Pebbles of Gold or Salmon of Time: Pebble Mine and the Cultural and Environmental Economics of Alaska Natives [1]

By
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Alaska still has what most of America has lost. Rick Halford, former Alaska State Senate President[3]

Abstract
Alaska's Bristol Bay is home to the most productive salmon runs in the world. For over 9,000 years, the indigenous people of the region have survived because of the salmon. In 2005 the Pebble Mine Project was proposed by the Pebble Partnership (PLP). The project proposal is to extract massive deposits of copper, gold and other minerals from the mountains making up the headwaters of Bristol Bay. The proposal has polarized people within the Native communities of the region. This case explores the trade off that is often made when jobs and profit are pitted against environmental protection.

Introduction

The Bristol Bay region is home to the most productive salmon runs in the world. Bristol Bay is Alaska's richest commercial fishery, and all five species of Pacific salmon (pink, chum, sockeye, coho, and chinook) spawn in the rivers and streams that feed into the Bay. For over 9000 years, the indigenous people of the region have survived because of the salmon. For decades the region has supplied salmon throughout the world. In 2007 the Pebble Mine Project was proposed by the Pebble Partnership (PLP). The Pebble Partnership was created in 2007 by Northern Dynasty and Anglo American. Northern Dynasty, a junior mining company, has never managed a mining operation to date. Anglo American is one of the largest mining companies in the world. The company began operating in the gold and diamond mines (of) during the period of the apartheid-governance system in South Africa.Apartheid-governed South Africa. It expanded this role leading up to and during why cap Apartheid to the point that it controlled large portions the South African economy. Anglo currently is responsible for active and retired mining operations around the world that have severely polluted the surrounding environment and sickened the nearby residents. From 2003 to 2008, 220 mine workers died at Anglo mining operations (Mattera, 2008).

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[3]Taken from Bristol Bay in the News by Shoren Brown. http://www.savebristolbay.org/blog/bristol-bay-in-the-news-November 27, 2012

The partnership proposal is to extract massive deposits of copper, gold and other minerals from the mountains making up the headwaters of the Bristol Bay Region of southwest Alaska. The PLP project is located on state land and is in the advanced exploration stage.

The proposal has polarized the Native communities of the region pitting those in favor of economic opportunity in the form of jobs versus those who want to protect their fishing industry, culture and the environment that it is tied to. This case explores the trade off that is often made when jobs and profit are pitted against environmental protection.

The Pebble Mine Region

Bristol Bay is the eastern-most arm of the Bering Sea. The Bay is 250 miles long and 180 miles wide at its mouth. A number of rivers flow into the Bay, including the Cinder, Egegik, Igushik, Kvichak, Meshik, Nushagak, Naknek, Togiak, and Ugashik. Bristol Bay was formed by glacial recession that took place over 10,000 years ago. The alluvial habitat of the watershed is made up of large gravel deposits left behind by glacial tilling, making the rivers and lake shores of the region perfect for salmon production. The Bristol Bay ecosystem (Figure 1) supports a wide variety of natural resources which sustain major commercial, subsistence, and recreational activities.

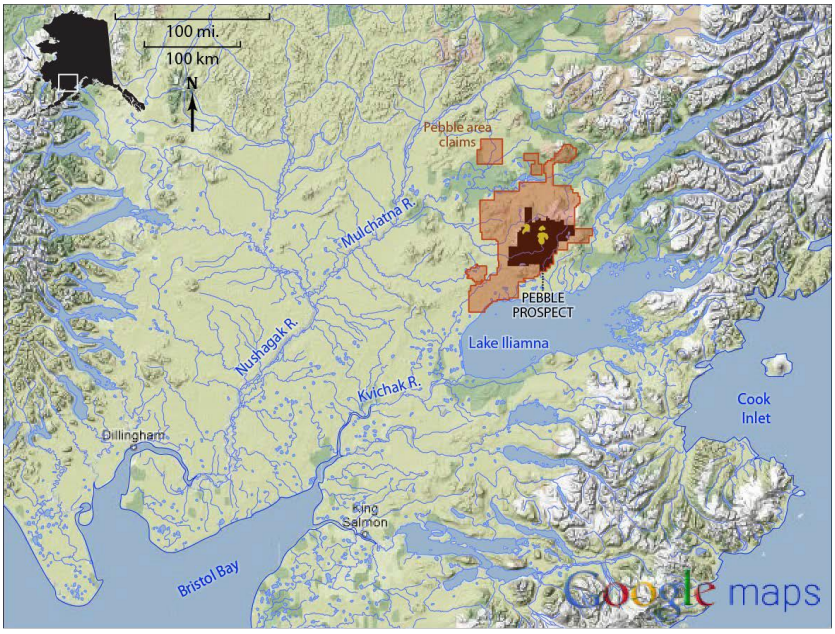

Figure 1. Location of the Pebble Mine (Woody et al.).

The world's largest sockeye salmon runs, comprising about 51% of world commercial harvest, originate here. This area is also one of the most geologically active areas of North America. A string of over two dozen active and dormant volcanoes begin in Katmai National Park and continue along the Alaska Peninsula (Figure 2).

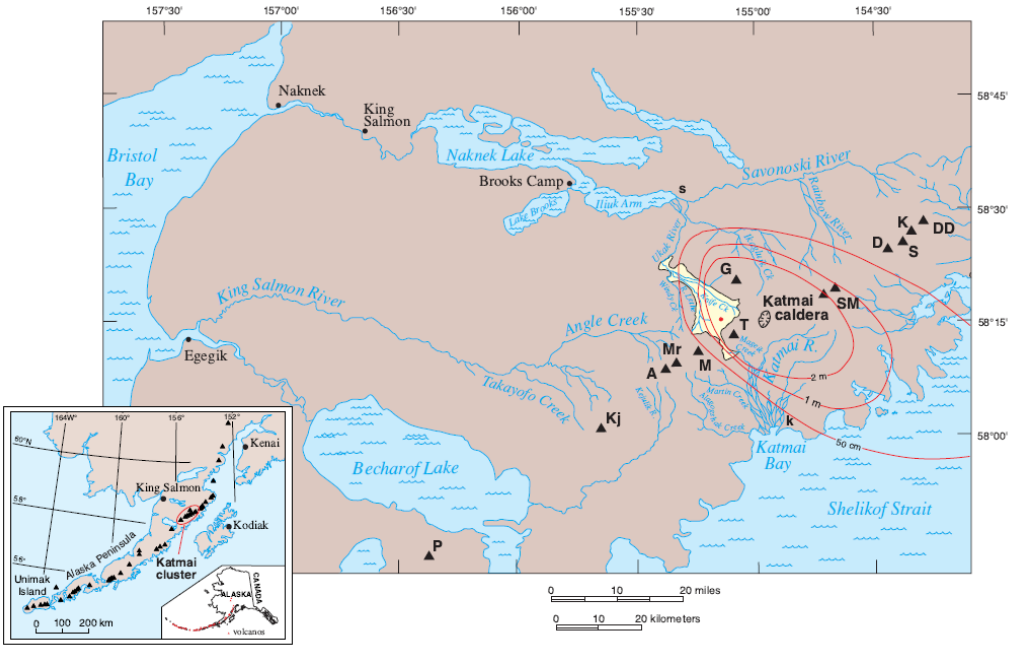

Figure 2. Bristol Bay region dormant and active volcanoes (Hildreth et al., 2003).

