A STUDY OF THE SUSTAINABLITIY OF WILD CAPTURE SALMON IN THE PACIFIC NORTHWEST.

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Research Proposal

I propose for my senior project to look at the commercial salmon fishing industries ability to be sustainable. I would begin by describing the two facets of the salmon industry, wild caught and farmed produced. Examination of fishery locations and fishing grounds along with the type of equipment and method being used would fall under this category. For example an in-depth look at the three ways to capture wild salmon commercially: seine, gillnet and troll. Also the type of fisheries used tank or enclosure. I would then look the amount of salmon that can be produced with these methods. I would then evaluate these practices for sustainability. I will be using Fishwise definition of sustainability to evaluate the practices in use today. That definition states that sustainable seafood production practices enhance the health of ocean ecosystems while satisfying the consumer demand for the product at an economically feasible price. Finally I will examine future practices that are being tested and or are attempting to be implemented to see if they may lead to a sustainable industry. These would include new technologies, new management practices and new marketing practices.

Annotated Bibliography

Charles, Anthony. 2001. *Sustainable Fishery Systems*. Oxford: Blackwell Science LTD.

In this book the author discusses the structure of the fishing system. He then goes into the different management styles that can be applied to create sustainable fishing. In order to understand the fishing system one has to understand the three major parts. Those parts are the natural, human and management style. Once these are understood, it makes creating sustainable methods much easier. The author believes that there are three approaches that can be used in order to achieve sustainability. These approaches are Precautionary, Ecosystem and the Co-management. The author gained the knowledge to write this book over his decades of studying the interdisciplinary and systematic analysis of fisheries. The only bias that may exist is that the author believes that fisheries can achieve sustainability and still be economically viable. This book presents actual sustainability methods that can be applied to any fisheries in the entire world, which would include the salmon industry which is the focus of my senior project. If the book had contained more actually case studies showing that the methods suggested the actually worked would have made the methods seem more likely to succeed. (188 words)

Clark, Colin. 2006. *The Worldwide Crisis in Fisheries Economic Models and Human Behavior*. New York: Cambridge University Press.

This book looks at the economic models that are currently being used by the commercial fishing industry. This model is a bio economic one that combines what the ocean and with stand with what the companies need to make financial to survive. It then goes into three major areas of the economic side that the industry should change if it wants to become sustainable. These three areas are Investment, Fisheries Management and risk assessment. The author feels that changing these areas can improve sustainability of the industry. The author used his knowledge of mathematics and economics to create the models. The author source of bias would be in his mathematics as he uses only numbers to make his analysis while ignoring other factors like habitat or specie specific problems. This source is important for my senior project as it provides a way to judge the economic side of the sustainability issue. I would have liked for there to be more actual data and not just mathematical theories in the book. (170 words)

Hutchinson, Laurence. 2005. *Ecological Aquaculture: A Sustainable Solution*. East Melon: Permanent Publications.

This book gives a step by step guide to creating and maintaining an aquaculture system that is sustainable with no negative environmental impacts. It looks mainly at the freshwater systems that are important for the spawning of many species of fish sold commercially. It also offers suggestion on sustainable feed for the fish being farmed. It also addresses way in order to prevent contamination that has been a major concern

with aquaculture. The author created his own aquaculture pond in 1987 has continued to till day in order to improve its sustainability. He has also worked as a consultant for the Organic Trade Association in the USA. Bias may exist in his devotion to Aquaculture and this may lead to exaggeration of the success of some suggested methods. This book is significant as it allows for a second opinion on how to make aquaculture in sustainable and confirming other solutions that have been suggested. (153 words)

Knudsen, Eric. 2000. Managing Pacific Salmon Escapements: The Gaps between Theory and Reality. *Sustainable Fisheries Management: Pacific Salmon.* Pp. 237-272.

In this article, the author discusses the problem with the current way that escapements are set for each year. Because the life cycle of Pacific salmon is so complex, there is no real way to tell if changes in amount of fish available for harvest are the result of amount harvested the previous year, habitat or hatchery influences or just natural variation. It is important to take all of these effects into account in order to get a more accurate picture of how many salmon may be harvested while still maintaining a healthy population of salmon. The major problem is that of all escapements set each year, 82 percent rate as fair poor or worse for sustainability. The author feels that the problem is caused by the lack of data being gathered about each managed fishery. The author used literature review in order to gather all the data that was digested. Possible bias may arise due to the author's relationship with the fishing industry and wanting to make sure that it remains economical. This article is significant to my senior project, because it demonstrates one of the problems faced by the commercial salmon industry when it come to achieving sustainability and then offers solutions. (203 words)

National Research Council. 1999. *Sustaining Marine Fisheries*. Washington D.C.: National Academy Press.

In this report, the amounts of each species of fish captured is given and then compared to the amount captured each year in order to establish sustainability levels. For this report sustainability is considered to have been reached when the fishery in question has a 2% growth rate per year. It then identifies where problems for sustainability in the fishing industry are occurring and how to correct them. In order to identify the problems, the report examines them in three ways, scientific matters, management concerns, economy incentives. It then gives options in those three areas that will help in achieving sustainability. The contributors were drawn from the National Academy of Science, the National Academy of Engineering, and the institute of Medicine. The National Research Council is known for remaining objective, however failing to include economist contributors may cause the financial cost of solutions to be considered. It is significant for my senior project as it provides possible ways to reach sustainability in the commercial salmon industry. (166 words)

Pillay, T.V.R. 2003. *Aquaculture and the environment 2nd Edition*. Oxford: Blackwell Publishing Ltd.

