Before the Secretary of Commerce

Petition to List the Iliamna Lake Seal, a Distinct Population Segment of Eastern North Pacific Harbor Seal (*Phoca vitulina richardii*), under the U.S. Endangered Species Act

Photo Credit: NOAA Fisheries/Dave Withrow

Center for Biological Diversity

6 February 2020

Notice of Petition

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On November 19, 2012, the Center for Biological Diversity (Center, Petitioner) submitted to the Secretary of Commerce and the National Oceanographic and Atmospheric Administration (NOAA) through the National Marine Fisheries Service (NMFS) a petition to list the Iliamna Lake population of eastern North Pacific harbor seal (*Phoca vitulina richardii*) as threatened or endangered under the U.S. Endangered Species Act (ESA). (*See generally* Center 2012.) On May 17, 2013, NMFS issued a positive 90-day finding "that the petition present[ed] substantial scientific or commercial information indicating that the petition action may be warranted" and initiated a status review. (78 Fed. Reg. 29,098 (May 17, 2013).). On November 17, 2016, NMFS issued a determination that listing was not warranted because "the seals in Iliamna Lake do not constitute a species, subspecies, or distinct population segment (DPS) under the ESA." (81 Fed. Reg. 81,074 (Nov. 17, 2016).) More specifically, NMFS concluded that while Iliamna Lake seals "are a discrete population, the best scientific and commercial data available suggest that they are not significant to the greater taxon to which they belong, *i.e.*, the eastern North Pacific harbor seal subspecies," and thus they did not meet the definition of a DPS under the Act. (*Id*.)

Since NMFS's 2016 determination, new scientific data have emerged in support of the Iliamna Lake seal's significance to the eastern North Pacific harbor seal subspecies. The Center thus submits this petition pursuant to Section 4(b) of the ESA, 16 U.S.C. § 1533(b), and 50 C.F.R. § 424.14(a) to list the Iliamna Lake seal as a threatened or endangered species and to designate critical habitat to ensure this seal population's survival and recovery. It incorporates by reference the Center's previous petition and all relevant, supporting information.

The Center for Biological Diversity is a non-profit, public interest environmental organization dedicated to the protection of native species and their habitats. The Center has more than 1.7 million members and online activists worldwide. The Center and its members seek to conserve imperiled species like the Iliamna Lake seal through science, policy, and effective implementation of the ESA.

NMFS has jurisdiction over this Petition. This petition sets in motion a specific process requiring NMFS to make an initial finding as to whether the Petition "presents substantial scientific or commercial information indicating that the petitioned action may be warranted." (16 U.S.C. § 1533(b)(3)(A).) NMFS must make this initial finding "[t]o the maximum extent practicable, within 90 days after receiving the petition." (*Id.*) Petitioner need not demonstrate that the listing is warranted, but rather present information demonstrating that such action may be warranted. The Center believes the best available scientific information demonstrates that listing the Iliamna Lake seal as threatened or endangered is warranted, and the available information clearly indicates that listing the species may be warranted. As such, NMFS must promptly make a positive finding on the Petition and commence a status review as required by 16 U.S.C. § 1533(b)(3)(B).

Respectfully submitted this 6th day of February, 2020.

Table of Contents

Executive Summary

Exclusively in Iliamna Lake, the largest body of freshwater in Alaska, lives a small population of rare and unique freshwater seals. As an isolated, discrete, and significant population of the eastern North Pacific harbor seal (*Phoca vitulina richardii*) whose persistence is threatened by a variety of factors, the Iliamna Lake seal constitutes a distinct population segment eligible for listing under the U.S. Endangered Species Act.

Alaska Native peoples describe Iliamna Lake seals as having lived in the lake since time immemorial. Aerial surveys and isotopic analysis have confirmed the year-round presence of seals in Iliamna Lake, indicating that this population is resident and persistent.

Iliamna Lake seals exhibit special characteristics that demonstrate their unique biological and ecological role as a distinct population segment. They are larger, darker, and have finer pelage than nearby marine harbor seal populations, all characteristics which may afford thermoregulatory advantages to a population that lives in an icy, freshwater environment. Genetic analysis has confirmed that Iliamna Lake seals are distinct from their marine counterparts. The lake seals' behavior, too, differs from marine harbor seals. Iliamna Lake seals make novel use of under-ice spaces during the winter, and their pupping may be delayed as compared to their Bristol Bay neighbors. Finally, the foraging ecology of Iliamna Lake seals differs in several respects from other eastern North Pacific harbor seal populations. Iliamna Lake seals rely heavily on freshwater fish throughout the year, even during periods of abundant sockeye salmon. The seals also undergo a developmental shift whereby their use of salmon increases as they mature. This distinct dietary strategy represents an adaptation to the Iliamna Lake seals' unique ecological setting (*i.e.,* a freshwater lake) and has significance for the evolutionary potential of the broader *P. v. richardii* taxon.

This extraordinary population of freshwater seals warrants Endangered Species Act protection because it is in danger of extinction, or likely to become so within the foreseeable future, due to several existential threats. First, the proposed Pebble Mine, a massive open pit mine at the headwaters of Bristol Bay, would directly disturb Iliamna Lake seals through, *inter alia*, increased vessel traffic (including year-round use of an ice-breaker ferry that would destroy critical winter habitat), construction activities, increased human presence, and anthropogenic noise; significant, adverse harm to the seals' freshwater and anadromous prey base; and habitat contamination through pollution and spills.

Climate change, which already is impacting Alaska more severely than other U.S. states, also threatens the Iliamna Lake seal through shifts in prey base and availability and changing habitat regimes (*e.g.,* precipitation changes, increasing lake stratification, altered lake ice dynamics). The Iliamna Lake seal's small population size and behavioral characteristics already makes it vulnerable to disease outbreaks; climate change makes these outbreaks more likely. Climate change also may increase predation pressure on the Iliamna Lake seal.

The small size of the Iliamna Lake seal population presents an inherent risk to population's continued existence. Scientists estimate that the population has stabilized at approximately 400 individuals. In small populations, changes in birth or survival rates can cause a population decline resulting in extinction. Such populations also are more susceptible to extinction from disease outbreaks and other environmental events. Genetic factors (*e.g.*, inbreeding, genetic drift) further threaten small populations. Individuals may be closely related to one another which, in conjunction with the loss of genetic diversity over time, increases the risk of inbreeding depression and other detrimental, population-level impacts.

Listing under the Endangered Species Act provides the only mechanism for effectively shielding the Iliamna Lake seal from threats to its continued existence. The Iliamna Lake seal is in danger of extinction, or likely to become so within the foreseeable future, due to its inherent vulnerability as a small, isolated population, and ongoing, high-magnitude threats including climate change and the Pebble Mine. The Center for Biological Diversity thus respectfully requests that the National Marine Fisheries Service list the Iliamna Lake seal under the ESA with concurrent designation of critical habitat to provide this distinct population segment with essential and much-needed legal protections.

PART I. SPECIES ACCOUNT

1. INTRODUCTION AND SPECIES DESCRIPTION

Photo credit: NOAA Fisheries/Dave Withrow

Exclusively in Iliamna Lake, the largest body of freshwater in Alaska, lives a rare and exceptional freshwater seal. This isolated population of approximately 400 eastern North Pacific harbor seals (*Phoca vitulina richardii*) lives in Iliamna Lake year-round. To thrive in this unique environment, the seals make use of Iliamna Lake's rich bounty of aquatic food resources including freshwater and anadromous fish. The seals also appear to make novel use of ice features in winter, using under-ice spaces and caves to shelter and avoid predation. Iliamna Lake seals year-round residency in a freshwater lake makes them unusual among harbor seal populations and unique among eastern North Pacific harbor seals. (Boveng *et al.* 2016, Brennan *et al.* 2019a.) While harbor seals commonly make use of freshwater bodies, the only known example of year-round harbor seal persistence in a freshwater lake—aside from Iliamna Lake—occurs in the Lac des Loups Marins complex of rivers and lakes in Canada. (Boveng *et al.* 2016, 81 Fed. Reg. at 81,084.) The Lac de Loups harbor seals (*P. v. mellonae*), which number between 150 and 600 individuals (Burns, Withrow & Van Lanen 2018), were designated as endangered in 2007 by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and were subsequently listed as endangered under Canada's Species at Risk Act (SARA). The *P. v. mellonae* subspecies bears many similarities to the Iliamna Lake seal including small population size, limited range, and reproductive isolation.

A. Taxonomy

Taxonomists currently recognize five harbor seal (*Phoca vitulina*) subspecies. (Boveng *et al.* 2016.) Scientists believe Iliamna Lake seals belong to the eastern North Pacific harbor seal subspecies (*P. v. richardii*), having distinguished them from similar-looking spotted seals (*P. largha*) based on certain morphological and behavioral characteristics. (*Id.*) This classification and differentiation from spotted seals has been verified by genetic evidence. (*Id.*, *citing* Burns *et al.* 2013; Burns, Withrow & Van Lanen 2018 (all sampled Iliamna Lake seals "were categorized as harbor seals using multi-locus genotypes").)

B. Physiology, Morphology and Behavior

Traditional local knowledge and the availability of scientific evidence, including genetic and isotopic evidence, confirm that there exists in Iliamna Lake a year-round population of harbor seals. (Boveng *et al.* 2016; Brennan *et al.* 2019a.) Compared to their marine counterparts, Iliamna Lake seals have been described as larger and fatter, with softer fur and different coloration. (Boveng *et al.* 2016, Burns *et al.* 2016.) Available evidence suggests that pupping may occur several weeks later in Iliamna Lake seals than in nearby marine populations. (Boveng *et al.* 2016.)

Iliamna Lake seals utilize their freshwater environment in ways novel and unique to the greater harbor seal species. For example, "local knowledge suggests that seals may be inconspicuous during ice cover; some may remain in various small open-water areas, use air trapped under the ice, or use areas along shore with air gaps under the ice." (Boveng *et al.* 2016, *citing* Burns *et al.* 2013; *see also* 81 Fed. Reg. at 81,077 (discussing the seals' possible use of air pockets that form under surface ice during winter), Burns, Withrow & Van Lanen 2018 (same).) "[L]ocal residents have reported hearing seals under the ice in such spaces." (81 Fed. Reg. at 81,077; *see also* Burns, Withrow & Van Lanen 2018.) This novel use of lake ice may represent one way these seals "have adopted specialized habits to avoid predation during winter ice cover, when terrestrial predators could easily reach the islands and bars used for hauling out during summer." (Boveng *et al.* 2016; *see also* Burns, Withrow & Van Lanen 2018.) Such use of lake ice differentiates Iliamna Lake seals from the greater harbor seal species, which "is not thought to have special adaptations that are typical of strongly ice-associated species" such as use of under-ice spaces. (Boveng *et al.* 2016; *see also* Burns, Withrow & Van Lanen 2018.)

Another way in which Iliamna Lake seals differ from their marine counterparts is diet. Iliamna Lake seals utilize summer salmon runs, more so as adults, and primarily feed on freshwater fish during the remainder of the year. (*See generally* Brennan *et al.* 2019a.) In its decision not to list the Iliamna Lake seal following the Center's 2012 listing petition, NMFS stated that "[n]o scientific data are available to determine whether enough fish remain in Iliamna Lake to support hundreds of seals during winter." (81 Fed. Reg. at 81, 077.) New evidence suggests that, in fact, it does. (*See generally* Brennan *et al.* 2019a.) This new research provides evidence of Iliamna Lake seals' adaptation to their freshwater environment throughout the year; the seals' unique dietary strategy, in turn, provides evidence supporting the species' discreteness as well as its significance to the eastern North Pacific harbor seal taxon. The lake seals' diet is discussed in more detail in Parts I.1.5, II.1.C, and II.2.A.ii, *infra*.

Little is known about reproduction in Iliamna Lake seals. They appear to haul out in small herds during the breeding season and use island beaches or sandbars primarily in the northeastern portion of the lake for pupping. (Withrow & Yano 2011, Burns *et al.* 2016; *see* Fig. A.) In general, harbor seals reach sexual maturity at three to four years of age for females and four to five years for males. (Burns 2002.) Pregnancy rates exceed 85% annually for most harbor seal populations, although the rate of another freshwater seal, the Saimaa lake ringed seal in Finland (*Phoca hispida saimensis*), is only 70 percent.

(Burns 2002, Sipila 2003.) First-year survival of harbor seal pups appears to correlate significantly with autumn body mass; in Sweden, only 63% of the smallest pups survive compared to 96% of the largest. (Harding *et al.* 2005.)

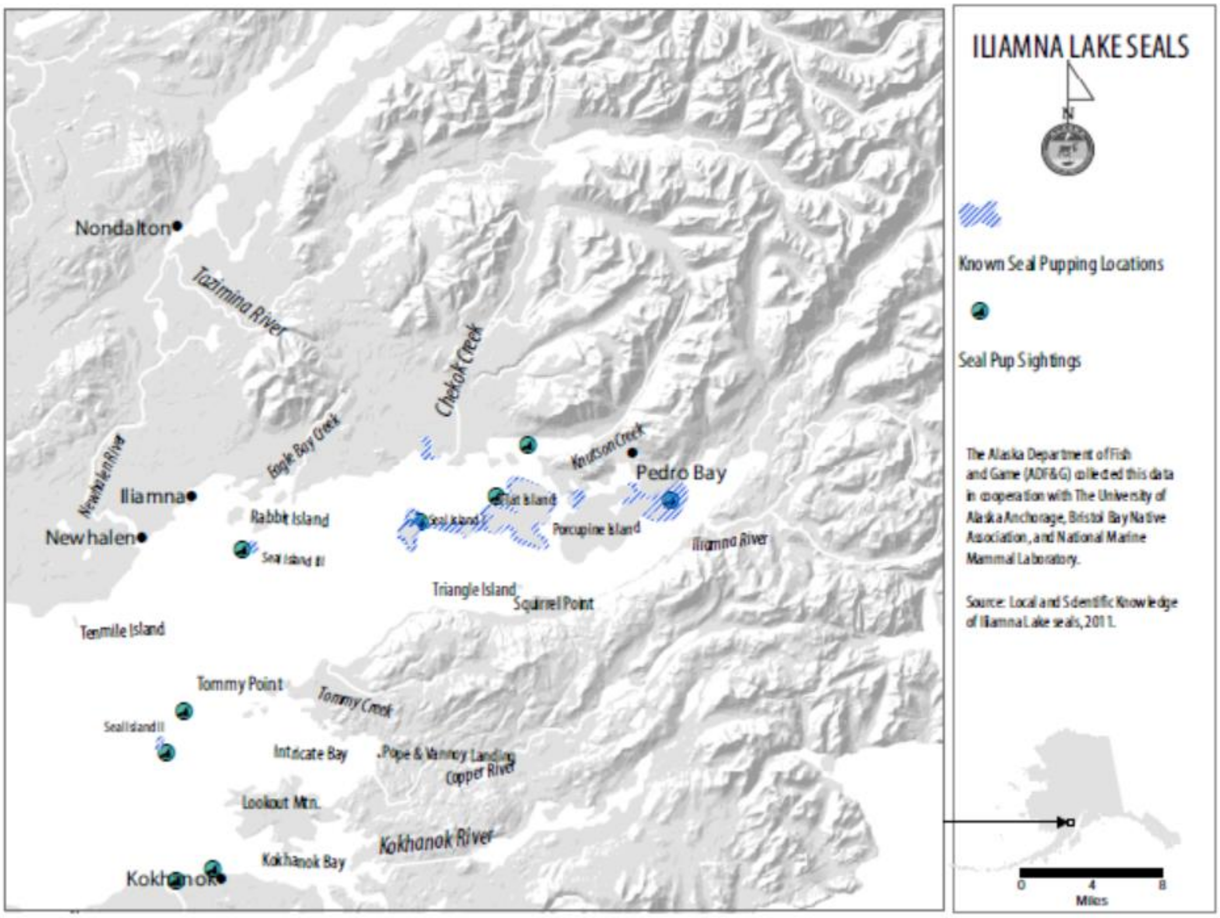

Fig. A. Known Iliamna Lake seal pupping locations. Map is Fig. 5-11 from Burns *et al.* 2016.

Appearance and precocity of newborn Iliamna Lake seal pups appear similar to what is seen in eastern North Pacific harbor seals. Both shed the lanugo before birth, and both swim soon after they are born. Eastern North Pacific harbor seal pups nurse for approximately four weeks, after which they are abruptly weaned and left to fend for themselves. (Burns, Withrow & Van Lanen 2018). Harbor seal pups are already catching their own food in the late stages of the nursing period. Pup behavior is unknown for Iliamna Lake seals, save one report of a subsistence fisher freeing a juvenile seal from a fishing net while the mother waited nearby. (Fall *et al.* 2010.)

2. DISTRIBUTION: GEOGRAPHIC AND BIOLOGICAL SETTING

Iliamna Lake seals reside year-round in Iliamna Lake. Located in Alaska, approximately 362 km southwest of Anchorage, Iliamna Lake is nestled between Lake Clark National Park and Preserve to the north and Katmai National Park and Preserve to the south. Bristol Bay lies to the lake's southwest and Cook Inlet to the east. This large glacial lake covers a total of 3,175 km^2. (Zamzow 2018.) At 124 km long and up to 275 m deep, Iliamna Lake is the largest lake in Alaska and the eighth largest freshwater lake in the United States. (*Id.*; Burns, Withrow & Van Lanen 2018.) Many islands dot the lake's surface.

Numerous rivers and streams run into Iliamna Lake and the sole outlet to the sea is the 115 km Kvichak River, which drains from the lake's southwest into Bristol Bay. (Boveng *et al.* 2016.)