Katmai, which had an eruption in 1912 that was more than 23 times as powerful as the Mt. Saint Helens eruption, is located about 93 miles from the proposed mining location (Hildreth et al., 2003). The area is seismically active as well. In addition to the seismic activity along the volcanic terrain, the largest earthquake ever recorded in North America, 9.2 on the Richter scale, occurred in the subduction zone of the Aleutian Trench, which lies approximately 125 miles south of the Pebble Mining location near the Shelikof Strait.

The mining site sits between the headwaters of two of the region's most important salmon producing systems. The Kvichak (*KWEE-jack*) River headwaters begin at Lake Illiamna and flow 60 miles into Bristol Bay's central arm. The native communities of Illiamna, Levelock, and Igiugig are all within the Kvichak River drainage. The Kvichak is used as a short cut by boats going between Cook Inlet and Bristol Bay via Lake Illiamna, Alaska's largest freshwater lake. The Koktuli River, in the heart of the proposed mining area in the Central Alaska Mountain Range, feeds the Nushagak, which flows for nearly 300 miles before emptying into the northern arm of Bristol Bay. Major tributaries to the Nushagak include the Mulchatna River, the Nuyakuk, and the King

Salmon River. Several Native villages and the town of Dillingham, an important fishing town, are dependent on the river (Figure 1).

The Mine

Based on preliminary mining plans submitted to the state by the PLP, the proposed mine will be the largest mine in North America and one of the largest in the world. The mining will be primarily open pit, the largest of which will be over two miles wide and several thousand feet deep.

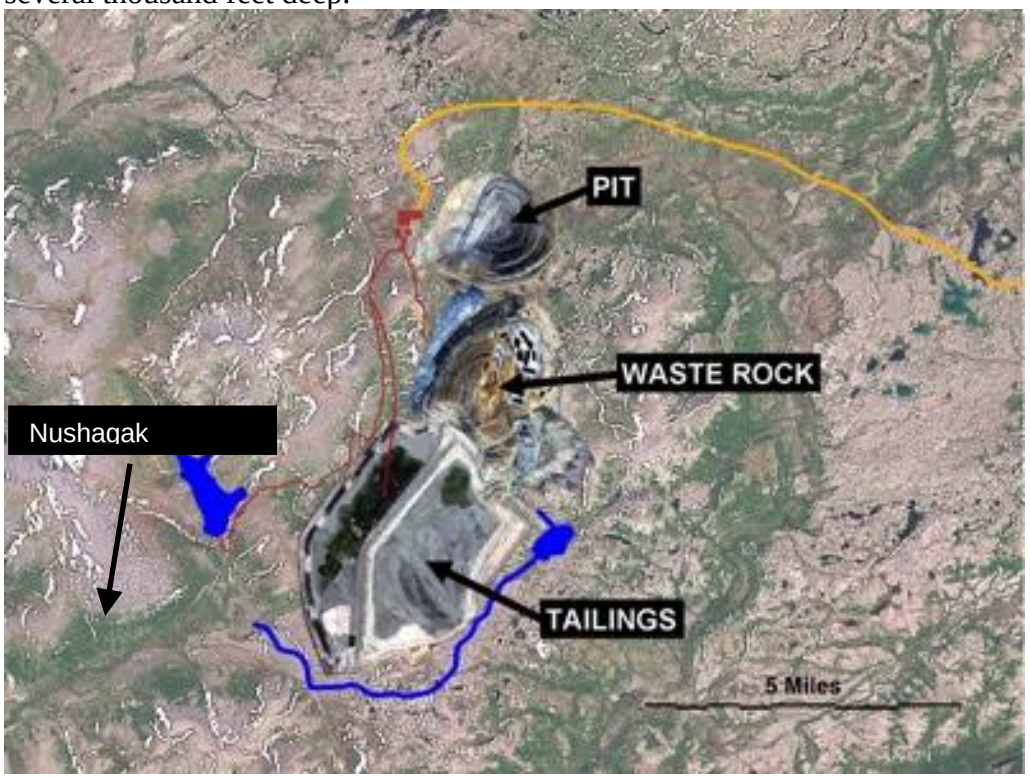

Figure 3. Illustration of open pit mine at Kvichak and Nushagak headwaters.

The proposed location for the tailings pond would completely destroy an existing freshwater lake, Frying Pan Lake. Past mining executives have called Frying Pan Lake (named not for its shape, but because Alaska Native people used to bring a frying pan up to the lake and catch trout and salmon in the lake and cook them) "just another glacier-scoured hole in the tundra" (Chambers, personal communication, 2013). An open pit mining method is used when minerals are located near the surface. Large pits are dug in a series of benches. These benches provide stability and access to remove the material being mined. Mining waste or tailings will be stored in a large reservoir at the headwaters of the Kvichak and Nushagak rivers. The giant dam, over 740 feet tall and 4.3 miles long, will hold back over ten billion tons of acidic mining waste (tailings) (Wild Salmon Center, 2012). This dam would need to be monitored and maintained in perpetuity.

PLP submitted development applications for an environmental review known as an Environmental Impact Statement (EIS). The process is a multi-year federal and state investigation that also includes multiple opportunities for formal public comment and

independent agencies' agency reviews. The Alaska Department of Natural Resources is responsible for coordinating the state permitting process. Under the guidance of state and federal agencies, the Pebble Partnership is collecting the majority of environmental data for the EIS.

