Resurrection Bay Wild Coho Salmon in Potential Danger

Seward High School

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Abstract

Resurrection Bay is located in south-central Alaska on the Kenai Peninsula, about 125 miles south from Anchorage. In this bay lives the coho or silver salmon whose natural population is declining due to the introduction of hatchery raised salmon. This salmon is about eight pounds and is about two feet long. The coho salmon lives from California up to Alaska, over to Russia and Japan. The coho salmon has a monetary, economic and cultural value in the Resurrection Bay estuary. There are industries built on harvesting coho salmon such as the salmon derby and the many tourists that come to harvest the coho. These hatchery raised salmon seem to be thriving more than the wild salmon. The trail lake hatchery raises most of these salmon and each year pump more Smolt into the system. Cook Inlet Aquaculture Association works closely with the bear lake weir to manage all the fish running into the bay. The hatchery took out 466 sockeye and 316 coho to sample. Only 0.2% of the sockeye and 1.6% of the coho were naturally produced. Eel River in California compares to the Resurrection Bay Estuary because both have the same environment and Resurrection Bay also has the potential to lose its coho like the Eel River Estuary. This is due to the extreme reliance on hatchery salmon in the Seward area. Our management plan is composed of three parts: lessening the amount of artificially spawned fish, promoting healthy spawning grounds, and regulating culverts. This will insure the health of the natural coho salmon fishery.

Introduction
Resurrection bay estuary is home to a very valuable resource, the coho salmon or *Oncorhynchus kisutch*. This salmon has various economic, monetary and cultural values to the Seward area. The coho salmon bring in an astounding amount of money each year, through commercial and trophy fishing. Estuaries play a huge role in the habitat and prosperity of the species. Estuaries also provide food, shelter and a place to spawn for these fish. Resurrection Bay’s natural coho salmon population seems to be declining at a rapid rate. It is being replaced by huge yearly deposits of stocked salmon. Throughout this paper we will be exploring possible solutions as to why the natural salmon population is declining and why natural salmon is better. We will also be comparing the Resurrection Bay estuary to the Eel River Estuary in mid-California.

**Problem**

The problem with the Resurrection Bay estuary is that the natural Coho salmon population is almost nonexistent. One assumption is that there is a lack of natural spawning grounds within the river and lakes for Coho salmon because of poor stewardship. There has been little concern and research of the health of the estuary. The salmon keep coming back each year with healthy numbers as well as size; therefore, no concern has been raised. Bear Lake has been “fertilized” stimulating phytoplankton growth, thereby increasing zooplankton population, which is the main source of food for the salmon fry.

In 2012 Cook Inlet Aquaculture Association, which manages the hatchery operation on the Kenai Peninsula, sampled 316 coho salmon as they exited Bear lake. They discovered only 1.6% of the population was from natural stock. From this data one
can conclude that the system is over reliant on hatchery-bred fish. There is little data other than anecdotal evidence to suggest the local system supported a larger wild population. But these stories do suggest that many of the local creeks, and the town’s lagoon did have much larger salmon populations. The suggestion here is that because the city has been so over reliant on hatchery fish, there has been little attention paid to the stewardship of the local estuaries, and that is why there is very little evidence of wild fish in the system. The city assumes purchasing more fry and smolt, with little regard for the fish habitat, easily controls the population of salmon. This is a problem.

Options do exist that can help the natural coho salmon population. The city can start to invest time and money into estuarine management, including improving riparian zones, cleaning streambeds, controlling flood zones, and creating thoughtful zoning laws. There has been a few examples of this type of stewardship locally in the last two years, including Resurrection Bay Conservation Alliance’s work on restoring Scheffler Creek habitat, and CIAA’s work on culvert at Exit Glacier, but this effort must expand beyond it’s little scope.

Reason

The reason behind our decision for choosing this topic to restore wild coho salmon is because nobody seems to care that the estuary salmon is so dependent on hatcheries. We are paying 50 cents per smolt in order to keep the estuary coho numbers healthy instead of trying to help restore the natural salmon populations.