Iliamna Lake and the greater Kvichak River system support one of the world's largest sockeye salmon (*Oncorhynchus nerka*) populations, averaging 10.75 million spawners annually between 1959-2005. (Boveng *et al.* 2016, *citing* Fair *et al.* 2012.) Indeed, Iliamna Lake is the "largest sockeye salmon rearing lake in the world." (Zamzow 2018.) The Lake also supports healthy runs of coho (*O. kisutch*), king (*O. tshawytscha*), chum (*O. keta*), and pink (*O. gorbuscha*) salmon. Resident freshwater fish in the lake include rainbow trout (*O. mykiss*), whitefish species, Arctic grayling (*Thymallus arcticus*), and northern pike (*Esox lucius*). Spawning salmon are fed upon by a large population of brown bears (*Ursus arctos*). Other terrestrial mammals common to the lake area include grey wolves (*Canis lupus*), wolverines (*Gulo gulo*), red foxes (*Vulpes vulpes*), moose (*Alces alces*) and caribou (*Rangifer tarandus*). Ravens (*Corvus corax*), bald eagles (*Haliaeetus leucocephalus*), and various species of gulls and jays frequent the lake year-round. The lake and river provide for local subsistence fishing and world-renowned recreational fishing, and the Kvichak River salmon runs also support large, sustainable commercial fisheries operations in Bristol Bay. (Duffield *et al.* 2007.)

Iliamna Lake is remote, pristine, and largely free from human influence.[1] Lakeshore communities include Iliamna (pop. 109), Newhalen (pop. 190), Igiugig (pop. 50), Kokhanok (pop. 170), Pedro Bay (pop. 42), and Pope-Vannoy Landing (pop. 6). (U.S. Census Bureau 2012.) Year-round residents are primarily Yupik Eskimos, Aleuts, and Athabascans, with residents highly dependent on subsistence hunting and fishing, including for sockeye and coho salmon. (Igiugig Village Council 2019.) Iliamna Lake is accessible by air travel and limited barge service. Fishing and hunting lodges on the lakeshore and along the Kvichak River draw sportsmen to the area during the summer.

3. ABUNDANCE AND POPULATION TRENDS

The Alaska Department of Fish and Game (ADF&G), NMFS, and other entities have conducted periodic aerial surveys of Iliamna Lake seals since 1984. (Boveng *et al.* 2016, Burns, Withrow & Van Lanen 2018.) This time series of counts was combined with a demographic model to estimate population size and trend. (Boveng *et al.* 2016.) Various model scenarios resulted in a relatively stable population of approximately 400 individuals between 1984-2013. (*Id.*) This population estimate comports with that given by local residents (329 individuals). (81 Fed. Reg. at 81,076.) This equilibrium was reached after the population plummeted to as few as 50 individuals during the 1970s due to severely cold winters. (Boveng *et al.* 2016)

4. HABITAT USE

Iliamna Lake seals utilize the entirety of the Iliamna Lake, though they appear to preferentially use the eastern portion, especially during the winter. (Boveng *et al.* 2016, Burns, Withrow & Van Lanen 2018.) This part of the lake may provide more favorable overwinter conditions, including cracks in the ice used by the seals for breathing and haul-outs. (Boveng *et al.* 2016, Burns, Withrow & Van Lanen 2018 (noting that the eastern portion of the lake may have small areas of ice-free water kept open by "water circulation patterns, springs, hydrothermal activity, [or] bottom topography" and that the northeastern

[1] *See* EPA 2014a (noting that "[t]he exceptional quality of the Bristol Bay watershed's fish populations can be attributed to several factors, the most important of which is the watershed's high-quality, diverse aquatic habitats unaltered by human-engineered structures and flow management controls.").

part of the lake, which is the deepest, freezes last.) In the ice-free season, the northeastern portion of the lake offers preferred haul-out and pupping sites on islands. (Pebble Partnership 2010a, 2010b, 2010c; Burns *et al.* 2016; *see also* Burns, Withrow & Van Lanen 2018 (noting that aerial surveys have revealed 24 haul out sites).) During the summer salmon migration and into the fall, seals are seen near salmon spawning streams and beaches as well as near the lake's outflow at the Kvichak River. (Boveng *et al.* 2016, Burns, Withrow & Van Lanen 2018.)

5. DIET AND FEEDING ECOLOGY

Iliamna Lake contains a variety of freshwater fish and invertebrates, as well as anadromous salmonids. Large (but variable) annual salmon runs and abundant lake fish species including arctic grayling, lake trout, stickleback, whitefish, pike, and sculpin, provide a rich bounty of food for the Iliamna Lake seal population (Hauser *et al.* 2008, Van Lanen 2012.)

Adult sockeye salmon start entering Iliamna Lake in late June or early July and run through the end of August, and are followed by spawning silver, chum, and pink salmon. Abundant salmonids in mid- to late summer provide a source of high-fat nutrition for Iliamna Lake seals in preparation for the winter months; the seals often selectively consume the most nutrient-dense parts of those fish (*e.g.,* eggs in pre-spawning females) (Hauser *et al.* 2008, Brennan *et al.* 2019a.) Subsistence fishers report that Iliamna Lake seals sometimes raid gillnet sets near the Newhalen River outlet, with one family estimating that two groups of seals took between 30 and 40 fish from their nets one summer. (Fall *et al.* 2010, Burns, Withrow & Van Lanen 2018).

Past research on fecal samples suggested that Iliamna Lake seals' summer diet consisted predominately of these adult salmonids, whereas marine harbor seals use of salmonids was less than 10 percent (Hauser *et al.* 2008.) More recent research reveals that Iliamna Lake seals "rel[y] principally on resources produced from in the lake, even when seasonally abundant and nutrient-dense spawning anadromous fish … [are] available in the lake." (Brennan *et al.* 2019a.) Brennan *et al.* used isotope ratios in teeth to reveal resource use patterns of the Iliamna Lake seal; they found that that Iliamna Lake seals undergo an ontogenetic shift from a principal reliance on lake food resources early in life to a heavier reliance (10-100%, depending on the individual) on seasonally abundant salmon later in life. (*Id.*) This dietary strategy of Iliamna Lake seals is "clearly … distinct" from that of marine harbor seals in Bristol Bay. (*Id.*; *see also* Parts I.1.5, II.1.C, and II.2.A.ii, *infra*.)

6. CAUSES OF MORTALITY

A. Natural Causes: Disease & Predation

Harbor seal populations have succumbed to epizootics resulting in large-scale die-offs. (Burns 2002.) Bacterial, viral, and fungal diseases all have the potential to devastate the small Iliamna Lake seal population. Examples of such diseases include *Morbillivirus* (*e.g.,* canine distemper virus and phocine distemper virus), phocid herpesvirus, influenza, *Streptococcus phocae*, *Mycoplasma*, and *Brucella*. (Geraci *et al.* 1982, Borst *et al.* 1986, Skaar *et al.* 1994, Burns 2002, Barrett, Sahoo & Jepson 2003, Goldstein *et al.* 2003, Härkönen *et al.* 2006, Zarnke *et al.* 2006, Hueffer, Gende & O'Hara 2013, Taurisano *et al.* 2018, Kennedy *et al.* 2019, NOAA Fisheries 2019a). The threat of disease to Iliamna Lake seals is discussed in more detail in Part III.3, *infra*.

While more research is needed to better understand predation effects on Iliamna Lake seals, wolves and wolverines are known predators. (Burns, Withrow & Van Lanen 2018.) Residents have observed both these species searching for lake seals by following pressure cracks on the ice. (*Id.*) Other possible predators include brown bears, which occasionally are seen on or near haul-out sites; coyotes (*Canis latrans*); red foxes; eagles, which are known to prey on freshwater Caspian seals (*Phoca capsica*); and gulls and ravens. (Burns 2002; Härkönen *et al.* 2008, Burns, Withrow & Van Lanen 2018.) There are no known aquatic predators of Iliamna Lake seals, although Wright (2012a, 2012b) hypothesized that a population of sleeper shark (*Somniosus pacificus*) could have colonized the lake. If that is the case, this species theoretically could predate on Iliamna Lake seals.

Other natural causes of death, particularly for pups, include malnutrition and starvation. (Steiger, Smith & Skilling 1989, Huggins *et al.* 2013.)

B. Anthropogenic Causes: Subsistence Harvest & Fishing

Subsistence hunting of Iliamna Lake seals has occurred for many generations, with seals providing valued meat and seal oil. (Fall *et al.* 2006, Van Lanen 2012.) Hunting often takes place in February to mid-March, while the ice is still thick, but seals also may be harvested in other seasons. (Fall *et al.* 2006, Burns *et al.* 2016). Hunters target areas of known seal abundance, including Rabbit Island, Eagle Bay Island, Triangle Island, Flat Island and surrounding waters, Seal Islands I, II, and III, Porcupine Island and waters to the west, and the Tommy Islands; the mouths of Chekok Creek, the Gibralter River, the Newhalen River, and the Kvichak River; waters of the Kvichak River, Tommy Creek, and Yellow Creek; Eagle Bay, Knutson Bay, Leon Bay, and Pedro Bay, Lonesome Bay; Little Chutes and Big Chutes; and Tommy Point, Squirrel Point, and Millets Point,[2] . (Fall *et al.* 2006, Burns *et al.* 2016; *see* Figs. C, D, E *infra*.)

[2] Note that local residents use different names for the islands, and these names also may differ from those used by USGS. (Burns, Withrow & Van Lanen 2018.) *See* Figs. B, C, D, *infra*.

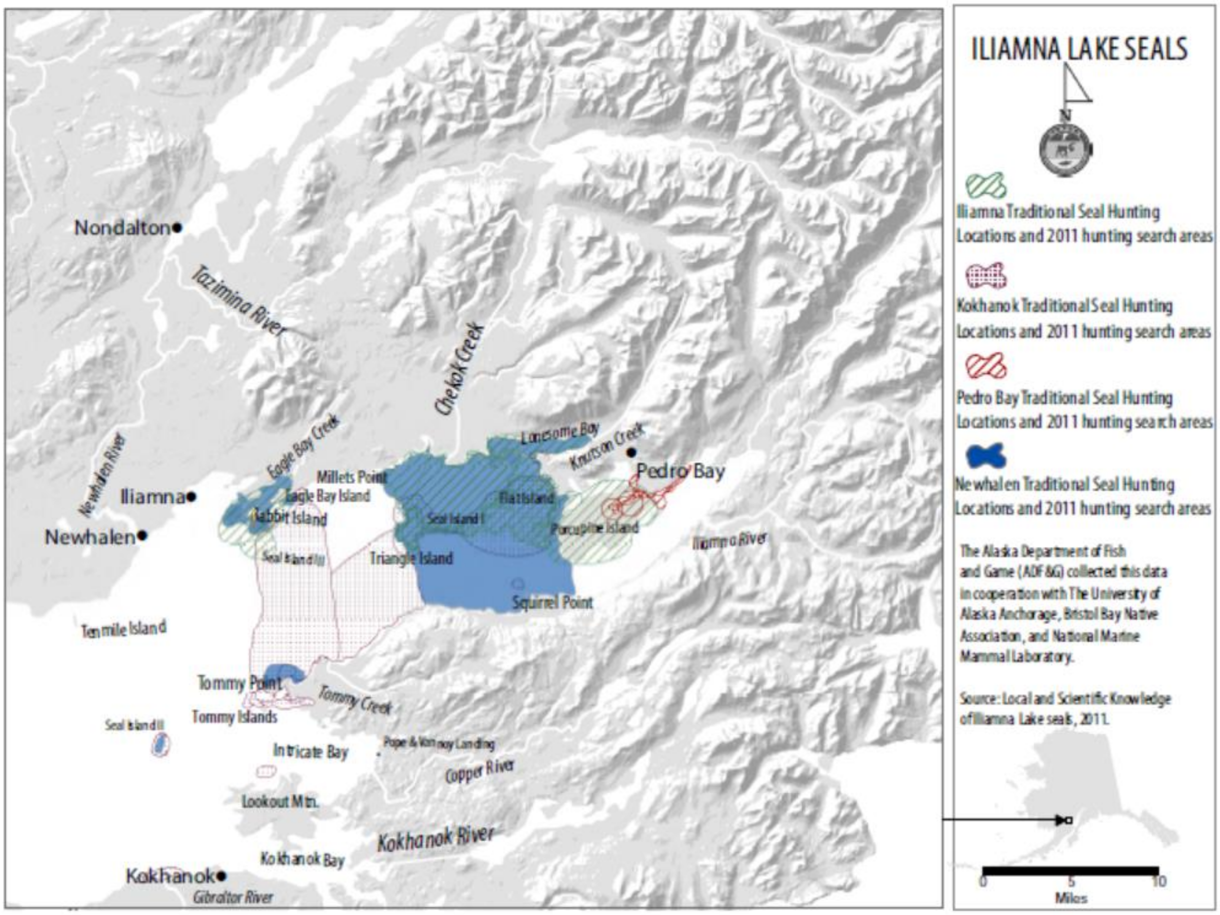

Fig. B. Traditional seal hunting locations for the communities of Kokhanok, Pedro Bay & Newhalen. Map is Fig. 5-36 from Burns *et al.* 2016.

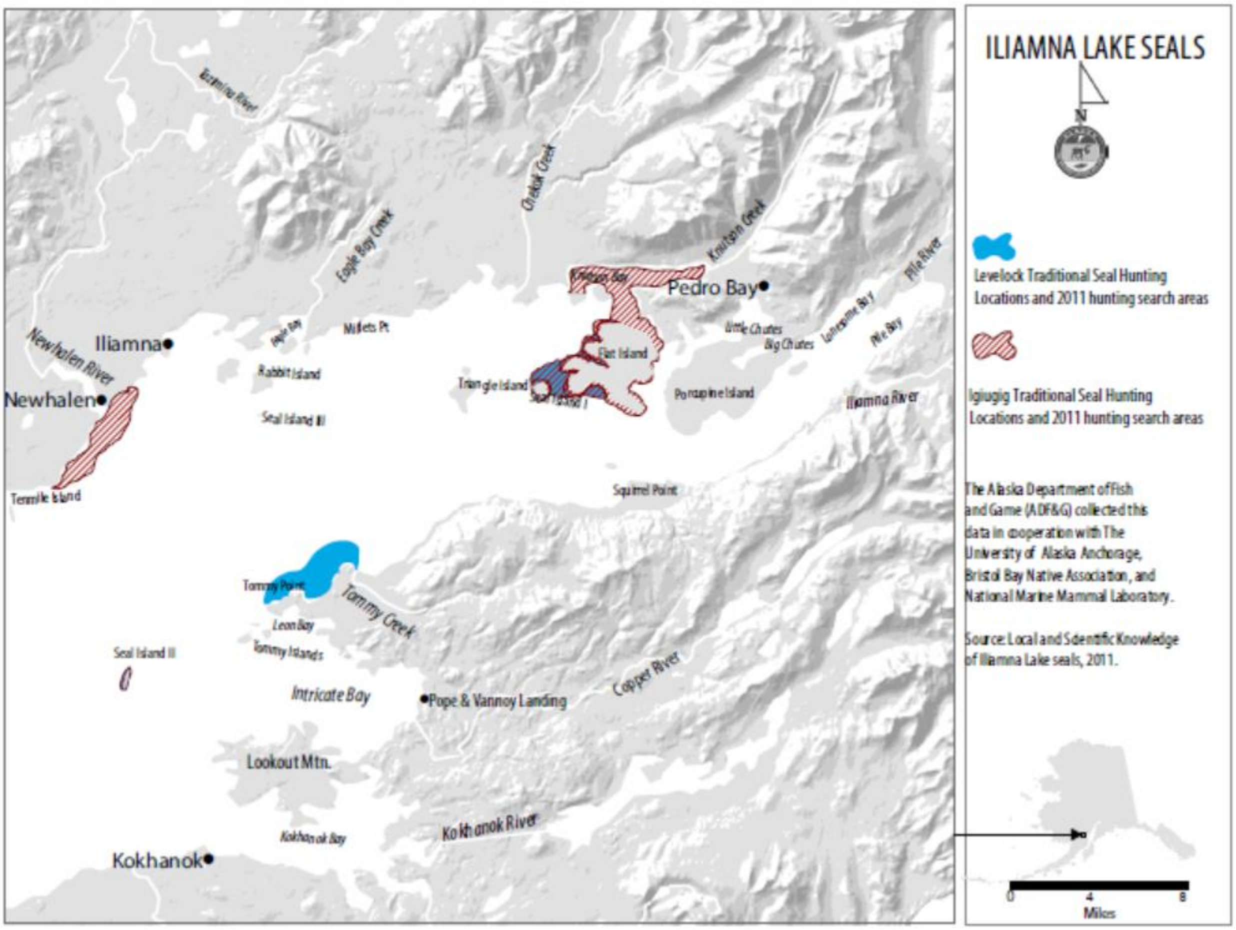

Fig. C. Traditional seal hunting locations for the communities of Levelock and Iguigig. Map is Fig. 5-37 from Burns *et al.* 2016.