The Mining Impacts

According to environmentalists and leading scientists across many disciplines, a tailings spill could destroy the current Bristol Bay ecosystem (Versar, 2012). The EPA's draft assessment describes in some detail the potential impacts of a catastrophic tailings dam failure, and several scientists' reviews of the report agreed with the assessment. David Atkins, the principal hydrologist from the review team, noted that the tailings dam failure would be catastrophic for the fishery. He went on to say that a tailings dam failure could harm a very large area of the watershed that would require a massive, expensive, long term cleanup effort (Versar, 2012). However, even without a spill, mining activities would have major impacts as well. The disruption of the headwaters is of major concern for many fishery scientists. Fundamental to that concern is the disturbance of groundwater sources in the mining area. The Nushagak and Kvichak rivers originate from the groundwaters at the Pebble mine site. Groundwater-fed rivers are primary producers of salmon in Alaska because they maintain ice-free habitat during the cold winter months. These groundwater flows protect fish eggs from freezing and provide navigable river for foraging juveniles once they have hatched (Woody, 2011). One of Northern Dynasty's previously hired hydrologists has called the area "the most complex watershed [he] has ever seen" (Chambers, personal communication, 2013).

Mining activities affect water quality and quantity as well. These impacts can occur throughout the mining period. Adverse impacts such as dewatering of streams and aquifers and water contamination can occur as a result of the removal of the alluvial sediments and rocks being mined. These impacts can remain for decades or even hundreds of years. Water flow patterns impacted by mining practices can disrupt underground hydrologic exchange between adjacent river systems and tributaries. These pathways can also lead to the contamination of ground and surface waters. The animals associated with these aquatic environments can be negatively impacted by the contaminants that include heavy metals, acidity increases, and a diverse list of chemical pollutants (Woody, 2011).

A primary function of alluvial sediments at the headwaters of groundwater-fed rivers is the cleaning properties they perform. These sediments act as a filter removing natural contaminants and fine sediments keeping the water and spawning gravel of the downstream rivers clean. Removal of these sediments for mining purposes will eliminate these cleaning properties as well.

Tailings storage, however, represents the most significant risk to the environment of Bristol Bay and the rivers and streams that feed into it (Chambers, 2011). The elements and compounds uncovered and liberated through mining and processing, which are not usually part of the ecological systems, have the potential to have very significant impacts on water quality. Over 10 billion tons of material will be contained in the Pebble

Mine impoundment. A short list of the elements contained within the mining waste includes copper, arsenic, mercury, sulfur, cyanide, sulfuric acid and hydrocarbons (EPA, 2013). These mining wastes will be covered with water and stored behind a giant earthen dam. This dam will need to be managed forever for structural integrity and the water that will be drained from the tailings pond to keep it from overflowing will need to be treated to remove all contaminants.

Requirements for Mining

Pebble mining interests maintain that the mining can coexist with a productive Bristol Bay environment. They point to environmental requirements that will be met through the permitting process by the State of Alaska as the avenue by which the protection of the environment will be ensured. The PLP intends the mine to be state-of-the-art and says that the company will go above and beyond the state requirements. For example, instead of building roads to the mine through fragile tundra, they will use helicopters to bring in most of the equipment. They intend to extensively monitor groundwater. The PLP has spent over one hundred million dollars on studies investigating the mine's potential environmental and cultural impacts. These reports contain reassuring data and language about air, soil, and water quality.

The purpose of the baseline information has been to develop a detailed description of the environment surrounding the project. Water quality, wildlife and fisheries, climate, air quality, land use, and subsistence resources were assessed. According to the PLP, the baseline data have four important uses: 1) To help Pebble Project regulators, stakeholders and the public understand the environment in and around the proposed project area. 2) To provide environmental input for the design process and ensure that the project will meet the requirements of state and federal regulators. 3) Baseline data are required as the basis for the environmental impact statement (EIS) mandated under the Federal National Environmental Policy Act (NEPA) as the process to identify and assess potential environmental and social issues related to the proposed project before it is built. 4) The data will support permitting efforts and a long term monitoring plan. PLP recently released 27,000 pages of analysis related to its mining claim (Pebble Partnership, 2012).

The Pebble deposit sits on a chunk of state land that, according to the State of Alaska Department of Natural Resources (ADNR) Bristol Bay Area Plan, is managed for multiple use and is open to mining. The state included much of the land in the Bristol Bay planning area because of its mineral potential, as well as its potential for oil and gas. In 1984 the original plan set aside 12 million acres of the Bristol Bay uplands and shores as wildlife habitat. In 2005 a revision of this designation reduced fish and wildlife habitat use by 90%. The area was also reclassified with mining as the co-designated use without listing a secondary use. The plan prohibits other uses not specifically designated if they are considered in conflict with mining (Wild Salmon Center, 2012).

The submittal of a mining plan will require an Environmental Impact Statement (EIS) in accordance with the National Environmental Policy Act (NEPA) (Wild Salmon Center, 2012). The NEPA process will be a multi-year federal effort that mandates multiple opportunities for formal public comment and agency review. The Alaska Department of

Natural Resources, Office of Project Management and Permitting, is responsible for coordinating the state permitting process. The State is monitoring PLP's collection of baseline environmental data for the project area. State and federal agencies are providing guidance to PLP for this data collection effort. Once Pebble files and completes the EIS and NEPA permitting process the State will engage with PLP to make sure that state permitting requirements are satisfactorily met. If the PLP can meet the state's requirements the project will be permitted (State of Alaska Department of Natural Resources, 2005).

The chance of ADNR permitting the mine is high, as the State of Alaska has never denied a mining permit. Sharmon Stambaugh, Large Mine Project Coordinator in the Office of Project Management and Permitting (OPMP), Alaska Department of Natural Resources, when asked about the state's mining permit approval record, had the following comments:

> *There are many different individual permits that are required. It's important to understand that the state doesn't own or control the permitting process. Federal agencies also must issue authorizations, and no one agency's permit trumps any other agency's permitting requirements. Permitting is an iterative process. Some projects, or some regulated aspect of them, have been denied permits initially, with the application sent back to the applicant for additional information, analysis or modifications. Several projects the state has reviewed, due to either permitting or financial reasons, were stopped after the Federal NEPA process* (Pebble Watch, 2013).

With so much at stake, nine Bristol Bay Tribes, the Bristol Bay Native Corporation, other tribal organizations and many groups representing commercial fishing interests from the area requested the Environmental Protection Agency (EPA) investigate the potential impacts, and in May 2012, the EPA released the draft Bristol Bay Watershed Assessment (EPA, 2012). On November 9th 2012, a report from twelve independent scientists released a review of the report that offered recommendations for improvement but commended the EPA for the first comprehensive investigation that was not done by PLP (Versar, 2012). The report did however also contain some commentary that was critical of the EPA Assesment. Below are some primary examples from some ot the reports authors.