The importance of protecting and restoring the wild coho salmon instead of using hatchery coho salmon is because of natural selection. Allowing salmon to evolve along
with their environment instead of remaining static creates a weaker and less adaptable population. In addition, if the estuary is not tended to, eventually any fry or smolt, wild or hatchery bred, will not thrive if there is pollution and a lack of food.

Study Area

Resurrection Bay is located in south-central Alaska on the Kenai Peninsula, about 125 miles south from Anchorage. The bay is approximately 20 miles long with multiple settlements surrounded by mountains. Seward is the main town in the bay with small settlements such as Lowell Point and Miller’s Landing surrounding it. Seward is an ice free port and was established in Alaska in 1903. It has a population of about 2,726 people, according to the 2011 census. The city limits occupy approximately 21.5 square miles or 56 square kilometers with 7.1 square miles or 11.4 kilometers of that being water.

Industries in this bay include tourism, fishing and a railroad terminal that exports coal and houses cruise ships. Tourists come to Seward one of two ways: on a cruise ship that docks at the terminal, or down the Seward highway. Tourists can go on fishing charters, which range from 175 dollars to 315 dollars a day per person. They can also go on tours of the bay which is in Kenai Fjords National Park with various tour companies. The railroad runs coal down from the Usibelli Mine in Healy to the terminal. In the summer, the railroad is used to bring tourists down from Whittier. Seward has many events for fishing including the Halibut Derby, June 1st through the 30th and the Silver Salmon Derby, from August 14th through the 21st. Both offer a 10,000 dollar grand prize and bring many tourists to the town. Seward’s main fish are: Halibut, salmon, Lingcod,
Yellow Rockfish and Orange Rockfish. According to a 2011 National Marine Fisheries Service report, Seward is the ninth most lucrative fisheries port in the United States based on the monetary value of fish taken from the port. In 2010, 69.2 million dollars’ worth of fish and shellfish passed through Seward. This was up significantly from 2009 when the port brought in 33.1 million dollars.

Temperatures in this region are not as harsh as the inland cities, but range from around 70 degrees Fahrenheit in the summer to about 15 degrees Fahrenheit in the winter.

Rivers in Resurrection Bay include Resurrection River, Fourth of July Creek, Spring Creek, Salmon Creek, Afognak Creek, Sawmill Creek, Japanese Creek, Spruce Creek Lowell Creek, Tonsina Creek and Scheffler Creek (which includes the town’s lagoon). The bay also has many coves such as: Thumbs Cove, Humpy Cove, Sunny Cove and Kayaker’s Cove. Resurrection Bay also has three islands extending out of the fjords; Rugged Island, Hive Island, and Fox Island which create the Eldorado narrows that the tour companies pass through.

Biology

*Oncorhynchus kisutch* have many names, including Silver Salmon, Hoopid salmon, White salmon, Medium Red salmon, and coho salmon. When fully grown the coho salmon measures 2 feet or more and on average weighs eight pounds. Coho salmon have a dark metallic grey or blue dorsal side with dark spots. The side of the coho blends to a light belly. When spawning in inland rivers the fish turns a dark, reddish-maroon color on its side (*Coho Salmon (Oncorhynchus kisutch), 2012*).

The coho salmon’s diet consists of plankton and insects in freshwater (*Ontario-
Great Lakes Area Fact Sheets, 2010). It switches to a diet of small fish and invertebrates while in a marine environment (Coho Salmon (Oncorhynchus kisutch), 2012). During the time when the fish are spawning they eat close to nothing. Coho salmon are historically distributed throughout the North Pacific Ocean. They live in California, Alaska, and out the Aleutian Chain, Russia and Japan. The status of coho populations from California to Alaska are varied. Some are healthy, one is endangered, and three are considered threatened under the Endangered Species Act (Coho Salmon, 2012).