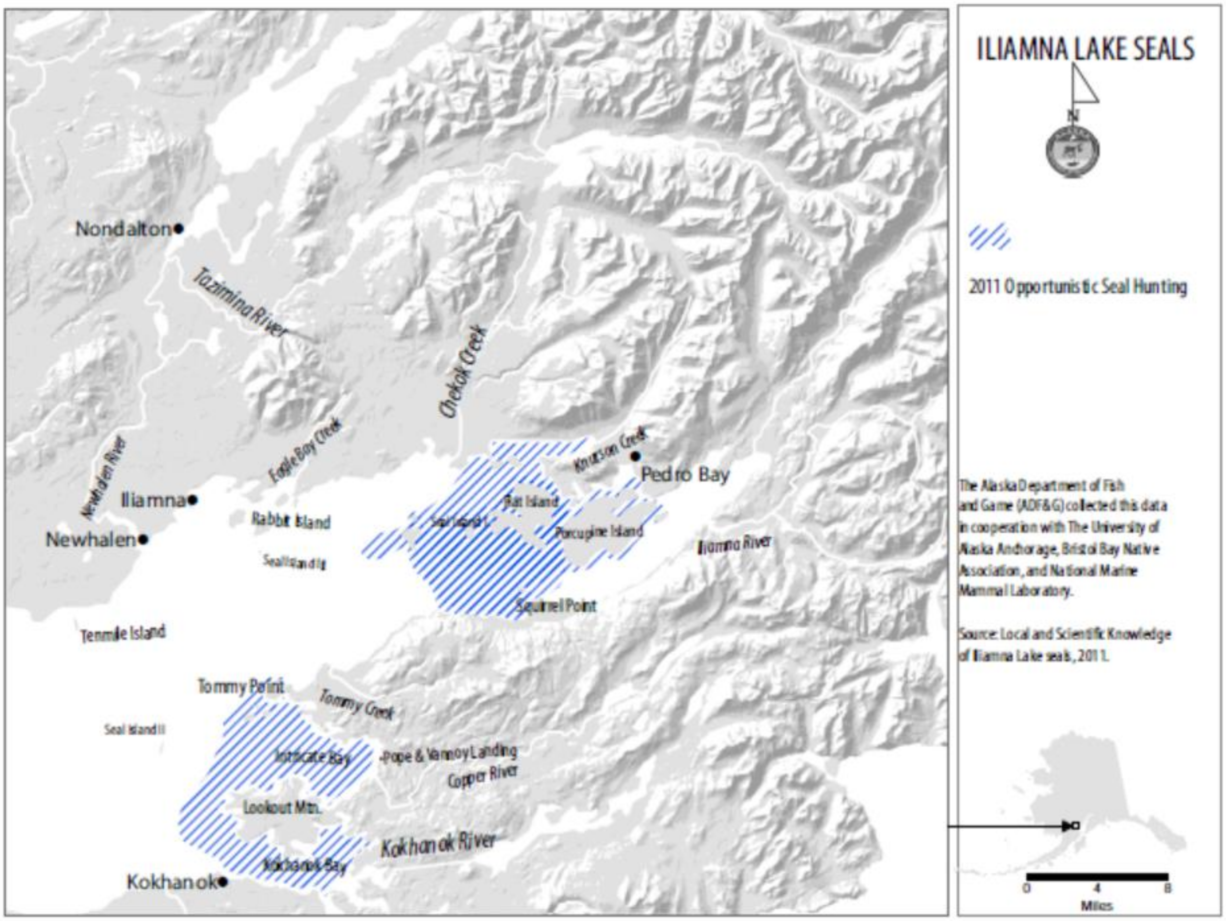

Fig. C. Opportunistic seal hunting areas in northeast Iliamna Lake. Map is Fig. 5-42 from Burns *et al.* 2016.

Total subsistence take of Iliamna Lake seals varies from year to year and remains poorly documented. (Fall *et al.* 2006, Burns *et al.* 2016.) Reports of take range from as few as two per year to as many as 33 (Fall *et al.* 2006, Withrow & Yano 2011, Burns *et al.* 2016; *see* Fig. E, *infra.*) Conservation measures are woven into traditional hunting practices for Iliamna Lake seals, including "adherence to a rule to only harvest what the community needs and to thus produce no waste." (Burns, Withrow & Van Lanen 2018.) Local residents place a high priority on monitoring and protecting Iliamna Lake seals so as to ensure their continued persistence. (*Id.*)

Year	Community	Estimated harvest	Unit	95% confidence limit (±) harvest
1982	Pedro Bay	0.0	ind	
1983	Igiugig	4.0	ind	150.0%
1983	Iliamna	5.0	ind	100.0%
1983	Kokhanok	0.0	ind	
1983	Newhalen	14.0	ind	107.0%
1988	Levelock	16.0	ind	43.0%
1991	Iliamna	10.0	ind	80.0%
1991	Newhalen	23.0	ind	30.0%
1992	Igiugig	2.0	ind	
1992	Kokhanok	11.0	ind	
1992	Levelock	0.0	ind	
1996	Pedro Bay	0.0	ind	
2004	Iliamna	8.5	ind	20.0%
2004	Newhalen	17.9	ind	8.0%
2004	Pedro Bay	0	ind	
2005	Igiugig	5.4	ind	29.4%
2005	Kokhanok	4.8	ind	6.9%
2005	Levelock	0.0	ind	
2010	Kokhanok	0.0	ind	
2010	Newhalen	2.0	ind	
2011	Igiugig	4.2	ind	22.5%
2011	Iliamna	2.4	ind	57.5%
2011	Kokhanok	6.6	ind	30.1%
2011	Levelock	0.0	ind	
2011	Newhalen	7.9	ind	50.9%
2011	Pedro Bay	1.3	ind	110.0%

Fig. E. Estimated and reported annual subsistence take of Iliamna Lake seals. Figure is Table 5-26 from Burns *et al.* 2016. Data prior to 1992 may have included marine harbor seals.

Fishing activities are widespread on Iliamna Lake. Subsistence fishers set salmon gillnets near the outlet of the Newhalen River on the north shore of Iliamna Lake. While subsistence fishers try to avoid operating in areas subject to excessive seal picking (since seals remove salmon and destroy nets), seals do sometimes raid net sets and occasionally become entangled in them. (Fall *et al.* 2010.) NMFS lists entanglement in fishing gear and other marine debris as a threat to the greater harbor seal species; when seals become entangled, they may drown or, if they break free and drag gear around, suffer from injury, fatigue, compromised feeding ability, reduced reproductive success, or death. (NOAA Fisheries—Harbor Seals.) Drowning in fishing gear is a known, major cause of mortality in other freshwater seal populations (*e.g.,* Lake Saimaa in Finland), though at current levels of fishing it does not appear to negatively affect the Iliamna Lake seal population (Sipila 2003, Canadian Science Advisory Secretariat 2008.) Neither subsistence, recreational, nor commercial at current levels appear to operate at a level detrimental to Iliamna Lake seals.

7. CONSERVATION STATUS

While seals are protected under the Marine Mammal Protection Act (MMPA), the Iliamna Lake seal has not yet been (though it should be) described or managed as a separate stock in NMFS's MMPA Stock Assessment Reports. Instead, both NMFS and the Alaska Department of Fish and Game include Iliamna

Lake seals as part of the Bristol Bay harbor seal stock. As a result, the Iliamna Lake seal receives no specific legal or management protections. Management of the Iliamna Lake seal under the MMPA is discussed in more detail in Part III.4.B.ii, *infra*.

PART II. THE ILIAMNA LAKE SEAL IS A LISTABLE ENTITY UNDER THE ESA

The Iliamna Lake seal represents a "distinct population segment" (DPS) of the eastern North Pacific harbor seal, and thus is a listable entity under the Endangered Species Act. Generally speaking, the ESA extends its protection to "species," a term broadly defined to include "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." (16 U.S.C. § 1532 (16).) A distinct population segment (DPS), in turn, is defined as a "vertebrate population or group of populations that is discrete from other populations of the species and significant in relation to the entire species." (NOAA Fisheries 2019b; *see also* 61 Fed. Reg. 4722 (Feb. 7, 1996).) A species or subspecies may be composed of several DPSs, some or all of which may warrant listing under the ESA.

To be considered a DPS, a population must be both "discrete" and "significant." Based on the best available science, the Iliamna Lake seal is both discrete from other populations of eastern North Pacific harbor seal and significant to the broader eastern North Pacific harbor seal taxon. Thus, the Iliamna Lake seal meets the ESA's definition of a DPS as set forth under the 1996 joint Fish and Wildlife Service (FWS)-NMFS "Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act" and constitutes a listable entity under the Act. (*See generally* 61 Fed. Reg. 4722.) Attributes that confer DPS status to the Iliamna Lake seal are described in the following sections.

1. DISCRETENESS

The Iliamna Lake seal represents a discrete population under the ESA. In its 2016 12-month finding, NMFS concluded that the Iliamna Lake seal "meet[s] the criteria for consideration as a discrete entity per our DPS policy." (81 Fed. Reg. at 81,082.) This remains the case. Under the DPS policy, a population segment of a vertebrate species is considered discrete if either:

(1) It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors. Quantitative measures of genetic or morphological discontinuity may provide evidence of this separation, or
(2) It is delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the Act.

(61 Fed. Reg. at 4725.) The Iliamna Lake seal satisfies criterion number one:[3] it is a discrete population "markedly separated from other populations of [eastern North Pacific harbor seal] as a consequence of physical, physiological, ecological or behavioral factors." (*Id*.)

A. Physical Factors

Iliamna Lake seals are a discrete population markedly separated from other populations of eastern North Pacific harbor seal as a consequence of physical factors. Iliamna Lake seals live in a unique physical and ecological setting—an interior, freshwater lake—spatially separated from eastern North

[3] Given that Iliamna Lake falls entirely within U.S. jurisdiction, criterion number two is not applicable.

Pacific harbor seals in Bristol Bay via 115 km of the Kvichak River. (Withrow & Yano 2011, Boveng *et al.* 2016, 81 Fed. Reg. at 81,079.) In their 2016 report, the Biological Review Team (BRT) convened by NMFS to evaluate the distinctness of Iliamna Lake Seals noted that "the length, current, channel characteristics, and seasonal ice cover of the Kvichak River seem likely to limit immigration and emigration from the lake." (Boveng *et al.* 2016.) Indeed, navigating a maze of shallow braided sandbars in summer or ice cover in winter would be energy-intensive endeavors, and there is no indication from genetic or isotopic evidence or otherwise to suggest these two populations are actively linked. Thus, the Iliamna Lake seal appears markedly separated from other eastern North Pacific harbor seal populations based on physical factors.

B. Physiological Factors

Iliamna Lake seals also represent a discrete population markedly separated from other populations of eastern North Pacific harbor seal as a consequence of physiological factors. NMFS's expert panel agreed, finding that—even lacking direct measures of physiological factors indicating separation—other evidence is sufficient to suggest physiological separation. (Boveng *et al.* 2016.) Such evidence includes reports from local residents that the taste, body type and size, and pelage of Iliamna lake seals differ from their marine counterparts, as well as evidence that reproductive timing in Iliamna Lake seals may be later than that of harbor seals in Bristol Bay, with a possible "15-day delay in the average peak pupping date in Iliamna Lake (July 12) versus the average peak pupping date in Nanvek Bay (June 27)." (81 Fed. Reg. at 81,080; *see also* Burns *et al.* 2016, Withrow & Yano 2011 (referring to local traditional knowledge that "everything happens in the lake about a month later than everywhere else"), Boveng *et al.* 2016.) Physiological factors thus also demonstrate the Iliamna Lake seal's marked separation from other eastern North Pacific harbor seal populations.

C. Ecological Factors

Iliamna Lake seals represent a discrete population markedly separated from other populations of eastern North Pacific harbor seal as a consequence of ecological factors. Boveng *et al.* begin their discussion of marked separation by ecological factors by stating that "[i]f the diet of harbor seals in Iliamna Lake is distinctly different than the diet of marine harbor seals, this could potentially induce or indicate marked separation." (Boveng *et al.* 2016). Previous research had demonstrated that adult salmon dominate Iliamna Lake seal diets during July and August, while salmonids typically comprise <10% of marine seals' diets. (Hauser *et al.* 2008). During the remainder of the year, Iliamna Lake seal diets were believed to consist primarily of freshwater fish, a belief supported by whisker and muscle stable isotope chemistry. (Boveng *et al.* 2016, Burns, Withrow & Van Lanen 2018.) As NMFS noted, "[t]he prey items and seasonal concentration of salmon in the diet of seals in Iliamna Lake are consistent with those documented for harbor seals in other *freshwater* systems." (81 Fed. Reg. at 81,080 (emphasis added).)

New evidence presented in Brennan *et al.* (2019a) confirms that the diet of Iliamna Lake seals is, indeed, distinctly different than that of marine harbor seals. This research used isotope analysis ($^{87}Sr/^{86}Sr$, $^{13}C/^{12}C$, and $^{18}O/^{16}O$) to compare diets of harbor seals from Iliamna Lake with those from Bristol Bay. The data demonstrate that Iliamna Lake "seals [are] born in the lake, remain … lifelong residents, and rel[y] principally on resources produced from in the lake, even when seasonally abundant and nutrient dense spawning anadromous fish (i.e., sockeye salmon *[Oncorhynchus nerka]*) [are] available in the lake." (Brennan *et al.* 2019a; *see also* Burns, Withrow & Van Lanen 2018.) Brennan *et al.* also documented an apparent ontogenetic shift where, "earlier in life, seals rel[y] principally on lake food resources. Later in life, seals shift … to rely more heavily on the seasonally abundance sockeye salmon." (Brennan *et al.*

2019a.) During these later life stages, sockeye salmon were found to contribute between 10% and 100% of seals' assimilated biomass, a range reflective of differences in foraging strategy among individual seals. (*Id.*)

This new research aligns with traditional ecological knowledge, with local residents describing the seals' shifting resource use throughout the year. (*See* Burns, Withrow & Van Lanen 2018 (quoting an Igiugig elder as saying "'I guess they just follow the salmon up, the food they use to survive. All [the seals] have to follow the salmon up and then when the salmon quit spawning, they find the lake trout, and rainbows, and grayling, and whitefish,' and noting that "[a]s salmon abundance declines, … seals begin working their way back toward the northeastern portion of the lake for overwintering and for feeding on nonsalmon fish, especially lake trout. 'They change locations depending on where the fish are,' … said a Pedro Bay elder.").) In sum, both local knowledge and "all dietary analyses performed support the conclusion that the seals are life-long residents within Iliamna Lake and that they subsist primarily on a diet of freshwater fishes, with seasonal inclusion of salmon potentially more important for older animals." (*Id.*) Iliamna Lake seals thus are discrete from marine harbor seals based on ecological factors.

D. Behavioral Factors

Iliamna Lake seals further represent a discrete population markedly separated from other populations of eastern North Pacific harbor seal as a consequence of behavioral factors. Boveng *et al.* considered several factors related to behavior and concluded they weighed in favor of marked separation of the Iliamna Lake seal. (Boveng *et al.* 2016.)

The first factor related to selection of locations for pupping and mating: "Pupping occurs annually in the northeastern portion of the lake and in Bristol Bay, the nearest marine harbor seal habitat, but has not been reported to occur in the intervening ~200 km of lake and river." (*Id.*; *see also* Fig. A, *supra.*)

> Because fidelity to birth sites—which fosters discreteness—is generally thought to be prevalent in harbor seals, we would expect there to be little breeding dispersal between these areas, especially given the impediment that the river is likely to impose, relative to the same distance in the marine environment. Thus, to the extent that use of a remote, unusual breeding location by seals in Iliamna Lake can be construed as behavior, this is evidence of some degree of separation, *i.e.*, the seals in the lake are unlikely to be freely interbreeding with the seals in Bristol Bay.

(Boveng *et al.* 2016; *see also* 81 Fed. Reg. at 81,076 (noting "strong evidence of site fidelity of harbor seals to their breeding or locations where they were tagged during summer").) NMFS agreed, "recogniz[ing] the possibility that the selection of pupping locations distant from other known pupping locations could be construed as a behavior and indicate marked separation as a result of the selection of pupping sites limiting the potential for interbreeding." (81 Fed. Reg. at 81,081). The agency thus concluded "that the best available evidence … indicates that harbor seals in Iliamna Lake may be markedly separated from other harbor seals of the subspecies *P. v. richardii* as a consequence of behavioral factors." (*Id.*)

Reproductive isolation also is supported by a potential later pupping time as well as pupping habitat characteristics. Specifically, while other phocids that inhabit freshwater environments (*e.g.*, fur seals) use snow or ice to shelter newborn and young seals, Iliamna lake seals appear to use remote terrestrial environments—something that a large lake like Iliamna makes possible. (Boveng *et al.* 2016.) This behavior is "unique not only within the taxon, but also among all five populations of three phocid seal species persisting in freshwater systems." (*Id.*)

Iliamna Lake seals also use lake ice habitat in ways unusual to the greater harbor seal species. For example, they appear to use protected under-ice haul-out sites or ice caves. (Van Lanen 2012.) These under-ice air spaces form as the level of water in the lake steadily drops from September until breakup in May. (*See* USGS 2012.) These spaces provide Iliamna Lake seals a protected area to breathe and haul out, and from which they can easily access open water to forage. Use of such spaces may be a learned behavior, unique to Iliamna Lake seals, that is critical to the seals' survival. (*See also* Boveng *et al.* 2016 ("Persistence of harbor seals in a freshwater body that freezes over almost completely in winter requires special behaviors for access to the water (*i.e.*, foraging) and for refuge from terrestrial predators that could exploit seals hauled out on the ice. The use of air spaces under ice along the shores and islands of Iliamna Lake … is believed to be a key over-wintering strategy for harbor seals in the lake.").)

Local traditional knowledge corroborates the use of under-ice spaces by Iliamna Lake seals. In the past, local subsistence hunters ventured onto the thin ice in December or January to spear the seals at their breathing holes, which the seals needed to keep open until the lake dropped enough to create air spaces between the water and ice. The use of "ice caverns" by seals in the winter is further supported by local traditional knowledge reports of a hidden rookery in the form of a cave, which provided the seals with shelter and access to unfrozen waters. (Van Lanen 2012.)

