BRISTOL BAY AND THE PEBBLE PROJECT:
RED OR GOLD?

by

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A Thesis: Essay of Distinction
Submitted in partial fulfillment
of the requirements for the dual degree
Master of Environmental Studies/Master of Public Administration
The Evergreen State College
June 2008

This Thesis for the Master of Environmental Studies Degree

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ABSTRACT

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The issue before Alaska's decision makers cuts to the core dilemma of the human enterprise: the conflict between the distribution of costs and benefits It boils down to two conflicted and highly polarized schools of thought. Proponents of approving the Pebble Project's copper and gold mine cite the need for more jobs for local residents; transportation infrastructure to provide additional economic stimuli and reduce the high cost of energy; and an economic base that provides stability-stability that could exceed one hundred years or more. Those opposed to Pebble object to the scope and scale of the project not to mention the potential environmental issues that have been associated with mining elsewhere. They argue that the world's largest run of wild sockeye (*Oncorhynchus nerka*) or "red" salmon as they are commonly referred to in Alaska, have sustained Bristol Bay's human and wildlife populations for millennia and continue to do so by providing the economic backbone for not only the region, but entire state as well. They contend that the toxics produced by the mine will contaminate the watershed and destroy the Kvichak and other rivers important to salmon.

In addressing this dilemma it is important to have a firm understanding of the eco-region, Pebble's proposed plans, and how those plans may negatively impact the environment. In addition, this thesis hypothesizes that an economic gap exists between the two options and quantifies the financial benefits of both the proposed mine and healthy, sustainable fisheries for consideration by decision

makers regarding this difficult issue. Taken to the extreme, the controversy can be summarized by asking what is more valued-the world's largest wild sockeye salmon run, or the world's second largest gold deposit? Or, put more simply- what is your favorite color, red or, gold?

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Acknowledgements

I would first and foremost like to thank Dr. Amy Cook, Evergreen faculty member and my reader for this thesis. Amy's enthusiasm and love of fish was an inspiration not only in the classroom, but also in her insightful feedback on drafts of this body of work.

In addition, I would like to thank Dr. Cheri Lucas-Jennings, also a member of the Evergreen faculty for her input. Cheri's passion for her students, the environment, and creating a space for learning will last with me for the rest of my days. Many thanks to Max Christian, conservation biologist, and my brother-in-law, and John Byorth, historian, author, and personal friend. Max and John answered my endless questions, and provided critical analysis for the conclusions drawn within. I would also like to extend my appreciation to MES colleagues Sarah Haque and John Means for their support throughout my academic career at Evergreen. Their tireless encouragement helped me through the rigors of the program and for this and their friendship, I am eternally grateful.

Finally I want to express my eternal gratitude to my wife Milli and daughters Kylie, McKenna, and Ryan for their love, understanding, and support which enabled me to complete the MES/MPA program and this thesis.

Part One
The Bristol Bay Region

Chapter 1
Alaska's Bristol Bay Region

Landscapes

"The Alaska Peninsula and Bristol Bay Basin eco-regions are considered to be unfragmented landscapes, shaped by unimpeded natural ecological processes…"

TNC-AK, Alaska Peninsula and Bristol Bay Basin Eco-regional Assessment, 2004

According to The Nature Conservancy (TNC), the Bristol Bay region stretches from Goodnews and Chagvan Bays on the west side around to the Cinder River on the southeast. It is bound on the west by the Ahklun and Kilbuck Mountains, on the north by the Kuskokwim River drainage, and on the east by the Aleutian Range. The Bristol Bay Basin ecoregion includes the Bristol Bay lowlands, the Wood-Tikchik Lake systems, and the lowlands draining into the east side of Bristol Bay. The terrestrial and freshwater portions of the ecoregion comprise over 7,064,200 ha. (Figure 1.) (TNC 2004).

Figure 1. Bristol Bay, AK Regional Map

The Bristol Bay region consists of rolling lowlands with elevations ranging from 0 to 150 meters and slope gradients of less than 2 percent (Gallant 1995). The region was glaciated during the Pliocene epoch and is covered by glacial moraine and outwash (Gallant 1995) and much of the lowland soils are dominated by silt and peat. In addition, there are isolated areas in the lowlands that are dotted with permafrost while most of southern portion of the region is free from permafrost (Gallant 1995).

According to the U.S. Forest Service (USFS 2008), the Bristol Bay regional climate is considered maritime[1] with a continental[2] influence marked by long, cold winters and short, cool summers. Coastal temperatures range from winter low averages of approximately 15C to summer high averages of approximately 18C. Average coastal precipitation of the Bristol Bay region is 600 to 3,400 mm/year with higher elevations averaging over 4,000 mm/year (Gallant 1995).

Due to the regional soil composition and climate, vegetation is characterized as alpine and wet tundra with wet tundra occurring more frequently-along the low lying areas and the coast (Figure 2) (Selkregg 1974). Interspersed with the wet tundra are dwarf shrub communities, and isolated strands of black and white spruce occur with alder, birch, and willow in areas with adequate drainage (Ricketts 1999).

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[1] Climates considered "maritime" are heavily influenced by the ocean or sea and marked by large amounts of precipitation.
[2] Climates considered "continental" are characteristic of a landmass of continental size, with more extreme temperature variations.

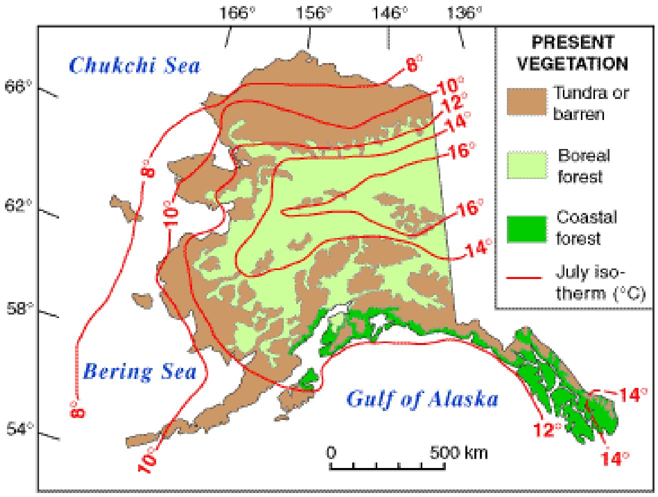


Figure 2. Alaska Vegetation Distribution

Ponds, lakes and wetlands dominate the topography of the Bristol Bay region. Lakes and ponds cover approximately 25% of the surface area while wetlands cover about 55% of the region (Ricketts 1999). In addition to providing for flood control, protecting shorelines, and recharging ground aquifers (Gosselink & Mitsch 2000), wetlands are being recognized as global carbon dioxide sinks and climate stabilizers (Gosselink & Mitsch 2000). The Bristol Bay regional wetlands provide significant critical nesting habitat for migratory waterfowl including the arctic loon, Canada goose, the highest densities of tundra swan, the majority of the world's emperor swans, and 50% of the world's black brandt population (Ricketts 1999) while the coastal marshes and tidelands support millions of shorebirds (Powers, Bishop, Grabowski & Peterson 2001).

The most significant of these wetlands, in both size and ecological importance, is Lake Iliamna. As Alaska's largest lake, Iliamna covers 2,622 km^2 (over 1,000 square miles) and contains a volume115 km^3 (Quinn 2005). Iliamna is also the rearing habitat for the world's largest run of wild Sockeye salmon (*Oncorhynchus nerka*) (Quinn 2005). Where other regions, such as the Pacific

Northwest have experienced the negative effects that development activities such as logging, dams, and urban sprawl have had on salmon, the Bristol Bay populations thrive. In response to declining returns, other regions have instituted hatcheries as the technological response to supplement wild populations. Studies have shown that this response has actually contributed to the continued declines of wild stock due to significant genetic and behavioral differences between the two (Vanden Brulle & Geyeski 2003). Bristol Bay is not faced with this dilemma. The pristine watersheds and undeveloped landscape help to ensure that future generations of this natural resource will continue in perpetuity.

Lake Clark drains into Lake Iliamna via the Newhalen River and Lake Iliamna, via the Kvichak River watershed, drains into Bristol Bay. Along the shores of Lake Iliamna there are 5 villages (Iliamna, Newhalen, Kokhanok, Pedro Bay, and Igiugig). According to the United States Census Bureau, the combined resident population of these villages is a mere 539 individuals (2000 census).

In addition to human populations, Iliamna is home to large populations of native Rainbow trout (*Oncorhynchus mykiss*), Arctic Grayling (*Thymallus articus*)[3], and one of only two fresh water seal populations in the world, the Nerpa seal (Quinn 2005).

[3] The Arctic Grayling is listed as an endangered species in the lower 48.

Adjacent National Parks and Refuge

" these lands are to be managed for the following purposes… to protect habitats for, and populations of, fish and wildlife including, but not limited to:,… to maintain unimpaired, the water habitat for significant salmon populations; and to protect scenic, geological, cultural, and recreational features."

AK National Interest Lands
Conservation Act of 1980

The Alaska National Interest Lands Conservation Act (ANILCA) was passed by congress and signed into law by President Jimmy Carter in 1980. The law provided for the creation or revision of 15 National Park Service properties and set aside other public lands for the U.S. Fish and Wildlife Service and the U.S. Forest Service. In total, the act set aside almost 80 million acres, a third of which were designated as wilderness[4].

According to the Alaska Department of Natural Resources (ADNR 2008), there are 16 national parks within Alaska's borders. The parks adjacent to the Bristol Bay region are Katmai National Park and Preserve, which includes the Alagnak River (Wild and Scenic River designation), and Lake Clark National Park and Preserve (Figure 3).

Figure 3. Alaska's National Parks

[4] The Wilderness Act was passed by Congress in 1964 (in response to and recognition of population growth and economic development) for the purpose of preserving and protecting lands in their "natural condition".

Katmai National monument was established in 1918 to preserve the Valley of Ten Thousand Smokes-a reference to the ash deposits (ranging 100 to 700 feet deep) from the eruption of Mt. Novarupta in 1912 (USGS 2008). Novarupta was the largest eruption of the 20th century and produced 21 cubic kilometers (5 cubic miles) of volcanic material (Wright & Pierson 1992). On December 2nd, 1980 Katmai was designated a National Park and Preserve and received Wilderness designation on that same date. Katmai is located at the head of the Alaska Peninsula and is comprised of over 4 million acres. The park is bounded to the north by the Lake Iliamna watershed and the west by the Bristol Bay coastal plain (National Park Service 2008).

Lake Clark National Park and Preserve also received its designation (both as a national park/preserve and as a wilderness area) in 1980. The park was created to "protect scenic beauty (volcanoes, glaciers, wild rivers, and waterfalls), watersheds essential for Red salmon (*O. nerka*), and the traditional lifestyle of local residents" (National Park Service 2008). Like Katmai, Lake Clark encompasses over 4 million acres. The Park and Preserve's southwest boundary is a mere 30 miles north of Lake Iliamna (National Park Service 2008). The lake itself (Lake Clark) drains a watershed of over 9,600 km². It is approximately 74 km long, between 3 and 8 km wide, and its average depth is 103 meters[5] (USGS 2008).

Together, Katmai National Park and Preserve and Lake Clark National Park and Preserve, protect over 8 million acres of wildlife habitat and in doing so,

[5] Lake Clark's maximum depth is measured at 300 meters.

form the eastern border of the Bristol Bay inland region (Figure 4)[6].

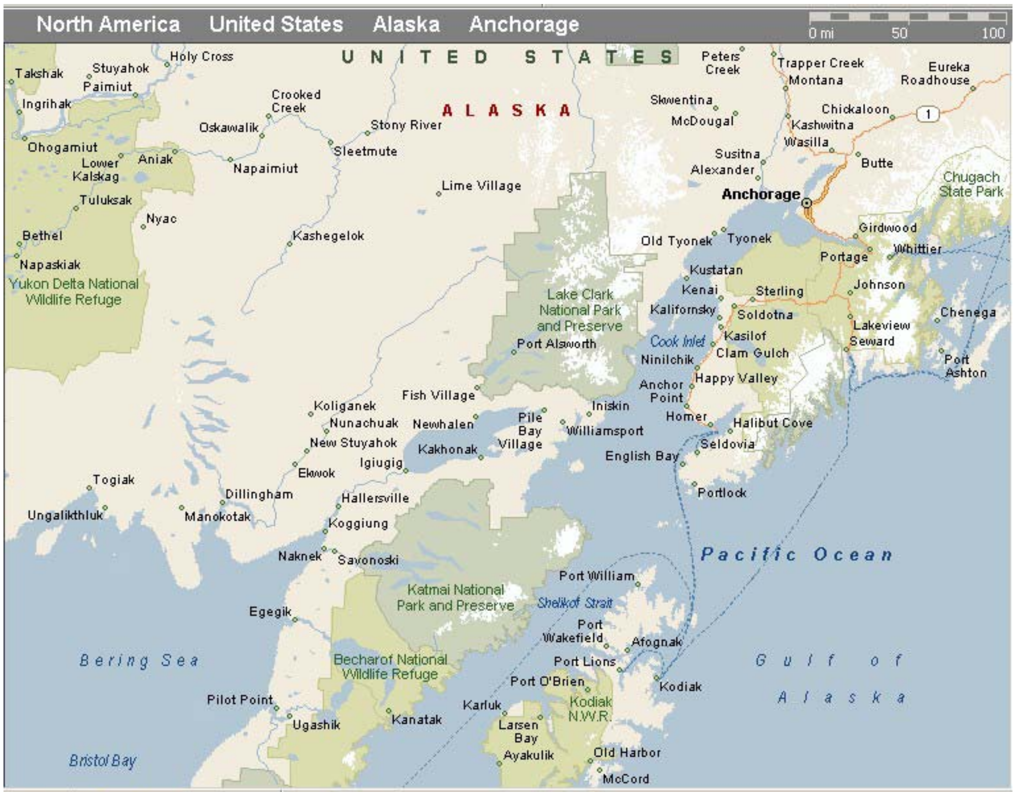


Figure 4. Katmai and Lake Clark National Parks and Preserves

Wildlife Habitat

"What is man without the beasts? If all the beasts were gone, man would die from a great loneliness of spirit. For whatever happens to the beasts, soon happens to man. All things are connected."

Chief Seattle, Leader
of Washington's
Suquamish people

In addition to sharing the Bristol Bay Region as a boundary, both Katmai and Lake Clark National Parks and Preserves along with the Bristol Bay region, form the Alaska Department of Fish & Game (ADF&G) fisheries and wildlife

[6] The Yukon Delta National Wildlife Preserve, although adjacent to the Bristol Bay Region is excluded from this discussion due to relative distance. However, it should be noted that the refuge protects over 19 million acres and the corridors between Yukon, Katmai, and Lake Clark are, as of this writing, uninterrupted.