The life cycle of a coho salmon starts when it is an egg. They are born in freshwater streams or rivers and incubate over the winter. The newly hatched alevin are born in late winter. Alevin have large eyes, a balloon like orange yolk sack on their stomachs, and a stick like body. The yolk sac is filled with fluid that contains nutrients for the alevin to live off. About four months after becoming an alevin, the fish changes into a fry. On average these fry are one inch in length (Coho Salmon, 2012). They have an elongated body and are free swimming. They are fry for almost a year. At first the fry stay in small back channels of their streams under hanging vegetation and defend their territory from other fry. Then in mid to late may the fry gather together to start traveling to the ocean. This is when they become smolt (Coho Salmon, 1996). When reaching the ocean the smolt stay by the mouth of the river or stream for a month or two before heading out to the ocean (Heine, 2009). Most Coho stay in the ocean two to three years. Some fish stay in one feeding area and others will travel extensively. After they have fully matured the salmon head back to the freshwater stream that they were born in. This is called anadromy. After the female makes a red, or a nest, she lays her eggs into it. A male fish then fertilizes the eggs with his milt. Being semelparity, the fish only spawn
once then die (Coho Salmon, 1996).

Although often overlooked, one of the most important contributions coho salmon have to the habitat which they live is the nutrients that they leave behind when they die. As the dead fish decompose the body is available for small insects and fry to eat. What is not eaten, seeps through the ground to the surrounding vegetation which absorbs it. This provides vegetation for fry to hide under. The proteins that are left for the young fish and entire ecosystem are very valuable (Profita, 2012).

Many coho salmon hatcheries try to produce batches of fish with the highest survival rate from alvin to adult. This results in a 90% survival rate which higher than wild fish. This is due to the absence of natural selection and the minimal amount of predation. The relaxed selection has even started to cause a genetic difference in the wild and hatchery fish. Genetic load in small brood loads and actually deflates the population instead of increases it (Kostow, 2004).

Hatcheries monitor fish by looking at their otoliths. The otolith is located in the inner ear and has specific pattern on it, basically telling the story of its life. These patterns are in the shape of rings and lines. The most used information that scientists can gather from an otolith is the age of a fish, although there is much more information that we can gather. “Fisheries biologists have discovered that they can extract a variety of information about a fish by looking at changes in these patterns. In some cases, these patterns are a natural record; in other cases they are induced by man” (Otolith Mark FAQ, 2006). Each hatchery has different designs they assign to the fish, meaning Trail Lake Hatchery raised fish will have different looking otolith’s than a hatchery raised fish from
Valdez. The hatcheries also use the otoliths mark to distinguish between wild and hatchery raised salmon.

**Hatcheries and Fisheries**

Hatcheries have a large influence on salmon production in the Resurrection Bay ecosystem. They raise a large portion of the salmon, fry and smolt that are released into the estuary and later return as adults. Commercial salmon seine boats as well as sports fishermen catch these adults in Resurrection Bay. The fisheries have a major impact on the Seward economy.

The Trail Lake Hatchery and the Bear Lake Weir raise young salmon until they are introduced into the wild. A weir is an obstruction built across a river or stream to regulate the salmons upstream travel. Most of the salmon released into Bear Lake and Creek are sockeye salmon, however they do release coho salmon.

In the Seward area commercial fishermen primarily seine for red salmon. The seining in this area focuses on hatchery-raised salmon. Hatchery salmon return two to three years after they are released and are caught by the seiners here in Seward. Small quantities of those fish run up Bear Creek to Bear Lake. Sports fishermen catch some of these fish also, but many of them are killed and used to populate the hatchery again. This is not a natural system and is human enhanced. There would be no commercial fishing without the hatchery fish because the wild population of salmon in the Seward area is not enough to sustain commercial fishing. Sports fishermen in the Seward area target silver salmon. This is also an enhanced fishery; meaning hatchery fish are released into the system yearly. The Seward Silver Salmon Derby in August draws in hundreds of
fishermen and brings in hundreds and thousands of dollars into this community. Both of these fisheries are worth quite a bit of money in the Seward area.

When the salmon reach a fry age, Cook Inlet Aquaculture Association (CIAA) releases around 450,000 silver salmon into Bear Lake, and around 2.4 million sockeye fry into Bear Lake every Spring. They adjust the temperature of the water they are housing the salmon in according to the temperature of the water where they release them. This gets the fish acclimatized to the temperature of the natural water. Once the salmon fry have matured enough they become smolt and begin their travel down Bear Creek past the weir and into the bay. This is where a portion of the fish are taken out of the water to sample. Sampling the fish means checking their otolith for the thermal mark, which identifies the fish. Bear Lake runs into Bear Creek, which flows into Resurrection Bay. The salmon are thought to stay in Resurrection Bay for a few days. Before traveling on father into the open ocean.