This book looks at aquaculture practices world wide and the effect that these practices have on the environment. These effects can be positive, like the recycling of waste products from the main land or increasing the supply of endangered wild species, there are problems that have to be addressed before aquaculture can become full sustainable. The first of these problems is that the genetics of farmed fish are different from the wild ones, thus if the farmed fish escape and breed it weakens the wild species. Secondly contamination of the product is a major problem. However the author offers some solutions in order to fix the problem. The author was formerly Programme Director, Aquaculture Development and Coordination Programme, Food and Agriculture Organization of the United Nations, which is where the knowledge was gained to write this book. Possible bias may come from his work in the field of aquaculture, resulting in him gloss over some of the negative aspects in order to promote the field. This is significant for my senior project as a major portion of the Atlantic salmon industry comes from aquaculture. (184 words)

Sainsbury, John. 1996. *Commercial Fishing Methods: An Introduction to Vessels and Gears*. Oxford: Blackwell Science Ltd.

This book describes in detail all methods of capture used in commercial fishing industry in order to capture salmon. In the pacific the major commercial industries use drum purse seining, while in the Atlantic Net traps are normally used. Also describes the impact that the methods have on the ocean. Both areas have also begun to adapt long line methods to limit accidental catching of other species and minimizing environment impact. The book also describes the necessary type of boat that is need for each type of fishing. The author most likely wrote this book by gathering data from fishing industry sources and ship builders and continues to update this knowledge as new technologies are created and adopted. Author only goal is informing others about the methods and ships used by the industry, however in the introduction he does say he hopes the information will be useful to scientist and environmental groups. This book is important to my senior project because it explains how the fish are caught making it easier to understand how these methods effect the environment. Would like to have seen the actual amount of which types of vessels are used. (193 words)

Shearer, W.M. 1992. *Atlantic Salmon: Natural History, Exploitation and Future Management.* New York: The Buckland Foundation.

This book gives an overview of Atlantic salmon fisheries. IT begins by describing the life cycle of the Atlantic salmon along with the problems that this fish experiences in the wild. It then goes into the fisheries that make their living off of Atlantic salmon. Begins with a look at wild salmon fishing and then goes into the farmed Atlantic salmon. For each of the two the author discusses goes into who owns an individual fishery and how said fishery is managed. Also discuss current fishing methods and the impact that these methods have on the environment. Finally the author ends by discussing the problems facing the farmed fished industry, which includes production rates and the lack of a sustainable food supply. The author has researched Atlantic salmon for the last thirty years and used the research that was gathered during this time to write the

book. The author is biased by his personal feelings toward the fish and his wish that no Salmon were harvested at all. It is significant for my senior project as it gives a good overview of the Atlantic salmon industry and its current practices. I feel that further data on the ownership should have been extended beyond the government's official response. (207 words)

Taylor III, Joseph. 1999. *Making Salmon: An Environmental History of the Northwest Fisheries Crisis.* University of Washington Press.

This book gives a complete historical overview of the environmental crisis that Pacific Salmon have faced. The problems faced by pacific salmon are guite different than those faced by Atlantic salmon as they are a completely different species. The salmon have a very complex life cycle that small changes can effect quite drastically. Another major problem is that instead of looking for solutions many different groups just blame the other. For example when the amount of salmon in the rivers started to decrease do to environmental reasons different commercial fishermen started turf wars with each other while saying the others where over fishing their quotas. Billions have been invested to save the salmon and it is not working. The author went to historical record, governmental report and local antidotal stories to come to his conclusions. The only bias is that the author feels that the solution is a difficult one and that all parties involved play an important part in the solution. This is significant as it gives an account of all the solutions solved so far in order to make pacific salmon fishing sustainable and the results of each different policy. The author's argument could have been made stronger if a solution that had been considered a solution was dissected and its failures shown instead of just focusing on the complete failure. (223 words)

Ulmer, Fran. 2000. The Elements of Alaska's Sustainable Fisheries. *Sustainable Fisheries Management: Pacific Salmon*. Pp. 63-66.

In this article, the author discusses the elements that have created Alaska's ability to have sustainable fisheries. Since becoming a state in 1959 Alaska has focused many resources on conserving and managing its salmon stocks. The most important policy that has been implemented is sustained yield managements. This has been effect and is made more successful when paired with programs like habitat protection, separation of allocation and conservation decisions and by gaining the support of all that depend on these resources. The authors knowledge of the subject comes from his time spent as lieutenant governor of Alaska. This is also his bias as his political career is helped by these ideas and policies succeeding, which means that the author may not want to reveal things that did not work. This article is significant for my Senior Project because Alaska has one of the largest commercial salmon fishing industries and looking at how Alaska is able to achieve sustainability will allow for solutions for the other fisheries around the world. (169 words)

Outline for Senior Project

Introduction Definition of key terms Sustainability Pacific Salmon Alaska Salmon Fishery Pacific: Alaska, Northwest Aquaculture Harvest By catch Incidental catch Commercial fishing industry Pacific Salmon industry Wild Caught Pacific Salmon(non Alaska) not sustainable Economics of industry Size, numbers of employed, amount sold Gear used by industry Types of Fishing equipment Trawl, line, etc Types of Ships Used Size, Fuel The Catch Size of Total Catch yearly Specifics looked for in individual fish Size, health, color Management Techniques Limits on catch size Limits on fishery allowed to be harvested Enforcement of set limits Economic effects on management Controlling environmental factors Sustainability Are Current Practices sustainable? Positive Negative New Ideas now being implemented Negatives New Ideas now being implemented Alaskan wild caught salmon sustainable but has issue Aquaculture salmon savior of industry but has some major issues

Economics of Aquaculture

Size, number of employees, amounts sold Types of Aquaculture **Net Fisheries** Locations, Yields, Health of Fish produced Equipment Used **Pond Fisheries** Locations, Yields, Health of fish produced Equipment used Environmental Impacts of Aquaculture Change in stream flow Creation of waste materials Management techniques Checks on environmental impacts Limits on size of individual fisheries Economic effect on management Sustainability Are current Practices Sustainable? Pros Cons New Ideas being implemented

Conclusion

Introduction

The focus of this paper is to evaluate the commercial salmon industry's ability to produce sustainable salmon harvests. In a 60 minutes report, it was reported that all wild salmon in the Northwest Pacific were going extinct (CBS). At the same time, sales of Salmon products, whole, fillet and smoked have climbed to 87 percent of the total world wide retail seafood market (Seagram). These two facts can not mutually exist. If the commercial Salmon fishing industry is going to continue to exist, it needs to focus on creating a sustainable product.

