

The copper river delta  
estuary  
environmental  
sciences essay



**ASSIGN  
BUSTER**

## **Abstract**

Chinook salmon (*Oncorhynchus tshawytscha*), also known as king salmon, are a crucial part of the economy and play a large role culturally. The Copper River fishery is one of the largest areas for harvesting Chinook salmon in the state of Alaska and shows a long history of the social importance of this species. Within the fishery, the Copper River Delta Estuary is vital to the life of juvenile Chinook salmon. In this fishery, especially in the estuary, this essential resource has been declining in recent years. This population has not been allowed the means to reinstate itself to a sustainable, healthy level. There has been little research done on the cause of the low population or the high mortality rate within the Copper River Delta Estuary. Looking at the Skagit Bay Estuary, it is apparent that we need to implement solutions because the Chinook population will not restore itself from a decreasing populace by human impact. Poorly enforced subsistence fishing regulations in the Copper River fishery and little protection from predators in the estuary have damaged the Chinook population, causing it to decline. In order to reverse the negative effect of human impact on Chinook salmon, we propose increased measures for regulations and managing vegetation in the estuary along with research within the estuary to effectively stabilize juvenile Chinook salmon health.

## **Introduction**

The Copper River Delta Estuary extends from the east outlet of the Strawberry Channel to the western edge of Controller Bay [Figure 1]. This covers, in entirety, 650 square kilometers. The estuary mainly consists of intertidal mudflats brought on by glacial sedimentation and contains

<https://assignbuster.com/the-copper-river-delta-estuary-environmental-sciences-essay/>

thousands of diverse species. These species include all five known species of Pacific salmon. It is also home to over 250 species of migratory birds. While the area is not known for the harvesting of organisms, it is essential to the growth of the many species that are fundamental to the local economy, culture, and ecosystem. Many species such as: salmon, 16 million shorebirds that gather each spring, sea lions, and others, inhabit the area. The juvenile salmon rely on the estuary for safety as well as the nutrients required for their migration to the ocean (Boggs 2012). The five Pacific salmon species found in the estuary are extremely important resources and are major components of Alaska's economy, contributing over 100 million dollars in 2011 in Prince William Sound (South-central Region, 2006). The Chinook salmon species, in particular, serves an essential role in the Copper River Delta Estuary (Barclay et al., 2009). The Chinook salmon has retained economic, ecological, and cultural importance for centuries among Alaskans and continues to uphold its integrity. The Chinook salmon is a main target species for sport, commercial, and subsistence harvesting. Main harvesting methods consist of netting, lining, and fish wheel entrapment. In 2012, the preliminary total run estimate was 46, 000 Chinook salmon. This estimate was 28, 000 less fish than the average run in the years 1980 through 2011, which was 74, 000 fish (Moffitt, 2012). Current regulations mandate two king salmon per permit per two days for all sport fisherman, six-hour periods for the four fishing periods for commercial harvesting, and five king salmon per two days per permit for subsistence by use of fish wheel (Alaska Department of Fish and Game 2012). The regulations for commercial and sport fishing change frequently and are dependent on the previous year's run and escapement totals. While in the estuary the juvenile Chinook salmon have a

<https://assignbuster.com/the-copper-river-delta-estuary-environmental-sciences-essay/>

relatively high mortality rate; about 60 percent (Botz, 2012). Along with the high juvenile mortality rate, the return rate has been decreasing since 2008 [Figure 2]. The diminishing population has not yet delivered a truly detrimental hit to the economy, but the salmon population is foreseen to continue to fall. By looking at the Skagit Bay Estuary in Puget Sound, in northern Washington, evidence has been found that, after human impact, Chinook salmon are unlikely restore themselves naturally. In the Skagit River, pollution and overdevelopment have taken a detrimental toll on the river's Chinook salmon population. As a result of negative human impact and improper management, the population's health and run size have been largely compromised. The Skagit Bay Estuary, however, offers an optimum environment for juvenile Chinook salmon. The estuary offers a variety of protective vegetation, including eelgrass (*Zostera marina*), which is a key environmental factor in the migration of juvenile Chinook salmon (Beamer, 2005). Given the declining population of the Chinook salmon in the Copper River Delta Estuary and the model of the Skagit Bay estuary, efforts must be made to ensure the population sustainment and health. After reviewing the Skagit Bay Estuary, the need is evident to actively protect this valuable resource in the Copper River Delta Estuary. Regulations monitoring the adult population and an improved vegetative environment are thereby necessary to protect the juvenile population. The Alaska Department of Fish and Game currently accounts for the low Chinook population and carefully watches the commercial and sports harvesting. Subsistence fishing, however, has continued to be loosely regulated and participants continue to abundantly exploit the Chinook salmon, especially by use of fish wheels. Within the estuary, the lack of vegetation, specifically eelgrass, frequently attributed <https://assignbuster.com/the-copper-river-delta-estuary-environmental-sciences-essay/>