South-Central Management Region-region 2. The region is divided into three separate management areas; the western, central, and eastern management areas (Figure 5) (ADF&G 2005).

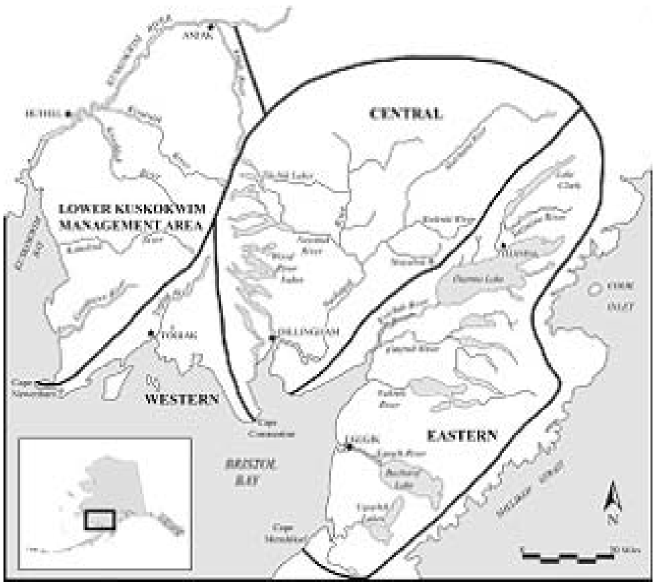


Figure 5. South-Central Management Region-Region 2.

In addition to the fish and bird populations discussed previously, region 2 provides critical habitat for a host of other wildlife populations including moose, dahl sheep, and bald eagles, to name a few. The Mulchatna Caribou herd (*Rangifer tarandus*), totaling approximately 120,000 individual members, utilizes the region for calving from early May through June (ADF&G 2008). The uninterrupted wildlife corridor allows species to migrate between and among critical habitats.

The largest populations of Alaska Brown Bear (*Ursus arctos*) are found along the Alaska Peninsula and the Bristol Bay coastal region. It is estimated that the area's brown bear density is 551 bears/1000km² (Alaska Peninsula and Katmai National Park and Preserve) representing approximately 50% of Alaska's total brown bear population (Chapman, Feldhamer, & Thompson 2003). These densities are a result of the large runs of Pacific salmon that return to coastal streams, rivers and lakes each year. This valuable source of protein has created two visible distinctions between the coastal populations and those populations found in interior habitats. First, coastal brown bears are significantly larger. Secondly, their fur is darker. These two differences are responsible for the distinction between Brown Bears and Grizzly Bears-distinctions within the same species as a result of their diet (Chapman, Feldhamer, & Thompson 2003).

Chapter Summary

The Bristol Bay region is unique. It is unique to the United States and it is unique from a global perspective. Few places remain in the world that have been left untouched by humans and our associated development activities. In considering this, one must also consider the natural wonders that can be found in the region-the largest freshwater lake in Alaska, which supports the world's largest Sockeye salmon run and one of only two freshwater seal populations on the planet; the highest brown bear density on the North American continent; arguably some of the healthiest estuary and marine environments worldwide; and, vegetation and wetlands that can play a major role in mitigating global climate change; a challenge we all face. The Bristol Bay region represents over 55,000 square miles of uninterrupted and unfragmented habitat with unimpeded natural ecological processes. It is unique.

Chapter 2
Bristol Bay's Sockeye Salmon

Oncorhynchus nerka Behavior and Ecology

"Though much can be learned about the ancestral lineage… most present populations were founded within about 10,000 years. Thus the species have existed for several million years but the populations are recent…"

Thomas Quinn, The Behavior and Ecology of Pacific Salmon & Trout

The Sockeye (*Oncorhynchus nerka*), widely referred to as "Red" salmon in Alaska, occurs in the North Pacific and Arctic oceans and associated freshwater systems. The species, in North America, ranges as far south as California's Sacramento River and north to Alaska's Kotzebue Sound, but their primary spawning range is from the Columbia River to Alaska's Kuskokwim River (Quinn 2005).

Sockeye, like all Pacific salmon, are anadromous. After hatching, juvenile Sockeye may spend up to three years in freshwater before migrating to sea as smolt weighing only a few ounces. Juveniles in freshwater have metallic green/blue backs, silver sides, and white bellies. They share the same markings with juveniles in saltwater but are less iridescent. Juvenile Sockeye also have dark, oval par marks on their sides. These marks are short and rarely extend below the lateral line (ADF&G 2005).

Sockeye spawning grounds are typically associated with lakes. Unlike other salmon species, upon emerging from the gravel, Sockeye move into lake systems where they rear for up to 2 years. A reason for this could be the fact that

Sockeye are the smallest of all North American salmon eggs (Quinn 2005). Rearing in freshwater allows them to avoid predation until such time as they are large enough to migrate to the sea. Sockeye eggs hatch in the winter and the fry feed off of their yolk sacs until early spring when they emerge from the gravel and move into rearing areas. They feed primarily on zooplankton, benthic amphipods, and aquatic insects. The ecosystem water quality and associated productivity are essential for the development of juvenile Sockeye. Therefore, water quality degradation could have significant negative impacts on the Sockeye populations.

After migrating from freshwater, Sockeye will typically spend between 1 and 4 years at sea before returning as 4 to 8 pound adults (although some reach as much as 15 pounds) to the same system in which they were born to spawn and eventually die (Quinn 2005). Upon entering the marine environment, Sockeye proceed immediately to the feeding grounds of the high seas (Eggers 1982). Unlike other species of Pacific Salmon, young Sockeye are rarely seen in estuarine or inshore environments after migrating to the marine environment (Miller & Brannon 1982). While at sea, they continue to feed upon zooplankton but will also prey upon larval and small adult fishes (ADF&G 2005).

Spawning occurs in summer months and varies between river systems. However, there is very little variation in spawning time from year to year within a particular system (ADF&G 2005). When adults return to their natal rivers and streams to spawn, the female selects a redd (or nest) with sufficient flow through the gravel to support the oxygen requirements of the eggs and embryos (Pauley, Risher, & Thomas 1989). A redd is excavated by the female and made up of 3-10 nesting pockets (Pauley, Reisner & Thomas 1989). The male and female then come together above the pocket and release the eggs (female) and milt (male). Immediately after release, the female uses her tail to cover the eggs with gravel (Quinn 2005). After spawning, adult Sockeye die.

The Bristol Bay Sockeye Populations

"Alaskan's may disagree on issues of salmon allocation,… but all Alaskan's can come together and agree on the need to maintain thriving wild salmon runs."

Frank Rue, Former
Commissioner of
The ADF&G

Bristol Bay is home to the largest runs of wild Sockeye salmon in the world where between 10 and 35 million fish return each year. With a few exceptions, the total returns, spawning stock, and total catch have been at record levels for the last 20 years (Hilborn 2006). The lakes, rivers, and streams draining into Bristol Bay (Figure 6.) support these runs and provide critical habitat for returning adults, incubating eggs, and juvenile Sockeye.

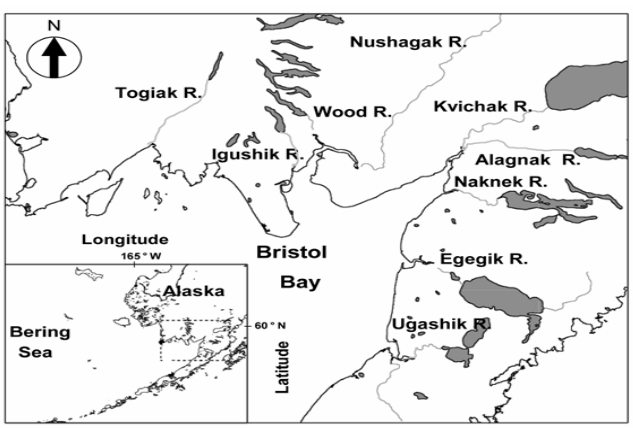


Figure 6. Bristol Bay's Major Sockeye Producing Rivers

In turn, the Sockeye help to support the systems to which they return. Sockeye are a keystone species for Bristol Bay's river and lake systems. As previously discussed, salmon return from the marine environment to their natal streams to spawn and die. This behavior transports millions of tons of marine rich nutrients to the region's nutrient poor freshwater systems. In addition to sustaining the productivity of rich riparian and lucustrine systems, the carcasses of spawned out salmon support many scavenger species including bald eagles, wolves, fox, lynx, and more (Helfield & Naiman, 2006).

The Kvichak River Sockeye

"Once producing over 50% of the salmon caught in the multi-million dollar Bristol Bay fishery, Kvichak salmon are in serious decline"

Carol Ann Woody, Ph.D.
Principal Investigator,
Lake Clark Sockeye Salmon
Research Projects

Translated, the word "Kvichak" means *from great water*-a reference to Lake Iliamna, the river's headwaters and Alaska's largest freshwater lake[7]. From Iliamna, the river flows approximately 70 miles southwest where it drains into Bristol Bay near the junction between the Alaska Peninsula and the mainland (Figure 7.). Historically, the Kvichak River has supported the largest runs of Sockeye salmon in the region (Johnson, Weiss & McLean 2004).

[7] Lake Iliamna is 75 miles long and up to 22 miles wide. It is the second largest freshwater lake in the United States (USGS).

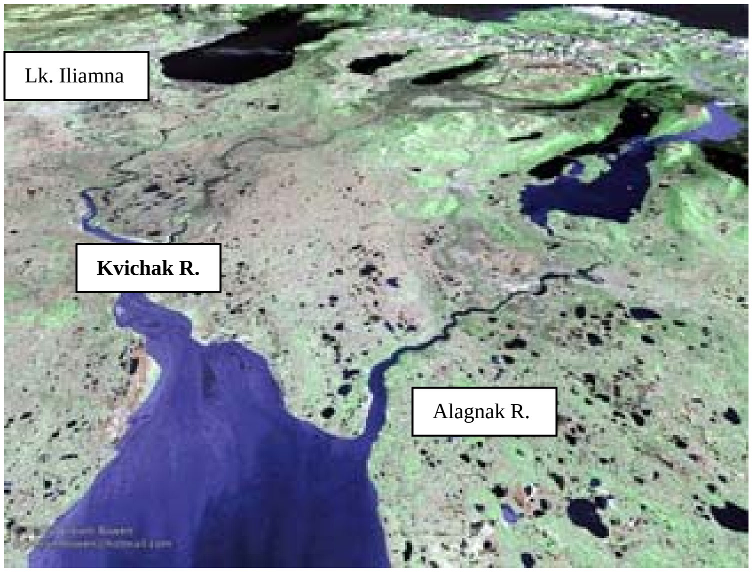


Figure 7. The Kvichak River Watershed.

On average, the Kvichak plays host to over 6 million returning Sockeye annually (Compton, et al. 2006). However, recent returns have been well below historic figures and ADF&G's forecast for 2008 predicts a Kvichak run of 3.56 million Sockeye-again, well below historic returns (ADF&G 2007). It is unclear why Kvichak River runs have declined. Some have hypothesized that low marine productivity associated with the Pacific Decadal Oscillation (El Nino) has negatively impacted Sockeye while residing in the marine environment (Hilborn 2006). This may not be the only factor as some regional systems, such as the adjacent Alagnak watershed, have experienced increased returns (ADF&G 2007) which suggests a freshwater mechanism as the culprit. The USGS Biological Science Office, recognizing a lack of biological information in the Bristol Bay region, has partnered with local, state, federal, NGO, and academic stakeholders in addressing the Kvichak River Sockeye through a cooperative research effort in Lake Clark. The results of this research are not yet available and a sound scientific rationale for the cause of Kvichak River Sockeye declines remains at large for this biologically sensitive ecosystem.

Chapter Summary

The Sockeye is the only member of the Pacific salmon family that utilizes lake systems for rearing. After spending up to two years in these freshwater environments juvenile Sockeye migrate to the marine environment where they feed, grow, and mature before returning to their natal streams to spawn and die. The Bristol Bay region provides the ideal habitat for spawning Sockeye as their migration routes are relatively short, the rivers are generally free from extensive turbidity, and, as previously discussed, are unimpeded and not impacted by development activities. The marine nutrients Sockeye bring with them each year provide the vital nourishment for not only other species, but the system itself. As a keystone species their annual appearance within the region is essential. The Kvichak River Sockeye runs have experienced recent declines that have created many unanswered questions. As the historic "producer" for Bristol Bay, the Kvichak is a case study with significant implications for other regional watersheds. As such, an argument can be made against any significant development activities prior to identifying root causes for the declines.

Chapter 3
Bristol Bay's Economy

Demographics

"The economy is substantially dependent upon the harvesting and processing of fishery resources…Commercial, sport, and subsistence fishing plays a role in virtually every community in the region."

Southwest Alaska Municipal Conference (SWAMC)

The Bristol Bay Region's cash economy, like much of rural Alaska is dominated by seasonal fisheries. Most residents participate, at some level, in the harvest, processing, or transportation of the catch. Next to fisheries, government jobs, primarily state and local government, make up much of the remaining employment opportunities-about 35 percent of the region's residents are not in the labor force (Northern Economics 2004). Additional employment opportunities, especially in the more remote communities, are scarce.

The region is divided into three jurisdictions-the Bristol Bay Borough, the Lake and Peninsula Borough, and the Dillingham Census Area. According to the Alaska Department of Commerce, Community and Economic Development (DCED), these municipalities represent many small communities (Figure 8.) and have a combined population of approximately 7,645 individuals (Bristol Bay Borough: 1,105; Dillingham Census Area: 4,912; and the Lake and Peninsula Borough: 1,628) (DCED 2008).

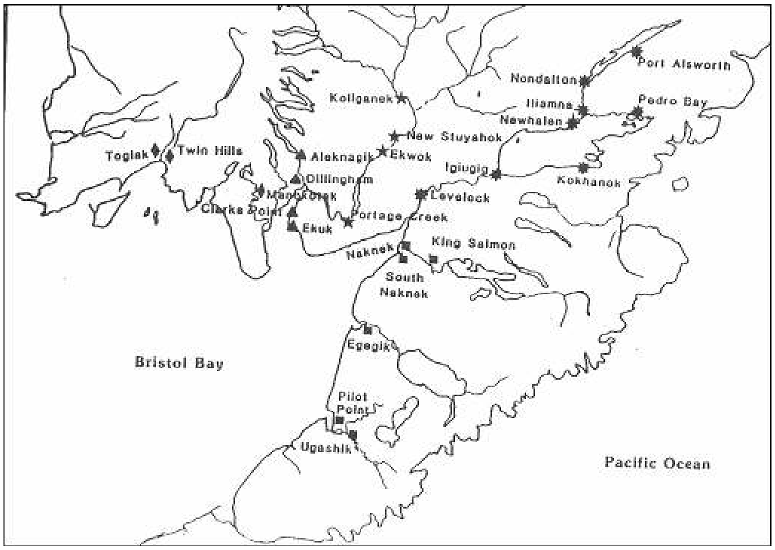


Figure 8. Bristol Bay Regional Communities

Located on the southeast edge of Bristol Bay, the Lake and Peninsula Borough is comprised of over 23,600 square miles with a population of .1 person/square mile. Interestingly, the county seat, King Salmon, is located within the jurisdiction of the Bristol Bay Borough (discussed below). As such, King Salmon is the main transportation hub for both boroughs. This unique arrangement illustrates the lack of transportation infrastructure throughout the region. The Lake and Peninsula Borough represents 17 small fishing communities and traditional Alaskan villages (DCED). As of the 2000 Census, the per capita income for residents of the borough was $27,900 with almost 19% of the population below the poverty level.