The commercial fishing industry is made up of two major segments. The largest segment is the commercial aquiculture salmon industry, also known as farmed Salmon. Aquaculture involves keeping the salmon in an enclosed area and raising them from an egg to market value and then harvesting them. The practice of Aquaculture is mainly used in the Atlantic, from Scotland across the Atlantic to Canada and Chile in South America, but it has also started to spread also to the pacific, especially in the Pacific Northwest. While it has been hailed a sustainable solution, it does have problems as aquaculture has been linked to fish health problems, non renewable feed supply, environmental effects and passing of disease along to humans. Due to these supposed problems some retailers have made a decision to no longer sale or use farmed salmon products. This has created a drive to make improvements to the processes. These improvements have include such things as new filtration devices to improve fish health, a focus on genetics of breeding to improve fish quality, a search for a new food source and improve testing to cut down or eliminate the passage of harmful bacteria from the fish to the humans.

The second segment of the commercial salmon industry is Capture Salmon, also known as wild Salmon. Wild Salmon fishing involves going out with a single vessel and using different kinds of nets and line fishing techniques to capture the salmon. The industry is mainly found in the Pacific Ocean in and around Alaska and extending down to the Pacific Northwest of the United States. It is believed that Wild Salmon is a non stainable resource as the fisheries have been over fished and wild breeding grounds have been damaged beyond repair. However, Alaska makes the claim that its wild fisheries are sustainable and the practices that they use could work in all wild fishing sustainable (Ulmer, 2000). These practices include limiting size of fishing grounds, limiting number of vessels fishing; creating guidelines on what size fish are acceptable for capture. Ulmer also believes that the effectiveness of said practices is due to Alaska's tough enforcement of said laws (2000). Other suggestions that have been made are to improve the vessels being used to minimize impact and to adopt newer more selective fishing methods.

With the advancement of technology the question of salmon sustainability may be a thing of the past. Many new ideas have been brought to the forefront. Things like underground tunnels to assist spawning of wild salmon to new techniques for genetically modifying farmed salmon have all been presented and begun small scale testing to be determined if they are a viable option to the sustainability issue.

The purpose of this paper is to evaluate if the current practices and the new ones being suggested in capture Pacific Salmon and aquaculture of the salmon industry are sustainable. In order to determine if sustainability is being achieved, industry practices will have to meet the sustainability standard set by Fishwise.org which is a non-profit organization designed to improve the sustainability and financial performance of seafood retailers, distributors, and producers. Fishwise is uniquely positioned between the seafood industry and marine conservation organizations which also it to give good, unbiased advice and evaluations(Fishwise.org). Thus their sustainability guidelines are the fairest. Each policy and suggestion will be evaluated on its environmental, economic, oceanic impacts.

Captured Salmon

In order to evaluate the sustainability of wild capture salmon in the pacific, we must first understand how sustainability will be defined. For the purpose of the this paper, Fishwise will provide the basic guideline, however as the pacific capture salmon industry is quite broad, we will be narrowing fishwise's definitions of sustainability down to three major categories: Environmental Sustainability, Economic Sustainability and Social sustainability.

Environmental Sustainability is the effect of salmon fishing practices which are currently in use have on the salmon themselves and the effects these have had on the wild salmon and the ecosystems of the fish. Economic Sustainability will look at the levels that are necessary to be captured to create a profit or what incentives exist to adapt to a more sustainable system. Finally Social Sustainability will look at what effects have human communities outside of the wild capture industry had in effecting the amount of salmon available for capture and what can be done by non fisherman to effect the industries ability to maintain sustainability (Pillay 36).

Problems of the Past and Present

To understand if the wild pacific salmon capture industry of the future can be sustainability it is important to understand what lead to the current unsustainable practices and situation that the industry finds occurring today. Environmentally, wild pacific salmon were over fished and their habitats destroyed both through the capture process and other human activities. Economically wild salmon fisheries aimed for a quantity over quality approach. Socially the Salmon were no longer viewed as an intricate part of the ecosystems as a whole but as a commodity to be controlled and moved around like any other commodity.

Environmental Wrongs

The major environmental factor that is hurting the wild capture salmon industry ability to be environmentally sustainable is the declining number of salmon that are in the ocean each and every year. This decline which is often blamed solely on the shoulder of the industry for over fishing it, which has a role which will be discussed later, has other causes that the salmon industry has little to no control over (Taylor 21). The first is the wild salmon spawning habits are quite different between species and no single policy will work in the Pacific Northwest. Secondly and much more effectively is the damage done to the habitat of wild salmon by humans in the process of shaping and forming the land.