"Unfortunately, because of the hypothetical nature of the approach employed, the uncertainty associated with the assessment… the utility of the assessment, is questionable." -- William A. Stubblefield, Senior Research Professor, Department of Molecular and Environmental Toxicology, Oregon State University[6]

"There is no detailed discussion of engineering practices. There is insufficient discussion of any potential mitigation measures and there is a lack of any detailed research into applicable engineering and mitigation methods." -- Steve Buckley, geologist with 25 years of experience in earth science, specializing in fluvial sedimentology[7]

"Without a more detailed understanding of the mine plan and associated engineering, as well as additional detailed analysis, it is difficult to determine if the failure probability estimates presented in the Assessment are reasonable." -- David Atkins, hydrologist and expert in mine hydrology and geochemical assessment[8]

"Some of the assumptions appear to be somewhat inconsistent with mines in Alaska. In particular, the descriptions or effects of stream flows from dewatering and water use do not account for recycling process water, bypassing clean water around the project, or treating and discharging collected water." -- Phyllis K. Weber Scannell, environmental consultant and former biologist for the Alaska Department of Fish and Game[9]

"If the risk to fish cannot be quantified because there is little or no demographic information, then any evaluation of risk to wildlife can't be quantified and must be qualitative. Merely stating that a qualitative increased risk for fish will also result in qualitative increased risk for wildlife is not adequate. I do not understand why the scope of the main document is limited to an indirect evaluation of fish-caused risks to wildlife."-- Paul Whitney, retired wildlife ecologist with extensive experience in fish and wildlife interaction[10]

The EPA is considering the recommendations before finalizing the Watershed Assessment. The report found that the mine would have significant impacts on fish populations and the watersheds surrounding the mine. The report went on to indicate that the mine would eliminate nearly 90 miles of salmon streams and impact over 2000 acres of wetlands at the headwaters of these important rivers. The report's final conclusion was that a tailings dam failure would be catastrophic to the ecosystem and the region. Findings from the report could lead the agency to stop further actions related to the mining claim because of violations to the Clean Water Act.

The State of Alaska reviewed the EPA report as well, and in a letter to the EPA made the following observations about the assessment (ADNR, 2012):

- The assessment draws speculative conclusions about potential impacts from a hypothetical large mine.
- Insufficient technical and scientific support for conclusions based on groundwater/surface water interconnections in the study area.
- Inadequate consideration of mitigation measures
- Data presented is not representative, complete or current.
- Incomplete and selective discussion of socio-economic impacts and potential benefits of mining.
- Unclear risk assessment methodology.
- Inconsistent scale and scope of project area.
- Non scientific presentation of the Assessment

The State has also been critical of the EPA's legal authority to make an assessment under The Clean Water Act. The State's position is that it actively protects the water, fish and wildlife, and subsistence uses in Alaska. The State cites its constitutional

mandate and other statutory obligations and prerogatives to manage its lands, waters, and resources for the maximum benefit of its citizens. The State believes these authorities are consistent with the management rights and authorities that Congress reserved to them under the Clean Water Act. As a result the State contends it will manage and implement a future Pebble mining project using its authorities in a balanced and reasoned manner to provide protection for waters, wetlands, habitat and wildlife. In addition Alaska will provide economic opportunities that necessarily depend upon responsible resource development, such as mining projects (ADNR, 2013).

During the public comment period of the EPA's review, the PLP addressed the EPA criticism as well, maintaining that the area can be mined safely while residents of the region continue fishing for salmon in Bristol Bay. The PLP review of the EPA assessment states that the EPA ignored its own standards and prepared a document that does not withstand professional scrutiny. Paramount in the critical review is the fact that the mine is evaluated based on a hypothetical mine that the state and other federal agencies would never have permitted. They recommend the EPA improve the watershed assessment portion of the report and wait until the final mining plan is released to review the impacts. They are adamant that if PLP becomes convinced fishing and mining cannot coexist, then the mine will not go forward (Northern Dynasty Mining, 2012).

The Native Community

According to the First Alaska Institute, the Bristol Bay region is home to nearly 5,800 Yup'ik Alaska Natives. These diverse people live in over 25 communities, each having their own distinct language and dialect (BBNC, 2012) (Figure 3).

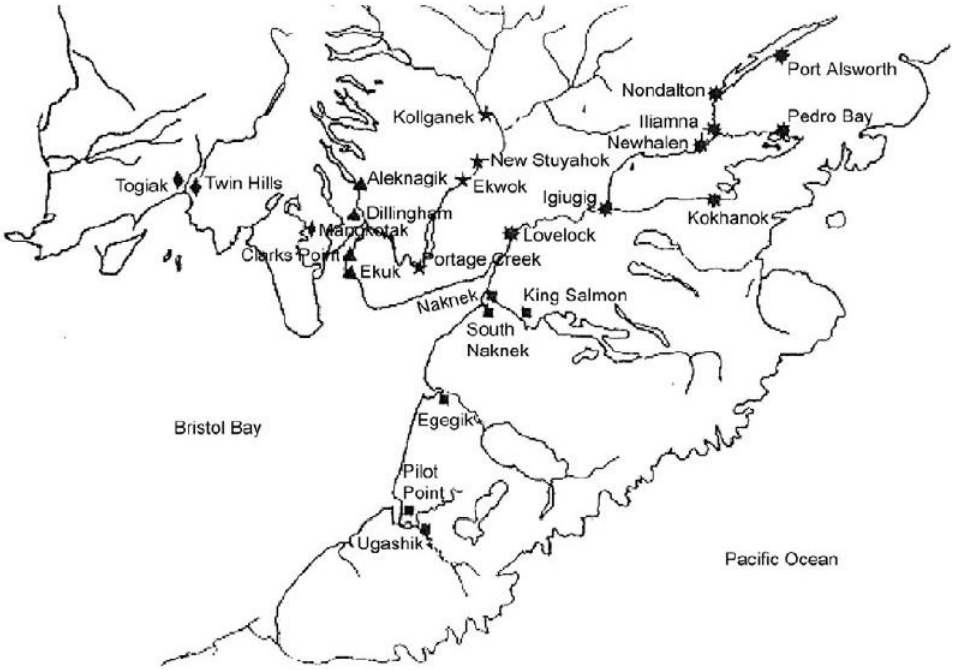

Figure 4. Native communities around Bristol Bay. (Duffield et al.)