Another possible behavioral adaptation unique to Iliamna Lake seals is nocturnal haul-out. Peak haul-out timing for Iliamna lake seals occurs as night, which differs from the mid-day peak haul-out time for marine harbor seals. (Watts 1996, Jemison, Pendleton & Wilson 2001, London *et al.* 2012.) Some studies suggest that the low nighttime haul-out activity for marine seals is due to nocturnal foraging activity. (Watts 1996.) The different diet of Iliamna Lake seals as compared to Bristol Bay harbor seals (*see generally* Brennan *et al.* 2019a), may require a different, diurnal foraging pattern. Utilization of this strategy may be an adaptation required for lake seal survival and population persistence.

In sum, numerous behavioral factors including birth site selection and fidelity, pupping timing and habitat characteristics, novel uses of lake ice, and nocturnal hauling out support marked separation of Iliamna Lake seals from other eastern North Pacific harbor seal populations.

E. Genetic factors

Genetic factors likewise support marked separation of Iliamna Lake seals. In its 2016 12-month finding, NMFS concluded that existing genetic information "supports a decision that harbor seals in Iliamna Lake are markedly separated from harbor seals in eastern Bristol Bay, and by assumption, from the remainder of the taxon." (81 Fed. Reg. at 81,082.) NMFS's expert panel strongly agreed that there exists evidence for a genetic discontinuity of Iliamna Lake seals supporting a marked separation from Bristol Bay harbor seals. (Boveng *et al.* 2016; *see also id.* (lack of gene flow suggests discreteness); 81 Fed. Reg. at 81,082 ("The BRT was in strong agreement that the genetic data reflect marked separation.").)

The primary evidence supporting genetic discontinuity comes from tissue sample analysis of 13 Iliamna Lake seals harvested over a sixteen-year period between 1996 to 2012. (Burns *et al.* 2013, Boveng *et al.* 2016, Burns, Withrow & Van Lanen 2018.) Scientists quantified genetic diversity in the samples by analyzing both mitochondrial DNA (mtDNA, which is maternally inherited) and nuclear, microsatellite DNA (nDNA, which also provides information about the male parent). Eleven of the thirteen samples yielded mtDNA haplotype sequences, all of which were the same (haplotype Pvit-Hap#7). While this is the most common haplotype (of at least 33 haplotypes) in Bristol Bay, there it occurs in only ~22% of the population. (Boveng *et al.* 2016.) The fact that the sampled males had the same Pvit-Hap#7 haplotype argues against the possibility that substantial numbers of Bristol Bay males enter the lake from marine waters to breed. (*Id*.)

Boveng *et al.* note that, while the sample size is small, "[f]inding only a single haplotype among 11 individuals collected in five different years over a 16-year period (1996-2002) suggests that genetic diversity is low in the seals of Iliamna Lake." (*Id*.) Further, the lack of other haplotypes in Iliamna Lake (both for mtDNA and for nDNA) yielded large and highly significant *Fst* values—values that measure genetic differentiation among populations. (*Id.*) Two additional measures of genetic differentiation based on genetic distances also were consistent with a high degree of differentiation between harbor seals in Iliamna Lake and those in Bristol Bay. (*Id.*; *see also* 81 Fed. Reg. at 81,082 ("These genetic differentiation results are suggestive of the presence of a small, isolated population of harbor seals in Iliamna Lake.").) All these measures taken together suggest that the genetic differences are real and not merely the result of random sampling variation. (Boveng *et al.* 2016.)

In sum, Boveng *et al.* concluded that

> [t]ogether, the mtDNA and nDNA results are consistent with a small, isolated population in Iliamna Lake. The substantial differentiation in allele frequencies between the lake and [eastern Bristol Bay] seals is consistent with isolation, *i.e.*, lack of breeding dispersal into the lake. Finding only a single haplotype within Iliamna Lake is consistent with the pattern of low diversity often observed in small populations of marine mammals.

(*Id*.) The existence and persistence of Iliamna Lake seals as a small, isolated population is further supported by the lack of rare haplotypes among sampled seals. As Boveng *et al.* explained,

> The number of haplotypes expected in a given population depends on, among other things, the effective population size (Table 4). Genetic drift results in a smaller number of haplotypes being sustained by smaller populations. This relationship gives some context to the pattern of haplotypes observed in harbor seals of Iliamna Lake. For populations that are naturally at low abundance, the number of haplotypes is expected to be low and normally there would be no truly rare haplotypes (defined here as haplotypes found at frequencies equal to or less than 5%). A population that has been isolated as a small group or reduced to a fraction of its historical abundance and then sampled within a generation or two of this reduction will retain many of the haplotypes from when the population was large. As a result, rare haplotypes will be common in such a population, unlike the Iliamna Lake sample.

(*Id*.) While the sample size analyzed by Burns *et al.* was small, the relative sampling density is higher than for other parts of the seal's range in Alaska and the genetic data are "consistent with the pattern expected from a small, isolated population. Genetic diversity appears to be low, and more significantly, genetic frequency differentiation from the nearest marine harbor seals appears to be high." (Boveng *et al.* 2016.) The expert team concluded that "[t]he genetics … provide a reasonably strong case for a history of isolation of the seals in the lake. Even in the absence of identifiable mechanisms, this information should be taken as evidence of separation." (*Id.*; *see also* 81 Fed. Reg. at 81,082 ("The results of these analyses also suggest that male and female-mediated dispersal between the Egegik and

Ugashik regions of eastern Bristol Bay and Iliamna Lake was restricted.”).) Iliamna Lake seals thus exhibit marked separation from other populations of eastern North Pacific harbor seals based on genetic factors.

F. Summary of Factors Supporting Discreteness

In sum, the Iliamna Lake seal represents a discrete population markedly separated from other populations of eastern North Pacific harbor seal as a consequence of physical factors including navigability of the Kvichak River; physiological factors including taste, body type and size, pelage, and reproductive timing; ecological factors including a unique foraging ecology; behavioral factors including birth site selection and fidelity, pupping timing and habitat characteristics, novel uses of lake ice, and nocturnal haul-outs; and genetic factors identified through analysis of mtDNA, nDNA, and haplotypes.

2. SIGNIFICANCE

In addition to being discrete, the Iliamna Lake seal is biologically and ecologically significant to the greater eastern North Pacific harbor seal taxon. (*See* 61 Fed. Reg. at 4722.) The determination of significance is highly context-specific and consideration may include, but is not limited to, the following:

(1) Persistence of the discrete population segment in an ecological setting unusual or unique for the taxon,
(2) Evidence that loss of the discrete population would result in a significant gap in the range of a taxon,
(3) Evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historical range, or
(4) Evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics.

(*Id*. at 4725.) “There is no general or standard metric for” significance; “it may stem from the abundance, productivity, spatial distribution, genetic diversity, or perhaps other attributes of the population segment and broader taxon.” (Boveng *et al.* 2016).

New science calls into question the BRT’s previous decision that “very slightly favor[ed] a conclusion that the population is not significant in the sense of the DPS policy.” (*Id*.) In their report, the BRT explained that

> [t]his slight majority must be viewed in light of considerable differences among the BRT members about the reliability of and weight to be given to the various lines of evidence; the evidence itself must be characterized as mostly indirect, qualitative rather than quantitative, and equivocal for the purpose of demonstrating biological or ecological importance to the broader taxon.

(*Id.*) New research findings released subsequently to the BRT’s report tip the scale in favor of the significance of the Iliamna Lake seal to the broader eastern North Pacific harbor seal taxon. That science, which highlights the Iliamna Lake seal’s unique foraging ecology, as well as other evidence supporting the Iliamna Lake seal’s significance, is summarized in the following sections.

A. The Iliamna Lake Seal Persists in an Ecological Setting Unusual or Unique for the Taxon

The Iliamna Lake seal meets three of the “significance” criteria listed above. First, the Iliamna Lake seal occupies a unique ecological setting for the taxon: namely, a freshwater lake that freezes over nearly completely in the winter. (Boveng *et al.* 2016, 81 Fed. Reg. at 81,084.) No other population of eastern North Pacific harbor seal does the same. In fact, the only other documented harbor seal that persists year-round in a freshwater environment is the Lac de Loups Marin harbor seal in Canada. (Boveng *et al.* 2016, 81 Fed. Reg. at 81,084.) “Therefore, the ecological setting for harbor seals in Iliamna Lake is unusual for harbor seals, *P. vitulina*, and unique for the subspecies *P. v. richardii*, the taxon to which the harbor seals in Iliamna Lake belong.” (Boveng *et al.* 2016.)

i. The Iliamna Lake Seal’s Persistence in a Unique Ecological Setting Has Resulted in Adaptations Conferring Importance to the Taxon as a Whole

Having concluded that Iliamna Lake seals persist in an ecological setting unique to the greater eastern North Pacific harbor seal taxon, the next consideration is “whether this ecological setting makes the seals that persist in the lake biologically or ecologically significant to the taxon as a whole.” (Boveng *et al.* 2016.) This inquiry involves consideration of “supporting biological information linking the habitat differences to adaptations that may confer importance to the taxon as a whole.” (*Id.*) Such evidence may include, *inter alia*, “indirect evidence in the form of phenotypic or life-history traits that do or *may* reflect adaptations, or evidence that members of other populations segments would be unable to persist in the unusual or unique segment.” (*Id.*) (emphasis added). The latter of these, *i.e.* the concept of “ecological exchangeability,” is the “idea … that if persistence in the unique ecological setting requires special traits or adaptations that are not present in the taxon as a whole, the discrete segment is likely to contain valuable genetic diversity that is important to conserve.” (*Id.*)

Possible phenotypic adaptations of Iliamna Lake seals include their larger size, darker coloration, and finer pelage, as reported by local residents. (*See id.*) While the BRT rejected the notion that these traits could confer any selective advantage to Iliamna Lake seals, the panel failed to consider the thermoregulatory advantages of all three attributes in the seals’ unique freshwater, seasonally ice-covered environment. (*Id*.) For example, Bergmann’s Rule posits that larger body sizes better conserve heat than smaller body sizes due to their smaller surface area-to-volume ratio. (*See* Donohue *et al.* 2000 (discussing role of pelage in thermoregulation of fur seals), Caro *et al.* 2012 (noting association between darker color of otariid pups and thermoregulatory considerations).)

In addition to these phenotypic adaptations, Iliamna Lake seals also display various behavioral adaptations including novel use of under-ice spaces. Whether the seals’ use of under-ice air spaces during the winter constitutes a true adaptation was a matter of contention among BRT members during the last scientific review, with some panel members believing such use “was … evidence of an adaptation, rather than a facultative behavior.” (Boveng *et al.* 2016.) This behavior clearly is unusual for harbor seals and is one pups reared in the lake would learn from resident adults. Given how well-utilized the strategy appears to be among Iliamna Lake seals and its advantages in terms of winter foraging and predator avoidance, it likely contributes to survival and persistence of the population. The use of under-ice spaces thus appears to represent a true adaptation.

In sum, the Iliamna Lake seal’s persistence in a unique ecological setting has resulted in numerous adaptations that may confer importance to the taxon as a whole including larger size, finer pelage, darker coloration, as well as novel use of under-ice spaces. It also has resulted in a foraging ecology unique among eastern North Pacific harbor seals, discussed in more detail in the following section.

ii. The Iliamna Lake Seal's Persistence in a Unique Ecological Setting Has Resulted in a Unique Foraging Ecology That Is Significant to the Broader Taxon

The Iliamna lake seal is significant to the broader North Pacific harbor seal taxon because its persistence in a unique ecological setting has led to a unique foraging ecology. (*See generally* Brennan *et al.* 2019a.) In a study released last year, Brennan *et al.* showed that the Iliamna lake seal's foraging ecology is unique among eastern North Pacific harbor seals. To arrive at this finding, Brennan *et al.* measured isotope ratios in the enamel and dentine of seal canine teeth ($^{87}Sr/^{86}Sr$, $^{13}C/^{12}C$, and $^{18}O/^{16}O$), as well as $^{87}Sr/^{86}Sr$ ratios and Sr concentrations [Sr] (mg/kg) of potential trophic resources, to reveal lifelong movement and resource use patterns of the Iliamna Lake seal. (*Id*.) The scientists considered whether Iliamna harbor seals migrate to the ocean and to what extent they exploit trophic resources from the lake versus the ocean. (*Id*.) The authors' findings reveal that Iliamna Lake "seals [are] born in the lake, remain … lifelong residents, and rel[y] principally on resources produced from in the lake even when seasonally abundant and nutrient dense anadromous fish … [are] available in the lake." (*Id*.)

Isotope ratios in Iliamna Lake seal teeth

> revealed general coherence among the early life-history patterns of individuals. During this period, $\delta^{18}O$ and $\delta^{13}C$ values in enamel fell within ranges consistent with the enamel of freshwater aquatic mammals. Similarly, $^{87}Sr/^{86}Sr$ ratios recorded in the earliest dentine layers also reflected freshwater residence.

(*Id.* (internal citations omitted).) Thus, early in life, Iliamna Lake seals rely principally on lake food resources. (*Id.*) Later in life, in an apparent ontogenetic shift that may reflect life stage-specific nutritional needs, Iliamna Lake seals rely more heavily on seasonal runs of sockeye salmon. (*Id*.) Utilization of salmon by adult seals varies by individual, contributing 10% to 100% of assimilated biomass. (*Id.*) Brennan *et al.*'s findings accord with earlier gut and scat content analysis which revealed that Iliamna Lake seals ate resident freshwater fishes even when spawning sockeye were available. (*Id.*)

Brennan *et al.*'s research confirms that "Iliamna seals clearly exhibit distinct patterns of habitat and resource use compared with proximate and closely related marine harbor seals in Bristol Bay." (*Id*.) Specifically, Iliamna Lake seals

> rel[y] on lake resources and consistent[ly display an] ontogenetic shift from a diet composed principally of lake resources to one that exploits seasonally abundant salmon. Both imply locally adapted abilities to exploit a food web unlike that of any other *P. v. richardii* population across the Eastern Pacific.

(*Id*.) These findings directly bear on the question of whether the Iliamna Lake seal is "significant" to the broader *P. v. richardii* taxon, providing evidence in support of the population's adaptions to its unique environment. (*Id*.) As noted by both Brennan *et al.* and Boveng *et al.*, "[a]daptation of unique foraging behaviors in unusual ecological settings can constitute … a measure of … significance." (*Id.*; *see also* Boveng *et al.* 2016.) Brennan *et al.* demonstrate that persistence of Iliamna Lake seals "in the[ir] unique ecological setting requires special traits or adaptations that are not present in the taxon as a whole"—specifically adaptations related to foraging ecology—and therefore that "the discrete segment is likely to contain valuable genetic diversity that is important to conserve." (Boveng *et al.* 2016.)

The Iliamna Lake seal's unique foraging ecology has significance for the evolutionary potential of the broader *P. v. richardii* taxon in a time of rapid change and increasing threats. (Brennan *et al.* 2019a; *see also* Schindler *et al.* 2010.) Should climate change or other stressors negatively impact local fishery resources, Iliamna Lake's resident seals have demonstrated an ability to utilize dynamic lake ecosystem food resources. Indeed, the salmon upon which Iliamna Lake seals feed already exhibit interannual variability in run timing and abundance.[4] (Brennan *et al.* 2019a.) The fact that the lake seal population remained relatively stable during dramatic swings in sockeye salmon run size in the 1990s-2000s suggests that Iliamna seals effectively integrate across available lake resources. (*Id*.) This ability to weather changes in lake resource availability may demonstrate a unique ability to adapt to rapidly changing conditions as compared to marine harbor seals, which have a more reliable, aggregate resource base. (*Id.; see also* 68 Fed. Reg. 13,370, 13,387 (Mar. 19, 2003) ("Evidence suggests that peripheral subpopulations are often genetically and morphologically divergent from central subpopulations. Distinct traits found in peripheral subpopulations may be crucial to the species, allowing adaptation in the face of environmental change.") (internal citations omitted.)

That adaptation of unique foraging behaviors in an unusual ecological setting constitutes a measure of "significance" under the ESA's DPS policy has been acknowledged by NMFS in several instances, including that of another generalist carnivore—the island-associated Hawaiian false killer whale (*Pseudorca crassidens*).[5] This particular example was raised both by Brennan *et al.* (2019a) and Boveng *et al.* (2016). The Hawaiian false killer whale biological review team (BRT) noted that the population's consumption of "prey associated with island habitat … suggest[ed] specialized knowledge of locations and seasonal conditions that aggregate prey or make them more vulnerable to predation." (Oleson *et al.* 2010.) Iliamna Lake seals similarly appear to have such specialized knowledge. As explained by Boveng *et al.* (2016), the Hawaiian false killer whale BRT found "that the foraging ecology of the population segment provided indirect evidence of adaptation to unique aspects of the Hawaiian insular habitat,[6] and that such adaptation is significant because if other (*i.e.*, pelagic) segments of the population were to colonize the Hawaiian islands, they would be unlikely to alter their foraging strategies to rely so entirely on the local, island-associated resources." (Boveng *et al.* 2016.) An analogous situation exists for the Iliamna Lake seal. To paraphrase: "the foraging ecology of the population segment provide[s] indirect evidence of adaptation to unique aspects of the [Iliamna Lake] habitat, and … such adaptation is significant because if other (*i.e.*, [marine]) segments of the population were to colonize [Iliamna Lake], they would be unlikely to alter their foraging strategies to rely so entirely on the local, [lake]-associated resources." (*Id*.) This is particularly true if such exploitation depends on "specialized knowledge of

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[4] These shifts would not affect the marine harbor seals of Bristol Bay in the same way. Salmon stocks available to Iliamna Lake seals "exhibit ~70% more interannual variability on average than the aggregate of all Bristol Bay stocks. Coastal marine mammal populations have the ability to integrate across this spatial and temporal variability, which makes the resource more reliable. However, consumer populations restricted within a single basin (*e.g*., Iliamna Lake) would not be able to exploit these portfolio effects in the same way. Iliamna sockeye stocks were the most abundant stocks prior to the mid-1990s in Bristol Bay, Alaska, but returns through the mid-2000s were some of the lowest on record. Harbor seals endemic to Iliamna Lake are subject to these large shifts; whereas, their closely related marine populations are not." (Brennan *et al.* 2019a.)