with juvenile salmon, is further decreasing the population. In this paper we will address the high mortality rate of the juvenile Chinook salmon in parallel with the declining adult population by addressing the factors stated previously. By first looking at the adequacy of regulations for harvesting, then working to sustain the juveniles within the estuary, we will present a plan to prevent a detrimental scenario, like that of Skagit Bay.

## **Physical Description of the Copper River Delta Estuary**

The Copper River Delta Estuary is a highly stratified estuary within the Prince William Sound. The delta covers about 120.7 kilometers of the coastline and consists of uplifted marshes, tidal flats, beaches, and dunes. The main driving force behind the dynamic and ever-changing nature of the estuary is the Copper River itself, which deposits, on average, 69 million metric tons of suspended sediments annually. The Copper River also is the main supplier of freshwater to the estuary. The river discharges approximately 1,630 cubic meters of water every second, but this value fluctuates greatly and peaks between the months of July and August, expelling close to 5,630 cubic meters of water per second during (Copper River Knowledge System 2005).

Formation of the Delta can be attributed to three main geomorphic processes: glacial, tectonic, and erosional. Glacial influence on the delta began approximately 9,000 years ago when the glacial dam that held Atna Lake failed, which resulted in a catastrophic flood. This flood drained the 5,180-square-kilometer lake and transported large amounts of sediments that first formed the delta. A more recent factor aiding in the formation of the delta is the tectonic uplifting in the region. This occurs roughly every 600 years and causes notable geographic changes. The latest tectonic uplifting in

the region was the 1964 earthquake. Erosion is a process currently affecting the delta. The process of erosion is extremely important to the overall success of the estuary as we see it today. The product of erosion, mainly in the riparian zone, is deposited to the outwash plains of the estuary. This sediment, mostly glacial silt, maintains the high turbidity within the system at around 574 nephelometric turbidity units (Kesti, 2004). Ecology of the Copper River Delta Estuary

The Copper River Delta Estuary accommodates all five species of Pacific salmon as well as many other Alaska sport fish. The delta hosts millions of birds during their annual migrations. These shore birds depend on the small fish, juvenile salmon, and herring as a source of energy after their passage over the Pacific Ocean and Gulf of Alaska (Copper River Knowledge System) 2005). During the bird's migration, juvenile Chinook salmon travel through the estuary on their way to the open ocean. As a repercussion, the juvenile salmon's mortality rate is dramatically increased during this time. Along with salmon, Pacific herring (*Clupea pallasii*) also reside in the estuary during their juvenile and spawning stages. Herring is a key food source for growing salmon in the ocean. Marine plant life is also essential, but, due to high turbidity, plant life is limited in the Copper River Delta Estuary. This deficiency increases the vulnerability of the juvenile fish species that use available vegetation for sanctuary from predators (Prince William Sound Science Center 2007). Another limiting factor to the species that inhabit Alaskan waters, including Chinook salmon, is the Pacific Decadal Oscillation (PDO). The PDO is characterized by a cycle of high and low productivity caused by warm and cold periods. It is similar to the El Niño Southern Oscillation (ENSO), which affects the majority of the South Pacific.

The salmon population fluctuation can be directly attributed to the PDO, <https://assignbuster.com/the-copper-river-delta-estuary-environmental-sciences-essay/>

because the cold periods of PDO limit primary productivity in the open ocean which, in effect, will decrease the overall population. In the high-productivity periods, or warm periods, salmon populations are usually much higher than they are in low-productivity periods, or cold periods (Mantua, 2003).

## **Chinook Salmon**

The Chinook salmon (*Oncorhynchus tshawytscha*) is the largest of the Pacific salmonids. These fish are distributed throughout the northern Pacific Ocean and are present in the river systems of North America, ranging from California's Ventura River to Alaska's Kotzebue Sound. In Asia, Chinooks are also distributed from Japan to as far north as the East Siberian Sea (Alaska Department of Fish and Game, 2012). Like all Pacific salmon species, Chinook salmon are anadromous, meaning they hatch in freshwater streams and rivers, migrate through estuaries to the ocean for feeding and growth, and then return to their birth waters to reproduce and die (BLM, 2012).