For thousands of years, the Yup'ik have occupied the Bristol Bay region. Their history in the region is one of a culture dependent on hunting and gathering. The Aleut and Alutiiq who live on the Alaska Peninsula facing the Pacific were skilled kayakers subsisting mainly on fish and sea mammals. These resources were not only harvested for food, but also for clothing, boats, and as oil for lamps. Wildlife such as caribou were harvested as well. Nets made from seaweed and tree roots were used to capture birds and fish. In addition whales were an important resource. The Dena'ina Athabascans live around Iliamna Lake and Lake Clark and subsisted primarily on the abundant runs of sockeye salmon. They also hunted moose, caribou, bear, beaver, porcupine, and waterfowl. They made canoes from a combination of birch bark, moose hide, and cottonwood. The Yupiit on the Bristol Bay side of the peninsula were salmon dependant but supplemented salmon with caribou, moose, bear, and other land animals. Salmon was harvested with the use of gill nets made of spruce root, while smaller fish were taken with scoop nets. Fish traps, harpoons, weirs and bone hooks were also used to take fish. Caribou were prized not only for their meat but for their skins which were used to make clothing and/or to trade. Brown bear skins were prized for bedding and as hangings at entrances in place of doors (BBNC, 2013).

These people of the Bristol Bay region were, and still are, heavily tied to the natural resources of the region. They gather berries and plants such as greens, mushrooms, and seaweed for food. In addition other plants and berries are gathered for medicinal purposes. Today, many Alaska Natives of the Bristol Bay region continue to live in the same location as their ancestors. They have a rich and diverse culture that is still tied to tradition, including dance, song, stories, and traditional food sources from hunting and fishing. In 2010 the median household income was $32,634 (First Alaska Institute, 2013). Nearly all the households rely on commercial fishing, subsistence harvest and other mixed cash economic opportunities, most of which are reliant on wild, renewable resources. In 2011 Bristol Bay subsistence fishers harvested about 140,000 salmon, preserving most for winter, following thousands of years of tradition (Salomone et al. 2011). These subsistence food sources are important, as many live below the poverty line (BBNA, 2011).

PLP indicates the mine will help the local communities by providing jobs and contributing to the greater regional economy, providing opportunity for successful business development. The mine proposal has polarized people within the region's Native community, however. Some are in favor of mining because of the job opportunities it creates, but others are concerned about losing their ties to salmon and their culture. Many see salmon as a renewable resource that has been part of their culture in the region forever. Organizations like the Bristol Bay Economic Development Corporation (BBEDC, 2012), which help guide economic opportunity on behalf of the Yup'ik people and the Bristol Bay Native Association, have spoken out against the mine's claims of economic opportunities, indicating that once the gold and copper are removed, they will be gone forever: however the salmon come back every year (BBNA, 2012). In addition, they are skeptical about whether Alaska Natives will get any of the

jobs being created. Some Alaska Natives, however, see Pebble as the future of the region's economic opportunity and welcome the 2800 jobs PLP says will be created. They believe the subsistence way of life is a thing of the past and note that the high cost of living cannot be offset by commercial fishing anymore (Frontline, 2012). The mine is opposed by most. In June 2011 the Craciun Research group found that 86 percent of Alaska Natives in the region opposed the mine (Craciun Research, 2011).

As part of the EPA assessment of Bristol Bay, the impact to the culture of the region was investigated. This study was conducted by cultural anthropologist Dr. Alan S. Borass et al. by asking questions of the native residents of the region. Examples of the questions asked were these: "How is wealth defined in this community?" "If you couldn't have wild salmon, what would you do?" and "Do you pray when you catch salmon?"

One of the most striking answers came from a Yupik man who indicated that salmon was their main food source: "If we lose it we will starve." According to Dr. Borass and company, the answers did not include phraseology like "we will find alternatives" or "we will have to move." Moving away and eating something else are not considered as an option. When asked about the definition of wealth, the Borass team reported that people would answer in one of three ways: a freezer full of salmon, family, and freedom. Monetary explanations are not included in the answers. The heavy reliance on salmon in a subsistence diet permeates the culture at every level. People are concerned that if you take away the salmon, the long cultural tradition will die out. Dr. Borass and his colleague recognized salmon as the engine that drives cultural values that are passed on. He noted that salmon were important in guiding lessons like how to handle fish, how to act around nature, how to be Yup'ik or Dena'ina in these particular areas, how to live as an adult, and how to conduct yourself right.

Clean water had a religious significance as well. The Great Blessing of the Water is a ritual held every year in which an orthodox cross is carved into the ice over the river and a priest baptizes the water. The baptism is meant to remove human-caused contamination. The water then is made ready for the salmon to return. Dr. Borass concluded that the loss or degradation of salmon in the region would have the following cultural impacts:

- Degradation of nutritional health due to diminishment of subsistence foods and lifestyles.
- Loss of political power due to becoming a minority in one's own homeland, if there's an influx of outsiders to the region due to extractive resource development.
- Deterioration of mental health due to the loss of culture and meaning for life.
- Loss of language and traditional ways to express relationships to the land, one another and spiritual concepts.
- Loss of meaningful work by extended families operating together as a cohesive unit.
- Reduction of gender equity resulting from loss of important economic activities and social networking opportunities due to the potential diminishment of

subsistence foods and harvest preparation and the replacement of this with jobs that are typically more accessible to men or to fewer women such as those who do not have small children.

- Loss of the means to establish and maintain strong social networks through sharing.
- Impact on belief systems that revere clean water and a clean environment.
- Increase discord in and among villages.

Borass et al. concluded that no one stands more to lose than the native people of the region if something were to happen to the salmon (Borass & Knott, 2012).

Salmon, Culture and Minerals: How much are they worth?

At the most fundamental level the Bristol Bay region is a fishing economy. Salmon are the driver of the ecology of the region, a keystone species, and help support the production capacity of other harvestable populations of pollock, cod, rockfish, halibut and crab fishing in the outer Bay. For example, juvenile salmon provide a food source for pollock, and other commercial stocks (Sturdevant, 2011) Adult salmon that die after spawning are an important nutrient base for the trophic food chain of the entire Bay. In addition salmon carcasses are an important food source for crab in the Bay. From 2005 to 2008, the value of fisheries in the area averaged $463 million annually, with five commercial species (salmon, pollock, King crab, Pacific cod, and halibut) accounting for almost 95% of that value. Salmon is the largest fishery in the Bristol Bay region, contributing one-third of total fisheries value. Four species (pollock, salmon, Pacific cod, and herring) account for almost 96% of total pounds landed.