To stop this decline, one idea that was brought forward early was the ideas of raising wild fish in ponds then releasing them at a certain size, this was also known as cultivation. However, cultivation lead further decline of stocks. According to Joseph Taylor, Salmon have evolved to survive in a complex world. This is do to the fact that Salmon have to deal with seasonal and random climate changes such as drought or

excessive rainfall, changes in the chemical and mineral concentrations of the spawning streams and changes in predication and types of predators that were coming after them. To that end different breeds of Salmon developed different spawn and nursery habits. For example Sockeye salmon spawn in lakes while other species are will spawn in streams. Chum salmon will immediately depart for the ocean upon birth, while Sockeye will spend up to three years before heading out to sea. Evolutionary pressures like this have lead to the differences that we see in today's fish, why some species are bigger or coloring is different. Why this fact proved to be an ecological disaster for Wild salmon is the policy of fish cultivation that was started in the late 1870's. While ecologist of the time recognized that salmon were quite complex, the people pushing for cultivation would simplify the process down to only the salmon species they cared about and would demand policies and practices that would support only the breed (Taylor 205).

Fish cultivation aims to increase the number of salmon available for harvest by releasing farmed fish into wild populations. One problem of this is that genetic interbreeding will occur between wild and farmed salmon. As Reisenbichler puts it, if the hatchery fish are less well-adapted for rearing in natural streams than are wild fish, interbreeding will reduce the fitness of the wild population. Another problem with interbreeding the two is that it makes the wild salmon more susceptible to predators and to disease with a shrinking of the gene pool through selective breeding process of a cultivation pond (Reisnebichler 231). All of these factors can lead to a decrease in the population of wild Salmon. In fact it got so bad that by 1970s scientist said that these changes would lead to the survival of wild salmon to be nearly impossible (Taylor 204).

The larger problem facing the environment in which wild salmon could survive and multiple is the effects that humans have had on the rivers and lakes in which the wild salmon have to use in order to reproduce. Damming of Rivers has done more damage to the salmon habitat then any other single factor (Taylor 174). Many early dams that were built in the early 1930s failed to include adequate fish ladders and the states of Oregon and Washington rarely prosecuted the companies for failing to do so. This got so bad that by 1932 it was estimated that spawning ground in the Columbia basin had diminished by 50 percent (Taylor 175). Further construction of Dams along the main-stem of rivers in the Pacific Northwest between 1939 and 1969 eliminated thousands of miles of habitat. The Grand Coulee in Oregon blocked over one thousand miles of river to one hundred thousand salmon from there up stream spawning grounds (Taylor 175). Hand in hand with Damming of rivers was the spread of irrigation across the Pacific Northwest. Irrigation brings run off from the fields back to the rivers and these chemicals can negative effect the Salmon. For example in California which has one sixth of the nations irrigated land has been responsible for 20 percent of the 104 species of salmon that have gone extinct (Gregory 292).

Other major industries such as mining and manufacturing dumped and still dump pollutions such as mercury into the rivers and other wastes further killing the habitat in which the salmon could grow (Gregory 293). Logging has also played a role in this decline as clear cutting has lead to increases in erosion, which leads to increased levels of silt in spawning beds, lack of woody material in the rivers and increased run off of pollutants from clear cut areas (Taylor 179). Humans are having quite the impact on the environmental sustainability of the wild Salmon.

Economic Mind Set

However, the Wild Capture industry is not innocent of hurting the number of salmon avail to fish. Over fishing and capture methods that promote quantity as the number one factor has had a severe impact on sustainable fishing, especially considering the spawning abilities have been drastically hampered as shown previously.

What is promoting the concept of catch as many as you can is the fact that Salmon are some of the most popular food fish and support extensive commercial fisheries. Many species are anadromous, spawning in fresh water and migrating to the oceans to feed and grow before returning to fresh water to spawn. Several types of Pacific salmon exist on both coasts of the north pacific (Sainsbury 10). These mindsets have lead to an industry that is capture first and ask questions later. This mind set can be seen in the type of equipment that is used to capture the fish.

The first major way to capture is known as drum seining. Drum seining is a method of encircling a dense school of fish on or near the surface with a large wall of net. The net is then drawn together underneath the fish to make an artificial pond in which to scoop the fish out with (Sainsbury 23). This method, while well suited for capturing salmon as it has little to no by catch, or capture of non target species, it captures a mixture sizes when it comes to salmon that it does catch (Sainsbury 215). These means that entire schools are being captured, which is bad for the sustainability of wild salmon as it eliminates both younger fish that have not yet grown large enough to spawn and the older salmon that are more fertile and more likely to produce viable offspring thus limiting the number of juveniles born to replace the losses due to capture. (Reisenbichler 227).

The other major type of equipment used to capture salmon is Gill nets. Gill nets are a wall or compounds of netting set out in a particular pattern so that a specific size salmon will get caught by the gills when it swims through (Sainsbury 23). While this type of netting does have some distinct advantages that will be discussed in the solutions for sustainability section, it shares the same problem that drum seining has, it targets larger older fish which ends up hurting the genetic diversity of the wild salmon population as more and more smaller cultivated salmon are added to the population (Reisenbichler 228).

As wild salmon begin to become harder to find and capture in quantities that the industry is used to, the industry will have to look at their mindset of capture as much as possible as often as possible and start focusing on newer and better methods to catch more sustainable viable salmon, in stead of everything or the biggest individuals.

