Copper River and Bristol Bay: Comparison of Salmon and Mineral Resources

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How similar are Alaska's two most famous sockeye salmon runs, the Copper River and Bristol Bay? And how similar are Alaska's two most famous copper deposits, Kennecott and Pebble? Does mining pose a similar risk to salmon in both watersheds? This note compares salmon and copper resources in both watersheds and examines potential for harm to salmon from mining at Kennecott and Pebble.

THE SALMON RESOURCE

During 2001 to 2010, the Copper River sockeye salmon run averaged 2.1 million fish[1], less than 7% of Bristol Bay's average run of 33.3 million fish[2] — the world's largest sockeye salmon run (Table 1). The Copper River run is annually supplemented with 20.9 million hatchery fry[3] of which 1.5% survives to maturity; in contrast, Bristol Bay sockeye salmon are all wild (Table 1).

photo by Michael Melford

THE COPPER RESOURCE

The question of whether mining will harm fish is not related to the kind of ore mined, but rather to the rock in which the ore is found, and the type of mining used to recover the ore. While copper deposits occur in the headwaters of both the Copper River and Bristol Bay, the deposits are entirely different.

The Copper River deposit, Kennecott, is a contact metamorphic skarn-type deposit, which means it contains very high-grade copper sulfides associated with carbonate minerals[5]. While sulfides generate acid, carbonates consume them, so mines with carbonate minerals pose less risk of acid mine drainage causing increased dissolved copper in water, which can harm fish[6].

Kennecott is located high on a mountain and was mined (1911-1938) by selective stope mining; ore was carried to a mill via an aerial tramway[7]. The high copper concentration, which averaged almost 13% copper over the life of the mine[8], also meant Kennecott's development produced minimal waste. Water for the mine was taken from a non-salmon bearing stream.

In contrast, the proposed Pebble mine is a porphyry deposit, with only scattered specks and tiny veins of copper throughout the ore. This low-grade deposit contains approximately 0.34% copper, 0.023% molybdenum, and

Table 1. Average salmon production during 2001- 2010 in the Copper River and Bristol Bay watersheds[4].

		Watershed[4]	
Statistic		**Copper River**	**Bristol Bay**
Average Annual Sockeye Run (millions)		2.1	33.3
Average Commercial Sockeye Harvest (millions)		1.2	22.4
Average Annual Hatchery Release (fry) (millions)		20.9	0
Average Hatchery Contribution to Run (thousands)		236	0
Average Subsistence Harvest (all users) (thousands)		168	109
Average Sport Harvest (thousands)		13	14
Average Non-Sockeye Commercial Harvest:			
	Chinook	32,032	48,603
	Coho	300,131	73,073
	Chum	9356	1,199,477
	Pink	20,572	122,565

0.01 ounces gold per ton[9]. Extracting one pound of copper requires pulverizing and chemically processing 294 pounds of ore; extracting one pound of molybdenum requires processing approximately two tons of ore, and extracting one ounce of gold requires processing 100 tons of ore. Processing ore at Pebble will require large amounts of water; 2006 permit applications for water currently total about 34 billion gallons per year[10]. Pebble has elevated concentrations of sulfides (1-9%), but unlike Kennecott it has virtually no carbonate minerals to neutralize acid production. Therefore, it has greater potential to produce acid mine drainage which can mobilize metals, such as copper[11], that are harmful to fish.

Porphyry deposits are typically mined using bulk-mining methods – surface open pit mining and underground block caving. Open pit mining often generates large volumes of waste rock in addition to ore. Milling (processing) the ore from both surface and underground mining requires large quantities of water, and the tailings (waste) which remain from processing will require perpetual on-site storage behind large tailings dams and in waste rock piles (approximately 99% of the rock mined becomes tailings or waste rock). One Pebble proposal includes plans for several earthen tailings dams, the largest over 700 feet high[12], which must be constructed to last into perpetuity to prevent releases of metals and processing chemicals that can be toxic to fish and aquatic life[13].

To put the size and potential impact of the two mines in perspective, it would take over 2,000 Kennecott-sized mines to produce the same amount of ore that is projected for the Pebble mine. Ore at the Kennecott mine averaged about 13% copper, while ore at Pebble averages about 0.34% copper. However, it is the mining waste, both tailings and waste rock, that bring long term environmental risk, so a size comparison based on tons of ore mined, rather than pounds of copper produced, is appropriate.