[5] *See also* Seminoff *et al.* 2015 (significance determination for green sea turtles based in part on "[u]nique diet due to very narrow continental shelf and low levels of seagrass").

[6] *See* Oleson *et al.* 2010 (referring to data indicating that "Hawaiian insular false killer whales employ a unique, island-associated foraging strategy compared to other false killer whales"); *id.* (finding that "other local populations would likely be adapted to the specific conditions of that local habitat, which would differ from the habitat found around Hawaii").

locations and seasonal conditions that aggregate prey or make them more vulnerable to predation." (Oleson *et al.* 2010.)

The fact that harbor seals writ large exhibit some degree of dietary plasticity does not negate the importance of this finding. As the Hawaiian false killer whale team noted, "[a]lthough false killer whales are socially complex adaptable animals, such that pelagic animals may be able to alter their foraging strategies to colonize insular Hawaiian waters, it is unlikely that their habitat use would change to rely entirely on the Hawaiian Islands." (*Id*.) Analogously, even if Bristol Bay harbor seals were to migrate into Iliamna Lake, their ability to survive in those waters would not necessarily translate into effective utilization across lake resources and long-term persistence and colonization. Transient seals would lack the in-depth knowledge of local resource availability and variability that Iliamna Lake seals have garnered over the generations—as well as any associated genetic basis for lake seal behaviors—that allows that population to thrive in the face of dramatic interannual resource availability. Such knowledge may be a cultural trait of Iliamna Lake seals, learned behavior passed down through the generations, that permits population persistence in an environment unusual for the taxon.[7] Brennan *et al.* reach a similar conclusion, stating that

> The unique foraging ecology of Iliamna seals, as shown here, supports the conclusion that this population has adapted to their unusual ecological setting. This includes their reliance on lake resources and consistent ontogenetic shift from a diet composed principally of lake resources to one that exploits seasonally abundant salmon. Both imply locally adapted abilities to exploit a food web unlike that of any other *P. v. richardii* population across the Eastern Pacific, which are significant to the evolutionary potential of the broader taxon.

(Brennan *et al.* 2019a.)

In sum, the ESA requires the use of the best science available (rather than the best science possible) in determining whether the Iliamna Lake seal is significant to the broader eastern North Pacific harbor seal taxon. It would be extremely difficult, if not impossible, to empirically test the hypothesis that marine harbor seals transplanted into Iliamna Lake would thrive over the long term at a level equivalent to the lake's resident seals. Fortunately, the ESA does not require such an experiment. Just as with the Hawaiian false killer whale, the agency may find sufficient evidence that "suggest[s] specialized knowledge of locations and seasonal conditions that aggregate prey or make them more vulnerable to predation." (Oleson *et al.* 2010.) Brennan *et al.* offer similar evidence demonstrating that Iliamna Lake seals have specialized knowledge of their freshwater prey base. The new evidence provided by Brennan *et al.* (2019a), in concert with the additional body of best available science on the Iliamna Lake seal,[8] supports the conclusion that Iliamna Lake seals are "significant" to the broader *P. v. richardii* taxon.

B. Loss of the Iliamna Lake seal Population Would Result in a Significant Gap in the Range of the Taxon

The loss of the Iliamna Lake seal population would result in a significant—*i.e.*, consequential—gap in the range of the species because it would eliminate the sole and complete freshwater range occupied by the eastern North Pacific harbor seal taxon. Nowhere else does *P. v. richardii* persist year-round in a

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[7] *See* Oleson *et al.* 2010 (discussing cultural diversity).

[8] While the sample size in Brennan *et al.* (2019a) is small, the study nonetheless represents the best science available.

freshwater environment. The gap that would be created thus cannot be filled by other eastern North Pacific harbor seals in the range. *See also* discussion Part II.2.A.ii, *supra* (discussing how the unique foraging ecology of Iliamna Lake seals is such that transient marine harbor seals may not be able to persist long-term in the lake environment).

NMFS has, in the past, considered this criterion to be of primary importance in finding a DPS significant to the broader taxon. (*See, e.g.,* Miller *et al.* 2014 (Scalloped Hammerhead Shark Status Review).) In the case of the Iliamna Lake seal, this criterion in combination with the other criteria discussed in this subsection support the significance of this population to the greater eastern North Pacific harbor seal taxon.

C. Genetic Characteristics of Iliamna Lake Seals Differ Markedly from Marine Harbor Seal Populations

As described in more detail in Part II.1.E, the genetic characteristics of Iliamna Lake seals differ markedly from other populations of eastern North Pacific harbor seal. To recap: tissue sample analysis of 13 Iliamna lake seals harvested between 1996-2012 provided evidence of a genetic discontinuity of Iliamna Lake seals from nearby marine populations. (*See* Burns *et al.* 2013, Boveng *et al.* 2016, 81 Fed. Reg. at 81,082.) All the mtDNA haplotype sequences analyzed were the same (haplotype Pvit-Hap#7). Those results in addition to highly significant *Fst* values, two additional measures of genetic differentiation, and the lack of rare haplotypes also were consistent with a high degree of genetic differentiation between harbor seals in Iliamna Lake and those in Bristol Bay. (Burns *et al.* 2013; *see also* 81 Fed. Reg. at 81,082). Based on these findings, Boveng *et al.* concluded that "the mtDNA and nDNA results are consistent with a small, isolated population in Iliamna Lake." (Boveng *et al.* 2016.) Specifically, "[g]enetic diversity appears to be low, and more significantly, genetic frequency differentiation from the nearest marine harbor seals appears to be high." (*Id*.) The sum of genetic evidence thus supports the notion of marked separation from marine harbor seals in Bristol Bay. (*Id.*)

In addition to genetic analysis, NMFS can consider indirect evidence of "mutations at … genetic loci that could be selective and have adaptive function" such as those "outwardly apparent in the morphology or behavior of the seals." (*Id*.) As noted above, Iliamna Lake seals differ markedly from marine harbor seals in behavior, morphology, ecology and habitat use—all of which could provide evidence of genetic novelty. This is particularly true for differences that give Iliamna seals an advantage in their freshwater environment (*e.g.,* unique foraging ecology; enhanced thermoregulatory properties from larger body size, distinct pelage, and darker coloration). (*See generally* Parts II.1.B-D, II.2A.i-ii, *supra*.)

Local traditional knowledge further supports the genetic novelty of the Iliamna Lake seal given its long-term residence in its freshwater home. According to traditional ecological knowledge, "Iliamna residents have observed and utilized the lake seals as long as they can recall." (Burns, Withrow & Van Lanen 2018.)

> [M]ost local participants in recent ethnographic research considered seals to have always lived in the lake, and some related stories of the seals' arrival in the lake that invoked mythic origin mechanism similar to those used by many ancient cultures to explain the origins of species that had always been present in their surroundings (*e.g.*, the seals came to the lake from the ocean via cracks under the mountains). … The shores of Iliamna Lake have been occupied by various cultures at least periodically for several thousand years. For example, a Pedro Bay village site confirms occupation some 4,500 years ago by people of the Ocean Bay Tradition,

> which may indicate that biological resources such as anadromous fish stocks capable of supporting people and seals were established by that time.

(Boveng *et al.* 2016.) Burns, Withrow and Van Lanen (2018) refer to ethnographic stories "suggest[ing] that the seals have inhabited Iliamna Lake at least since humans have occupied the area (4,000 to 6,000 years) and likely much longer." (*Id*.) The BRT estimated that Iliamna Lake seals have been isolated from marine harbor seals from between 200 to 5,000 years. (Boveng *et al.* 2016.) They reason that, all else equal, "a period of several thousand years, or several hundred generations seems to be sufficient time for novel sequences to arise by mutation in the mtDNA marker of these phocid species." (*Id.*)

In sum, local traditional knowledge in addition to direct and indirect genetic evidence all suggest that these freshwater seals have occupied Iliamna Lake for sufficient time for genetic novelty to arise, which supports a finding of significance for the Iliamna Lake seal.

D. Summary of Factors Supporting Significance

The Iliamna Lake seal is significant to the greater eastern North Pacific harbor seal taxon because it persists in an ecological setting unusual for harbor seals and unique for eastern North Pacific harbor seals (*i.e.*, a freshwater lake that freezes over nearly completely in the winter); exhibits numerous adaptations that may confer importance to the taxon as a whole including phenotypic traits that may confer thermoregulatory advantages (*e.g.,* larger size, darker coloration, and finer pelage), novel use of under-ice air spaces during the winter, and a unique foraging ecology; and differs genetically from nearby marine harbor seal populations. Loss of the Iliamna Lake seal population also would result in consequential gap in the range of the subspecies by eliminating its only occurrence in freshwater.

3. SUMMARY: THE ILIAMNA LAKE SEAL REPRESENTS A DISTINCT POPULATION SEGMENT

The Iliamna Lake seal is both discrete and significant and thus represents a distinct population segment under the Endangered Species Act. As NMFS concluded in its 2016 12-month finding, the Iliamna Lake seal population is discrete because it is markedly separated from other populations of eastern North Pacific harbor seal. (*See* 81 Fed. Reg. at 81,082.) Evidence supporting its marked separation comes from physical factors including navigability of the Kvichak River; physiological factors including taste, body type and size, pelage, and reproductive timing; ecological factors including a unique foraging ecology; behavioral factors including birth site selection and fidelity, pupping timing and habitat characteristics, novel uses of lake ice, and nocturnal haul-outs; and genetic factors including analysis of mtDNA, nDNA, and haplotypes.

The Iliamna Lake seal is significant to the greater eastern North Pacific harbor seal taxon. First, the seal persists in an ecological setting unusual for harbor seals and unique for eastern North Pacific harbor seals: a freshwater lake that freezes over nearly completely in the winter. Occupation of this freshwater lake has led to numerous adaptations that may confer importance to the taxon as a whole, including phenotypic traits that may confer thermoregulatory advantages (*e.g.,* larger size, darker coloration, and finer pelage); novel use of under-ice air spaces during the winter; and a unique foraging ecology. Brennan *et al.*'s work describing this unique foraging ecology was not available for consideration by NMFS or its BRT during the last petition review process. (*See generally* Brennan *et al.* 2019a). It provides new, key insights into how Iliamna Lake seals' foraging ecology differs from that of marine harbor seals and how it may contribute to the evolutionary potential of the broader *P. v. richardii* taxon. (*See generally id*.) In addition, the Iliamna Lake seal is significant to the broader *P. v. richardii* taxon because loss of this population would result in a significant and consequential gap in the range of the subspecies by eliminating its only occurrence in freshwater. There is no indication that other harbor seals would repopulate Iliamna Lake or colonize it as successfully as the present population. Finally, genetic characteristics of the Iliamna Lake seal differ markedly from marine harbor seal populations, again highlighting the population's significance to the broader taxon.

Since the Iliamna Lake seal is both discrete from other populations of *P. v. richardii* and significant to the broader taxon, it constitutes a distinct population segment under the Endangered Species Act.

PART III. THE ILIAMNA LAKE SEAL QUALIFIES AS THREATENED OR ENDANGERED UNDER THE ESA

The Iliamna Lake seal population is both discrete and significant to the eastern North Pacific harbor seal taxon. It thus qualifies as a DPS under the ESA. As such, NMFS must conduct a status review to evaluate the seals' "endangered or threatened status … based on the Act's definitions of those terms[9] and a review of the factors enumerated in section 4(a)." Those factors include:

(A) the present or threatened destruction, modification, or curtailment of its habitat or range;
(B) overutilization for commercial, recreational, scientific, or educational purposes;
(C) disease or predation;
(D) the inadequacy of existing regulatory mechanisms; or
(E) other natural or manmade factors affecting its continued existence.

(16 U.S.C. § 1533(a).) The agency's review and determination must be based solely on the best scientific and commercial data available. (16 U.S.C. § 1533(b)(1)(A).)

The population of Iliamna Lake seals numbers approximately 400 individuals. As a small population, it easily could be wiped out by a natural or anthropogenic catastrophe such as a disease outbreak or contaminant spill. Indeed, a series of cold winters in the 1970s drove the population down to only ~50 individuals, highlighting its vulnerability to environmental change.

Two looming threats, the proposed Pebble Mine and climate change, pose existential risks to the small population of freshwater harbor seals residing in Iliamna Lake. (*See* 78 Fed. Reg. at 29,100.) The proposed Pebble Mine stands to harm Iliamna Lake seals through direct disturbance (*e.g.,* ice-breaker ferry use, dock construction), significant adverse effects to the seals' prey, and severe and long-term habitat degradation. Climate change, which already is impacting Alaskan ecosystems to a degree greater than the global average, also stands to impact Iliamna Lake seals through habitat changes (*e.g.,* lake ice formation and duration), impacts to key prey species, and increased potential for disease outbreaks. These and other threats to the Iliamna Lake seals rendering the DPS threatened or endangered under the ESA are discussed in the following sections.

[9] An "endangered species" is defined by the ESA as "any species which is in danger of extinction throughout all or a significant portion of its range." 16 U.S.C. § 1532(6). A "threatened species" is defined as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." *Id.* § 1532(20).

1. THE PRESENT OR THREATENED DESTRUCTION, MODIFICATION, OR CURTAILMENT OF THE ILIAMNA LAKE SEALS' HABITAT OR RANGE

NMFS recognizes habitat degradation and destruction as threats to harbor seal populations. (NOAA Fisheries—Harbor Seals). Habitat degradation and destruction may flow from physical barriers such as shoreline development (*e.g.,* dredging, pile driving, ferry terminals), which limit access to important feeding, breeding, or pupping areas. (*Id.*) It also may include activities such as increased boat traffic that displace seals from preferred habitats. (*Id.*) Finally, it may encompass habitat loss caused by anthropogenic climate change. Specific habitat degradation and destruction threats faced by the Iliamna Lake seal, *i.e.* the Pebble Mine and climate change, are discussed in more detail in the sections that follow.

A. The Pebble Mine Poses a Significant Threat to the Iliamna Lake Seal

In February 2019, the U.S. Army Corps of Engineers released the Draft Environmental Impact Statement (DEIS) for the Pebble Mine (also "Pebble Project"), a massive open pit mining operation that would be located in a wild, remote, and pristine ecosystem at the headwaters of Bristol Bay. (*See generally* DEIS 2019.) According to the Army Corps, The Pebble Partnership, owned by the Canadian mining company Northern Dynasty Minerals,

> proposes to develop the Pebble copper-gold-molybdenum[10] porphyry deposit (Pebble deposit) as a surface mine in Southwest Alaska near Iliamna Lake, approximately 200 miles southwest of Anchorage and 60 miles west of Cook Inlet. … The project would include development of the open pit mine, with associated infrastructure to include a 270-megawatt power generating plant. A 188-mile natural gas pipeline from the Kenai Peninsula across Cook Inlet to the mine site is proposed as the energy source for the mine. The transportation corridor includes mine and port access roads, an 18-mile crossing of Iliamna Lake, and an Amakdedori port facility on the western shore of Cook Inlet.

(DEIS 2019; *see* Figs. F, G, *infra*.)

[10] The mine would also yield silver, palladium, and rhenium. (Northern Dynasty Minerals Ltd. 2020.)

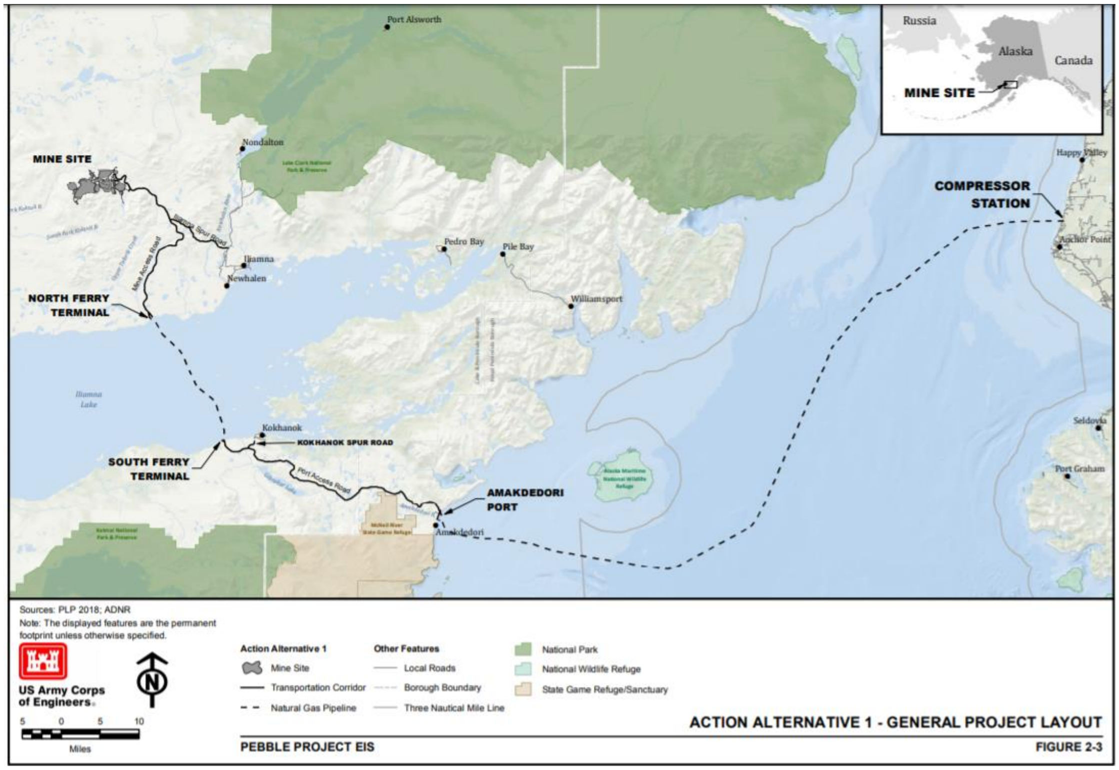

Fig. F. Applicant's proposed Pebble Mine site and project area, Action Alternative 1. Fig. 2-3 from DEIS (2019).