Lack of Social Commitment

As shown in the previous sections, It is clear that sustainability of wild salmon is surely threatened by practices of the industry its self and by the practices of all human beings when it comes to the habitat and breeding of wild salmon. Even more strange is why was something not done in the 1880s when problems were first observed or even in the 1970s when scientist said that wild salmon survivability has reached critical mass (Taylor 204). This has occurred for two major reasons. The first is the political atmosphere of the Pacific Northwest. In that region if one wants to have political success and to remain empower, one need to play the blame game quite effectively. Thus each side has fashioned the history of the problem into severely distorted partisan visions (Taylor 239). When each side thinks they are innocent it is hard to come to a

solution. The other reason is that current suggested solutions are always viewed as an economic downfall for one party and an improvement for a different group of people. As shown in the environmental section, clear cutting and mining in the pacific North West helped to destroy habitat, yet both of those industries represent major money makers for the area. Thus land owners would resist attempts to save salmon as it would affect their bottom line (Taylor 246). It also set different ethnic groups against each other. For example, the "Boldt Decisions" ended up limiting the fishing ability of non-native Americans in Washington of Salmon while allowing federal subsidies to help pay for the re- outfitting of the native Americans salmon fishing fleets(Taylor 243). Even more divisive for the Pacific Northwest was the 1992 idea of removing dams on certain rivers (Taylor 246). This lead to protest over loss of land, power, jobs and yet the salmon situation was ignored. In the end the Pacific North west has invested 3 billion dollars into fixing the problem and nothing has worked (Taylor 249). Because of the high expense critics would often attack those supporting salmon recovery as just abusing the power, it got so bad that a US Senator from the area who was anti-salmon recovery argued that there was if the cost was to high then you need to let the species go extinct and helped to pass federal legislation that limited the amount of money which could be spent on the recovery of the salmon (Taylor 247). Such a situation and rhetoric has just made things worse for the salmon and by extension the wild capture industry as the figure point began to make some citizens of the Pacific Northwest to open resent the fish and express hopes that the salmon would go extinct that the problem would no longer exist (Taylor 248).

All of these attitudes came from a lack of understanding the complexity that is the threat to salmon in the Pacific Northwest. As pointed out in the environmental section, many different human activities have played a role in the destruction of the habitat of the salmon which limits its spawning capabilities. Taylor (256) gives an excellent example of this when talking about an election in Oregon in 1992. Sport fishermen wanted to pass a measure that would eliminate gill netters. In the process of getting out there message they used paper made of wood from clear cutting, electricity from hydroelectric dams, ate food from irrigated farms. All these things with the fisherman play a role in the problem. Until society can be convinced that the problem is a more complex then anyone will admit, sustainability of wild capture salmon will never be attainable.

Solutions for Sustainability

In this section all the problems of the previous section will be addressed and possible solutions will be suggested on how to fix problem. Throughout this section I will be constantly referring to the Alaska Salmon fishery as it is the only Salmon fishery in the Northwest pacific to be rated as sustainable by Fishwise.org. According to MSC it was first certified as sustainable in September 2000 and was recertified in November 2007. It is made up 5 species of salmon which are divided up into 16 units of fishable ocean each being individual certified as sustainable. For the remainder of this paper, Alaska will refer to this salmon fishing area.

In order to provide to make the wild salmon capture industry sustainable, there has to be a solution to all of the problems discussed in the previous section. While it may seem a daunting task to create a sustainable solution, Alaska stands as a viable and working solution to the sustainability problems that plague the rest of the Pacific

Northwest salmon industry. Sustainability has to come from the same areas as the problems arose, environmentally, economically and socially. However when it comes to sustainability social acceptance become the most important, thus I will start there.

How to become Socially Sustainable

In order for the wild capture salmon industry to attain sustainability there will have to be a change in the way that society views salmon. To do this society will have to change the question that is currently being asked of how do we fix the problem to as Taylor puts it "asking how we can help people without hurting salmon. This moves us away from the fallacy of trying to control nature and toward the more realistic goal of trying to govern ourselves" (257). One option for promoting social concern would be to apply a retail tax to the purchase of wild salmon. This would have the effect of bringing the choice to continue non sustainable practices directly to the consumers' pockets and at the same time provide a source of revenue to further sustainability research (Fujita 658). A better way to promote this guestion is to involve all members of the community in the process. For example, the Asotin Watershed Project was considered a success because they brought members of the community together with scientists and government officials to come up with a comprehensive plan for the watershed (Thiessen 642). Such group projects focus the sustainability question towards the community and when communities care sustainability can be reached and maintained. Another way to promote this sense of joint responsibility is the concept of Community development Quotas or CDQs. These CDQs grant the authority to manage a share of the allowable harvest to a group made up of fishermen, scientists, environmentalist, local businessmen and other stakeholders. These fishing rights belong to the community and

it is there decision if they want to fish or lease it out and good management would lead to continued profit and benefit for the community (Fujita 659). In fact such practices have been used for the last ten years with success (Ulmer 65). Once social sustainability has been achieved then solutions to fix the other major areas becomes much more likely to be successful.

Achieving Economic Sustainability

To solve the economic sustainability issues the major problem of over fishing the Salmon needs to be addressed. The first way to do this to alter the methods that are being used to capture salmon. Instead of Drum Seining and Gill netting which have sustainability issues there is another method available. Line fishing is the concept of running a number of fishing lines carrying multiple baited hooks, lures or multi-hooked jigs either in a stationary position which in known as long line fishing or from a drifting vessel, which is know as trolling (Sainsbury 24). What makes these methods more sustainable is the fact that this method is highly selectable in what type of Salmon will be caught. Specific gear such as the hook or bait can be specifically targeted to the specific species of Salmon wishing to be caught (Sainsbury 276). Even better, is that while there is by catch of different species or salmon that are an incorrect size can be quickly released and the lines can be rest with minimal effort (Sainsbury 277). In fact, Alaska has recently begun to provide a tax rebate for fishermen who choose to use the line method (Ulmer 64). Using a line fishing method means a decrease in the amount of Salmon caught, however this does not mean a lose of income for the fishermen. According to Giovanni Comin, CEO and Owner of Central Coast Seafood in Atascadero "Wild Salmon that are captured using the line method are a better quality and demand a

higher price that seafood companies are happy to pay as better quality fish mean more sales and happier customers."