COPPER MINING AND SALMON

Salmon use headwaters of the Copper, Nushagak, and Kvichak Rivers during the freshwater phase of their life history. The Kennecott mine is high in the mountains above a glacier, away from salmon habitat (Figure 1) and water for ore processing was taken from a non-fish bearing stream. Contemporary Alaska Department of Fish and Game records show coho salmon use the Kennecott River[16], however, no other species are documented as spawning or rearing downstream of Kennecott in the Nizina or Chitina rivers although those waters are salmon migration corridors[17] (Figure 1).

In contrast, Pebble ore lies directly under salmon streams[18] (Figure 1) that drain to the Nushagak River and Iliamna Lake of the Kvichak River. From 1956 to 2010, these two river systems produced over 678 million sockeye salmon, about 40% of total Bristol Bay sockeye production[19]. Upper Talarik Creek, originating in Pebble claims, flows about 20 miles from the Pebble ore body into Iliamna Lake, the world's largest sockeye salmon rearing lake, where millions to billions of sockeye fry from over 48 different spawning populations rear. Pebble has high potential to develop acid mine drainage which can increase dissolved copper, zinc[20], and other metals harmful to fish into ground and surface waters that feed essential salmon spawning, incubation, rearing and migration habitats.

SUMMARY

1. Copper River produces an average of 2.1 million sockeye per year; in contrast, Bristol Bay produces an average of 33.3 million sockeye salmon per year.

Table 2. Comparing the Kennecott Copper Mine deposit and proposed Pebble Mine deposits in terms of copper resources and mining methods.

	Kennecott Mine (Copper River Drainage)	**Pebble Mine (Bristol Bay Drainage)**
Copper Deposit	Skarn Deposit	Porphyry Deposit
Mining method	Underground stope mining	Open pit and/or block caving
Mineral resource	≈ 5 Million tons[14]	10.8 Billion tons[15]
Ratio of resource extracted to waste materials produced	High	Low
Acid generation potential	Acid-neutralizing carbonates present in large quantity	Few acid-neutralizing minerals present