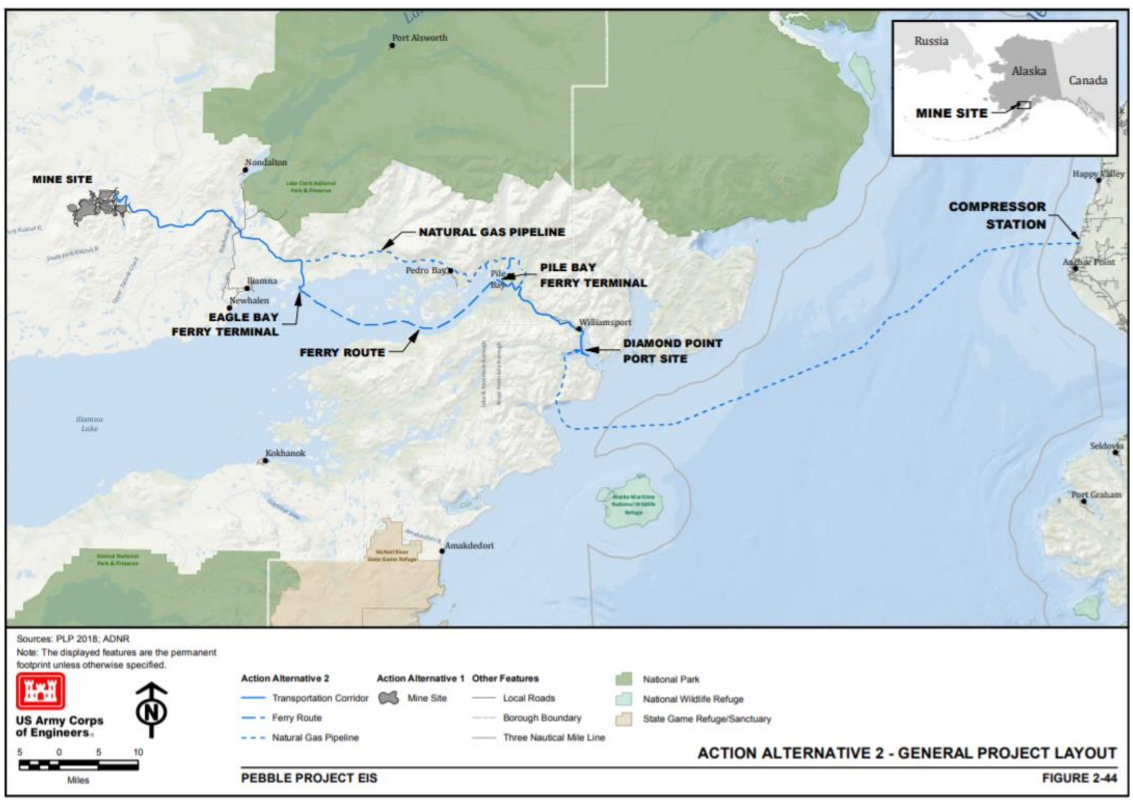

Fig. G. Applicant's proposed Pebble Mine site and project area, Action Alternative 2. Fig. 2-44 from DEIS (2019).

If built, the Pebble Mine would be among the largest open pit mining operations in the world. The DEIS considers only a fraction of full development (11% of the deposit over 20 years); mining of the full deposit would have even more devastating impacts than those described herein. Even the "small" mine site considered by the Army Corps would cover 8,086 acres and

> include [a 608-acre] open pit,[11] [a 2,796 acre] bulk [tailings storage facility], [a 1,071 acre] pyritic [tailings storage facility], overburden stockpiles, material sites, main and open pit water management ponds …, seepage collection ponds …, sediment ponds, milling and processing facilities, and supporting infrastructure such as the 270-megawatt power plant, water treatment plants …, camp facilities, and storage facilities.

(DEIS 2019.) Tailings facilities, particularly the pyritic tailings facility, would contain vast quantities of acid-generating waste that could ravage this fragile ecosystem. Much of this planned infrastructure could directly or indirectly impact Iliamna Lake and its resident seals.

Per the preferred alternative, the proposed mine site would connect to Amakdedori Port on Cook Inlet via a 47-km mine access road, 29-km ferry crossing, and 60-km port access road. (*Id.*; *see* Fig. F, *supra*). Additional spur roads would connect this transportation corridor to Iliamna, Newhalen, and Kokhanok. (DEIS 2019.) The road system would include nine bridges and 86 stream culverts. (*Id*.) The Pebble Partnership estimates that, during project operations, daily transportation needs would require up to 39 truck round trips for each leg of the road as well as one round-trip per day across Iliamna Lake by an all-season ice-breaking ferry. (*Id*.) The ferry would dock at terminals to be constructed and operated on the northern and southern shores of Iliamna Lake. (*Id.*; Figs. F, G, *supra*). In addition, a 29-km natural gas pipeline would be laid across Iliamna Lake-bed, coming ashore at the north ferry terminal. (*Id*.)

If the proposed Pebble Mine goes forward, construction and operations would have major, population-level impacts on the Iliamna Lake seal. These impacts include, but are not limited to:

(1) Direct disturbance (harassment and possible mortality) to Iliamna Lake seals through dock construction, ferry operations, and other-mine related activities;
(2) Significant adverse impacts to Iliamna Lake seal prey, including anadromous and freshwater fish; and
(3) Severe and long-term impacts on habitat, including water quality degradation.

Each of these impact categories is discussed in the following subsections. It is important to note that, in addition to the proposed Pebble Mine, there exist numerous other sites in the immediate region that may be industrialized by mining activities in the foreseeable future. (*See id*.) The cumulative impacts of these other mines in addition to the Pebble Mine would compound impacts to Iliamna Lake seals. (*See* EPA 2014a.)

i. The Infrastructure and Human Activity Associated with the Pebble Mine Would Harass, Harm, or Otherwise Disturb Iliamna Lake Seals

Short- and long-term anthropogenic disturbances from the Pebble Mine could have individual and population-level impacts on Iliamna Lake seals through harm to both habitat and the seal itself. The

[11] Final open pit dimensions for this truncated mining plan: 6,800 feet in length, 5,600 feet in width, and 1,970 feet in depth. (DEIS 2019.)

proposed mine site lies approximately 40 km northwest of major Iliamna Lake seal haul-outs including island groups southwest of Pedro Bay and north of Kokhanok. (*See* Fig. H, *infra*.) The applicant's preferred alternative (Alternative 1) includes construction of a natural gas pipeline across Iliamna Lake, construction of two ferry terminals on the lakeshore, and year-round use of an ice-breaking ferry[12] across 29 km (each way) of this water body alongside known Iliamna Lake seal haul-outs. (DEIS 2019; *see also* Figs. F, H, *infra*.) Roads would include a 47-km two-lane, unpaved road from the ferry terminal on Iliamna Lake to the mine site as well as separate unpaved spur roads connecting the transportation corridor to communities including Iliamna, Newhalen, and Kokhanok. (DEIS 2019.) Under the preferred alternative, air traffic would come through the Iliamna airport and an airstrip constructed at Amakdedori Port. (DEIS at 2-60, 2-62.) Under Alternative 2, the ice-breaker ferry would run immediately adjacent to preferred Iliamna Lake seal habitat including haul-outs and pupping areas in the northeastern portion of the island. (*See* Figs. G, H, *infra*.) The DEIS also mentions the possible use of helicopters or drones to monitor pipelines under this alternative. (DEIS 2019.)

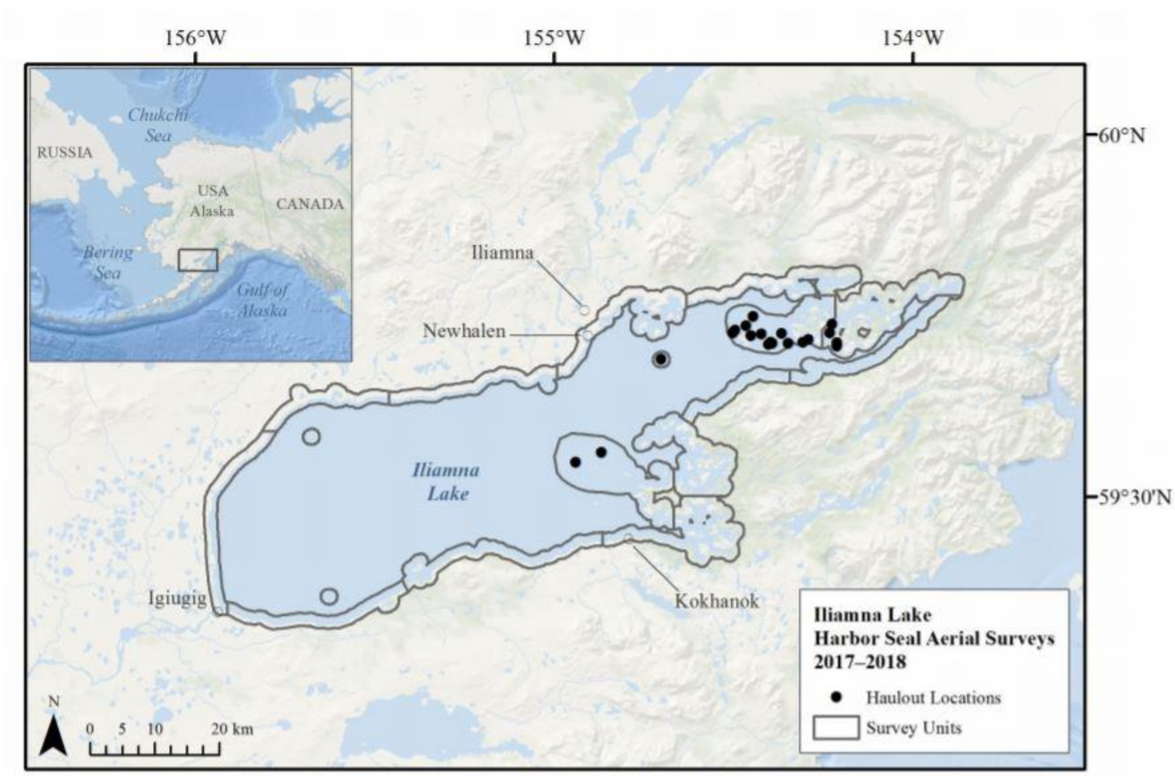

Fig. H. Known Iliamna Lake seal haul-out locations 2017-18. (Map excerpted from Christman & Boveng 2019; basemap contents courtesy of Esri, Garmin, GEBCO, NOAA NGDC, and others).

Harbor seals are sensitive to anthropogenic disturbance including boats, aircraft, motor vehicles, and human presence. (*See, e.g.,* Henry & Hammill 2001, Manna *et al.* 2006, Montgomery, Ver Hoef & Boveng 2007, Becker, Press & Allen 2009, Andersen *et al.* 2012, Osinga *et al.* 2012, Blundell & Pendleton 2015, Cates & Acevedo-Gutiérrez 2017.) Even short-term, somewhat distant (>1 km) industrial disturbance can have dramatic population-level impacts on harbor seals. (Seuront & Prinzivalli 2005.) In Prince William

[12] *See* DEIS 2019 ("The one-way ferry trip is about 18 miles and would take approximately 3 hours to complete in ice conditions, or 1.5 hours in open water. Ferry transit speeds would range from 6 knots (approaching landing) to 11 knots (in open water). On average, one round trip per day across the lake would be required.").

Sound and the Gulf of Alaska, significant harbor seal declines have been partially attributed to human activities and disturbance. (Frost, Lowry & Ver Hoef 1999, Papa & Becker 1999, Boveng *et al.* 2003, Wang *et al.* 2007.) Compared to other seal populations, Iliamna Lake seals may be especially vulnerable to human disturbance because of their relatively small size, restricted range, and site fidelity. (*See* Forney *et al.* 2017.) Further, Iliamna Lake seals are little accustomed to human activity and may not easily habituate. Specific expected harms to Iliamna Lake seals from Pebble Mine-related infrastructure include disturbance from increased human presence, vessel traffic, and other anthropogenic noise.

a. <u>Increased Human Presence</u>

Increased human activity in this sparsely-population region stands to negatively impact Iliamna Lake seals. Peak labor force during mine construction will be 2,080 individuals, with an operational workforce of 1,120 for the next 25 years (Northern Dynasty 2011.) Human presence alone could alter seal behavior, and associated disturbances (*e.g.,* increased air traffic, increased industrial and recreational vessel activity, increased vehicle traffic including haul trucks and ATVs, increased human infrastructure including housing, and increased light pollution in winter) would compound those effects. (*See, e.g*., Frost, Lowry & Ver Hoef 1999, Papa & Becker 1999, Henry & Hammill 2001, Boveng *et al.* 2003, Manna *et al.* 2006, Montgomery, Ver Hoef & Boveng 2007, Wang *et al.* 2007, Becker, Press & Allen 2009, Andersen *et al.* 2012, Osinga *et al.* 2012, Blundell & Pendleton 2015, Cates & Acevedo-Gutiérrez 2017.)

More ready human access to the seals could lead to increased seal hunting or poaching (a threat documented for other wildlife species such as wolves and bears (*see* Thiel 1985, Mech *et al.* 1988, Benn & Herrero 2002, Nielsen *et al.* 2004, Schwartz *et al.* 2006, Person & Russell 2008, Boulanger & Stenhouse 2014)) as well as increased competition for the fish species Iliamna Lake seals rely upon for survival. Canine companions accompanying the influx of workers both could predate on seals (particularly pups) and introduce disease (*e.g.*, canine distemper virus) to this small, vulnerable seal population.

b. <u>Vessel Traffic</u>

Vessel traffic associated with the proposed Pebble Mine will imperil the seals living in Iliamna Lake. Harbor seals are vulnerable to vessel collisions, which can lead to serious injury and death. (NOAA Fisheries—Harbor Seals). Should the Pebble Mine proceed, seal habitat in Iliamna Lake will be degraded by increased vessel traffic, including year-round use of an ice-breaker ferry.

Ice breaking activities will destroy lake ice—something this seal population relies upon for survival during the winter months. As described above, scientists and local residents believe Iliamna Lake seals use lake ice in novel ways to survive the winter in their freshwater environment. For example, the seals likely use ice caves or air spaces underneath the ice to breathe and haul out. Little is known about underwater ice topography and seals' use of ice-related habitat (not to mention interannual variation in these), so there is no way to operate an ice-breaker ferry in a way that would avoid critical seal habitat. Ice-breaker ferry use during the winter may destroy vital ice features and displace Iliamna Lake seals from preferred overwintering sites. (DEIS 2019.) Forcing them to abandon these under-ice spaces also could subject Iliamna Lake seals to increased predation. (*See* Boveng *et al.* 2016.)

Use of an ice-breaker ferry on Iliamna Lake will destroy seal habitat, leading to behavioral disturbance and ultimate displacement of seals. These impacts at minimum will induce stress response; at worst, they could lead to substantial seal mortality. Icebreaker impacts would not be limited to the winter season. (*Id*.) The most direct route between the two planned ferry terminals for Alternative 1 goes through or along Thompson Island,[13] one of the known primary haul-outs for Iliamna Lake seals during the ice-free season. (*See* AFSC 2019.) The ferry route for Alternative 2 likewise runs adjacent to a significant number of seal haul-outs and pupping locations in the northeastern portion of the lake. Locals report that, during the spring melt, "seals begin to consistently haul out on islands and sandbars between Kokhanok and Newhalen," and that they are "somewhat lethargic" at this time of year "due to low energy from surviving a long winter." (Burns, Withrow & Van Lanen 2018.) The ferry would thus disrupt and disturb Iliamna Lake seals during an especially vulnerable time of year when they may have little capacity to endure the stress imposed by the ice-breaker ferry. Jansen *et al.* (2015) found unexpectedly broad-scale disturbance to Alaska harbor seals by single vessels, underscoring the potential harm the ferry may cause to the small Iliamna Lake seal population.

The "high vessel areas" associated with Pebble Mine activity identified in the DEIS are crucial for Iliamna Lake seal survival. (DEIS 2019.) The proposed ferry routes run through or alongside primary seal haul-out sites and pupping locations. (*See* Figs. H, I, *infra*.) Avoidance or abandonment of such areas may have significant individual and population-level consequences. In addition, as numerous studies have reported, harbor seals rarely haul-out in areas with constant disturbance and may abandon them altogether. (Henry & Hammill 2001.) In Iliamna Lake, there likely do not exist suitable replacement habitats to which the seals can relocate. (*See* Forney *et al.* 2017.)