Secondly is how to convince salmon fishermen they need to limit the amount of salmon that they capture each year and setting what that limit should be. In order to set the limit requires that there are accurate escapement goals, geographic gradients in fishing mortalities and making sure that enough salmon escape to the spawning grounds to create the next generation (Mundy 326). A good way of doing this would be to copy the method established in Alaska. In Alaska there is a separation of the regulatory decision that affects allocation of what can be caught and what needs be done to promote conservation. The Alaska Board of Fisheries is a citizen panel that holds public hearing to set the limits that will be assigned. However these goals have to protect the escapements that are set by the Alaska Department of Fish and Game who are required by law to set levels so that it will promote stock increase (Van Alen 183). Once all of this information is gathered then it is easier to set up the solution that will convince the fisherman to not over fish. That solution is an Individual transferable guota or ITQ. What an ITQ is a transferable allocation of fishing privileges such as a percentage of total catch of salmon allowed each year that belongs to the individual fisherman. Because levels of allowed fish are being set so that the Salmon population can continue to grow, this ITQ represents ownership of a growing investment. Because it belongs to the individual fisherman, protecting their own resource becomes much more important and the ability to pass this ownership along helps promote a willingness to attempt sustainability (Fujita 659). With these changes, wild capture salmon fishing should become sustainable.

Achieving Environmental Sustainability

To achieve environmental sustainability requires two things. The first is to protect the genetics of the wild Salmon runs that are still viable. It was shown earlier that cultivation of Salmon stocks in the Pacific Northwest has lead to a decrease in the genetic diversity of the Salmon that exist in the wild and this has led to difficultly in keeping the stock levels up. While cultivation can not be removed entirely, if it is managed correctly then the genetics of the completely wild salmon can be protected. To do so require that managers of the cultivation be conscious of the biological risks to diversity, fitness and productivity that cultivated fish have (Smoker 408). Alaska has successfully dealt with this problem by prohibiting transport of salmon between regions of Alaska and from outside Alaska (Smoker 416). By not allowing transfers of cultivated stock around the state Alaska has confined the genetics of the cultivated stocks to specific regions where through selective breeding those stocks can be made more genetically diverse, while still protecting their wild stock (Smoker 419). This will in time solve the genetic problems that face the wild Salmon.

The second environmentally problem is the destruction of habitat. This, while being the biggest problem is the easiest to fix. All it requires is the reconstruction of habitat in spawning rivers and the salmon will come back. One way to do this is through vegetation planting and construction of artificial banks for breeding. Vegetation serves a vital function as a food source and protection of the water quality of the streams in which the salmon spawn. Banks allow places for the eggs to gather and protection from predication. This simple step has worked and a good example of this is the Campbell River estuary where 14 years after planting sedges on 4 artificially islands saw a 30%

increase of Chinook salmon (Langer 344). A second part to the vegetation restorations is the restoring of woody debris to the streams. This debris is important as it plays a role in stabilization of smaller rivers and provides the important biological function of providing high velocity escape routes to the salmon (Dominguez 547). The woody debris also provides a means for the dead salmon bodies to return to the soils of the vegetated areas around the streams making the soils more fertile and productive (Dominguez 547). What makes this solution so effect is that salmon do not care if the woody debris is actual debris or man made locations that have the same effect. For example in Oregon, by simply depositing large amounts of gravel and fines upstream of functioning spawning grounds led to a three fold in the first summer after the gravel had been placed (Dominguez 549). In Washington by carefully place simple bundles of logs in spawning rivers, the juvenile salmon yield increased by eight times by the next summer after placement (Dominguez 549). The best part of this wooden debris is that it is inexpensive, and provides a need rehabilitation to the rivers as it takes time for the vegetation planted on land to grow.

Once vegetation is restored the next step is to improve the water quality. This means limiting the amount of animal-generated bacteria, dissolved oxygen, heavy metals in both sediments and the water column (Fresh 532). This can be easily down by restricting the types of water discharges that are allowed to be directly dumped into the rivers and lakes systems of the Pacific Northwest. In fact since 1971 when water monitoring began levels of the degrading materials have decreased and nutrients important to salmon growth and development have been increasing (Fresh 534). With further restrictions, the water quality could be fully restored. Another way to help protect

water quality is to pass laws limiting what land is available for development and which is not. In Canada, there is a current law called the Municipal Act that allows local legislations to decide locally how to use the land (Langer 356). There is no obligation of the local cities to attempt to protect local salmon habitat. It is hoped in Canada that with an amendment to the law in 1997, which change the decision of land use based on environmental factors to a more scientific approach over the old local cities decide and the salmon spawning streams will receive the protection they deserve (Langer 357). So while environmentally humans have done the most damage to the salmon population, it is the easiest to fix in an attempt to reach sustainability.

Aquaculture

Another solution to making the commercial pacific salmon industry sustainable is to give up on the entire fishing process all together. Salmon aquaculture has been steadily on the rise since the 1960's when it first started in Norway and has sense spread to the entire Atlantic Ocean habitat of Salmon. More recently Salmon fisheries have begun to arise off the coast of Chile and some rivers in the Pacific Northwest. While the owners and operators of these facilities claim that aquaculture is the best solution to the problem, they are ignoring many of the effects that aquaculture has on the surrounding environment.

To better understand why salmon farming in the Pacific Ocean is not a sustainable one should observe the three parts of the sustainability judgment as mentioned in previous sections. While it is true that salmon fishing would be very economically sustainable as according to the FAO it produces 2.3 million tons a year world wide versus only 1.1 million tons of traditional captured salmon, this is only true is

the only factors involved in sustainability was that initial investment, lead to short term profits and long term all profit is greater than traditional fishing. However this economic sustainability comes at a cost to Environmental sustainability and social sustainability. Once these two factors are gone, then the economic sustainability will no longer be there.