According to DCED, the Dillingham Census Area consists of 11 small communities scattered over 18,000 square miles (.3 residents/square mile) along the northwest edge of Bristol Bay. The largest of these communities is the town of Dillingham. Other than a road connecting Dillingham with the village of Alegnegik some 25 miles away, there is no infrastructure supporting the remaining communities. The town of Dillingham represents the economic, transportation, and public service center for western Bristol Bay (DCED). The per capita income for the Dillingham Census Area was $27,900 in 1999 (2000 Census) with 24.4% of the population below the poverty level.

The Bristol Bay Borough is comprised of the villages of Naknek, South Naknek, and King Salmon and includes the Kvichak River watershed. The borough has jurisdiction over approximately 504 square miles. This translates to about 2.5 residents per square mile compared to 79.56 residents per square mile for the rest of the nation (2000 Census)[8]. It is the smallest of all the sixteen incorporated Boroughs in Alaska (Northern Economics, 2004). However, according to the U.S. Bureau of Economic Analysis, in 2001 the Bristol Bay Borough was the wealthiest, with a per capita income of $42,401-almost $5,000 higher than the state's largest municipality, the city of Anchorage (Northern Economics, 2004). The village of Naknek serves as the borough's "county seat" and is connected by road to King Salmon. The town of King Salmon supports a commercial airport and serves as the borough's transportation hub and link to the "rest of the world". The village of South Naknek (located just across the Naknek River from the village of Naknek) is a more traditional Alaskan village as there is no transportation infrastructure support other than a small airport.

[8] For context, consider that King County, Washington consists of approximately 2000 square miles with a population of over 817 individuals per square mile while Thurston County, WA consists of 727 square miles with a population of 310 individuals per square mile.

Subsistence

"Subsistence continues to be an important part of the diverse cultures and regional economies… Subsistence provides a measure of economic stability in areas with a mixed cash economic system."

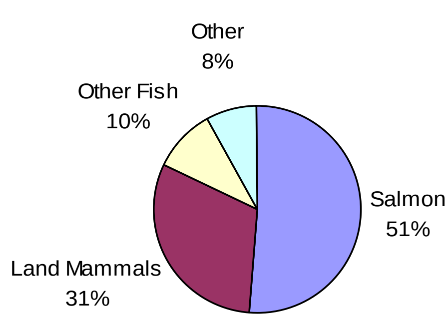
Alaska Dept. of Fish and Game
Division of Subsistence

As the cash economy is seasonal (associated with the summer salmon runs), residents of the Bristol Bay region, as is the case with most of rural Alaska, rely heavily upon subsistence hunting and fishing (SWAMC). The wide abundance of salmon and wildlife provide the basis for this element of the economy and help sustain not only the residents of the region, but the culture of the native peoples. In her testimony before the U.S. Senate Committee on Indian Affairs, Rosita Worl, who received her Ph.D. form Harvard in anthropology, described rural Alaska as one of the few remaining places in North America where the people are largely dependent and culturally attached to a hunting and gathering way of life (Worl, 2002). Worl, an Alaskan native, President of the Sealaska Heritage Institute, board member of the Alaska Federation of Natives, and Chair of the board's Subsistence Committee, draws upon her professional research and her experience as a participant in the Alaska subsistence culture in applying her perspective that where other native cultures have succumbed to the pressures placed upon them by governments to assimilate, Alaska native cultures, languages, and lifestyles thrive.

According to Scott Goldsmith of the University of Alaska Anchorage Institute of Social and Economic Research (ISER), about 90% of rural Alaska households are engaged in subsistence activities (Goldsmith 2007). Goldsmith goes on to state that the average per person annual harvest is estimated at 544 pounds-351% of the daily average population protein requirement. To quantify this for economic purposes, the ADG&G's Subsistence Division has conducted studies and assigned a replacement value of between $3 and $5 per pound[9]. Based on these numbers, the annual food replacement value is between two and three thousand dollars per person.

Regarding Bristol Bay, just over 50% of the total subsistence harvest comes from salmon (Figure 9.) (Fall & Krieg, 2006). The Alaska Board of Fisheries in 1993, established a harvest range between 155,000 and 172,000 fish annually for Bristol Bay subsistence with almost two thirds of those fish coming from the Kvichak River watershed. As such, it comes as no surprise that Sockeye salmon represent almost 80% of the recent 10 year (1996-2005) subsistence fisheries harvest (Fall & Krieg 2006, Alaska Board of Fisheries, 2008).

Figure 9. Bristol Bay Subsistence



Source: ADF&G Division of Subsistence

[9] It should be noted that these values do not represent the cost of engaging in subsistence activities. Costs associated with regional subsistence include fuel, machinery, ammunition, nets, etc.

Government Employment and Payments

“The $8.4 billion the federal government spent in Alaska in 2004 was roughly equivalent to all the wages private industry paid and,… supported one in three Alaska jobs.”

Understanding Alaska: People, Economy, and Resources Institute of Social and Economic Research, University of Alaska Anchorage

According to the University of Alaska, Anchorage Institute of Social and Economic Research (ISER) (2006), local governments receive about 30 percent of Alaska’s federal dollars in the form of grants with about 40 percent of federal spending going to individual residents in the form of income, social security, etc. Alaska’s businesses receive approximately 20 percent (purchases and contracting), while Native Corporations (federally recognized tribes) receive just over 8 percent. The balance of federal funds is distributed between the university system and other non profit organizations. Alaska’s residents also receive payments in the form of oil rents from the “Permanent Fund”. Created in 1976 by voters, the Permanent Fund captures a share of the state’s oil revenues. Each year, individual residents receive a Permanent Fund dividend check. In 2007, the individual permanent fund dividend was $1,654.00 (Alaska Permanent Fund Dividend Division).

Government sector employment in the Bristol Bay region is dominated by local government opportunities. In 2005, 1,367 jobs and over $34 million in payroll were attributed to local government spending (Table 1.)

Table 1. Bristol Bay Region Local Government Jobs (2005)

Jurisdiction	Local Govt Jobs	Total Jobs	Govt. Payroll ($million)
Bristol Bay Borough.	155	315	$5.50
Dillingham Census Area	822	2,488	$21.20
Lake & Pen. Borough	390	710	$7.70

Source: State of Alaska Div. Labor

State government has a much smaller presence in the region. In 2007 there were a combined total of just 134 state jobs making up less than .6 percent of the state's total (Table 2.)

Table 2. Bristol Bay Region State Government Jobs (2007)

Jurisdiction	State Govt Jobs	Percentage of Total
Bristol Bay Borough.	33	0.1
Dillingham Census Area	93	0.4
Lake & Pen. Borough	8	<.1

Source: Alaska Div. Labor

Commercial Fisheries

"*Given the importance of the industry (commercial fisheries) to the region,… any changes in management structures, policies,… as well as any changes in external economic forces, could have pervasive effects."*

Southwest Alaska Municipal Conf.

The Bristol Bay commercial salmon fishery drives the region's economy. Salmon harvest, processing, and shipping provide the economic base for the region's cash economy. The fishery is managed by the ADF&G Commercial Fisheries Division and divided into 5 districts-Togiak, Ugashik, Egegik, Nushagak, and the Naknek/Kvichak (Figure 10.) (ADF&G). The districts are managed by escapement goals (number of fish reaching the spawning grounds) for individual systems and river specific stocks.

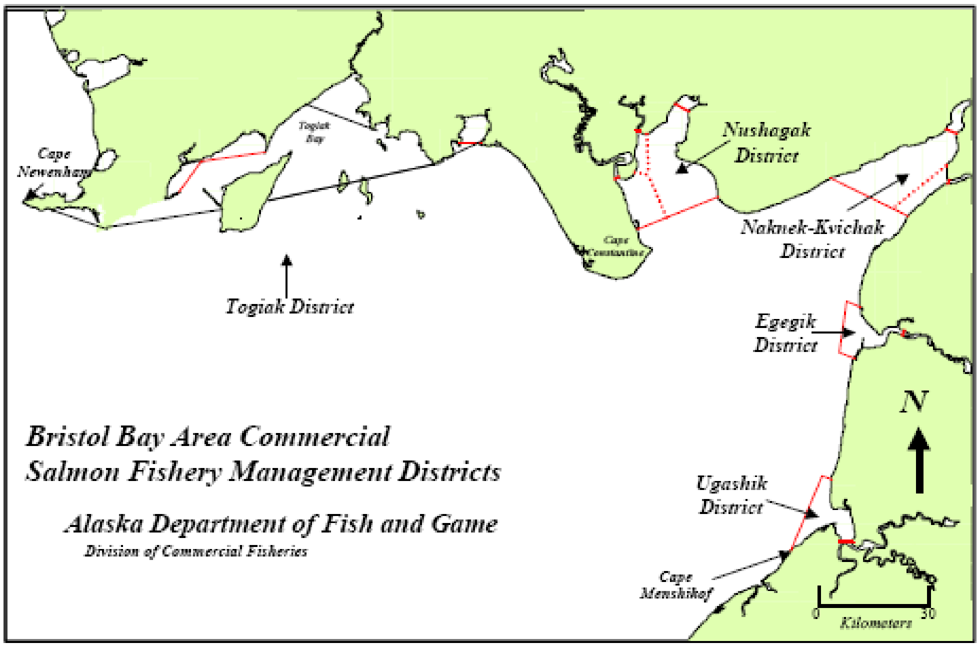


Figure 10. Bristol Bay Commercial Fishing Districts (source: Trout Unlimited)

Over the course of its 125 year history, Bristol Bay commercial salmon fishermen have caught "more than 1.5 billion fish from the icy waters of the near shore Bering Sea" (Link, et al., 2003). The fishery, over time, has seen its share of fluctuation in annual catch numbers. According to Link, et al. (2003), where the average annual harvest in the1990s was the highest on record at 30 million, the long term fishery average is 15 million annually. It is important to keep this in context as the fishery has recently experienced returns that are more in line with historic averages. However, the most recent numbers suggest a possible upturn. According to the ADF&G (2008), the 2007 Bristol Bay harvest was approximately 31.6 million while the 2008 forecast predicts a total catch of over

31 million. In addition, all of the districts, including the Kvichak met their 2007 escapement goals (ADF&G, 2008).

Regarding the value of the harvest and in addition to fluctuating returns, the fishery has also experienced fluctuation in the market value of the catch. Per pound price for Sockeye peaked in 1989 at $3.19 and hit an historical low of just $.40 in 2002[10] (DCED, 2008). As a result, the cash incomes of resident fisheries participants can be highly variable. For example, in 2002, of the 2,121 total, 607 Bristol Bay resident permits were fished. Resident fishermen grossed a total of $17,613,867. In contrast, the 2005 season saw 2,476 total permits with 617 of them belonging to local residents. The gross resident earnings topped $45 million-a threefold increase (Table 3.). The primary reason for the decline of

Table 3. Bristol Bay Harvest 2001-2005

Year	Total Number Permits Fished	Alaska Resident Permits Fished	Bristol Bay Region Resident Permits Fished	Gross Resident Earnings
2001	2,713	1,635	703	23,544,895
2002	2,121	1,279	607	17,613,867
2003	2,451	1,453	662	27,660,128
2004	2,406	1,386	611	36,540,218
2005	2,476	1,419	617	45,059,323

Source: Author's calculations-source data from Alaska Department of Labor

Ex-vessel value has been attributed to the increase in farmed fish on the market (Duffield, Neher, & Patterson 2007). Farmed salmon, from Chile and British Columbia, are available year round and have driven down the value of wild stocks.

Licensed crew members make up a large part of the salmon harvest workforce and share in the gross earnings of the catch. This share usually takes

[10] Per pound price has decreased in recent years with the increase in farmed fish.

the form of a percentage of the gross earnings. Residents of the Bristol Bay region who participated in the fishery are shown in Table 4. Crew member wages are highly variable (ranging anywhere from a fixed salary to between 2.5 and 50 percent of the gross earnings).

Table 4. Bristol Bay Resident Crew Members

Borough/Census Area	2000	2001*	2002	2003	2004	2005
Bristol Bay	241	N/A	187	183	175	172
Dillingham Census Area	858	N/A	524	596	608	643
Lake and Peninsula Borough	225	N/A	115	157	137	164
Total Regional Residents	1,324	N/A	826	936	920	979
All Crew Members	5,710	4,899	3,745	4,416	4,313	4,368

Source: Commercial Fisheries Entry Commission

*Crew data not available for 2001 season

In addition to harvesting the catch, employment processing the catch is also an important component of the commercial fishery economy. Between 2001 and 2005, Alaska resident workers earned between a low of $3.03million (2003 season) and a high of $4.04 million (2001 season) in wages (Table 5.).

Table 5. Bristol Bay Processing Employment

Year	Total Workers	Alaska Resident Workers	Resident Wages (million)
2001	2,862	704	4.04
2002	2,273	509	2.84
2003	2,484	621	3.03
2004	3,474	590	3.3
2005	3,272	641	3.47

Source: Author's calculations-source data from Alaska Dept. of Labor

Bristol Bay region residents made up about 20 percent of the total labor force during the 2006 season. Of the total processing jobs available, 354 were held by resident workers. The total gross wages topped $16 million and local resident's share of the take was over $3.5 million ($3,583,672) (Table 6.) with 454 Bristol

Table 6. 2006 Seafood Processing Bristol Bay Region Resident Workforce

Borough/Census Area	Total Workers	Resident Workers	Total Wages	Resident Wages
Bristol Bay Borough	2,009	354	16,400,671	2,542,104
Dillingham Census Area	485	65	3,386,262	514,712
Lake and Peninsula Borough	446	35	4,222,846	527,856
Bristol Bay Total	2,940	454	24,009,778	3,584,672

Source: Author's calculations-source data from Alaska Dept. of Labor, Research and Analysis Section

Bay residents participating, their individual gross earnings fell just shy of $8 thousand at $7,895. At first glance, given the short duration in which it was earned (less than 3 months), the wages appear significant. However, when considering that this figure represents a significant share of an annual household income, the figure becomes much less impressive.