These fish typically have a life span of 3 to 7 years. As adults, Chinook salmon traverse the open ocean. They feed primarily on other fish, but also feed on planktonic diatoms, copepods, kelps, seaweeds, jellyfish, and starfish. These fish typically weigh about 14 kilograms and have a length of approximately 91 centimeters, but are capable of growing much larger. Most of a Chinook's body is dark gray or blue. Adults are recognized by an unsystematic array of black spots on the dorsal surface and fins. Chinook salmon have elongated bodies with conical shaped heads. Males are more boldly patterned than females and can be identified by their hooked noses. A unique trait of Chinooks is their black oral cavity. Adult Chinooks require a rich, open ocean habitat to acquire the strength needed to travel back

upstream, escape predators, and reproduce. Chinook salmon remain in the ocean for one to eight years, then, relying mainly on fat reserves, they return to spawn in their fresh water spawning streams (Alaska Department of Fish and Game 2012). Chinook spawn in larger and deeper waters than other salmon species and can be found on the spawning redds from September through December. Chinooks, like all salmon, need adequate spawning habitat. Clean, cool, well-oxygenated, non-turbid fresh water is essential for proper egg development. After laying eggs, female Chinook protect the redd for up to 25 days before dying, while males seek additional mates. All Chinook salmon die after spawning. Chinook salmon eggs hatch 90 to 150 days after fertilization. Egg deposits are timed to ensure that the young salmon emerge during the correct season to support survival and development (Alaska Department of Fish and Game 2012). When the alevin hatch, they stay in the gravel beds until their yoke sac is completely absorbed. Then, they feed on the streambed, as fry, until they are prepared for the migration downriver. Riparian vegetation and woody debris help juvenile salmon by providing cover from their many predators and maintaining low water temperatures. They feed on insects, amphipods, and other crustaceans. Fry usually stay in fresh water for 12 to 18 months before they travel to their respective estuary, where they remain as smolts for several months. Juvenile salmon grow in clean, productive estuarine environments and gain the energy for migration. They rely heavily on eelgrass and other seaweeds for camouflage, shelter, and foraging as they make their way to the open ocean. Later, they change physiologically to live in saltwater and grow into adults (Fisherman Direct Wildlife Pacific Salmon,



2007). The lifecycle of the Chinook salmon is similar to all Pacific salmon species [Figure 3].

## **History of the Copper River Basin**

The Copper River Delta Estuary has played an important role in the cultural and economic development of South Central Alaska; for at least a millennium, the Ahtna Athabaskan Natives inhabited the upper Copper River. In fact, "Ahtna" is the Athabaskan term for the Copper River. Most native settlements were either fish camps or winter villages along the river at lower elevations (Copper River Country, Alaska). The Copper River and its tributaries serve as spawning and rearing habitat for the five species of salmon. Salmon was one of the Ahtna's most critical food resources of the, and it remains an important dietary staple of Copper River Basin residents today. Major commercial development of the region began with the installment of the Kennecott Mine by the Kennecott Copper Company in 1910 after the discovery of the richest copper deposit in the world. The company also built a railroad between Cordova and McCarthy in order to transport raw materials, supplies, and workers. Perhaps the greatest social and economic impact to this region occurred with the construction of the Trans-Alaska Pipeline in the mid-1970s (Copper River Country, Alaska). This development greatly increased the region's population. Subsequently, these developments in oil and mining increased the fishing industry greatly. An average of one to three million salmon return to the Copper River annually. Five species of Pacific salmonids make up this mass migration. Of these salmon species, the Chinook salmon is the least common. In other words, it is a very vulnerable resource. This precious resource holds status socially, as

our state fish. Chinook salmon have been harvested commercially since the late 1800s (Barclay et al., 2008). From 2003 through 2007, an average of 38,000 Chinook salmon were caught commercially in the Copper River District annually. This is a relatively small amount of fish when compared to the astronomical Sockeye catch numbers. The Chinook salmon is also exploited through subsistence fishing. About 8,500 residents participate in the subsistence fishery annually. At the dawn of the 20th century, western pioneers instituted fish wheels in the Copper River. By 1920, fish wheels were one of the dominant methods of harvesting salmon for subsistence. On the Copper River, subsistence participation and harvest has increased from about 4,500 permits in 1984 to over 8,000 today. In 1984, 2,300 Chinook were harvested in subsistence fisheries; in 2003, 4,500 Chinook were harvested (Copper River Knowledge System, 2005). In recent years, Alaskans harvested an annual average of 6,000 Chinook using fish wheels in the Copper River (Copper River Country, Alaska). This increase in subsistence harvest accounts, in part, for the drastic decrease in the Chinook salmon population. Copper River Chinook Salmon Fisheries