Environmental factors

Environmentally sustainability can be divided into the two distinct categories. The effluents coming out of the Salmon farms and the damage which farmed fish can have on the wild population. The effluents can be divided into two major categories: Feed waste and Chemical waste, both trough feces of Salmon and man made chemicals. The Damage the farmed fish cause are based in the disease that farm salmon help spread and the danger that farmed salmon posses to the wild salmon population.

The feed used for Salmon farms has two major impacts on the environment. The first is that the feed itself is made from other fish. The second is that the feed is also one of the wastes that escape from the salmon farm. According to Grescoe at the most efficient farms it requires at least four pounds of wild caught fish dispensed in feed pellets to produce a single pound of salmon (Grescoe 94). Secondly the way that the fish are feed, usually by just dumping a set amount of feed pellets into the water results in the uneaten feed pelts to sink to the bottom and mix with the sediment helping to cause hypernutirfication (Pillay 59). To both these challenges, Salmon farmers claim that they do pay attention to what goes into the feed and what the correct amount to fee is, however when looking at the Salmon farmers best practices the only real stipulation

is that farmers should request the information on if the feed is safe for the environment and if it comes from a sustainable source (Scottish 40-41). There is no other form of oversight that the salmon farmers feel is necessary.

Chemicals also make up a major source of effluents. Chemicals such as nitrogen and phosphorus which occur naturally from the feces of the salmon help in the hyper nitrification process discussed later. Men made chemicals are used for the control of predators, disinfection and the treatment of diseases. The environmental impact of using chemicals is more direct in salmon farms because they are in the open waters. For example in Norway they use the pesticides Neguvon and Nuvon to control fish lice and these pesticides have had a lethal effect on the local crab and lobster populations (Pillay 69). Another major problem to the use of chemicals is that it is not well studied or regulated as to what is actually being used. For example it is malachite green and fomalin account for more then half of the chemicals being used. This is a scary fact because malachite green is banned in the US as it is considered to a carcinogenic (Pillay 70). Even worse states Pillay is that Salmon farmers are now experimenting with the use of hormones and human growth formulas to produce larger fish, which is a concern as those products can then be passed from the fish to the people who are consuming the fish. For the Salmon farming industry, when it comes to dumping chemicals and medicines in to the pens the only guideline is to make sure you work with a Veterinarian and have a prescription (Scottish 23).

Because of all the different effluents coming from the salmon farmers two major things can and will occur to the ocean or river surrounding the farm. The first is hypernutirfication which means that the concentration of nutrients in the water has had a

substantial and measurable increase. This is a dangerous thing to occur as such nutrient rich environments make excellent breeding grounds of Algal blooms, which are quite deadly to sea life both in the farms and in the surrounding area as the fungal bloom spreads. For example the catastrophic blooms of Chrysochromulin Plylepis wiped out entire salmon farms and threatened the salmon cage industry in Norway (Pillay 73). Such deadly blooms are definitely a possibility as more and more farms appear on the coasts of the Northwest and Alaska.

The second major of hypernutirfication is the increase in phytoplankton which leads to areas of the ocean that lack oxygen due to it being consumed in the hypernutrification zone. Such "Dead Zone" can destroy the sea life on the ocean floor. According to Grescoe within a half-mile radius of salmon farms all prawns have disappeared, and even worse, Rockfish, which stay near the sea floor have started to be covered in strange growths and ugly lesions. When it comes to effluents the Salmon farming industry takes it a bit more seriously. For example it states that all farms should work with their countries environmental protection agency (EPA) and allow for full access to routine testing and inspection to make sure that they are meeting the prescribed guidelines (Scottish 25). However, individual EPA can set differing standards based upon differing studies and results leading to no uniformity or understanding of long term effects.

Because Farmed salmon are so tightly packed together in the farms disease is quite rampant. In fact, the hypernutrification zones described above can prove an excellent breeding ground for disease (Pillay 94). Such disease as Sea lice which not only devastate the farmed fish, but then spread to the spawning ground where they

attach to the new born salmon and destroy the entire next generation of wild salmon who have no way of being treated for the pest (Grescoe 94). Even more damaging is the parasite known as Gyrodactlyus Salaris, which feeds by attaching to the salmon and secrets an enzyme that dissolves the scales and the skin and the only way that was found to stop its spread from the farmed salmon to the wild salmon was to flood the rivers with a pesticide that not only wiped out the parasite but also all sea life in those river (Grescoe 95). Even more recently Chilean Farmed Salmon has been struck by Anemia that causes the flesh to become mushy and can possible spread tapeworms to those who eat the salmon raw or in a ceviche (Grescoe 95). Because of the way Salmon farms are designed there is no way to prevent these diseases from spread to the wild population.

There is also a problem with foreign fish mixing with the wild fish in different eco systems. For example, the majority of Farmed salmon on both coast of the United States is the species found in the Atlantic. It is known to be quite carnivorous. Because common practice for Salmon Farms are to light the pens at night, in order to attract smaller fish and provide free food (Scottish 28), these Atlantic salmon are eating entire new generations of wild pacific salmon (Grescoe 94). If said species can get lose and begin to breed it becomes an almost super predator destroy much of the local system. The Salmon Farmers Code of Good conduct does address this issue, both of disease and escape. In the case of Disease is the same as mention above. For Escape, they recommend that farms maintain their netting constantly and vigilantly and attempt to recapture any fish that do mange to escape (Scottish 21). However, there are currently

no laws holding farm Salmon companies responsible for the damage the diseases and escapement cause.

When all of these factors are added up it points to an unsustainable system. While the Salmon farmers claim to have protections and procedures in place, in reality there is too little oversight, and not enough understanding of the long term effects of the policies to make them effective.

Social Factors

Closely and perhaps more important we have the social effects that come from having salmon farms take over where the traditional fishermen once were.