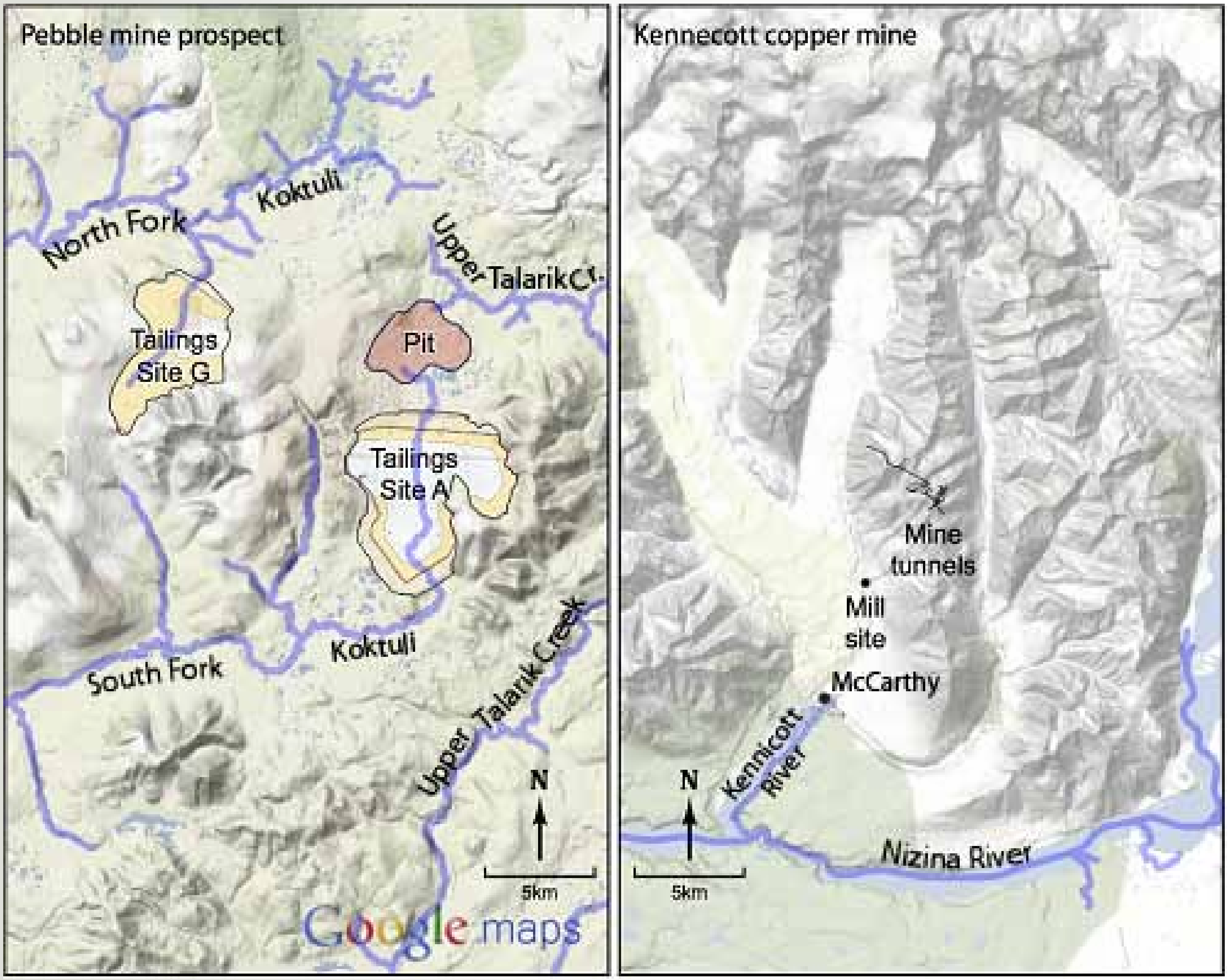

Figure 1. Left panel shows location of Pebble ore deposit (red) and proposed tailings facilities[21] in contrast to the Kennecott ore deposit (tunnels in right panel), which had minimal waste. Anadromous salmon streams depicted in blue for both sites[22]. Since 2006, the Pebble ore deposit has increased from 2.5 to 10.8 billion tons therefore estimated tailings facilities would be significantly larger than depicted here.

2. The Copper River Kennecott Mine was the world's richest copper deposit averaging about 13% copper; it was not acid generating, it produced minimal waste which did not require perpetual storage or water treatment. In contrast, Pebble is a very low-grade deposit averaging about 0.34% copper, it has high potential to produce acid mine drainage (1-9% sulfides), and over 99% of what is mined will be waste that will require perpetual storage, monitoring and perhaps treatment.

3. It would take over 2,000 Kennecott-sized mines to produce the same amount of ore that is projected for the Pebble mine.

4. The Kennecott Mine did not destroy productive salmon habitat; in contrast Pebble will destroy salmon habitat, and poses a long term contamination risk to two rivers that account for over 40% of the total Bristol Bay sockeye run since 1956.

CONCLUSION

Compared to the Kennecott Mine, development of the Pebble Prospect poses a greater risk to salmon production.

Three-ton copper nugget found in the bed of Nugget Creek, Nizina 1903. Fourth man from the left is James McCarthy, for whom the town of McCarthy was named after. Courtesy of Anchorage Museum of History and Art. Identifier AMRC-b62-1-573

Image of Kennecott Mine power plant and facilities with the Root Glacier in the background, Kennecott Mines National Historic Landmark, Wrangell -St. Elias National Park and Preserve, McCarthy, Alaska. Photo and history of the mine available from www.nps.gov/wrst//images/20060705142735.JPG. Kennecott is considered the best example of early 20th Century copper mining.

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[1] http://www.adfg.alaska.gov/FedAidPDFs/FMR10-55.pdf

[2] http://www.sf.adfg.state.ak.us/FedAidpdfs/FMR11-23.pdf

[3] http://www.sf.adfg.state.ak.us/FedAidpdfs/FMR11-23.pdf

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[17] Alaska Department of Fish and Game fish distribution database at: http://gis.sf.adfg.state.ak.us/AWC_IMS/viewer.htm

[18] ADFG anadromous waters catalogue for Iliamna region available at http://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?ADFG=maps.display&LocationID=ILI250.PDF&region=swt

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