According to the PLP, the Pebble deposit is among the largest copper-gold systems and one of the greatest stores of mineral wealth ever discovered. In total, the current Pebble estimate includes 5.94 billion tons of measured minerals, containing 55 billion pounds of copper, 67 million ounces of gold and 3.3 billion pounds of molybdenum. It is estimated the mine contains an additional 4.84 billion tons in the inferred category, containing 26 billion pounds copper, 40 million ounces of gold and 2.3 billion pounds of molybdenum. Quantities of silver, palladium and rhenium also occur in the deposit. It is a known mineral resource with the volumes, grades, metallurgy, geometry and potential to support a modern, long-life mine. The value of the minerals extracted from the mine is estimated to be between 250 to 500 billion dollars over the 100 year lifespan of the project (Northern Dynasty, 2013). These value estimates encompass such a wide range because they are dependent on supply and demand governed by global economic viability. In addition the estimates are strictly based on the value of the minerals given market conditions and are not estimates of profit that would include the cost of mining. Given the significance of the economic opportunities at stake, how can the opportunities for profit from the mine and the contribution to the local cash economy be measured in relation to the environment, natural resources and cultural value in the region?

Model 1: Private investment analysis. This model measures mine revenue from the sale of the target minerals versus the cost of the extraction, which would include the expense of permitting and the regulatory measures of environmental protection. This simple,

profit based method is the assessment model that has been used to evaluate the profitability of development actions for hundreds of years. In the case of the Pebble mine the flaw of a simple private investment economic model is revealed by the fact that the mine will produce over 200 billion dollars in minerals, yet the mining plan calls for a dam and wastewater treatment facility that would need to be maintained and operated forever. How can the economic model effectively predict the cost associated with maintaining the dams' waste forever?

Model 2 Conventional Cost-Benefit Analysis

Cost-benefit analysis is a common economic model that is used as part of a public process to determine all of the consequences of a policy or project. It can cover the immediate costs and benefits, secondary impacts like pollution from spillovers and the existence value---or what people would pay to keep the area "pristine" or leave certain features functional or in pristine condition. .

An overly simplified application of this method might only assess the direct market based costs and benefits and is not comprehensive. If cost-benefit analysis on environmental policy is not done correctly in a way that allows for assessing the secondary impacts and the existence value, it would fail as a decision tool for public processes. Poorly applied, the results can be seen in the conditions of our environment in relation to development actions throughout the world.

Services like providing breathable air and drinkable water, called ecosystem services, are required to support the people and animals. If the cost-benefit method is too narrow in scope or it is mis-applied as a way of getting speedy approval for a project, it fails to make a full assessment of these components.

Model 3a: Cost-benefit Method Using the Environmental Economic Model

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The environmental economic model utilizes the cost of marketable natural resources lost to help estimate the actions and dollars needed to mitigate resource loss as part of the cost-benefit method. This model incorporates the potential loss of marketable environmental resources, in this case fish and fishing jobs, against the mineral's value. In evaluating the economic benefits of the Bristol Bay fishery against the economic opportunities presented by the extraction of resources from the mine, the risk to marketable natural resources posed by the mine needs to be calculated. Fundamental to this analysis is the fact that the fishery resource is renewable while the mineral extraction is finite. This model includes the costs of secondary impacts. If the proposal would result in pollution, than the cost-benefit method using the environmental economic model application assesses the cost of cleaning up pollution. These impacts associated with a proposed action are sometimes called externalities by economists and they can be given market-based costs. The existence value of a natural environment or environmental feature can be given an "existence value." For example, researchers would conduct a survey to find out how much people would pay to keep Bristol Bay in pristine condition. Using this technique, sometimes called conditional valuation, a

monetary value can be assigned. The Department of the Interior has been using this type of analysis since the Clinton administration.

Model 3b: Cost- benefit Method Using the Ecosystem Services Model
This model adds a more holistic assessment that is gaining ground in the practice of expanded environmental economic models that add the valuation of ecosystem services. The idea behind this model is that ecosystems provide goods and services that are valuable and essential to the culture, the quality of life, economic prosperity and natural beauty of the area being considered for development action. When these ecosystem services are lost, the political and economic cost of replacing only a fraction of the services comes at sometimes insurmountable cost (Baggerthum, 2011). For example, water filtration can be provided by the healthy functioning properties of the headwaters of Bristol Bay region, where the mine is proposed. This habitat provides high quality, clean water without cost. Alternatively the construction, operation and maintenance of a water filtration plant that costs hundreds of millions of dollars would be needed to replace the natural water cleaning function of the alluvial sediment that is already in place.

Ecosystem services are largely non-market services and have not, until recently, been incorporated into economic models. This natural capital in the form of ecological services are "the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life" (Daily 1997). These benefits include natural resources (timber, fish, minerals, berries) or natural services (storm and flood regulation, water filtration, recreation, aesthetic value) and are provided in perpetuity and for free by healthy ecosystems (Daily et al. 2008). Work on the identification, classification and valuation of these ecological services is very difficult, ongoing and, as the model develops, will continue to require input from a network of economists and environmental scientists The database maintained by the University of Vermont Grund Institute for Ecological Economics is a good example of work that is being done in this regard (http://www.uvm.edu/giee/).

An example of this work classifies ecosystem functions into four main categories:

1. Regulating functions
2. Habitat functions
3. Provisioning (production) functions
4. Cultural (information) functions

Table 1. List of ecosystem services (De Groote, 2002)

Functions		Ecosystem Processes and Components	Examples
Regulating functions - Maintenance of essential ecological processes and life support systems			
1	Gas regulation	Role of ecosystems in bio-geochemical cycles	Maintenance of good air quality
2	Climate regulation	Influence of land cover and biol. Mediated processes on climate	Maintenance favorable climate for human and salmon existence
3	Disturbance prevention	Influence of ecosystem structure on dampening environmental disturbances	Storm protection from wetlands
4	Water regulation	Role of land in regulating runoff & river discharge	Drainage, natural irrigation, and regulation of flows necessary for spawning
5	Water supply	Filtering, retention and storage of fresh water	Provision of water for consumptive use (e.g. drinking water)
6	Soil retention	Role of vegetation root matrix and soil biota in soil retention	Maintenance of water clarity
7	Soil formation	Weathering of rock, accumulation organic matter	Maintenance of productivity on different land cover types
8	Nutrient regulation	Role of biota in storage and re-cycling of nutrients	Nutrient cycling salmon provide for Kamchatka brown bears, birds and other species
9	Waste treatment	Role of vegetation & biota in removal or breakdown of nutrients and compounds	Pollution control
10	Pollination	Role of biota in movement of trophic-dynamics	Pollination of wild plant species
11	Biological Control	Population control through trophic-dynamic relations	Control of pests and diseases
Habitat functions - Providing habitat (suitable living space) for wild plant and animal species			
12	Refugium functions	Suitable living space for wild plants and animals	Suitable habitat for Kamchatka Brown bears
13	Nursery function	Suitable reproduction habitat	Suitable spawning area for Pacific Salmon
Provisioning functions - Provision of natural resources			
14	Food	Conversion of solar energy into edible plants and animals	Pacific salmon as a food source
15	Raw materials	Conversion of solar energy into biomass for human construction and	Timber provided by forests