Sport Fisheries

"Many go fishing all their lives without knowing that it is not fish that they are after."

Henry David Thoreau

Anglers from around the world visit the region to experience Bristol Bay's pristine watersheds in search of wilderness, adventure, and pescatoral nirvana. The sport fishery targets all five species of Pacific Salmon but is renowned for the trophy Rainbow Trout (*Oncorhychus mykiss*) populations of the Kvichak River watershed. Each year, thousands of fishermen test their skills and in doing so, spend millions of dollars[11]. Next to commercial fishing and processing, sport angling is the most important private economic sector in the Bristol Bay Region (Duffield, Patterson, and Neher 2007). In their report for Trout Unlimited, Alaska, the authors attribute a total of 1,252 jobs (in 2005) in Bristol Bay to support the recreation industry. Of this total, 846 Alaska resident jobs and $27 million in traceable pay role were associated with sport fishing in the region (Duffield, Patterson, and Neher 2007). Unfortunately, only about 50 percent (430) of those employment opportunities were held by Bristol Bay region residents. There is little information regarding the current jobs and associated incomes for local residents as a direct result of the sport fishery. What information exists is outdated. As a result, the ADF&G has undergone a study to quantify the direct economic effects induced at both the state and local levels by the sport fishery. These effects will be expressed in terms of total jobs, wages, taxes, etc. at both the regional and local levels. The study timeline indicates that the data collection phase has been completed and the data analysis phase is scheduled to be completed in July 2008. A final report is expected in December of 2008. More information regarding the study can be found at: www.sf.adfg.ad.us/Statewide/Economics/updates.cfm

[11]In 2005, 24,276 non-Alaska resident visitors spent $75 million. Source: Duffield, Patterson, and Neher 2007).

Regional Economic Development

"In Fiscal 2006, the Alaska Office of Rural Development delivered over $100 million in housing… for Fiscal 2007, we look to continue this record of achievement and look to continue improving the quality of life for rural Alaskans

Chad Padgett, Acting State Director
USDA Rural Development

The Bristol Bay Native Corporation (BBNC), along with 12 other regional native corporations, was formed by the Alaska Native Claims Settlement Act (ANCSA) of 1971 (Public Law 92-203). ANCSA, signed by President Nixon and enacted by congress, settled once and for all, the 100 year claim that had persisted since Alaska was purchased from Russia in 1867. This act remains as the largest monetary compensation and land settlement of aboriginal claims in U.S history. Never before had indigenous people received monetary compensation (over $962 million), lands, funds for corporate development, mineral rights, and a legislative resolution to their land claims (Liebner 2006).

As a non profit diversified holding company, the BBNC represents approximately 8,000 individual native shareholders in the region. A review of the organization's website found numerous references to the BBNC's commitment to conserve the region's natural resources and to "celebrate and preserve the Alaskan native culture and linkage with the land that provides the basis of our style of life" (BBNC Strategic Intent 2008). The corporation either owns or holds a significant share in ten companies nationwide and has emphasized stability, economic development, and employment opportunities for shareholders with its investment portfolio (BBNC 2008) while paying out over $70 million in dividends since inception in 1971 (BBNC 2008). In 2007 the BBNC, for the first time ever, exceeded $1 billion in total revenues and paid shareholders a $5,185 dividend (BBNC Annual Report 2007). The emphasis on economic development and profits has not been at the cost of the natural environment. In order to continue the tradition of profitability while conserving the landscape, the BBNC and its stakeholders must find creative, sustainable solutions to the region's under employment challenges.

Chapter Summary

Alaska's boasts the highest percentage of indigenous peoples of any state in the nation. Nearly 1 in 5 Alaskans is native. The ratio increases in rural Alaska where, on average, one third of the population is native (2000 Census). The Bristol Bay region is remote, sparsely populated, and with the exception of the regional centers, virtually devoid of transportation infrastructure. As a result, local residents are highly dependent upon natural resources (particularly salmon) for both income and subsistence. Of the 7,645 individuals living in the region, about 30 percent are unemployed. The majority of the population takes part in some form or fashion in the harvest, processing and/or transportation of the seasonal fisheries catch. In addition to natural resources, residents are also dependent upon government employment and payments. As the second leading source of employment, government jobs represent about one third of the region's total. The limited employment opportunities within the region can be linked directly to the lack of transportation infrastructure. This limits the cash economy as most goods and services must be obtained outside of the region including many basic necessities and translates into an inflated cost of living. Additionally, as employment opportunities are limited, many residents are dependent upon subsistence activities to supplement cash incomes.

Part Two

The Development Dilemma

Chapter 4
Alaska's Mineral Resources

Resource Extraction in Alaska

"The Alaska mining industry produced another strong year in 2007… Revenue to the state of Alaska from the minerals industry for FY 2007 increased 292% and reached $179 million."

Alaska Minerals Commission
2008 Report to the Governor
Executive Summary

Much like the lower 48, the emergence of the white man on the landscape marked a significant change for Alaska. In the early 19th century, Russian explorers were the first to recognize the region for its rich mineral deposits (Alaska Mining 2008) and upon acquisition by the United States (in 1867), exploration and prospecting continued in Southeast Alaska. In fact, the discovery of gold deposits eventually led to the location of the state capital-Juneau. These discoveries, in addition to those of the Yukon and Klondike, led to additional prospecting in Alaska's interior region. In 1899 placer gold was discovered in Nome and within 11 years, over 550 thousand ounces were produced (Alaska Mining 2008). Accordingly, the Fairbanks district gold production reached $6 million/year by 1905. In short, gold and other valuable mineral resources have been, and continue to be, abundant in the 49th state. In fact, according to the Alaska Minerals Commission, created by the state legislature in 1986, the Alaskan mining industry revenues increased 292% in 2007 and reached $179 million (2007 report). Although much has changed since statehood, one thing remains constant-mining (Figure 11.).

According to the Alaska Department of Labor and Workforce Development, an estimated 14,000 Alaskans are employed in the mining industry (2008). In addition, DCED attributes the “re-emergence” of mining as the

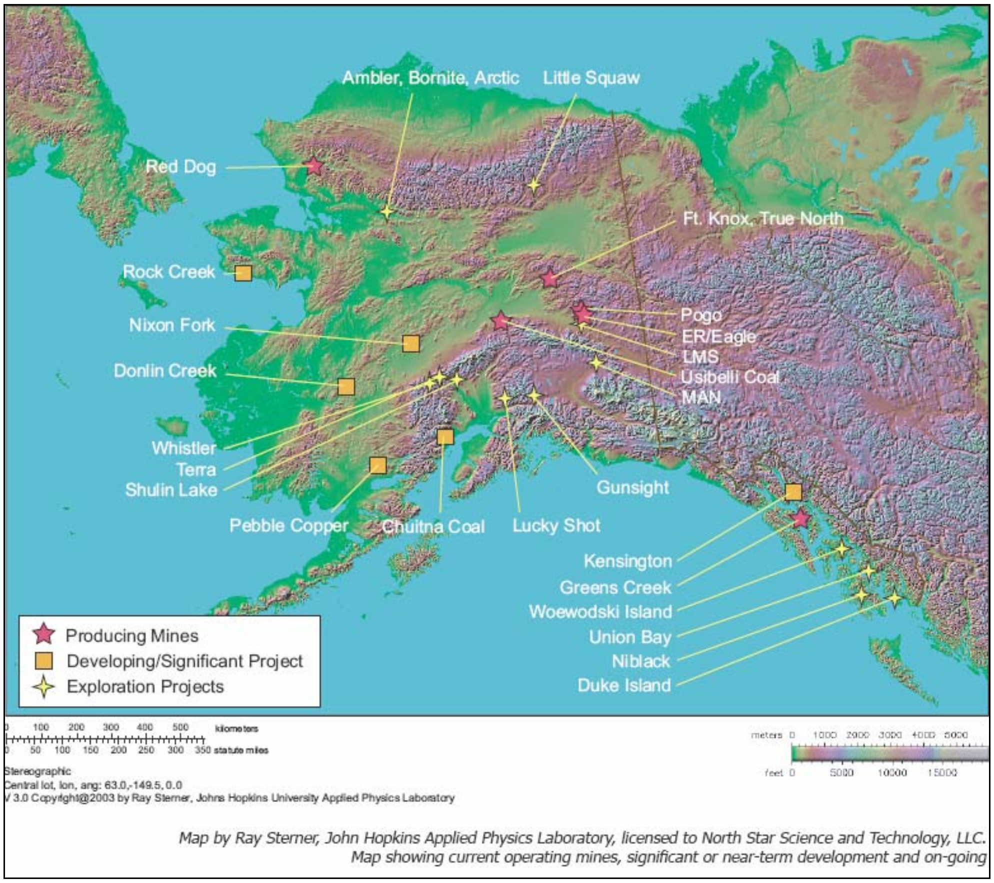


Figure 11. Major Mining Activity in Alaska; DCED 2008

catalyst for infrastructure development in rural regions and an economic base for the state (DCED 2006). DCED describes Alaska’s mineral exploration and development opportunities as “among the best in the world” citing over 241 hard rock mineral deposits.

Northern Dynasty Minerals Ltd.

"NDM clearly recognizes that a feasible project is one that is both economically viable and environmentally and socially responsible."

Northern Dynasty Mines Inc
Draft Environmental
Baseline Studies Proposed
2004 Study Plan

Headquartered in Vancouver, Canada, Northern Dynasty Minerals, Ltd (NDM) operates as a mineral exploration company. NDM, formerly known as Dynasty Resources, Inc., was incorporated on May 11, 1983. The company changed its name to Northern Dynasty Minerals, Ltd. on October 11, 1997. NDM became a reporting company in the province of British Columbia in 1984 and was listed on the Vancouver Stock Exchange from 1984-1987, the Toronto Stock Exchange from 1987-1993, and unlisted but still in good standing with all the security commissions from 1993-94. From 1994 to present, the company has been listed on the TSX-Venture Exchange (formerly the Vancouver Stock Exchange). In November of 2004, the company's common shares were also listed on the American Stock Exchange (AMEX).

NDM is categorized as a "junior" mining exploration company (SEC Form 20-F) and wholly owns two Alaskan subsidiaries. Northern Dynasty Mines, Inc. is their operating subsidiary and Northern Dynasty Holdings Inc. is their Alaska mining claims title holding subsidiary.

NDM's primary means of generating capital resources is through the sale of common shares. According to NDM's SEC form 20-F, filed in 2005, the company has never shown a profit. Furthermore, NDM, since incorporation, has "paid no dividends on its shares and does not anticipate paying dividends in the foreseeable future" (NDM SEC form 20-F 2005). As an industry, the exploration for minerals is highly speculative and involves substantial financial risk over an extended period of time (Moon, Whately, & Evans 2006). If exploration and its associated activities do not result in commercial grade mineral deposits, all evaluation and land acquisition costs are lost. Industry wide, the business of exploration results in but a few producing mines (Moon Whately, & Evans 2006). According to their annual report SEC form 20-F filed in 2005, the company has had but one "success"- a small scale mining operation in Nevada of which NDM held a "participating interest". The Little Bald Mountains Project attained modest gold production and subsequent cash flow. Otherwise, NDM has never seen a project through to the operation phase.

The Pebble Partnership

"The Pebble Project is making a tremendous economic contribution to our communities today, and could make an even larger contribution in the future-one that would benefit all Bristol Bay residents."

Letter of support signed by Iliamna Natives Ltd., the Alaska Peninsula Corp., and the Pedro Bay Corp.

The first mineral exploration efforts in the Bristol Bay region were conducted in 1986 by the exploration company Cominico Alaska Exploration (CAE) (NDM SEC form 20-F 2005). Initial core sample drilling in the area now know as "Pebble West" began in 1988 (NDM SEC form 20-F 2005). Located just 17 miles from the village of Iliamna and the shores of Lake Iliamna, the Pebble deposit is a near surface mineral deposit. It lies entirely on state owned land located adjacent to what is considered the “heart” of the Kvichak watershed (Figure 12.).

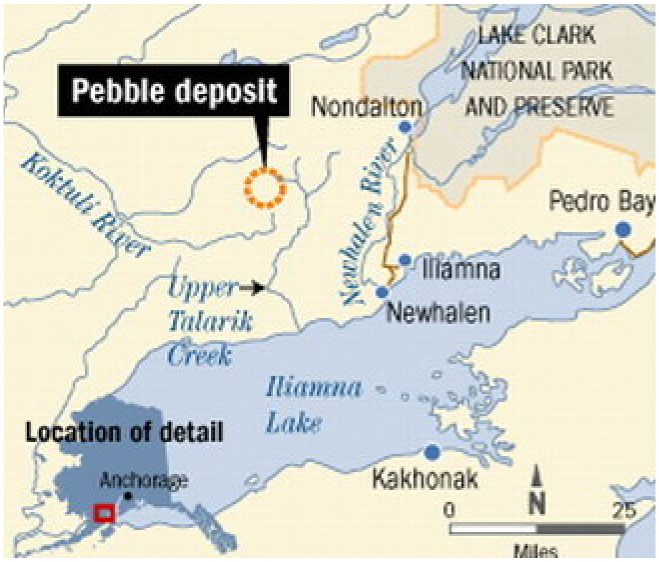


Figure 12. “Pebble” Mineral Deposit Location

CAE continued their exploration efforts until 1993 and estimated that the deposit contained approximately 3 million tons of copper and 11 million ounces of gold. Upon completion of these estimates, little other activity ensued for almost a decade.

In 2001, NDM obtained options from Teck Cominico (the successor and parent company of CAE) on the almost 100,000 acres of Alaska state mineral claims land. NDM then invested $5 million in the project and began an extensive drilling program in an attempt to determine and delineate the deposit and by early 2005 expanded the estimate to over 4,100 million tons of ore. In September of 2005 NDM announced that, as a result of their exploration efforts, a richer, deeper deposit had been discovered east of the Pebble West site. End of year 2005 exploration activities estimated that the “Pebble East” deposit contained a 3.4

billion ton resource including 42.6 billion tons of copper, 39.6 million ounces of gold, and 2.7 billion pounds of molybdenum. This discovery expanded the scope and potential value of the combined mineral resources making the Pebble Project one of the world's most significant. As a result of the project's potential, NDM attracted the attention of one of the world's leading mine operators, Anglo American-a British owned corporation (Pebble Partnership 2008 NDM SEC form 20-F 2005). In 2007, a wholly owned U.S. subsidiary of Anglo American partnered with NDM to work toward permitting, construction, and operations of the Pebble Project. The deal saw Anglo American become a 50% partner with NDM in exchange for a $1.425 billion investment in the project (Pebble Partnership 2008). The investment will provide the capital necessary to complete the pre-feasibility study, the feasibility study itself, and the equity needed for the construction phase of the project.