In 2012 CIAA collected 466 sockeye and 316 coho samples from the Bear Lake weir as the smolt exited the system. Only 0.2% of the sockeyes sampled, and 1.6% of the cohos sampled came from natural production. When the fish return to the weir to spawn, they plan to collect the same amount of fish and go through them and determine what percentage is wild salmon or hatchery raised. The data shows that natural salmon are not doing well in this system. However, the hatchery fish seem to be doing quite well.

Bear Lake is strongly dependent on hatchery production even though approximately 6000 female and 6000 males (sockeye) are available to naturally spawn. Each female has approximately 2500 eggs so this is an egg potential of about 15,000,000
sockeye salmon eggs. In 2012 CIAA enumerated 466,895 sockeye smolt passing through the Bear Creek weir. Of that based on the 2012 otolith information above 99.8% came from the fry they stock in the spring of 2011. Only 0.2% was from natural production or (933 smolt). Hence from a potential of about 15 million eggs from fish spawning naturally only 933 made it to the smolt stage.

For the coho 150 female and 150 males are available to spawn naturally. A coho female has approximately 3500 eggs so this is an egg potential of about 525,000 coho salmon eggs. In 2012 CIAA enumerated 47,640 coho smolts through the Bear Creek weir. Based on the otolith collection above, 98.4% came from the fry they stock in the spring of 2011. Only 1.6% was from natural production (762 smolts). Hence from a potential of about 525,000 eggs from fish spawning naturally only 762 made it to the smolt stage. This is a better survival rate than the sockeye but still not great.

As you can see this system is highly dependent on hatchery-raised fish. The question is why aren’t the natural fish surviving? The estuary seems to have enough food because the hatchery fry are surviving and the adult salmon returning are healthy. In addition, the City of Seward is planning on adding 50,000 more smolt to Bear Lake weir in 2014. Without the hatchery raised fish there would be not enough wild salmon to sustain the fishing pressure we have here in Seward. Taking away the hatchery might also mean a collapse in other estuaries in the Seward area that are home to some salmon stocks. Hatchery raised salmon are extremely important in sustaining the salmon population, but not necessarily the estuary in Seward, Alaska.
We chose to compare our estuary to the eel river estuary in mid-California. It shares characteristics with the Resurrection bay estuary. Its main species is the coho salmon. The Eel River Estuary is located in mid-California inside Mendocino National Park. It is the third largest estuary in California and is home to a variety of anadromous animals such as the coho salmon, steelhead trout and many species of lamprey. The river is over 200 miles long with ample places for coho salmon to hide, feed and live. The Resurrection Bay Estuary is located in South-central Alaska on the Kenai Peninsula, close to the town of Seward. Its boundaries stretch beyond Kenai Fjords National Park and is home to Coho, Sockeye and Chinook salmon.

Back in the nineteen seventies California was experiencing a dramatic drop in the Coho salmon population. Now that drop has consumed ninety percent (Moyle, 2011) of the once 600,000 salmon the estuary housed yearly. This decline was for an unknown reason but it is speculated that it was due to an altered sediment supply. It could also be due to overfishing or predators in the area. The other possible option is that stocked salmon were spawning with wild salmon and the offspring were losing their ability to adapt quickly to a new environment (ADN, 2012). It’s estuary was also compromised due to over development.

This could occur in the Resurrection Bay estuary. The populations appears to be over reliant on the hatchery bred fish introduced yearly. In 2014 the Seward Chamber of Commerce is planning to release 50,000 coho smolt at $0.50 apiece to aid the salmon population and to stock for the salmon derby. They will be partnering with the Cook Inlet Aquaculture Association to meet stocking goals not met since 2002 (Seward Chamber of Commerce, 2012). That would be a total of 365,000 coho salmon released instead of the
regular 315,000. The stocking has been irregular for the past twenty years with the stock in 1999 being 306,000 coho salmon in Bear Lake and in 2009 they stocked 68,000 but in 2011 they released a total of 437,000 coho salmon.