Conflicts with traditional fishing activities in foreshore areas and estuaries may have to be accounted for when choosing a location for a salmon farm. For example management problems created by the salmon aquaculture in the bay of Funday, Canada resulted in conflicts with traditional fishing for herring, lobster, clams and scallops. Another site conflict that arises is that capture fisheries collect all the juvenile salmon that come out of the river in which the farm is placed. This leads to conflict between the traditional salmon fishers and the Farm (Pillay 123).

Salmon farmers detest sea birds and predatory mammals. Both of these types of creatures represent a serious threat to a Salmons farm productive ability which means a decrease in the commercial viability of the project.

In the case of sea birds in the Pacific Northwest, a single pelican can consume between 1 and 3 tons of fish per year (Pillay p98). According to Pillay (p98) a breeding pair or cormorants, which are quite numerous in the Pacific Northwest, will catch about four and a half tons of fish per year. Sea birds also represent a health risk to the fish

being raised. Gulls, which will use the floating structures of off-shore cage farms as roast, place large amounts of droppings in and around the areas where the fish feed. These feces have been shown to contain fish tapeworms, fish flukes and pathogenic organisms, such as salmonella, fecal coliforms. All of which result in the lost of productive stock and a possible threat to future consumers (Pillay 99). Sea mammals such as otters and seals have an even more devastating effect on fish stocks. They have been known to be capable of destroying up to 80 percent of the salmon in a single attack.

According to Code of Good Conduct for Scottish Finfish Aquaculture, Antipredator netting and other physical barriers such as exterior anti-predator nets, top nets, double-bottomed nets, overhead wires/lines to deter birds, maintenance of net rigidity, using rounded and larger nets, reduction of net mesh size, and installation of perimeter fencing are the only method that should be used to prevent predatorily animals from attacking the stock.

While the above code of conduct may seem like humane way to stop these attacks and protect the stock, in the end it just leads to more dead animals. In April 2007 51 California Sea lions were trapped between the layers of netting and drowned (Grescoe 94) at a single salmon farm. However such incidents are not reported very often so it is hard to judge the actual effects on the sea mammals' population. Sea birds have the same problem. While the non-lethal means are recommended. In the United States, the U.S Fish and Wildlife Service will issue a permit to the aquaculture facility to kill a limited number of birds that are causing the damage to help enforce the non-lethal means. The problem with this is that there is no oversight set up by the US Fish and Wildlife Service to make sure that the killings are limited to the permitted number. According to Pillay, while today the deaths of sea birds and mammals at Salmon farmers do not show a significant impact on those species populations in the future this may change as wild salmon become sparser and more animals are attracted to the salmon farms. Thus Salmon farming as an industry approves of the destruction of predatory sea life in order to protect its profits. This practice will lead to battle with local populations and environmental groups as Salmon fishing becomes more wide spread.

However most important is whether or not Farmed Salmon is safe for human consumption. Best Practices of the Salmon Fishing industry sets aside an entire section to the promises of the safety of the product that they will be selling to the public. For example, they promise traceability and freedom from all possible harmful and dangerous substances that may possible get into the fish (Scottish 11-12). They recommend that this is done through inspection at the countries of wish the fish is to be consumed. However this falls terrible short of actually protecting anyone. Grescoe has an excellent example of how this falls short. Canadian salmon farmers spike their feed with a toxin called emamectine benzoate to kill sea lice. However the USFDA does not regularly test for this toxin as they are hard pressed checking other products from other countries. Therefore, because Canada provides 38% of the salmon that sells in the United States almost every fillet that is bought in a store contains this toxin. This is dangerous because the EPA list emamectin benzoate as a highly toxic neurotoxin and states it should not be consumed by humans, but it is coming through in farmed salmon fillets.

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Another draw back to humans is that farmed salmon have been shown to contain up to 10 times more persistent organic pollutants then wild salmon. Some of these pollutants are toxic and all are considered carcinogenic (Grescoe 95).

It in not just the dangerous chemicals that find there way to the dinner plate, it is also the fact that farmed Salmon does not have the nutritional value of Wild salmon. Because of the amount of soy used in feed for salmon, there is a disproportionate amount of omega-6 fatty acid that promotes inflammation and has been linked to heart disease (Grescoe 95). Farmed salmon also have four times less vitamin D then wild salmon, which is important as vitamin D helps prevent colorectal cancer (Grescoe 95). With so many dangers with little benefit to human health, why take the risk on farmed salmon.

Conclusion

The wild capture salmon industry as it stands now is non-sustainable. Each year more and more wild pacific salmon are pulled from the oceans with fewer being born each year. This has devastated the wild salmon populations and threatens their very survival. Another factors to this devastation is the fact that humans have destroyed the habitat of the Salmon and in our attempts to grow more have altered the very DNA of the Salmon to make survival nearly impossible. The industry its self exasperates the problem with its attitudes of more fish caught the better it is. Finally our entire society prefers to point the finger at each other for the responsibility of the disappearance of salmon from the Pacific Northwest. However, it is not all doom and gloom. The Wild

Pacific Salmon Fisheries show that it is possible to be sustainable, although those fisheries do suffer from much less human impact than fisheries of the coasts of Canada, California, Oregon and Washington. The environmental damage can be repaired with current technologies and continued enforcement of water quality laws. New methods of fishing have begun to change the quantity to a quality mentality of the wild capture fishing industry. Sadly the biggest road block to the wild salmon industry achieving sustainability is whether or not society can realize that it's not who is hurting the salmon but how all are responsible and thus solutions to the problem must involve all of us. Finally, the solution being pushed today, aquaculture has been shown to be non-sustainable in its current form and thus does not provide an easy solution to the problem.

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