By the end of 2006, the partnership had invested $126 million for the activities associated with preparing a proposed mine development plan for submission and review by government and the public (Pebble Partnership 2008). In planning and developing the associated timelines, the partnership will be subject to numerous regulatory reviews and promises to operate under the following "guiding principles" (Pebble Partnership 2008):

- Pebble Will Benefit People-Pebble Is For All Alaskans
- Pebble Will Co-exist With Healthy Fish, Wildlife, And Other Valued Natural Resources
- Pebble Will Apply The World's Best And Most Advanced Science
- Pebble Will Help Build Sustainable Communities

- At Pebble, We Listen Before We Act

The plan is still being developed and is scheduled for completion in 2009. According to NDM's project timeline, they anticipate permitting approval by end of year 2011 and beginning the production phase at both locations sometime in 2015 (NDM Presentation).

Economic Benefits of Pebble

"The Pebble Partnership is working to maximize benefits to local communities,… The Pebble project is expected to provide Alaskan's 2,000 new jobs during construction and 1,000 long term operation jobs once the mine starts production."

Northern Dynasty Minerals
Investor Center Fact Sheet
January, 2008

Mining has played a key role in the economic development of rural Alaska. Improved infrastructure, increased revenues, rents, and jobs can all be associated with the approval of large-scale mining. One of the more recent examples of this is the Red Dog mine-the world's largest Zinc concentrate producer (AKDNR 2008). Red Dog began production in 1989 and represents a partnership between NANA (the local native association) and Teck Cominico Alaska-the Canadian company's wholly owned U.S. subsidiary (Alaska Miners Association). Located in an otherwise remote and undeveloped region in Northwest Alaska on the middle fork of Red Dog creek in the Delong Mountains of the western Brooks Range (AKDNR 2008), the Red Dog mine is an open pit zinc and lead mine. The mine is responsible for the Delong Mountain Regional Transportation System, transportation infrastructure that was non-existent prior to mining. In 2007, Red Dog employed 456 workers (56% of whom were NANA shareholders); paid $9 million to the Northwest Arctic Borough in payments in lieu of taxes (PILT); and paid $170 million in net smelter royalties to NANA (McDowell Group 2006).

Supporters of the Pebble Project hope that approval of the mine will have similar impacts in the Bristol Bay region. In fact, the mine could be the economic base for one of the states poorest regions with some of the lowest average annual incomes and the highest unemployment rates. The Pebble partnership has estimated and publicly stated that the mine would create 2,000 jobs during the construction phase and 1,000 operations jobs paying about $80,000 annually for the life of the mine. Given that the mineral deposits are the world's second largest and could support an 80+ year mining operation, this could represent an employment base for the next 3-4 generations of Alaskans. In addition, the size and scope of the project could generate tens of millions of dollars in local and state government revenues annually and billions over the life of the mine while generating hundreds of millions of dollars annually in service and supply contracts. The region would also benefit by the transportation infrastructure that would be required to support the mining operation. This infrastructure would link Bristol Bay to more developed and accessible Alaska and, in doing so, could significantly reduce the costs of goods, reduce energy costs, and create opportunities for additional economic development for local residents.

Chapter Summary

Mining was the first established industry in Alaska. Early prospecting, finds, and "rushes" created the state's urban areas. Settlement in cities such as Anchorage, Fairbanks, Skagway, and the state's capital, Juneau are all linked to mining (McDowell Group 2006). Mining also created much of the transportation infrastructure that exists today including the Alaska Railroad and the Richardson Highway. Recent mines have provided additional infrastructure, jobs for rural Alaskans, and millions of dollars in revenues for state and local governments while creating economic stimulus for goods and services through service contracts and payments to native corporations.

When considering the vast natural resources found in Alaska, it is not surprising that the world's most significant deposit of copper and gold lies beneath the Bristol Bay region's landscape. The Canadian-based junior exploration company, Northern Dynasty Minerals and London-based Anglo American have partnered to develop a long-term, large-scale mine known as Pebble adjacent to the shores of Lake Iliamna. The project promises jobs, infrastructure and billions of dollars in revenues over the estimated 80-year operation. An operation that the Pebble Partnership promises will "co-exist with healthy fish".

Chapter 5
Mining and the Environment

The Open Pit Extraction Process

"The non-ore waste is significant… and typically contains many of the sulfide minerals found in the ore. Decomposition of these minerals causes heavy metals to be leached from the waste, which can contaminate surface and groundwaters on and off the mine site."

David Chambers, Ph.D.
Center for Science in
Public Participation

Open pit mining is one of the least expensive underground ore mining techniques and has facilitated the extraction of low-grade ore quantities such as those found at Pebble (Chambers 2007). The process involves blasting to remove material and produces more waste than similar deposits utilizing underground mining techniques as the material around the ore must be moved as opposed to selectively mining only the ore as is the case with underground mining techniques (Figure 13.).

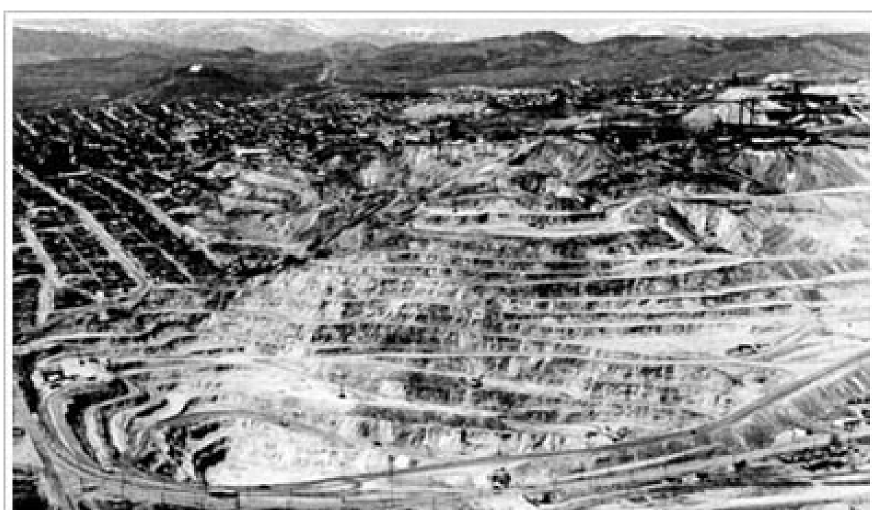


Figure 13. Butte Montana's Berkley Pit (Clark Fork Coalition).

The material removed from the pit is classified as either ore or waste. The ore is processed while the waste material is stored on site in ponds behind tailings dams. Waste typically contains acid generating rock and low-grade sulfide minerals found in the ore. Metalloids such as arsenic and selenium can also leach from both acid generating and non-acid generating waste rock. If not properly contained within the pond, during decomposition, these can leach into groundwater both on and off of the site (Chambers 2007). Modern techniques employ a liner for tailings storage to minimize seepage and groundwater contamination. The ore producing rock is ground and crushed before being placed in flotation tanks where chemicals including cyanide (primarily for gold ore) are added to separate the sulfide minerals from the rock. The degradation of some process chemicals including cyanide can produce ammonia and are toxic to aquatic organisms.

Upon closure of an open pit mine, a pit lake forms due to precipitation. Pit lakes can negatively impact the environment in two significant ways. First, the exposed rock can cause mineralization and contamination of the water. Secondly, depending on the hydrology of the site, pit lake water can migrate due to fractures from blasting and contaminate both ground and surface water off site.

The Underground Extraction Process

"With underground Block Caving no pillars [support] are left… In fact, Block Caving is designed to induce collapse in the ore zones"

David Chambers, Ph.D.
Center for Science in
Public Participation

Of the many forms of underground mining, Block Caving is primarily used for low-grade ore deposits. Profitability of underground mining requires the application of production rates and Block Caving provides the highest production rates of all mining techniques. Consequently, Block Caving is also the cheapest form of underground mining (Chambers 2007). Unlike "Room and Pillar" mining where shafts are supported by pillars of ore during mining and then backfilled after closure, Block Caving does not utilize pillars and is actually designed to induce collapse in the ore zones (Chambers 2007). The material is then removed for processing. One of the primary disadvantages to block caving is the fact that large areas void of stabilizing material can cause subsidence features on the landscape (Figure 14.).

Figure 14. Block Caving Subsidence (Groundwater Awareness League).

From an environmental standpoint, subsidence is a problem. As is the case with open pit tailings, the underground material will be mineralized and it can be assumed that the mined area will have both oxygen and water available to it. Again, as is the case with open pit mining, this could lead to decomposition, acid mine drainage, and contamination of surface and groundwater. According to their website, Pebble intends to utilize Block Caving for their underground operation at Pebble East (2008).

History is filled with examples of environmental degradation associated with mining. States such as Utah, Nevada, and Arizona (among others) have experienced water contamination, human illnesses, and loss of species as a result of mining activities. Regarding Pebble, the primary environmental concern is the region's water quality and its importance for healthy fish populations. Western Montana's Milltown dam, once the nation's largest Superfund site (EPA 2005) is an example of the negative environmental impacts mining can have on an ecosystem. Milltown is responsible for degradation of habitat, water quality, and fish populations. The dam operated for nearly one hundred years and in doing so, served essentially as tailings impoundment and reservoir for the Berkley pit collecting over 6 million cubic yards of mine tailings behind its wall. The Milltown case offers insight into a possible future for the Bristol Bay region.

The Milltown Dam Case Study: A Century of Mining

"…when the last piece of timber is added to the dam it will be in such condition that the highest waters ever known in this vicinity will not affect it in the least."

George Slack, Superintendent
Milltown Dam

In 2004, the Milltown Dam located just below the confluence of the Blackfoot and Clark Fork Rivers in Western Montana represented the largest Superfund site in the nation. Over one hundred years of mine tailings have come to rest behind the dam representing approximately 6.6 million cubic yards of toxic laden sediment that threatens to contaminate the city of Missoula's water supply-located some 10 miles downstream-not to mention the fish populations throughout the entire river system. The Environmental Protection Agency determined that the dam will come down and that the contaminated sediment will be removed (work began in 2006).

Background

The Milltown Dam was, at the time, one of the largest hydroelectric dams in the world with the ability to provide 11,000 volts of electricity. It was built by William Clark, the "Copper King" to support his logging and mining interests in the region. The dam was finished on January 10, 1908 and, almost immediately, tailings from the Berkley Pit, one of the largest open pits mines in the world at the time, began coming to rest behind its walls.

Prior to the completion of the dam, George Slack, the construction supervisor, stated publicly, "…when the last piece of timber is added to the dam it will be in such condition that the highest waters ever known in this vicinity will not affect it in the least." Five months later, the dam was breached as a result of the great flood of 1908 (Devlin). The flood event was so powerful it destroyed every bridge in Missoula. Water poured over the top of the Milltown Dam and flooded the powerhouse to a depth of six feet while upstream tailings were further deposited behind the barrier.

In 1981, almost 100 years after completion of the dam, Residents of Milltown began to complain about a "strange taste" in their local water supply. The strange taste led to testing of the area well water. Test results showed high levels of arsenic, up to 510 parts per billion (EPA 2003). A high arsenic level is known to be carcinogenic causing cancer in the bladder and kidneys and local residents were asked to stop drinking the water in August of 1981 (Clark County Coalition, p. 6-7, 2002). The discovery was fortuitous in that arsenic is tasteless and if not for the complaints, the discovery may have come much later if at all. Eventually the contaminants were traced to the reservoir where not only arsenic but various other heavy metals including copper, zinc, cadmium, and lead were discovered. Subsequently, state and local officials performed an extensive well-sampling program which uncovered a groundwater plume of arsenic extending from the reservoir into the aquifer beneath Milltown, rendering much of the communities' groundwater unsafe for human consumption-unsafe as a result of the toxic sediments behind the dam (Clark County Coalition, p. 7, 2002).

Although viewed as a significant public health issue, direct action regarding the sediments was still a decade away. During the years leading up to February 9, 1996, the Milltown dam was little more than a topic of concerned discussion. Late January and early February saw a cold snap of sub zero temperatures that covered the Clark Fork and Blackfoot Rivers in ice. This cold snap was followed by an extreme warming trend (commonly know as a “Chinook”) which caused extreme melting and associated ice flows as the rivers began to thaw. Above Milltown an ice flow measuring 10 feet in height, 40 feet in width and flowing at a rate of 10 mph was heading straight for the dam. In fear of a total loss, the dam’s superintendent ordered the spillways opened in an attempt to save the dam. The ice stopped up river from the dam but the real damage had been done. The ice flow scoured the river bottom and Milltown’s spillways released a pulse of toxic sediment downstream. Prior to the event, the Environmental Protection Agency (EPA) was set to leave the sediments stored in place behind the dam. After this incident, the EPA changed its mind. Three months later the Montana Fish, Wildlife and Parks (MFWP) noted that the downstream trout populations had been decimated (Devlin 2005).

Implications for Fish

Copper is known as the “fish killer”. According to Nowak and Duda (1996), copper is one of the most toxic heavy metals to fish, especially during the juvenile stage. Excessive amounts of copper causes stunted growth (predisposing them to predation) and decreased antibody production of bacterial pathogens (exposing them to disease). In addition, fish exposed to high doses or concentrations of copper often suffer from an altered gill structure affecting respiration. As a result of the 1996 ice jam, sediment scour, and flow release, MFWP estimated that, at a minimum, 50% of the downstream Rainbow and

Brown Trout population had been lost. To date, MDFW estimates that the river only holds about 20% of its probable fish populations.

CERCLA

In 1983, shortly after arsenic was detected in the groundwater, the Milltown site was listed by the EPA under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)-also known as Superfund. Prior to the enactment of CERCLA, industrial waste disposal practices were jeopardizing public health and the environment. Existing environmental laws were inadequate in addressing these practices. CERCLA was drafted with the legislative intent to fill this statutory gap and achieve effective remediation of contaminated sites. Although not a comprehensive list, CERCLA provides for the following:

- Ensures that money is available for remediation by assigning liability (the polluter pays).
- Provides funds for various actions that site clean up may require from assessment to the actual remediation effort.
- Allows states and the federal government to recover costs associated with remediation through litigation against private parties (polluters)
- Requires that the contaminated sites be prioritized in terms of the risk posed to the public and the environment (the National Priorities List or NPL)

CERCLA is a complex statute whose scope is beyond that of this paper. The following describes the steps required within the Superfund process: **Preliminary Assessment/Site Inspection (PA/SI)-**Here an investigation of the site conditions occurs and a determination is made whether or not the site requires an immediate or short-term response action/s based on the threat to public health and the environment.