## **Commercial and Sports Harvesting**

As a member of Alaska's world-renowned sport fishing industry, Chinook salmon play an important role in the Prince William Sound and Upper Copper River economic zones. Most fish are caught using fishing line through the use of various types of lures and additional tack (South-central Region, 2006).

The Chinook salmon is sought after in the sport fishery of South Central Alaska due to its ability to grow to sizes larger than any other Pacific salmon.

The sport fishery contributes to Alaska's economic growth largely in the

tourism industry. It provides guiding opportunities for local Alaskans to assist international and out-of-state residents in their search for a trophy fish.

Lodging and hospitality in the Prince William Sound area is all but dependent on seasonal fishing schedules. The Chinook salmon commercial fishery is located at the mouth of the Copper River. Chinook salmon are caught commercially using drift gillnets in the open ocean. Commercial fishing for Chinook salmon is greatly diminished by the monumental efforts put toward the celebrated Copper River sockeye salmon industry, even though wild Chinook salmon are actually much higher in nutritional benefits. Restaurants seek out the richly flavored and nutrient packed meat that is not available in the meats of raised salmon. Additionally, Chinook salmon, in 2011, sold for 5.33 dollars per 454 grams; comparatively, three to eleven times more than other salmon (South-central Region, 2006). In 2010, Alaska flew approximately 317,500 kilograms of this desirable salmon from the Copper River to the continental United States (Hedlund, 2010). The average Chinook salmon run size for the Copper River is 78,000 fish. Currently, the Copper River has an annual escapement goal of more than 24,000 Chinook salmon. The Copper River Chinook salmon sport fishery allows only two fish 50.8 centimeters or longer per day, with a limit of four fish per person annually (Alaska Department of Fish and Game 2004). In recent years, The Chinook salmon population and catch numbers have been radically declining. In 2011, the Chinook salmon fishery in the lower Copper River Region harvested a recorded total of only 72 fish that were approved by the Alaska Department of Fish and Game. In 2012, the commercial harvest of Chinook salmon in the fishing area outside of the Copper River east of Prince William Sound was 11,617 fish, which made up 97 percent of the total harvest of the <https://assignbuster.com/the-copper-river-delta-estuary-environmental-sciences-essay/>

Prince William Sound (Botz et al., 2010). This harvest was considerably lower than the previous 10-year average of 20, 000 fish (Hedlund, 2010).

## **Subsistence Harvesting**

The Chinook Salmon Subsistence Fishery in the Copper River consists of four fishing types. Gillnet fishing, as a type of subsistence fishing, occurs at the mouth of the Copper River. More prominent to the fishery, in terms of bulk harvest, are the fish wheels. Fish wheels are large structures designed to gather fish from a flowing river with minimal human effort. Fish wheel permit holders may only catch five Chinook salmon per 48 hours. Improper regulation of fish wheels in the Copper River may be responsible, in part, for the decline in Chinook salmon population in the ecosystem.

## **Skagit Bay Estuary Comparison**

Part of the Puget Sound Fjord Estuary, Skagit Bay Estuary is located approximately 65 kilometers north of Seattle, Washington, and is positioned between the mouths of the north and south forks of the glacier-fed Skagit River (Washington Department of Fish and Wildlife, 2012). Eelgrass habitat, located along the border of the Skagit River Delta, connects the river to the estuary. These habitats, as previously stated, are highly valuable to juvenile salmon. This rich estuarine environment, due to the mixing of fresh and saltwater and tidal action, provides critical habitat for many organisms such as shorebirds, waterfowl, fish, and other aquatic species. We chose this location because of the fact that its natural ecosystem is similar to that of the Copper River Delta Estuary and faces similar impediments. Furthermore, it contains the population of our select resource species, the Chinook

salmon, which are prevalent to our perspective of the Copper River Delta  
<https://assignbuster.com/the-copper-river-delta-estuary-environmental-sciences-essay/>

