. <http://www.npr.org/2013/02/12/171376575/for-a-florida-fishery-sustainable-success-after-complex-process>

“World Resources 2008; Roots of Resilience- Growing the Wealth of the Poor.” 2008. Washington, D.C.: World Resources Institute; United Nations Development Program; United Nations Environmental Program; World Bank.