National Priorities Listing (NPL)-As mentioned above, the EPA is required under CERCLA to keep and maintain a list of those sites posing the greatest threat.

Remedial Investigation/Feasibility Study (RI/FS)-During this part of the process, the nature and extent of the contamination is determined. Also, an assessment is conducted regarding site "treatability" and an evaluation of treatment costs and potential is conducted. Here remediation alternatives are developed, screened, and analyzed. Public comment is also obtained and analyzed.

Records of Decision (ROD)-The ROD represents the final determination of the RI/FS process. The ROD represents the "decision summary" and documents, in great detail, the entire process while providing justification for the preferred remediation alternative. Again, public comment is obtained and analyzed.

Stakeholders-Opposed

Liability for the Milltown contamination and remediation was assigned (under CERCLA) to two individual parties-Atlantic Richfield Corp. (ARCO), the owner of both the Berkley Pit and the Anaconda Smelter and Northwestern Corporation, the owner of the Milltown Dam. Both parties opposed remediation of the site but for very different reasons.

Northwestern Corp. opposed the CERCLA determination of liability arguing that as the owner of the dam, they are not directly responsible for the contamination. The EPA determined that although not directly responsible, the structure "significantly" contributed to the contamination (EPA).

ARCO, having no argument against the determination of the Berkley Pit and the Anaconda smelter as the primary pollutant sources, took a somewhat different approach. ARCO argued that the effects of Arsenic on human health were exaggerated. In 1986 they funded a scientific study hoping to "disprove" previous studies and show that Arsenic was far less toxic and believed. The research team concluded that Arsenic represented an even *greater* risk to humans than previously thought and recommended more strict federal standards regarding acceptable levels (Knundsen 2004). ARCO was successful in repressing the publication of the study for almost a decade (Knudsen 2004).

According to the Consent Decree (EPA) - an agreement signed by the EPA, the state of Montana, the Confederated Salish and Kootenai Tribes, ARCO, and Northwestern that includes negotiated terms for integrated remediation and restoration which became effective April 10th, 2006, ARCO is financially responsible for $83,380,000, Northwestern is responsible for $12,124,356, and the state of Montana will contribute $7,600,000 (these funds originated from a lawsuit settlement with ARCO).

Stakeholders-In Favor

According to the ROD, 98% of the public comments obtained throughout the CERCLA process were in favor of dam removal and either total or partial sediment removal (EPA 2005). This cohort included private citizens, state and federal agencies, Tribes, and non-governmental organizations such as the outspoken Clark Fork Coalition, Trout Unlimited, and American Rivers. The remaining 2% included the liable parties (obviously) and a small portion of the public, who, it is assumed, did not trust the federal government would provide the public health and environmental protection outcomes promised by the project. There were a total of 3,853 individual public comments (excluding ARCO and Northwestern) submitted, analyzed, and considered in the final Record of Decision (EPA).

Alternatives Considered

As required by law, the RI/FS process requires that remediation alternatives to include taking no action must be developed analyzed and considered. The original RI/FS included ten alternatives, their level of long term effectiveness, and their associated costs. The alternatives considered are briefly summarized and listed in the table below:

Alternative Considered	**Level of Effectiveness**	**Total Cost ($million)**
1. No Action	Moderate	$17
2. Modification of Dam and Practices	Moderate	$20.65
3. Same as above w/Erosion and Scour Protection	Moderate	$52.12
4. Modification of Dam/Practices w/channelization	Moderate	$73.11
5. Modification of Dam/Practices w/Periodic Sediment Removal	Moderate	$59.86
6. Dam Removal/Partial Sediment Removal/Treatment	Low-Moderate	$121.46
7. Dam Modification w/Total Sediment Removal (Lower Reservoir Area)	Moderate-High	$117.47
8. Dam Modification w/Total Sediment Removal (Entire Reservoir)	Moderate-High	$190.7
9. Dam Removal w/Total Sediment Removal (Lower Reservoir)	High	$120.82
10. Dam Removal w/Total Sediment Removal (Entire Reservoir)	High	$201.81

Table 7. Alternatives Considered. Adapted from the Milltown Reservoir Focused Feasibility Study; EPA

The majority of the public comments mentioned in the previous section were in response to the alternatives considered in the RI/FS process. Interestingly, of those in favor of site remediation, the controversy and discussion was focused not on whether the dam would come down, but how much sediment should be removed. Ultimately, the effectiveness and project cost would determine the final outcome.

Record of Decision (ROD)

As required in statute, the Record of Decision for the Milltown site documents the entire process (EPA). First submitted in 2004, the ROD was made available and posted for public comment prior to finalization. The document describes the preferred and selected alternative (total dam removal with partial sediment removal-lower reservoir) and justifies the decision. The decision was based on the fact that the toxic sediments were primarily isolated directly behind the dam (probably as a result of the 1996 flood/scour event) and that the cost of partial removal versus total removal was approximately $80 million less.

The question becomes, will this be enough? Environmental and Biological assessments (included in the ROD) estimate that the river and groundwater will heal itself over time-four to ten years (again, according to the experts). The project " broke ground" in July of last year (Clark Fork Coalition) and work will continue through 2009 at which point the Clark Fork and Blackfoot will, for the first time in almost 100 years, flow freely.

Alaska and the Toxics Release Inventory (TRI)

"… denying that mining has a pollution problem is a little like denying that major league baseball has a steroid problem."

Scott Brennan, Director
Alaskans for Responsible Mining

Recognizing that an argument can be made that the Milltown case represents past practices of time gone by in an area with few physical similarities to Bristol Bay other than a harsh climate, consider that in 2000 the EPA listed Alaska as the fourth largest polluter in the nation. According to the 2000 TRI along with Nevada, Arizona and Utah, Alaska made the list due toxic releases from mining facilities. For the third consecutive year the hard rock mining industry lead the country as the largest toxics polluter releasing 3.3 billion pounds-47% of all toxics released by industry (EPA). The primary source of Alaska's toxics problem then was the Red Dog mine. Red Dog produced over 1 million tons of zinc and lead concentrate annually and in 2000, Red Dog was also responsible for producing 83% of the state's toxic releases-about 445 million pounds worth. The 2002 TRI cited Alaska and Red Dog as the nation's largest polluters and upon the EPA's release of the 2003 TRI, Alaska once again topped the federal list of polluters and again, Red Dog was responsible. Of the 540 million pounds of toxics released in Alaska, Red Dog contributed 487 million pounds[12]

[12] The sources of the remaining toxic releases were from Alaska's Greens Creek mine and the Fort Knox mine (EPA)

Chapter Summary

Open pit mines are essentially bulk tonnage strip mines where low-grade ore, disseminated throughout the bedrock, must be crushed and soaked in chemical solutions to extract the ore. The process requires that a massive amount of earth be moved to produce a single ounce of gold or pound of copper. The resulting tailings that can contain residual chemicals must be stored in ponds or impoundments that are typically constructed by damming an existing creek valley and diverting the stream. Water quality issues associated with the tailings impoundments have, historically, resulted in toxic conditions for both ground and surface water on and off of the mine site.

Examples of environmental degradation as a result of open pit mining have been widely documented in the lower 48 over the last 100 years but Alaskan's need look no further than their own Red Dog mine and the associated impacts it has had on the environment to find an example. Since inception in 1997 the EPA's Toxics Release Inventory has included The Red Dog in each of its reports since 2000. As of 2003, not only is Red Dog the state's biggest polluter, it also owns bragging rights as the largest emitter of toxics in the nation.

Chapter 6
The Policy Dilemma

Red or Gold?

"The existing fishing industry and the residents of the area deserve a permitting process based on sound science and a full and open public process. There needs to be a thoughtful and thorough benefit/risk analysis…"

Gabrielle LeDoux, Alaska State Representative, 36th District-Kodiak and Lake Iliamna regions

The issue before federal, state and local decision makers represents the classic conflict between economic development and environmental protection and conservation. It boils down to two conflicted and highly polarized schools of thought. At one end of the controversy are proponents of approving the Pebble Project's copper and gold mine who cite the need for more jobs for local residents; transportation infrastructure to provide additional economic stimuli and reduce the high cost of energy; and an economic base that provides stability-stability that could last for the next 80+ years. At the other end of the spectrum, those opposed to Pebble object to the scope and scale of the project not to mention the potential environmental issues that have been associated with open pit mining elsewhere. They argue that the Sockeye (*Oncorhynchus nerka*) or "red salmon" as they are commonly referred to in Alaska have sustained Bristol Bay's human populations for millennia and continue to do so by providing the economic backbone for not only the region, but also the entire state. They contend that the toxics produced by the mine will contaminate the watershed and destroy the Kvichak and other rivers important to salmon.

Taken to the extreme, the controversy can be summarized by asking what is more valued-the world's largest wild Sockeye salmon run, or the world's second largest gold deposit? Or, even more simply put-what is your favorite color? Red or gold? Although many may agree that questions such as these constitute the extent of policy debate, recognizing that the dilemma represents drastic, permanent changes to an untouched landscape is much more helpful. In addressing this dilemma it is therefore important to have a firm understanding of what is being planned in support of mining operations at Pebble and how those plans may negatively impact the environment.

The remainder of this chapter will discuss the primary elements of the Pebble Partnership's draft design plan and quantify the scope of the project in the region. Environmental concerns specific to the plan will also be included to address the potential costs (to the environment) associated with approving the project.

The Pebble Plan

"My core message to all those with concerns about the project is that I appreciate at first hand, the beauty and value of all Alaska's natural resources… I firmly believe that [Pebble] can be developed…into a mine that goes well beyond industry standards…"

Cynthia Carroll, CEO
Anglo American-Speech
before AK Resource
Development Council

A large scale mine in the region will require the development of infrastructure to include energy, transportation, and operations. Although not finalized, the Pebble Partnership has drafted a plan that would support the extraction, processing, and delivery of ore to market. It includes a 104 mile single lane road and adjacent pipeline[13] from the mine site, around Lake Iliamna, terminating in Cook Inlet's Iniskin Bay on the northeast coast of the Alaska Peninsula (Figure 15.). There a deep water port would be developed to support shipping of the ore for additional processing or to market and as a receiving site for mining operations consumables.

In addition, the Partnership has "partnered" with the Homer Electric Association (HCA), a member-owned cooperative serving the Kenai Peninsula in reviewing options for providing power to the site (Pebble Partnership 2008). According to the Pebble Partnership's website, preliminary plans include the development of a new power plant on the peninsula and a submarine power cable to the proposed port site.

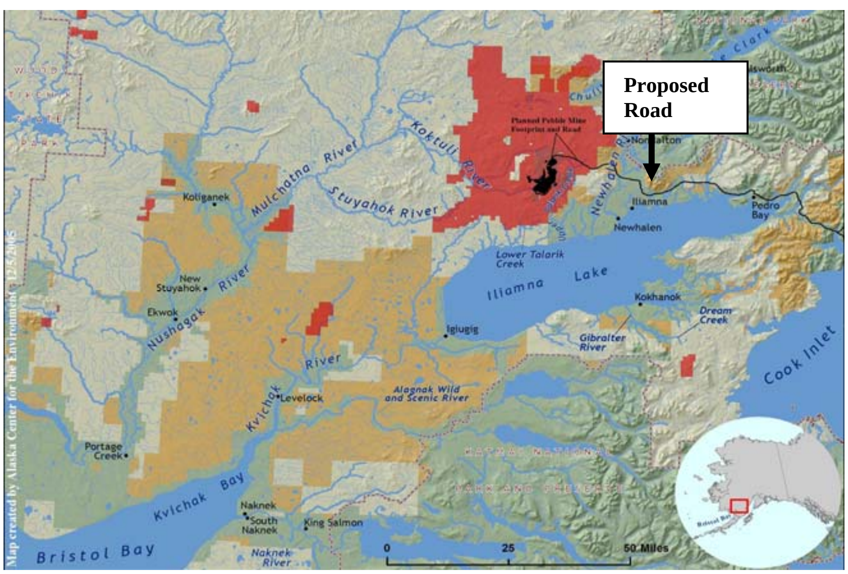


Figure 15. Proposed road and pipeline. (adapted from Pebble Partnership)

[13] The pipeline would transport ore concentrate to the port and return the wastewater to the mine site (Pebble Partnership)

The mine site itself will have a footprint of approximately 30 square miles (Hauser 2007) with the main components being the actual mine pit, crushing plant, ore processing plant, tailings storage facilities, and water treatment facility (Figure 16.).

In 2007 NDM estimated the current Pebble resources at 8.2 billion tons (70 billion pounds of Copper, 81.7 million ounces of Gold, and 4.05 billion pounds of Molybdenum) the majority of which (about 98%) will remain on site as waste or "tailings" (Chambers 2007). If the entire resource were developed, over 12 billion tons of earth will need to be moved creating huge amounts of waste.

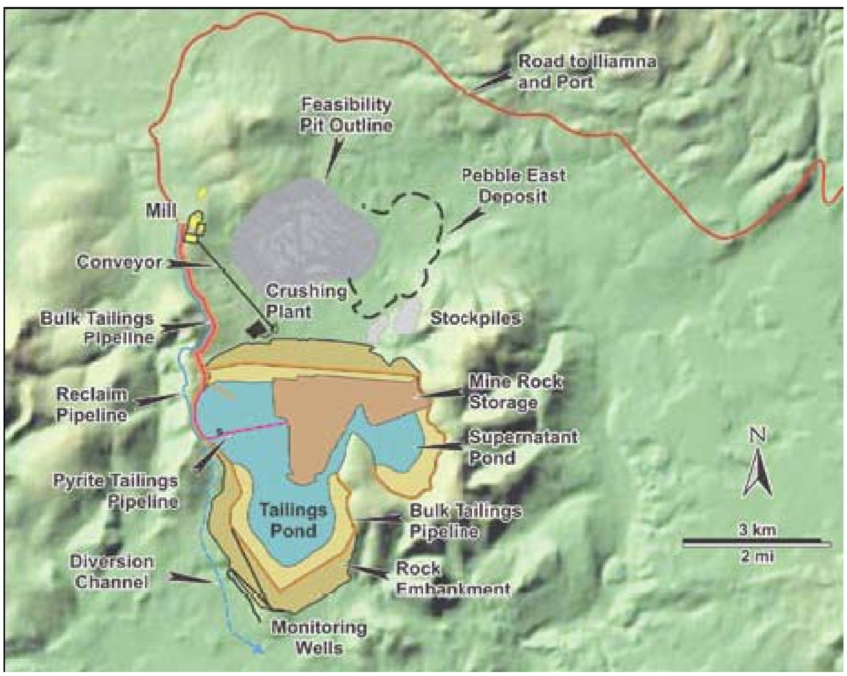


Figure 16. Pebble Mine Operations (Pebble Partnership)

Tailings

The Pebble Project will generate two types of tailings 1.) cover rock material, and 2.) material from the ore zone. The material from the ore zone will no doubt, contain some amount of ore depending upon the cut off used for classification (waste or ore) by NDM and Anglo American.