Estuary. Chinook salmon have been listed under the Endangered Species Act in the Puget Sound since 1999. This is primarily due to habitat loss, mainly from dredging, diking, and shoreline hardening (Skagit River System Cooperative, 2007). Skagit Bay was once known to support one of the largest wild Chinook runs in the Puget Sound. Regrettably, This thriving population decreased in 1999 when the returning wild spawning spring Chinook numbers had fallen to a mere 471 fish (Dean et al., 2002). Healthy estuarine habitats are essential for healthy Chinook populations. They provide juvenile Chinook salmon, who spend approximately two to eight weeks in the estuary, with physiological transition zones, important feeding locations, predator protection, and an environment for rearing and growth. Both Copper River Delta Estuary and Skagit Bay Estuary have many similarities in the composition of their habitats; both habitations include large mudflats and glacier-fed rivers: the Copper River and the Skagit River. This results in both of the estuaries having limited vegetation. Skagit Bay Estuary, however, has an organism that supports its inhabitants that the Copper Estuary lacks: eelgrass. Certain places in the Skagit Bay Estuary, like Padilla Bay, are known for having eelgrass. This sea grass provides protection for the juvenile Chinook salmon and allows macro-invertebrates to flourish. In the Copper River Delta Estuary, the turbidity prevents this plant from growing. Although Skagit Bay Estuary has prime habitat for juvenile Chinook salmon, the species is suffering due to negative human impacts. Twelve years after the original decline, a management plan was set in place, but the population is far from being restored.

## **Management Plan**

Although naturally occurring declinations in populations, such as those caused by the low- productivity period of the PDO, cannot be mitigated, there is much that can be done to safeguard the Chinook salmon population while the species' wellbeing is compromised. To protect and stabilize the population of our resource, our management plan needs to address the species' condition in the estuary and in the fishery. Our plan works to accomplish these goals by improving the natural habitat and increasing the spawning population of the Chinook salmon. We have created two implementations. Each implementation has been concocted with the overall estuary health, economy, and culture in mind and will benefit each of these aspects.

## **Increasing Vegetation**

This management plan considers the necessity of maintaining the current habitat of the Copper River Delta Estuary for Chinook salmon. Eelgrass is found in practically all estuaries that host juvenile Chinook salmon, including our comparison estuary Skagit Bay. Eelgrass provides essential cover from predators, increases dissolved oxygen level, and increases the macro invertebrate population (Chen, 2012). Currently, eelgrass is not found in the estuary due to the high turbidity. Our proposed procedure for the implementation of our management plan includes rooting genetically engineered eelgrass into the current estuarine system of the Copper River Delta Estuary. The genetically altered eelgrass could provide essential ecological components in the Copper River Delta Estuary. The gene SUB1, which increases water-submergence tolerance and, sequentially, turbidity

tolerance, would enable the eelgrass to survive in the Copper River Delta Estuary's high turbidity levels (Bailey-Serres et al., 2008). Genetically engineered plants have proven their success in many agricultural crops, allowing species to grow in different climates and conditions with no apparent negative effects. The SUB1 gene has already shown satisfactory results with its use in flooded rice crops in tropical, desert, and temperate regions (Global Rice Science Partnership (GRiSP)). Genetic engineering is still a developing scientific field. However, many species have had artificial cross-species gene transfers, especially between similar species. Of course, research development, preliminary experimentation, and in-lab cultivation would need to be accomplished in order to effectively transplant eelgrass into the Copper River Delta Estuary (University of Nebraska - Lincoln, 2001). This project will require the installation of 2.6 square kilometers of eelgrass in a location that will be later determined. Planting an acre of eelgrass has been estimated to cost 245,000 dollars (Fonseca et al., 2001). This includes the restoration site selection, National Environmental Policy Act compliance/permitting costs, preparation of map/ground-truthing sites, collection preparation and installation of planting units, restoration oversight/supervision costs, monitoring, and contracting profit on restoration/monitoring. This price, however, does not include the research needed to introduce the SUB1 into the eelgrass for its use in the Copper River Delta Estuary. We would allocate \$100,000 for this genetic engineering and could be done in partnership with the International Rice Research Institute, the original gene designers. Additional funding required could be requested from an organization like the Pacific Coastal Salmon Recovery Fund, which finances coastal recovery and habitat research <https://assignbuster.com/the-copper-river-delta-estuary-environmental-sciences-essay/>