Concerns about the estuary in California included altered sediment supply, lack of overhanging brush due to fires and clearing, fires and climate change. Concerns for salmon in Alaska are less severe as the salmon population is still healthy. The major concern in Alaska is the wild salmon are spawning with the stocked salmon reducing their adaptive capabilities. There is also declining attention to estuary health, and predator prey relationships to consider.

Within one hundred years most of California’s coho salmon were gone and the species was put on the endangered species list. Resurrection Bay’s salmon have not declined or overpopulated yet but they could go the same way if we upset the delicate balance of the estuary and continue to over stock salmon in our system.

Solution

We have formulated a plan that would be effective in managing the wild coho salmon population while keeping the estuary healthy. Part one of the solution would be to lessen the amount of salmon that is artificially stocked in the Resurrection Bay estuary. Most of the Department of Fish and Game’s Coho egg requirements for the South-central region's needs were obtained from the Bear Creek adult return (Alaska Department of Fish and Game). A total of 496 females and 121 males were artificially spawned, yielding an estimated 2,180,760 eggs. These eggs did not occur naturally, which is detrimental to the environment. The hatchery-spawned salmon interbreed with the wild salmon,
degrading their ability to adapt to changing conditions, according to a U.S.-Canada research team (The Globe, 2010).

The second part of our management plan is to promote healthy spawning grounds. This can be accomplished by creating more overhanging vegetation and keeping the estuary clean. Coho salmon prefer to spawn in places with little sunlight. Therefore, planting trees and other overhanging vegetation by the water would create more shade, which the salmon would favor. Runoff from construction sites is problematic because not only are chemicals being washed into the water, but so is sediment. The sediment clogs and abrades salmon’s gills and also smothers their eggs (Copper River Watershed Project). Keeping the estuary clean would require putting new zoning laws into action. This would help insure that there is pollution-free water for the salmon to spawn in.

The third part to our plan is to make sure salmon are able to pass through culverts with ease. This would be done by creating stricter regulations on the culverts. Water inside the culverts needs to be at the right volume and going the adequate velocity, that way they will not disrupt the natural movement of the salmon. There has been some attention to replacing a few of the local culverts.

Our management plan is composed of three parts: lessening the amount of artificially spawned fish, promoting healthy spawning grounds, and regulating culverts. These three components would help the population of wild coho salmon to grow without having to depend on human interference. This plan would also help maintain the health of the estuary, because there would be less pollution, allowing the ecosystem to maintain a healthy balance.
Irresponsible stewardship and populating the system with an excessive amount of hatchery fish has led to a decline in the natural wild coho salmon population. Pollution and blocking the waterways interferes with the salmon’s migration path. Culverts can harm and potentially kill salmons in times of floods, droughts, and where strong currents occur. Our solution of this problem includes lessening the amount of stocked fish, promoting and providing healthy spawning grounds, and adding more regulations on culverts. With our three part plan in order the natural wild coho salmon population will be restored to its prime amount. The Resurrection Bay estuary will be restored to its peak and the fishery will be restored to its naturally healthy state.

Conclusion

Irresponsible stewardship, culverts and overly artificially stocking has led to a decline in the natural wild coho salmon population. Pollution and blocking the waterways interferes with the salmon’s migration path. Culverts can harm and potentially kill salmons in times of floods, droughts, and where strong currents occur. In 2012 one in every 316 coho salmon are natural wild salmon. We compared the Resurrection Bay estuary to the Eel River estuary in mid-California. The estuary has a 90% decrease in it’s original coho salmon population. One of the possible reason that numbers have declined so rapidly is over stocking. This is similar to what is happening to the Resurrection Bay estuary. Our solution of this problem includes lessening the amount of stocked fish, promoting and providing healthy spawning grounds, and adding more regulations on culverts. With our three part plan in order, the natural wild coho salmon population will be restored to its prime amount. The Resurrection Bay estuary will be restored to its peak once more and the fishery will have years of profit to be made of it.
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