		other uses	
16	Genetic resources	Genetic material and evolution in wild plants and animals	Drugs and pharmaceuticals
17	Medicinal resources	Variety in (bio)chemical substances in natural biota	Plants used for medicinal purposes
18	Ornamental resources	Variety of biota in natural ecosystems with ornamental use	Resources used for fashion or jewelry (e.g. feathers or orchids)
Cultural functions - providing opportunities for cognitive development			
19	Aesthetic information	Attractive landscape features	Enjoyment of scenic views in Kamchatka
20	Recreation	Variety of landscapes with recreational uses	Tourism as a result of salmon fishing
21	Cultural and artistic information	Variety in natural features with cultural and artistic value	Use of salmon in books, painting, national symbols, advertising etc…
22	Spiritual and historic information	Variety in natural features with spiritual and historic value	Use of nature for religious purposes
23	Science and education	Variety in nature with scientific and educational value	Use of Kamchatka biostations for scientific research
24	Navigational	Variety in nature with navigational value	Use of natural objects for navigating

The table above from De Groote (2002) gives a brief description of these services and the potential benefits they provide. Salmon provide are a critical component of the regions ecosystem. Their abundance can also serve as an indicator of the overall production of ecosystem services.

As shown in Table 1, these ecosystem service evaluations should also be combined with socio-economic/cultural analyses to give a more complete picture of both the ecological and market-based costs and benefits of management options (De Groot et al. 2002). A cultural-economic analysis is significantly important and should include benefits and costs borne by those affected. Issues of equity for indigenous cultures in particular are often overlooked in conventional economic studies.

Fundamentally, the purpose of the continued substantial efforts needed to monetize ecosystem services is to improve the information available to decision makers in a language politicians are familiar with. Providing an economic based assessment may help secure better policy, leading to improved environmental protection by scoping exploitation scenarios from development strategies to ecosystem loss.

What Can History Teach Us?

The negative externalities or unintended cost to the public of open pits mines like the one proposed by the PPL have been well documented. In a report published in 2004, the Environmental Protection Agency (USEPA, 2004) identified 156 mines with $24 billion of potential cleanup costs. Thirty percent of the 159 mines did not have a stakeholder to pay for cleanup. The report predicted acid mine contamination would multiply cleanup

costs by at least tenfold. Over half of these mine sites will require over forty years of cleanup and twenty percent will require a permanent water treatment facility to be maintained forever. It is unlikely that any companies will endure long enough to compensate taxpayers for reclamation costs. When mines are abandoned and included in the Superfund program, federal taxpayers and state taxpayers end up paying the cleanup costs.

Zortman and Landusky Mine

A look at past mining operations can provide a window into what we can expect from a project like Pebble. In 1979 the Zortman and Landusky mines were started in the mountains of Central Montana. The mines, sitting adjacent to one another, lie at the headwaters of the Milk and Missouri Rivers about a quarter mile from the Fort Belknap Indian Reservation. Between 1979 and 1996, 79 tons of low grade ore were mined using the same cyanide leaching methods proposed at the Pebble project. Like the Pebble project proposes, the mine created a few hundred jobs which were important to the region, significantly lowering the unemployment rate there. The jobs lasted for 17 years. Between 1979 and 1990, the state of Montana allowed 9 expansions of the original mining proposal. These expansions as well as the original mining permits had few regulatory guidelines. The provisions necessary for the treatment of mining waste were instituted by the mining company and considered to be industry standards.

In 1993 acidic mining waste entered the town of Zortman, a few miles away. During this time the mine experienced 12 cyanide spills into the watersheds, including a 50,000 gallon spill of cyanide-laced waste water. The residents of the reservation living downstream of the mine have filed multiple lawsuits to try to restore clean ground and surface water. The Montana Department of Environmental Quality reported that the ground and surface waters connected to the mine will be impacted from the acidic mine drainage in perpetuity. The lawsuits resulted in a decision requiring the mining company to construct water-treatment systems and to establish a trust for the long term operation and maintenance of these systems. Even with these mitigation measures, Switch Gulch, a tributary below the mine, has turned bright orange and has an acidity that kills fish and most other aquatic life. By 2004 the source of the acidic water into Switch Gulch had not been located, and the stream was still being contaminated. In 2008 a private firm was contracted to develop a solution to the water quality issues that were still impacting Fort Belknap Reservation. The goal is to use state of the art water treatment technology to improve water quality downstream. Research and development for the project is ongoing.

Clark Fork Basin

Mining in Montana's Clark Fork Basin has contaminated over 100 miles of the Clark Fork River. The area is now the largest Superfund site in the United States (Woody et al. 2010). The contaminated area includes millions of cubic yards of contaminated tailings in the Clark Fork watershed. The mine is smaller than the proposed Pebble Mine and has a tailings pile 800 feet high, covering over 2 square miles. Many of the tributaries are void of aquatic life. It has been found impossible to treat all of the contaminated groundwater in the area, and the tailings runoff is contaminating surface

water in places. The copper mine pit is smaller than that proposed by the Pebble project (542 feet deep, 4,000 feet wide) and, as with Pebble, once decommissioned, the mine pit becomes a toxic lake. In the case of the Milltown mine, the abandoned mining pit contains about 250 million gallons of acidic water and metals (aluminum, arsenic, cadmium, copper, zinc) and continues filling with ground and surface water seepage, requiring perpetual water treatment from a massive treatment plant that cost $75 million to build and costs $10 million per year to maintain and operate. Treatment of the groundwater at the city of Butte requires a $20 million plant and annual operating and maintenance costs of $500,000. The EPA sued the mining company, the Atlantic Richfield Company (ARCO), a subsidiary of British Petroleum, for $680 million for water treatment. After five years of litigation, a 187 million dollar settlement was awarded. However, current and perpetual costs are certain to exceed the amount awarded. Most costs will be incurred by taxpayers (EPA, 2008).

While there is little potential for private economic gain from protecting important ecosystem services, there is a high potential for significant economic loss. This means that unless mechanisms are developed to preserve these ecosystem services, just as past experience has shown us, the Bristol Bay region and the international community that benefit from the ecosystem services present there will most likely lose immense economic value in the future.

What the Yup'ik Raven Says

Raven is an important character in the legends of the Yup'ik. One creation story is told in the following way:

> *They tell stories about Tulukaruk, Raven, and what he did. One story about Tulukaruk happened when the land was ice but someone put dirt there and let it became land. Tulukaruk apparently was being busy doing various things at that time and place. He was doing something with the ice and broke his ice pick. And when his ice pick broke he said, "Sometime in the future when one of my descendants finds the broken part of my ice pick my descendants will become rich." (UCB, 2012)*

Pebble Zombie: 2020 Update for the Mining Proposal that Won't Die.