projects. The estuary's health is a top priority. Therefore, the whole ecosystem must be taken into account with the addition of eelgrass. Many times when new species are introduced to new locations, they become an invasive species and overwhelm indigenous populations. However, the currently existing aquatic ecosystem within the delta lacks aquatic diversity and by introducing eelgrass, while it would disrupt current balance, would not create competition between species and would only expand the presently existent ecosystem. The bird life, which is essential to the ecological balance of the delta as well as predators of the juvenile Chinook salmon, would experience a small food shortage. This food shortage would be short-lived. Within a few years, the Chinook salmon population would restore itself, mitigating the issue (Bishop et al., 2001). Key indicator species used in the United States Department of Agriculture Classification of Community Types study in the Copper River Delta will further allow us to monitor the Copper River Delta to ensure we are maintaining an ecological balance and not solely benefiting juvenile Chinook salmon (Boggs, 2000).

## **Fish Wheel Harvesting**

An effective management plan for the sustainment of a species health must recognize the need to protect the species at multiple stages of life. In order to support our efforts in the estuary we devised a new method to properly enforce fish wheel harvesting in the Copper River Fishery. Our system achieves this with a slight variation in the live box portion of the fish wheel and only differs slightly from conventional design. Fish are caught and go down a chute into a live box. The chute is designed with padding to decrease chances of injury infliction and is equipped with a motion-sensing camera



located where the chute connects to the live box. The top of our livebox that connects to the chute only allows one fish to enter at a time. When a fish passes through, an image is taken that enables the recording of the numbers and types of fish that enter the live box into a database. The opening of the live box will also present a convenient way to log the frequency in which the fish wheel is checked onto the database [Figure 4]. These databases will be kept by the Alaska Department of Fish and Game, who is currently responsible for harvesting regulations. These adaptations allow for tighter enforcement of the current regulations. Our estimated cost for the live boxes to be added to existing fish wheels ranges from 2, 000 to 4, 000 dollars per apparatus. The overall implementation cost would approximately be around 24 million dollars. This estimate is based on the apparatus used in the 2011 U. S. Fish and Wildlife Service study in Fairbanks which includes the cameras, trigger system, hard foam padded chute, power source, and physical differentiation. It is important to keep in mind that this initial cost eliminates future costs associated with traveling and surveillance (Zuray, 2011).

Through the Fish Restoration Grant F12AS00032, funding could be provided for the implementation of the proposed improved live boxes by the U. S. Fish and Wildlife service (Fish and Wildlife Service, 2009)In a 2005 study done in Fairbanks by the U. S. Fish and Wildlife Service, finding the recorded fish and actual catch, employed a method much like this and found a four percent error over the two-year study (Daum, 2005). A four percent error at the currently low Chinook population could result in a 2, 000 fish run loss. This new system will allow the Alaska Department of Fish and Game to ensure regulations are followed. We suggest that a new regulation be put in place that mandates all fish wheels in the Copper River Fishery to have this live

<https://assignbuster.com/the-copper-river-delta-estuary-environmental-sciences-essay/>

box adaptation in order to be legal. Cultural and social importance is not to be set aside. Fish wheels are a prominent part of many Alaskans' way of life. Many Alaskans employ fish wheels each season in the Copper River Fishery (Copper River Knowledge System, 2005). Due to their integral reputation to Alaskan culture, fish wheels have been able to escape the rigid regulation that watches over different types of fish harvesting methods. This leniency could be afforded in past decades when the Chinook salmon had a sustainable population, but recently, with the decline of Chinook, this clemency cannot be overlooked. Commercial and Sport harvesting fisheries are successful, largely based on Chinook harvest, and have already experienced setbacks (Alaska Department of Fish and Game, 2008). Our live box adaptation will ensure a healthy supply of Chinook salmon to residents by confirming that the resource is not being exploited, but being preserved.

Conclusion Recent trends in the population of the juvenile Chinook salmon in the Copper River Delta Estuary, further exemplified by the decreasing adult population, display the reduction of the abundance of Chinook salmon. Research, economic reports, and cultural history support the importance of this resource as well as our need to take action. In comparison to Skagit Bay Estuary, we see that the Chinook salmon population will not restore itself naturally and will continue to steadily decline. Thus, it is necessary to manage the resource within the estuary. Through the modernization of fish wheel technology, the increase in research accessibility, and the improvement of the estuarine habitat we can reverse the decline and stabilize the health of Chinook salmon population. These solutions would permit the adult population to increase, preserve the juvenile salmon, and allow more research to be done for further understanding.

<https://assignbuster.com/the-copper-river-delta-estuary-environmental-sciences-essay/>