Traditional ecological knowledge highlights potential harmful vessel impacts to Iliamna Lake seals. For example, during the pupping season and when pups are small, local residents avoid haul-out and feeding areas because they believe vessel traffic reduces seal pup survival. (Fall *et al.* 2006). Mother-pup pairs are especially vulnerable to disturbance, which can lead to reduced nursing time or pup abandonment. (*See* Pitcher & Calkins 1976, Osinga *et al.* 2012.) Pups permanently separated from their mothers will starve. (Osinga *et al.* 2012). Even if reunited, a decrease in nursing time could reduce pup survival rates. Recurring disturbances during the pup-rearing season may have a considerable negative impact on recruitment. (Henry & Hammill 2001, Andersen *et al.* 2012.) In a population as small as that of the Iliamna Lake seal, such reduced reproductive success could threaten the long-term viability and persistence of the population.

[13] Thompson Island stated location at at 59.54569 N 154.92510 W. (Pebble Partnership Report N-11.)

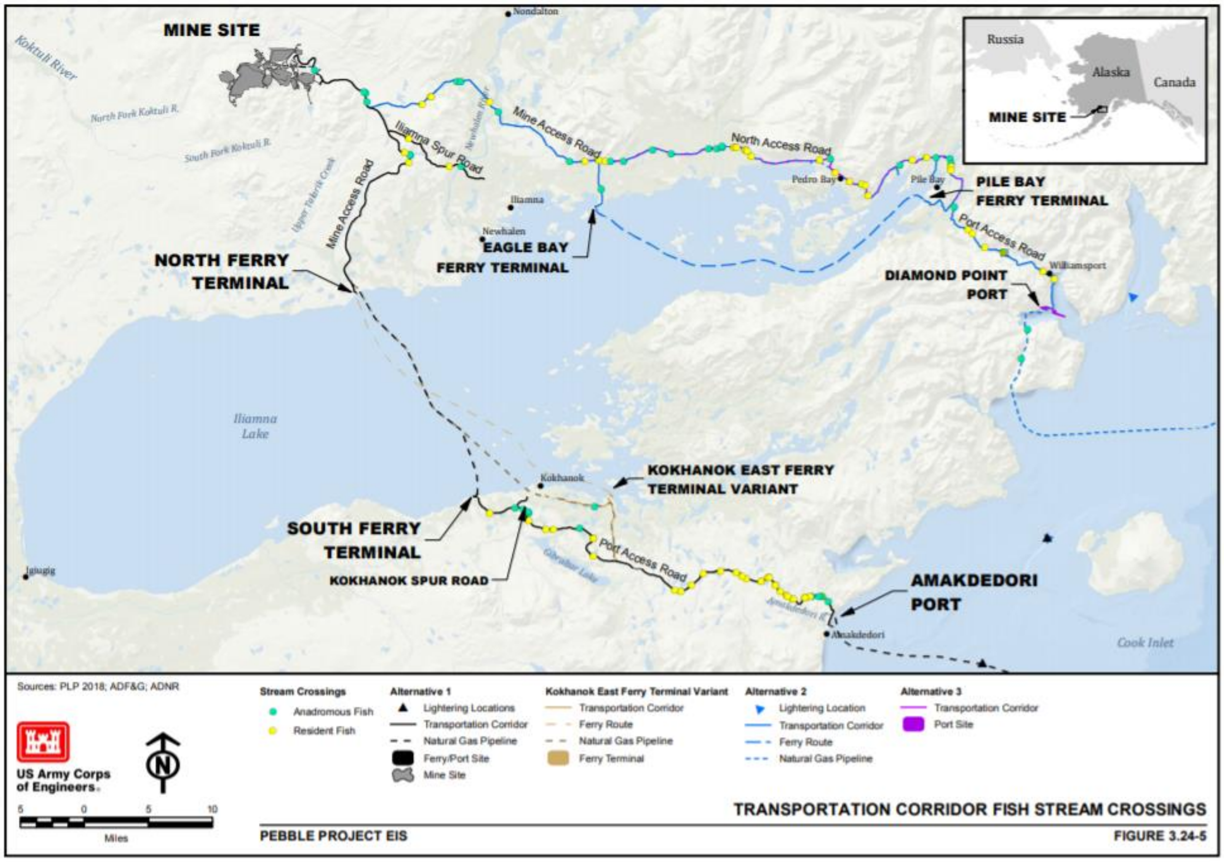

Fig. I. Proposed ferry routes running through Iliamna Lake. Figure 3.24-5 from DEIS at 3.24-14.

In sum, vessels associated with the Pebble Mine are likely to significantly impact Iliamna Lake seal behavior and condition by, *inter alia*, shifting habitat use, leading to abandonment or altered use of preferred haul-out and feeding sites, increasing energy expenditure, affecting body condition, and reducing reproductive success. All of these impacts may have disastrous individual- and population-level consequences for this small, endemic seal population. (*See* Suryan and Harvey 1999, Seuront and Prinzivalli 2005, Becker, Press & Allen 2009, Andersen *et al.* 2012.)

c. Anthropogenic Noise

In addition to the vessel impacts just described, the noise associated with year-round use of an ice-breaker ferry, ferry terminal construction and use (including associated road traffic), and construction of a natural gas pipeline across the lake would negatively impact Iliamna Lake seals. Scientists have documented myriad detrimental impacts of underwater noise on marine mammals including seals, including "tolerance, masking of natural sounds, behavioral disturbance, temporary or permanent hearing impairment, or non-auditory physical effects." (DEIS 2019; *see also* Kastak *et al.* 2005, Kastak *et al.* 2008, Aarts, Brasseur & Kirkwood 2018 (discussing behavioral responses of grey seals to pile-driving); Southall *et al.* 2019.) Pile-driving, in particular, may lead to noise exceeding injury thresholds. (DEIS 2019; *see also* Hastie *et al.* 2015, Kastelein, Helder-Hoek & Terhune 2018a, Kastelin *et al.* 2018b (discussing effects of pile driving on harbor seal hearing and noting that "[p]ile-driving sound is in the frequency range of best hearing of harbor seals").)

In addition to waterborne noise, noise from aircraft (*e.g.,* airplanes, helicopters, drones) associated with mine operations would disrupt Iliamna Lake seal behavior and physiology. (DEIS 2019.) For example, low-flying aircraft[14] may displace seals using surface haul-out or pupping areas or foraging near spawning streams, resulting in energetic costs and stress responses. (*Id.*, Pitcher and Calkins 1976, Osinga *et al.* 2012.) Such flights even have been implicated in high levels of harbor seal mortality. (Pitcher & Calkins 1976, Suryan & Harvey 1999.) Noise associated with haul trucks, ATVs, and other terrestrial vehicles likewise would disturb seals in the vicinity.

In sum, the noise disturbance associated with vessel, aircraft, and vehicle activity stands to disrupt seal behavior, leading to temporary or permanent abandonment of preferred breeding or feeding habitats, avoidance, vigilance, or masking behaviors. (DEIS 2019.) Physical harms including hearing loss, physical injury, and death also are possible.

ii. The Pebble Mine Would Significantly and Adversely Impact Iliamna Lake Seal Prey, Including Freshwater and Anadromous Fish.

The Pebble Mine would contribute to reduced prey availability for Iliamna Lake seals. Specifically, the mine would cause the loss of spawning and rearing habitat for multiple species of anadromous and resident fish in regional watersheds, including in and around Iliamna Lake. (EPA 2014a.) The diversity of streams and rivers across which salmon spawn provides stability to overall salmon productivity in the Bristol Bay region; harming just a fraction of this habitat "portfolio," as the Pebble Mine would do, could have devastating implications for regional salmon populations. (*See generally* Griffiths *et al.* 2014, Bentley *et al.* 2015, Schindler, Armstrong & Reed 2015, Baldock *et al.* 2016Thorson *et al.* 2018; Brennan *et al.* 2019b, Schindler 2019.)

Under the mine proposal evaluated in the current DEIS, one of the primary pathways of impact of the Pebble Mine to Iliamna Lake fish species would occur via hydrological connections with the Upper Talarik Creek watershed. Upper Talarik Creek flows from its headwaters on the eastern edge of the mine site into Iliamna Lake. (DEIS 2019.) Substantial inter-basin transfer—including transfer of mine-related contaminants—would occur through surface- and groundwater connections in the region. (*See* EPA 2014a ("Surface and subsurface waters are highly connected, enabling hydrologic and biochemical connectivity between wetlands, ponds, streams, and rivers").)

Aquatic impacts to the Upper Talarik Creek watershed from the mine would flow from mine access road impacts (*e.g.,* siltation), the mine site itself (*e.g.,* through direct stream loss and pit dewatering), water treatment discharge, and mine facility impacts. (*Id*.) For example, the applicant's preferred alternative includes construction of a 47-km, 30-foot wide gravel access road (346-acre footprint) and 18 km of spur roads (134-acre footprint). Siltation from road-building activities and routine use (up to 39 truck round trips per day) will smother incubating eggs and fish hatchlings as well as fish prey. (EPA 204a2; DEIS 2019). The road access system estimates placement of 86 culverts, which act as barriers to juvenile and adult fish passage. (DEIS 2019.) Less than half of these culverts would be designed with fish passage in mind. (*Id*.) They also theoretically could impede Iliamna Lake seal movement.

Both the main stem of Upper Talarik Creek and its tributaries provide prime spawning, rearing, and overwintering habitat for sockeye, Chinook, coho, chum, and pink salmon. (DEIS 2019.) They also provide high-quality habitat for rainbow trout as well as Dolly Varden, Arctic grayling, whitefish (*e.g.,* round whitefish, humpback whitefish, least cisco), sculpin (C*ottus* sp.), and threespine and ninespine

[14] Frost *et al.* (1993) found that spotted seals responded to an approaching aircraft at a distance of over 1 km, even when the plane's flying altitude was 760 m.

stickleback. (*Id*.) Of the anadromous salmonids, sockeye are the most common species in Iliamna Lake, where they are known to use shoreline habitat for spawning (particularly in the northeastern portion of the lake).

Iliamna Lake seals feed upon the rich diversity of fish species found in the lake, including some reliant on Talarik Creek and its tributaries. (Hauser *et al.* 2008, Burns *et al.* 2016).A significant reduction in anadromous and/or freshwater fish would be devastating for Iliamna Lake seals, leading to poor body condition, reduced reproductive success, and almost ensuring precipitous population decline. (*See* Harding *et al.* 2005 (noting that pups of the year are more vulnerable to changes in food supply).) A substantial reduction in prey species would reduce the carrying capacity of the lake for Iliamna Lake seals; this would make the challenges associated with small population size (*see* discussion Part III.5.A, *infra*) more acute. Loss of these salmon runs also might increase predation pressure on the seals by other terrestrial carnivores (*e.g.*, bears, eagles) that currently focus their feeding efforts on these anadromous fish. (EPA 2014a.)

In addition to providing food for Iliamna Lake seals, anadromous salmon serve as a keystone species for the region because their carcasses provide a necessary influx of nutrients for the entire freshwater ecosystem. (Hauser 2007, EPA 2014a, Brennan *et al.* 2019a; *see also* Schindler & Smits 2017 (discussing anthropogenic disruption of aquatic subsidies to terrestrial ecosystems).) The non-anadromous, freshwater fish species relied upon by the seals depend on the increase in primary productivity from these salmon-derived nutrients, as do (in turn) bears, eagles, and other predators that feed upon them. (*See* Gende *et al.* 2004).

iii. The Pebble Mine Would Have Severe and Long-Term Effects on Lake Habitat Quality

The Pebble Partnership plans to build a metallic sulfide mine in one of the world's most remote, pristine, and earthquake-prone ecosystems. Water quality in Iliamna Lake is exceptional, but mine-related activities would change that, introducing sediments and toxic contaminants that would harm fisheries and wildlife, including the Iliamna Lake seal. (EPA 2014a).

a. <u>Turbidity</u>

Mine construction and operations inevitably will lead to increased turbidity and siltation of Iliamna Lake and its associated network of streams and rivers from, *e.g.*, road construction and use. Traffic, erosion, and dust production will degrade water quality, reduce primary productivity, and reduce reproductive success for both anadromous salmon and freshwater fish species (*See* Fall *et al.* 2006, Hauser 2007, EPA 2014a.)

Iliamna Lake seals' prey species also stand to be impacted by "[h]abitat alteration, turbidity, and discharge from routine activities" associated with ferry terminal construction and use. (DEIS 2019.) These impacts will affect Iliamna Lake seals, reducing the available prey base and potentially degrading or destroying preferred fishing grounds.

b. <u>Toxic Contaminants</u>

The Pebble Mine will introduce myriad toxic contaminants into regional watersheds, including into Iliamna Lake. This contamination may come as the result of routine activities, environmental processes (*e.g.*, contamination traveling via groundwater or surface water),[15] small to moderate-sized accidental spills, or catastrophic spills, seismic ruptures, or dam failures. Such contamination will impact species from the base of the food chain through apex predators including Iliamna Lake seals, with effects including, *e.g.*, reduced reproductive success, immune system impairment, and mortality from acute toxicity. (*See* Harding 2000, Baird 2001, EPA 2014a.) Contamination of prey could prove particularly problematic for upper trophic level consumers like Iliamna Lake seals if the contaminants of concern bioaccumulate or biomagnify. (*See* NMFS BA 2019.)

Toxic contamination flowing from failures or accidents related to the Pebble Mine could devastate the Iliamna Lake seal, its prey, and its habitat. (EPA 2014a). The EPA recognized several types of accidents or failures including:

i. the release of acid, metal, or other contaminants from the mine site, waste rock piles, and tailing storage facilities;
ii. the failure of roads, culverts, and pipelines in the transportation corridor, including spills of copper concentrate; and
iii. the catastrophic failure of the tailings dam.

(*Id.*) Long-term evidence from other open pit mines of similar design and scope suggest the inevitability of one of more of these accidents or failures, which would result in immediate, severe, and long-term impacts on salmon, seals, and their habitat. (Hauser 2007, EPA 2014a.) The Pebble Mine's location in an active seismic zone further increases this risk.

Such accidents or failures would have major implications for Iliamna Lake seals and their prey. Exposure to released contaminants could lead to mortality or population-level harms through decreased reproductive rates and immune system suppression. *See also* Part III.5.E, *infra* (discussing contaminant impacts). Iliamna Lake seals are particularly vulnerable to contaminant-related harms flowing from Pebble because (1) they are highly dependent on fish species that would be directly impacted by a release, (2) they constitute a small, isolated population with limited ability to survive a major mortality event or other significant change to the ecosystem on which they depend. Releases, spills, and failures are discussed in more detail below.

1. Releases

Large, modern-era hardrock mines have a poor environmental record, especially when—as with Pebble—they occur with close proximity to surface water or groundwater resources. (Maest *et al.* 2006.) When such mines have a moderate to high acid drainage or contaminant leaching potential, as does Pebble, they are inherently high risk. Nearly all such mines examined by Maest *et al.* (2006) had operational water quality impacts, with many leading to exceedances of water quality standards.

Specifically, for thirteen mines with close proximity to surface water and high acid drainage or contaminant leaching potential, Maest *et al.* found that mining activity impacted surface water at 92% of the mines. (*Id.*) Eleven exceeded standards or permit limits in surface water despite the fact that ten of those eleven predicted no exceedances in pre-operational environmental analyses. (*Id.*) Maest *et al.*

[15] *See, e.g.*, DEIS 2019 (stating that "[t]he region surrounding the mine site has significant groundwater-surface water interactions" and that "[t]here is potential for some fluid with elevated metals from the pyritic release to permeate shallow groundwater aquifers in losing stretches of the [South Fork Koktuli] watershed. If this were to occur, there is potential for some of this contaminated groundwater to flow into the [Upper Talarik Creek] watershed") and from there into Iliamna Lake.

concluded that mines with these inherent characteristics are likely to require perpetual treatment to reduce or eliminate long-term surface water impacts. (*Id.*)

Maest *et al.* further found that fourteen of fifteen mines (93%) with close proximity to groundwater, springs on site, or discharges to groundwater and with high acid drainage potential or contaminant leaching potential adversely affected groundwater, seeps, springs, or adit water. (*Id.*) Close proximity to groundwater in combination with moderate to high acid drainage or contaminant leaching potential thus appears to greatly increase the risk of water quality impacts. (*Id.*)

These adverse impacts to groundwater and surface water were underestimated in pre-mining environmental impact statements (EISs) for over three-quarters of the analyzed mines—particularly when those EISs took mitigation measures into account. (*Id.*) This makes sense given that mine approval generally would not be possible if the EISs anticipated exceedances of water quality standards. (*Id.*) The fact that those conclusions usually are wrong, however, suggests that surface and groundwater contamination in and around the Pebble Mine site are nearly certain to occur.

Slow and insidious damage from ongoing contaminant leaching or leakage is essentially inevitable at a porphyry copper mine like Pebble. (*See* EPA 2014a.) This is problematic because copper toxicity to salmon, one of the Iliamna Lake seal's primary prey species, is well-known. Even trace amounts of the metal affect a salmon's sense of smell and ability to navigate back to natal spawning grounds. (Saunders and Sprague 1967, Hansen *et al.* 1999, Baldwin *et al.* 2003, EPA 2014a.) Copper toxicity from the Pebble Mine could reduce spawning salmon numbers in the Iliamna Lake system and could ultimately result in the loss of entire salmon runs. This, in turn, would have a substantial impact on Iliamna Lake seals.