Review

In 2015 near the end of the Obama administration the Environmental Protection agency (EPA) determined that the proposal for one of the world's largest open pit copper and gold mines would put water quality, fish, wildlife, the local economy and native communities at risk. As a result of their findings they issued a set of federal restrictions that would limit the project, vastly reducing the scope of the proposed project. These restrictions included:

- **Limit Loss of streams:** Restricts the removal of five or more miles of streams with salmon or the loss of 19 or more miles of streams where salmon are not currently documented within the project area.
- **Limit Loss of wetlands, lakes, and ponds:** Restricts the development of 1,100 acres or greater of wetlands, lakes, and ponds that connect with streams with used by salmon.
- **Limit Streamflow alterations:** Restricts altering streamflow greater than 20 percent of daily flow in nine or more miles of streams used by salmon.

These restrictions put a hold on the project because as it was proposed the project would be unable to abide by the limits (Environmental Protection Agency, 2014).

The rulings would not put an end to the Pebble Mine project. The owners of the project, Northern Dynasty Minerals, sued the federal government claiming the permitting process was not followed and they were entitled to an unbiased review that included information about how technology would guarantee environmental protection. In 2017 under the Trump administration, the Environmental Protection Agency director met with executives of the Pebble Mine Partnership to settle the case (Los Angeles Times, 2020). Shortly after the meeting the EPA removed the Obama administration restrictions. After a meeting between Alaska's Governor and Mr. Trump this action put in place a second Environmental Impact Statement (EIS) to be conducted by the Army Corps of Engineers, the same agency who's initial review of the proposal was deemed insufficient, paving the way for the EPA's first Environmental Impact Statement under the Clean Water Act.

Current Efforts

After reversing the initial recommendations by the EPA and in order to reduce impacts and increase the likelihood of approval the Pebble Partnership is completing an Environmental Impact Statement (EIS) for a mining project with a smaller footprint (Army Corps of Engineers, 2020). The proposed project would reduce the scope of the mining project, removing only about 10% of the minerals proposed in the original project. However, a 90% reduction in scope does not necessarily mean a proportionally smaller impact. Former mining environmental consultant Richard Borden indicated in a letter to the Army Corps of Engineers that a smaller mine would create very large environmental impacts continuing to put the salmon and communities of the Bristol Bay region at risk. As proposed, the project is "almost certainly not economically feasible," said Mr. Borden, who spent 23 years working for the mining company Rio Tinto PLC. In addition the proposed smaller project creates a mining a pit over a mile long, a mile wide and 200 meters deep, impacting 3,500 acres of wetlands, lakes, and ponds. Eighty-one miles of salmon streams would also be disturbed. Despite these concerns the AOCE is pushing the review forward for completion in half the time of a typical new mining project EIS (Wild Salmon Center, 2020).

Tribal and federal agencies and environmental groups have voiced concerns that the draft EIS released in 2019 does not even meet industry standard practice. They state that the review is missing critical details and in many cases making conclusions that are erroneous. In the last year the Department of the Interior, Environmental Protection Agency, Fish and Wildlife Service, and National Marine Fisheries Service have criticized the strategic deficiencies, nevertheless The Army Corps of Engineers continues a rushed schedule without the use of relative field data or public comments (Earth Justice, 2020).

Bristol Bay Tribes Sue

As a result of the Army Corps negligence the United Tribes of Bristol Bay representing 31 tribes and tribal governments sued the EPA in federal court in Anchorage, Alaska, over the Trump administration's lifting of the Obama EPA 2014 Clean Water Act protections. In addition, a similar lawsuit was filed against the EPA by more than a dozen other environmental groups.

The Tribes stated they filed the lawsuit against the Trump Administration's effort to remove Clean Water Act science-based protections that were set in place to preserve the integrity of our salmon bearing streams. The removal of those protections put at risk the livelihood of the Bristol Bay native communities who have a say in the management of their rivers, streams, and wetlands.

The environmental groups echoed the tribes concerns stating the "EPA's decision to abandon protections for Bristol Bay is driven by politics, not science, and Alaska's wild salmon fishery and the people and communities who depend on it are the victims," said Joel Reynolds, the Western director at the Natural Resources Defense Council (CNN, 2020).

Local Support

In Seattle representatives from five Coast Salish Tribes joined with leaders from the United Tribes of Bristol Bay to initiate the Bristol Bay Proclamation.

The document was created to show unified support with the northern neighbors and states that the U.S. government protect the tribes' way of life, as “people of the salmon,” by halting the Pebble Mine in Southeast Alaska. This is pledge of unity in a fight that has been never ending for the Bristol Bay native community. The proclamation states that the land and water of the native peoples near the proposed mining area would be irreversibly harmed by the mining efforts to extract copper, gold and other minerals by the Pebble Partnership. These actions would harm the salmon which not unlike their Salish Coast counterparts are a spiritual, economic and important food source for the tribes of Bristol Bay.

Washington’s Quinault Indian Nation President Fawn Sharp, who leads the National Congress of American Indians, spoke about the newly initiated mining proposal at the signing. “Under international standards, under our indigenous laws, under all the teachings that we have been afforded for generations, this is illegal,” Sharp said.

Although it is in Alaska, tribal commercial fishermen from the Puget Sound region head north to Bristol Bay every summer to catch wild sockeye. In many cases they catch enough to sustain themselves all year.

Ellie Kinley is a commercial fisher and a member of the Lummi Nation. She says several dozen of her tribe’s members fish in Bristol Bay every year, including four men in her immediate family. “ It’s a huge fishery for Bellingham and Seattle — for Washington state,” Ellie said.

Ellie, the Lummi Tribe and other local tribes are working to send a clear message to the U.S. Army Corps of Engineers that tribes oppose anything that can harm salmon and the cultures that depend on it, no matter where this occurs.

The Coastal Salish proclamation follows other local tribal resolutions to have been adopted recently protesting the Pebble Mine. The National Congress of American Indians and the Affiliated Tribes of Northwest Indians put forth proclamations signed by their leaders as well as the Lummi, Suquamish and Makah.

The United Tribes of Bristol Bay representative MaryAnn Johnson is thankful for the support at the event at the Burke Museum live-streamed on Facebook. We've had a long 15 years of fighting this mine alone," she said. "And we are heartened to know that we are no longer standing alone."

The U.S. Army Corps of Engineers will issue an Environmental Impact Statement this summer, with a record of decision expected in the fall (KNKX, 2020).

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