Environmental Concern Associated With Tailings

The primary concern regarding mine waste is water quality and the potential for acid mine drainage. Acid mine drainage occurs when sulfide minerals in the waste rock are exposed to air and or water forming sulfuric acid. The acid leaches out minerals in the waste rock. Minerals such as arsenic, lead, zinc and copper can leach from waste rock and contaminate both ground and surface water. At the proposed Pebble site, in a region comprised of 75% wetlands and streams that support the world's largest salmon run, this is of particular concern. Both the Kvichak watershed and the Nushagak watershed are down gradient from the proposed mine and therefore threatened. Figure 17 depicts those rivers and streams that would be directly impacted by Pebble.

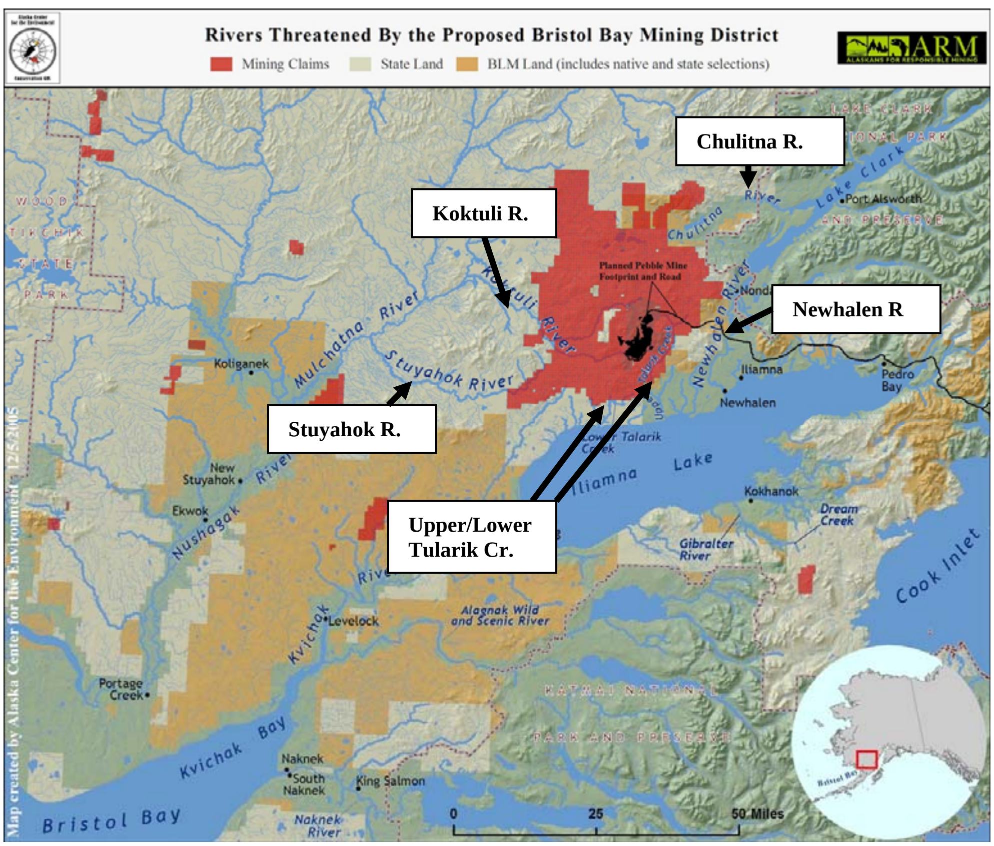


Figure 17. Rivers directly threatened by potential for contamination

The interaction between ground and surface water is well documented and given the importance of hydrology and clean water to salmon for spawning and rearing, the potential for contamination is significant and raises the question of acceptable levels. Opponents of the mine argue that any contamination whatsoever is unacceptable and according to a recent study, their claims have merit. Researchers at the Northwest Fisheries Science Center in Seattle, WA, have found that copper concentrations of just 2-20 ppb can destroy a salmon's sense of smell (Baldwin, et al. 2007). Salmon rely on their sense of smell to detect their natal streams (Quinn 2005). Contaminated rivers could become devoid of salmon simply due to the fact that the salmon are not able to home in on their respective spawning grounds. This could have other impacts as well. The salmon could die prior to spawning in search of their natal stream, or they could inhabit other, uncontaminated watersheds creating overburden on a system that may not be able to support them.

According to Bruce Switzer, Ph.D. and former Director of environmental affairs for Cominico at the Red Dog mine, water quality issues abound at the proposed Pebble site. Switzer reminds us of the unanticipated precipitation and permafrost melt that caused acid mine drainage flooding and resulted in the contamination and associated fish kill at Red Dog creek. Switzer also considers Pebble to be a much more difficult region to mine than Red Dog given that the region receives 4 times the precipitation and the water table is at the surface. (Switzer 2008).

Tailings Storage

In response to the need to adequately store tailings, NDM and Anglo American propose to build 5 earthen dams encompassing over 10 square miles and filling two valleys in order to store in perpetuity the acid producing waste (Roosevelt 2007). The “non-acid producing” tailings material would be utilized to construct the impoundment, which, would be fitted with a liner to prevent seepage and protect the integrity of the structure. The liner would not be utilized for the purpose of creating a barrier between the tailings and the base of the impoundment. The base of the impoundment is glacial moraine and mortar will be used as a supplement to prevent seepage (Chambers 2007).

Environmental Concern Associated With Impoundments

The primary concern is with tailing impoundments is also one of water quality and acid mine drainage due to structural failure. Additionally, and in order to support the impoundments, the existing landscape will be changed forever. In 2006 NDM submitted plans to create two tailings storage facilities requiring dewatering of the Nushagak watershed’s South Fork of the Koktuli River, a tributary of the North Fork of the Koktuli River and the Kvichak watershed’s upper Tularik Creek . Two of the required dams needed to hold the tailings would be larger than China’s Three Gorges Dam (Figure 18.), one of which would be the largest dam in the world standing 740 feet high and 4.3 miles long (AKDNR).

Figure 18. China's 3 Gorges Dam (TravelChinaTour.com)

Structural failure can occur as a result of seepage and erosion and in North America's most active seismic region; failure as a result of seismic activity is of particular concern (Chambers 2007). Although the Pebble Partnership's website proclaims that, "tailings embankments at Pebble will be built to withstand seismic events larger than could happen in Alaska" (2008), Steven Vick, a leading tailings dam expert, noted that "As time goes on, the largest event to have been experienced can always be exceeded" (2001). Even if a major event never occurs, multiple smaller events can, over time destabilize and weaken earthen structures causing landslides and breaches. Alaska has more earthquakes annually than any other state (Figure 19.) and is one of the most seismically active regions in the world experiencing a magnitude 7 earthquake each year and a magnitude 8 earthquake about every 14 years (USGS 2008).

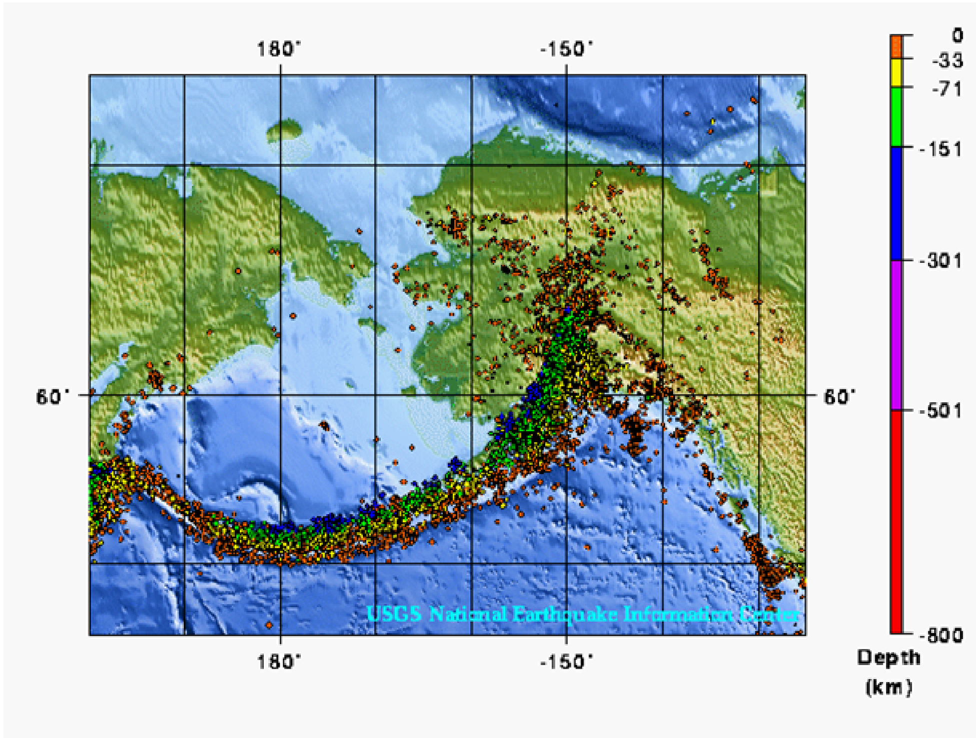


Figure 19. Alaska Earthquakes 1975-Present (USGS).

In fact, according the University of Alaska Fairbanks Earthquake Information Center, there were 154 earthquakes worldwide in the 48 hours between 4pm May 5th and 4pm May 7th, 2008-142 of them were in Alaska.

Ore Processing

Although the Pebble Partnership has not disclosed the methods by which they will extract the ore from rock it can be assumed conventional methods will be utilized. Procedurally, and in simplistic terms, after the ore is crushed it is transported to on site flotation tanks and undergoes a series of flotation operations where chemicals are added to separate the sulfide minerals from the host rock. The final flotation occurs in the tailings pond where a pyrite concentrate is added. This material is highly reactive and must remain submerged to inhibit the development of acid mine drainage (Chambers 2007).

Environmental Concern Associated With Processing

Again, the primary environmental concern is water quality. Residual chemicals from the process will remain in the tailings pond. According to Chambers (2007) most chemicals utilized to separate the sulfide minerals are organic and therefore degrade in the environment. However, Chambers is quick to point out that the degradation of some process chemicals produce byproducts such as ammonia which is toxic to aquatic organisms.

When asked, the Pebble Partnership has not ruled out the use of cyanide. Therefore, it can be assumed that its use is being considered and a subsequent discussion is warranted. According to the Mineral Policy Center (2008), cyanide compounds are widely used by the mining industry to assist in the extraction of metals from rock. In gold mining, a dilute cyanide solution is sprayed on crushed ore that is placed in piles (heaps), or mixed with ore in enclosed vats. The cyanide attaches to minute particles of gold to form a water soluble, gold-cyanide compound from which the gold can be recovered. Cyanide is used in a similar manner in the extraction of non-precious metals, such as copper and molybdenum. Consequently, cyanide is often found in discarded mine wastes.

Mining and regulatory documents often state that cyanide in water rapidly breaks down in the environment into largely harmless substances, such as carbon dioxide and nitrate. However, Moran (2000) states that cyanide also tends to react readily with many other chemical elements and is known to form, at a minimum, “hundreds of different compounds.” Many of these breakdown compounds are generally less toxic than the original cyanide, but are still known to be toxic to aquatic organisms. These breakdown compounds may persist in the environment for an unknown period of time, and there is evidence that some forms of these compounds can accumulate in fish and plant tissues (Moran 2000).

The water quality at and around the mine site is not the only concern. Once separated from the host rock, the ore will travel along side the 104 mile road to Cook Inlet. There the water will be separated from the ore and returned via pipeline back to the mine site for treatment and/or storage. As this water is toxic, failure of the pipeline in either direction could have extreme environmental impacts on salmon and wildlife habitat outside of the Kvichak and Nushagak watersheds. From the port at Cook Inlet, the ore will be loaded on to ships that are subject to disaster as was the *Exxon Valdez*. The result could negatively impact coastal habitats.

Chapter Summary

The Pebble Partnership's plan to develop approximately 30 square miles of the Bristol Bay region represents a serious dilemma for federal, state, and local decision makers. Approval of the mine could increase the quality of life for local residents through high paying jobs, increased transportation infrastructure, and decreased cost of goods and energy. It would also generate millions in revenues. This, on the surface, sounds appealing until one considers the potential impacts of the project. It is when considering those impacts that the question of legacy comes in to play. Decision makers and local leaders, probably more so than the rest of us, contemplate their legacy. Generally speaking, they want to be remembered for accomplishments and making decisions that benefited their constituents or followers. Decision makers, primarily Alaskan decision makers, are faced with three possible, if not probable legacies associated with this difficult issue. First, they could approve the mine and the project could be managed and operated as promised (co-existing with healthy fish populations). This scenario, although unlikely given the mining industry's track record, represents a win-win situation for all stakeholders. Secondly, they could approve the mine and environmental degradation and loss of species could occur. This scenario would leave behind a legacy marked by a willingness to sacrifice a resource that belongs to all for the benefit of but a few. Finally, they could deny the project and in doing so be accused of not caring about the well being and quality of life of the local residents who are in desperate need of opportunities to prosper. With this scenario there is an opportunity for decision makers to meet the development needs of the people of the region-an opportunity for sustainable economic development.

Chapter 7
The Economic Gap

Quantifying the Choices

Sound regulatory decision making relies upon numerous factors-not the least of which is political feasibility. In addition, a firm understanding of and grounding in the issue/issues; compliance with existing statures; future implications; and, quite often, a cost benefit analysis are essential elements. Regarding the Pebble project, and given the environmental concerns, it is possible that the decision to approve the mine could significantly impact fisheries in

Bristol Bay-a resource that, at present, is the foundation of the regional economy. In fact, opponents of the mine cite impacts to fisheries as the primary reason for denying Pebble permits and applications. It is therefore important for decision makers to weigh the potential economic benefits of mine approval against those of Bristol Bay's fisheries to identify the gap between the two.

Economic Benefits Associated with Mine Approval

Estimating with any degree of certainty, the economic benefits of a project still in the development stage requires the application of assumptions and the elimination from the discussion of potential benefits due to insufficient information. Pebble is no exception as the project is still in the pre-feasibility phase of development. In addition, the price paid for mineral commodities fluctuates depending on market demand, which has had high historic volatility. Therefore, the benefits associated with Pebble will be limited to quantifiable information published by NDM to date. Because of this, the benefits discussed within will not represent a comprehensive list. For example, NDM has promised service and supply contract opportunities but at this stage of the project, has not provided specific details. As a result, this element of the potential economic benefits will not be included. Similarly, the Pebble East underground resources have been confirmed and drilling to date estimates a total resource of 3.9 billion tons (49 billion pounds of copper, 45 million ounces of gold, and 2.8 billion pounds of molybdenum) (NDM 2008). Pebble East is currently undergoing additional delineation drilling, the results of which are not expected until late

2008 or early 2009. Until the Pebble East deposit is fully delineated, NDM will not publish data required to estimate annual production.[14]

Regardless, it is unlikely that the site will utilize two mills;[15] in fact NDM's draft plans indicate a single mill will be utilized with the capacity to process 200,000 tons of ore per day. In addition, as the Pebble East deposit has not been fully delineated, determining the life of the mine also becomes problematic. For the purpose of this discussion and according to NDM, a 100+ year mine operation is not unrealistic.[16] Data from NDM's investor center estimates annual revenues at just under U.S. $1 billion annually (Table 8.) with copper production making up 60 percent of combined revenue total. NDM's economic modeling is based on current market prices for gold and copper, now at historic highs in inflation-adjusted dollars.

Table 8. Pebble Production

Production (200k tbd)	Annual Production	Total Revenue (million)	Percentage of Revenue
Copper	580 mil. lbs.	580	57
Gold	680 thous. oz.	272	32
Molybdenum	20 mil. lbs.	120	11

calculated at US $1/lb copper, $440/oz Gold, $6/lb molybdenum

Alaska taxes mining in three distinct ways-through a mining license tax, a corporate net income tax, and through a net income royalty (Alaska Office of the Assessor). Because each is based on the corporation's net income, the state sees little in the way of revenues. According to Alaska State Representative Paul Seaton, while state revenues from oil and gas production amount to approximately

[14] Personal communication with NDM Director of Investor Services.

[15] Personal communication with Steven Chambers, Ph.D-Mining Expert. Utilization of more than one mill is typically cost prohibitive. It is much more likely that additional deposits would extend the life of the mine rather than increase annual production.

[16] Personal communication with NDM investor center representative.

20% of the total production value with an additional 2% paid to the local municipality, the mining industry pays the state less than 1% (.7%) and the local municipality receives 1% (AK Dept. of Revenue). According to NDM's figures, their annual contribution to the state would be $68 million while the local jurisdiction would receive $97.2 million annually for a combined total of $165.2 million in revenue payments.

The other quantifiable benefit that NDM has published relates to employment opportunities. The project has promised to provide 1000 long term jobs for local residents throughout the life of the mine. They have promised an annual average salary of $80,000 (2008 dollars) for these positions. The state of Alaska does not have an income tax nor does it levy a sales tax. Rather, the state's constitution grants broad authority to jurisdictions and municipalities and there are very few taxable exemptions required by law (Alaska Division of Taxation). This allows local jurisdictions to levy sales, use (levied on the storage, use, or consumption of goods), and other taxes as approved by voters (Alaska Division of Taxation). Table 9 indicates taxable items for the Bristol Bay region.

Table 9. Bristol Bay Regional Taxes

Municipality	**Property Tax**	**Sales Tax**	**Use Tax**
Bristol Bay Bor.	Yes	No	3% Fish, 10% Bed
Dillingham C.A.	Yes	6%	10% Bed/Liquor, 6% Gaming
Lake & Peninsula Bor.	No	No	2% Fish,2% Guide, 6% Bed

Alaska Division of Taxation

The increase in jobs and associated wages provided by Pebble would not provide revenues for the state. With the exception of the city of Dillingham, the increased salaries as a result of the Pebble project would have little impact on revenues for the local jurisdictions as the use taxes are designed to capture revenues from sources outside the region such as tourists and those participating in the commercial fishery. However, it does provide for purchase power. The jobs promised by Pebble create an annual gross parole of $80 million.

Economic Benefits Associated with Fisheries

As with the mining industry, fisheries experience fluctuation in not only Ex-vessel value (market value of the fish sold) but also in annual run size which, as discussed in chapter 3, has varied between 30 and 50 million fish annually in Bristol Bay. Recently, and as a result of the influence of farmed fish has had on the market value, the run size has had little impact on ex-vessel prices.

According to the Alaska Commercial Fisheries Entry Commission (CFEC) (2004), nearly one third of all earnings from Alaska's salmon fishing industry comes from Bristol Bay. In 2005, about 1,600 local residents (617 permit holders, 979 licensed crew members) participated in the salmon harvest and in doing so, grossed $11.26 million or, 25% of the total gross earnings. In addition, 802 Alaska residents from outside the region captured 32% of the harvest earning $14.42 million. Another 454 Alaska residents participated in processing the harvest earning $3.6 million[17]. Combined, Alaska residents participating directly in the harvest and processing of the 2005 run grossed $29.28 million.[18]

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[17] Data on local resident processing jobs and associated pay role is not currently available.
[18] Authors calculation from Department of Labor data.

The 2005 harvest represented a total Ex-vessel value of just over $45 million (ADF&G 2005) generating approximately $662,000 in local fish tax revenues (Table 10.)

Table 10. Bristol Bay Regional Fish Tax Revenues			
Jurisdiction	**% of Harvest based on total catch**	**Value of catch ($ million)**	**Fish Tax Revenues**
Bristol Bay B.	27	12.16	$365k (3%)
Dillingham CA	40	18.02	No Tax
Lake & Peninsula B.	33	14.87	$279k (2%)

Author's Calculation (ADF&G, Dept. of Labor)

In addition to local revenues, the state of Alaska levies taxes on the harvest. The Alaska Department of Revenue (DOR) collects fisheries business taxes, fishery resource landing taxes, a salmon marketing tax, and other seafood taxes from licensed seafood processors and exporters (DOR website). In 2004, the state of Alaska received approximately $53.5 million in fisheries revenues (2005 data not yet available) of which approximately $17.65 million comes from Bristol Bay.

Alaska's sport fishing industry supports over 12,000 jobs with an associated pay role of $259 million and direct expenditures from non-residents in excess of $640 million (ASA 2003). Today, there is a data gap that the ADF&G is addressing. They are currently collecting data to quantify the economic impacts of sport fisheries for specific fisheries. Their final report is due in early 2009 (see chapter 3, sport fisheries). Although specific information such as number of local jobs and associated pay role is not available, according to the Bristol Bay Health Corp., it is estimated that the Bristol Bay sport fishery generates between $50 and $60 million annually (Bristol Bay Health Corp. 2008).

This revenue generation is conceivably sustainable in perpetuity, assuming the resource continues to be well managed.

As discussed in Chapter 3, Bristol Bay's fishery drives the regional economy and economic benefits associated with the annual salmon run provide the basis for other sectors such as goods and services (not to mention the unquantifiable- but real- cultural value of traditional fishing to indigenous inhabitants). It could be argued that those same sectors could be driven by the activities of the Pebble Project and, as a result, will not be included in the discussion.

Chapter Summary

Based on the above, the Pebble Project would provide a direct economic benefit of $242.5 million annually ($68 million in state revenue, $97.2 million in local revenue, and $80 million in pay role). In contrast, the annual economic benefits of the regions fishery provides a direct economic benefit of $102.59 million ($29.28 million in commercial fishery earnings, $662 thousand in local revenues, $17.65 million in state revenues, and approximately $55 million in direct spending related to sport fisheries) (2005 data) indicating a deficit of $139.61 million annually.

The potential "costs" of these two economic sectors must also be considered-in this case, the environmental costs. Regarding operation of the mine, the environmental costs are considerable. As discussed in Chapter 6, habitat will be lost in perpetuity with the development of dams, roads, and tailings storage. Additionally, the environmental concerns associated with mineral extraction specific to Pebble could result in the benefit of one resource (minerals) at the expense of another (fish). In contrast, Bristol Bay's fisheries do not represent a cost. They have been and continue to be managed sustainably.

Chapter 8
Additional Considerations

Interestingly, it is the undeveloped landscape and pristine habitats that serve to both provide for the residents of the Bristol Bay region and inhibit additional economic prospects. Challenges such as the limited opportunities for employment and the high cost of goods and services (especially energy) make proposals such as the one presented by the Pebble Project appealing-especially given the significant gap ($139 million annually) between approving the proposal as opposed to insuring a sustainable fishery. I propose that $139 million is a small price to pay for a healthy, in tact ecosystem and challenge Alaska's decision makers to consider the following:

Recommendations

One of the most significant expenses facing the residents of the Bristol Bay region is the high cost of energy. Bristol Bay, like most of rural Alaska's energy economy is supported by fossil fuels-primarily diesel (costing as much as $6/gallon) for electricity generation. According to the U.S. Department of Energy, current resources indicate that Alaska has sufficient wind resources to support both large and small scale wind power (2008). In fact, Bristol Bay's coastal region wind resources potential is considered "outstanding", including inland areas that encompass the communities around Lake Iliamna (Figure 20.).

These resources indicate the real potential for development of wind generated power and a transition to a less expensive, sustainable energy economy.

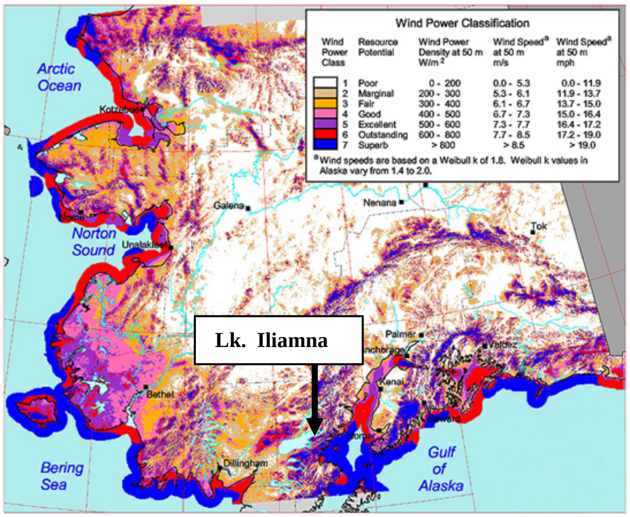

Figure 20. Alaska Wind Power Classification (USDE)

Alaska's decision makers and organizations such as the Bristol Bay Natives Corporation (BBNC) should consider developing wind as not only an alternative energy resource, but also as an opportunity for additional income for regional residents. Organizations such as the American Wind Energy Association (www.awea.org) and Native Wind (www.nativewind.com) provide technical and financial assistance for qualified programs (those that can demonstrate carbon offsets, etc.) which could go a long way in reducing the start up costs and required infrastructure. In addition, a co-op could be formed that would offset the cost of wind energy for individual users based on annual consumption and pay dividends for those who practice conservation.

Secondly, Bristol Bay's pristine environment is a resource that warrants further development of eco-tourism income opportunities. The regional sport fisheries have benefitted the state economically to the tune of approximately $50 million annually while representing a missed opportunity for local residents who see little in the form of economic benefits as a result. Decision makers should implement a "user pays" policy regarding the sport fishery as most of the area lodge owners and guides are from outside the region. By levying a user tax for the benefit of the region's inhabitants, the state could insure that some of the economic benefits remained within the region. There is also an opportunity for the BBNC to establish "Borough Lodges" as an addition to their holding company portfolio. These lodges would be owned by the residents who would also be employed by the lodge. Small business low or no interest loans provided by either the state, borough, or BBNC could also stimulate local resident lodge/guide development and in doing so, assist in tapping into the sport fishery resource.

In addition, the commercial fishery is in desperate need of increasing the Ex-vessel price of the catch. ADF&G, the Limited Entry Fisheries Commission, and the fishery's marketing associations should consider allowing alternative methods of harvest that could potentially produce a better quality product while maintaining current management practices. In addition and with the current trend in wild, organic, free trade products, Bristol Bay's commercial harvest is situated to out compete farmed fish and should be marketed as such. Also, a permit buy back program could reduce the "race for fish" by reducing the size of the fleet. This could have positive impact on the individual Ex-vessel price.

Also, decision makers should consider the current status of Pacific Salmon populations in the Pacific Northwest. As a result of overharvest, development activities, and hatcheries, wild salmon populations in Washington, Oregon, and

California have been reduced to a fraction of their historic abundance (Montgomery 2003). As icons of the region, millions of dollars are spent annually in habitat restoration activities to restore salmon populations in natal watersheds. Steps to avoid similar outcomes in Bristol Bay should be at the forefront of any policy decisions for the region.

Finally, it is evident that a data gaps exist regarding the Bristol Bay eco-region. Opportunities for additional research, especially hydrological data for both the Kvichak and Nushagak watersheds, should be undertaken prior to approving Pebble. In addition, it is very important to fully understand the economic benefit of the regions fisheries. There exists an adequate body of knowledge regarding the commercial fishery. However, little is know regarding the economic impact of the sport fishery with respect to local resident participation and associated benefits. ADF&G is in the process of quantifying this important economic sector and their work could provide the basis for additional policy considerations for maximizing the potential of this resource for local residents.

Conclusion

The choice facing policy makers in Alaska cuts to the core dilemma of the human enterprise: the conflict between the distribution of costs and benefits. Whether to sacrifice an in tact natural system with, i.) abundant natural capital that, ii) provides priceless ecosystem services (priceless because they are not valued under our current economic framework) iii.) for many people, iv.), for many generations, for the short-term economic benefit (profit) of a corporation and the few who will benefit directly (salaries, investor dividends). In economics, this issue comes down to "substitutability" vs. "complementary" (Daly, Beyond Growth, 1997). The assumption under our current economic framework is that natural capital (forests, rivers, salmon), and the ecosystem services they provide (clean water, air, climate regulation) are "substitutable" with capital (money), meaning they can be equally substituted for one another. But as natural capital becomes increasingly scarce (due to development, habitat degradation, climate change), no amount of money can buy back an intact, functioning ecosystem, so natural capital and money are actually "complements". At some point in the future, those additional dollars created by development will not provide future generations with the clean air and water (and in this case, salmon) they will need to live. As a result, future generations will spend any amount for those ecosystem services (eg. the Milltown Dam removal for clean water for Missoula and healthy fish populations). Moreover, current economic modeling tends to use discount rates which "discount" the future, meaning that short-term economic benefits tend to be pulled to the current generation while the costs (typically environmental) tend to get pushed out to future generations. Therefore, typical cost-benefit analysis does not provide a comprehensive picture of the costs and benefits, especially since many environmental costs can be externalized. Additionally, there are evolving ecosystem service markets (eg. for water-FONAG, carbon-Kyoto) which may provide opportunities for additional economic benefits from conserving intact ecosystems such as the Bristol Bay region, which are not currently assumed in a Cost-Benefit Analysis.

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