2. Spills

Mining and associated activities at the Pebble site also could lead to spills or contaminant releases into Iliamna Lake seal habitat. One potential source of a spill is the ice-breaker ferry, which "would transit Iliamna Lake, carrying inbound supplies from Amakdedori port to the mine site, and returning with copper-gold and molybdenum concentrates, backhauled waste, and empty shipping containers." (DEIS 2019.) The agency states that "[f]uel and other potential contaminants would be stored in tanks inside the hull and away from the shell to prevent spills," but fails to discuss the ecological implications of such a spill should this precaution fail. (*Id.*)

Spills could impact Iliamna Lake seals in various ways. For example, a concentrate spill or diesel spill could "impact … [seal] foraging habitat in river mouths that empty into Iliamna Lake." (*Id.*) In the event of a concentrate pipeline break, there may be a "loss of prey species for Iliamna Lake seals where the concentrate covers up and smothers eggs." (*Id.*) There also would exist the "potential for Iliamna Lake seals to be temporarily disturbed while cleanup activities occur." (*Id*.) Avoidance of the area during clean-up activities may have energetic costs for the seal, and the use of hazing activities on this unhabituated seal population (as proposed) is likely to have substantial harmful effects. (*Id.*) The seals also may be affected by exposure to spilled contaminants (*e.g.,* diesel) themselves. (*See, e.g.,* Harris *et al.* 2011 (noting that fetal exposure to PAHs in utero can cause neurotoxicity and affect normal embryonic development); Stimmelmayr *et al.* 2018 (proposing that observed pathologic pulmonary, cardiac, adrenal and gastric lesions resulted from oil exposure in ringed and spotted seals).)

Tailings spills pose a long-term risk to Iliamna Lake seals and their prey; "if the tailings are not recovered, the minerals would slowly dissolve, leaching metals into the water, some of which could bioaccumulate in the food chain." (*Id.*) Copper toxicity from such waste poses a risk, particularly to the Iliamna lake seals' prey. Copper levels slightly over background levels can prove toxic to salmon and other aquatic life. (Woody & O'Neal 2012, Morris *et al.* 2019a.) Even small increases over background levels can interfere with salmonids' ability to smell and sense vibration. (Hansen *et al.* 1999, Baldwin *et al.* 2003, Woody & O'Neal 2012.) These handicaps, in turn, can interfere with migration and homing and put the fish at greater risk of predation. (*See* McIntyre *et al.* 2012, Morris *et al.* 2019b.) They also can interfere with other physiological and/or behavioral responses including sperm production, food location, recognition of kin and conspecifics, and reproduction. (Woody & O'Neal 2012.)

Copper also can kill major salmon food sources including zooplankton and aquatic insects. (Woody & O'Neal 2012.) Even if the food sources survive, ingestion by salmon can result in copper bioaccumulation and adverse health outcomes including reduced growth and whole-body energy stores. (Berntssen, Lundebye & Maage 1999, Woody & O'Neal 2012.) This concern is not merely theoretical for Pebble. Copper pollution of wetlands and waters already has been observed from exploration of the Pebble Mine site, and the impacts from sequestered copper likely will be long-term. (Zamzow & Chambers 2019.)

3. Seismic Rupture or Tailings Dam Failure

The impacts of a seismic rupture or tailings dam failure on the Iliamna Lake seal would be catastrophic. In the DEIS, the Corps acknowledged that even in the event of a smaller spill during operations, "personnel … [might] not necessarily have training to respond to such a release" and that "[i]n the event of a very large release, spill response, recovery of tailings, and remediation would be difficult." (DEIS 2019.) A release on the scale of a massive tailings dam failure would be uncontainable, with contaminants affecting both Iliamna Lake seals and their prey for the foreseeable future.

The proposed pyritic tailings storage facility alone would hold approximately "155 million tons of pyritic tailings, 160 million tons of [potentially acid generating] waste rock, and an operating supernatant pond" in the North Fork Koktuli and South Fork Koktuli watersheds. (*Id*.) In the event of a release, the pyritic supernatant would contain levels of antimony, arsenic, beryllium, cadmium, cobalt, copper, lead, manganese, mercury, molybdenum, selenium, silver, and zinc in exceedance of water quality criteria. (*Id*.) These acids and heavy metals would "accumulate in streambed sediments, wetland soils, or isolated waterbodies" and could leach from unrecovered tailings, affecting water quality for decades to centuries or more. (*Id*.)

The tailings contamination hazard would not disappear when mine activities cease; rather, "the pyritic tailings would be pumped into the open pit, which would then be allowed to fill with water, so that the pyritic tailings would be permanently stored subaqueously" in perpetuity. (*Id*.) As proposed, this pit will contain more contaminated water than the famed and much-maligned Berkeley Pit in Butte, Montana—a Superfund site that is visible from space and continues to host catastrophic wildlife mortality events. (*See* Guarino 2016.) Pathways of contamination via surface water-groundwater connections and underground hydrology exist for the North Fork Koktuli, South Fork Koktuli, and Upper Talarik watersheds as well as Iliamna Lake; regional hydrology is known to be complex and inter-basin connectivity occurs throughout the region. The harms from a massive failure are not likely be contained. Under expected mine expansion, additional tailings dams would be constructed, compounding the potential for devastating ecosystem harm.

Catastrophic consequences also would flow from a seismic rupture underneath the pit. In short, the toxic waste produced by the Pebble Mine will be substantial and if released or spilled it will persist in perpetuity, with grave implications for regional wildlife and fisheries including the Iliamna Lake seal.

iv. Summary

The threats posed to Iliamna Lake seals by the proposed Pebble Mine are substantial and have the potential to threaten the seals and their ecosystem indefinitely. Direct disturbance from mine-related operations, significant adverse impacts to seal prey, and severe and long-term impacts to water quality all place the Iliamna Lake seal at increased risk of extinction. Climate change poses another long-term, existential threat to these seals, threatening both their habitat and their prey.

B. Climate Change

The international scientific community has concluded that anthropogenic climate change is occurring and that severe impacts to human and natural systems flowing from this change will worsen as greenhouse gas emissions continue to rise. (IPCC 2014; *see also* USGCRP 2018.) The Intergovernmental Panel on Climate Change (IPCC), the international scientific body charged with assessing climate change, concluded in its 2014 Fifth Assessment Report that "[w]arming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen." (IPCC 2014.) The effects of climate change already are making themselves apparent in Alaska, from thinning sea ice to melting permafrost to increasingly frequent and intense wildfires. The Iliamna Lake ecosystem and its resident seals will not be spared from these effects.

Climate change poses an existential threat to Iliamna Lake seals. Indeed, concerns about climate change have led to protective measures for other freshwater seal populations,[16] including those found in the Caspian Sea (*P. caspica*), Lake Baikal (*P. sibirica*), and Lake Saimaa (*P. hispida saimensis*). (Burns, Withrow & Van Lanen 2018.) Climate change will degrade lake habitat, negatively impact prey species, and produce synergistic adverse effects when coupled with other stressors (*e.g.*, by increasing contaminant bioavailability). (*See* DEIS 2019.) These harms are described in more detail below.

i. Greenhouse gas emissions are resulting in severe climate change impacts that will worsen as emissions rise

Key climate change impacts include, but are not limited to, changing temperatures; the rapid loss of glaciers and ice sheets, Arctic sea ice, and Antarctic ice shelves; diminishing snow cover; ocean acidification; increasing frequency of heat waves and other extreme weather events; flooding of coastal regions by sea level rise and increasing storm surge; and jeopardized global food and water security. Climate change threatens ecosystem structure and function and increases species extinction risk. (Melillo *et al.* 2014; USGCRP 2017; USGCRP 2018.)

One of the most prominent features of climate change is temperature rise. Global average surface temperatures have risen by 1.8°F (1.0°C) since 1901, most of which occurred during the past three decades. (USGCRP 2017.) As of 2018, 16 of the last 17 years were the warmest ever recorded by human observation. (USGCRP 2018.) Global average temperature reached a record high in 2016, which scientists determined was "only possible" because of anthropogenic climate change. (Knutson *et al.* 2017.) The year 2017 ranked as the second hottest year on record. (NASA 2018.)

[16] In contrast to the freshwater harbor seals discussed in this petition, these seals are believed descended from ringed seals that were isolated during the last ice age. (Burns, Withrow & Van Lanen 2018.)

The United States warmed by 1.8°F (1.0°C) between 1901 and 2016, with the most rapid warming occurring after 1979. (USGCRP 2017.) The U.S. is expected to warm by an additional 2.5°F (1.4°C), on average, by mid-century relative to 1976-2005, and record-setting hot years will become commonplace. (*Id.*) By late century, much greater warming is projected, ranging from 2.8 to 7.3°F (1.6 to 4.1°C) under a lower emissions scenario and 5.8 to 11.9°F (3.2 to 6.6°C) under a higher emissions scenario, with the largest increases in the upper Midwest and Alaska. (*Id.*)

Unfortunately for the Iliamna Lake seal and other species threatened by climate change, global and U.S. greenhouse gas emissions continue to rise. Global emissions of fossil carbon dioxide (CO_2)—the dominant greenhouse gas driving anthropogenic climate change (NRC 2011)—increased 2.1 percent in 2018, reaching 36.7 Gt (billion tons) CO_2[17] per year for the first time in history. (Friedlingstein *et al.* 2019; *see also* LeQuéré *et al.* 2018, Jackson *et al.* 2018.) U.S. carbon dioxide emissions increased by 2.8 percent in 2018 after an overall downward trend since 2007. (Friedlingstein *et al.* 2019.) The U.S. emissions increase largely came from a rise in natural gas and oil consumption. (IEA 2019.) U.S. emissions in 2018 rose across all sectors—power, transport, industry and buildings. (Rhodium Group 2019.)

As emissions continue to rise, so too does the average global atmospheric CO_2 concentration at the earth's surface. This concentration reached 407.4 ± 0.1 parts per million (ppm) in 2018, the highest on record and in ice core records dating back 800,000 years. (Blunden & Arndt 2019.) In 2019, "[a]tmospheric carbon dioxide continued its rapid rise …, with the average for May peaking at 414.7 parts per million at NOAA's Mauna Loa Atmospheric Baseline Observatory …. This is the highest seasonal peak recorded in 61 years of observations." (NOAA 2019b.) The last time CO_2 in Earth's atmosphere was at 400 ppm, global mean surface temperatures were 2 to 3°C warmer and the Greenland and West Antarctic ice sheets melted, leading to sea levels that were 10 to 20 meters higher than today. (LeQuéré *et al.* 2018, WMO 2017.) The current atmospheric CO_2 concentration is nearly one and a half times larger than the pre-industrial level of 280 ppm, and much greater than levels during the past 800,000 years when the atmospheric CO_2 concentration fluctuated between ~174 and 280 ppm. (IPCC 2014, WMO 2017.) The atmospheric concentrations of methane (CH_4) and nitrous oxide (N_2O), two other potent greenhouse gases, are 257 percent and 122 percent of their pre-industrial levels. (WMO 2017.) Global carbon emissions over the past 15 to 20 years are tracking the highest emission scenario used in IPCC climate projections, the RCP8.5 scenario, which is projected to lead to devastating impacts. (IPCC 2014, USGCRP 2017.)

ii. Alaska is warming much faster than other regions

Alaska "is on the front lines of climate change and is among the fastest warming regions on Earth." (USGCRP 2018.) It is warming faster than any other U.S. state, with temperatures—including those in Bristol Bay—rising at twice the rate of the global average since the mid-20th century. (*Id*.) Statewide, the years 2014-2016 were notably warmer than the past few decades, with 2016 the warmest on record. (*Id*.)

Both terrestrial and freshwater ecosystems in Alaska are experiencing effects from climate change (*e.g.,* nutrient cycling, hydrology, freshwater acidification, thermal stratification), with implications for fish and wildlife populations. (*See* Aicher, Todd & Ebersole 2012, Ou *et al.* 2015, Hasler *et al.* 2016, Weiss *et al.* 2018.) For example, permafrost in Alaska continues to melt, with implications for "river and stream

[17] Friedlingstein *et al.* (2019) reported emissions as 10 GtC. One Gt C equals 3.67 Gt CO_2, so 10 Gt C*3.67=36.7 Gt CO_2.

discharge, water quality, and fish and wildlife habitat." (USGCRP 2018.) Riverine erosion is a serious problem across the state. (*Id*.) Glaciers continue to melt, with an estimated loss of 75 ± 11 Gt of ice volume annually from 1994-2013—nearly double the rate seen from 1962-2006. (*Id*.) Modeling studies indicate that ice loss rates will continue to increase in the coming decades, "with the potential to alter streamflow along the Gulf of Alaska and to change Gulf of Alaska nearshore food webs." (*Id*.) The climate is expected to become more hospitable to harmful algal blooms as well as infectious agents, increasing the threat of disease for regional wildlife populations. (*Id.*) Diseases known to be threats to the Iliamna Lake seal, including phocine distemper virus, are spreading throughout Alaska alongside melting sea ice associated with climate change. (*See* Harvell 1999, VanWormer *et al.* 2019.)

Alaska's marine ecosystems, too, are undergoing dramatic change. According to the U.S. Global Change Research Program,

> Alaska's marine fish and wildlife habitats, species distributions, and food webs, all of which are important to Alaska's residents, are increasingly affected by retreating and thinning arctic summer sea ice, increasing temperatures, and ocean acidification. Continued warming will accelerate related ecosystem alterations in ways that are difficult to predict, making adaptation more challenging.

(*Id*.) Warming ocean waters may lead to "northward expansion of fish species, ecosystem changes, and potential relocation of fisheries." (*Id*.) Ocean heat waves also may become more common with uncertain repercussions for regional fisheries. (*Id*.) For example, the recent Gulf of Alaska heat wave resulted in zero harvest for Pacific cod in 2016 and 2017, and an 80% reduction in quota in 2018. (*Id*.)

Compounding these temperature-mediated effects is ocean acidification, which is intensifying in Alaska's marine waters. (*See* Mathis, Cross & Bates 2011, Mathis *et al.* 2014, Mathis *et al.* 2015a, Mathis *et al.* 2015b, USGCRP 2018.) The global ocean has absorbed approximately a third of all the carbon dioxide (CO_2) released into the atmosphere since the pre-industrial era. (IPCC 2014.) While this oceanic absorption has buffered increases in air temperature, it has resulted in a 26% increase in the acidity of ocean waters. (*Id*.) By the end of the century, ocean acidity is projected to increase by another 100-109 percent under the RCP8.5 scenario. (*Id*.)

The process of ocean acidification occurs when CO_2 reacts with seawater to form carbonic acid, lowering seawater pH. Hydrogen ions released by the carbonic acid bind to carbonate (CO_3^{2-}), forming bicarbonate (HCO_3^-). Lower carbonate concentrations in the ocean inhibit the ability of certain calcifying planktonic organisms to build and maintain calcium carbonate ($CaCO_3$) shells, in turn affecting their growth and survival. (Riebesell *et al.* 2000, Feely *et al.* 2004, Orr *et al.* 2005, Fabry *et al.* 2008, Comeau *et al.* 2009, Bednaršek *et al.* 2012, Bednaršek *et al.* 2016, Bednaršek *et al.* 2017, Manno *et al.* 2017, Bednaršek *et al.* 2018, USGCRP 2018, Bednaršek *et al.* 2019.) Scientists have observed the harmful effects of acidification (alone and in concert with warming ocean temperatures) on pteropods, including shell dissolution, impaired growth, and reduced survival, in the wild. (Bednaršek *et al.* 2012, Bednaršek *et al.* 2016, Bednaršek *et al.* 2017, Bednaršek *et al.* 2018, USGCRP 2018, Bednaršek *et al.* 2019.) This is problematic because these calcifying planktonic organisms (*e.g.*, pteropods and foraminifera)[18] form the basis of the marine food chain, particularly in high latitude waters, serving as the key food resource for salmon and other prey species consumed by salmon. (Orr *et al.* 2005, Doney *et al.* 2009, Hofmann *et al.* 2010.) Some scientists predict pteropods in parts of the Pacific Ocean could suffer drastic declines due to ocean acidification as early as the second half of this century (Orr *et al.* 2005, Comeau *et al.* 2009.)

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[18] These planktonic species also will be affected by warming ocean temperatures in addition to ocean acidification.

Such declines in key plankton species would have significant impacts on the survival of North Pacific salmon.

Ocean acidification also appears to impact salmon directly. For example, laboratory experiments show that ocean acidification affects the survival, growth, and sensory abilities of pink salmon—a species that also is known to feed on pteropods. (Doubleday & Hopcraft 2015, Ou *et al.* 2015, USGCRP 2018, Daly *et al.* 2019.) Juvenile coho salmon exposed to elevated CO_2 levels experience extensive disruption in genes involved in olfaction. (Williams *et al.* 2019.) Any reduction in salmon survival due to ocean acidification's effects on salmon themselves or their prey species could have substantial and deleterious impacts on the trophic functioning of the Iliamna Lake ecosystem. (*See* Brennan *et al.* 2019a.) Iliamna Lake seals—particularly reproductive-aged seals—would lose an important prey resource, likely leading to reduced survival and decreased reproductive success. Loss of these prey resources also may make the seals less resilient to other ecosystem perturbations. Prey loss on its own or in concert with cumulative effects of these stressors threaten the survival and long-term viability of this small, freshwater seal population.

iii. Climate Change Impacts on the Iliamna Lake Ecosystem

Climate change threatens the Iliamna Lake seal through impacts to its habitat and ambient environment. Many lake ecosystems worldwide are experiencing warming due to climate change. (O'Reilly *et al.* 2015, Sharma *et al.* 2015.) Spring air temperatures in the Iliamna Lake region warmed by approximately 3.3°C between 1962 and 2006. (Rich *et al.* 2009.) These warmer air temperatures have led, and will continue to lead, to warmer spring water temperatures and an earlier date of ice breakup. (*Id*.)

In the Bristol Bay watershed writ large (including Iliamna Lake, *see* Fig. J, *infra*), climate change is expected to result in shifting species ranges, changes in prey availability (timing and abundance), increases in diseases and parasites, increased glacial retreat and freshwater run-off, changes in the amount (projected increase of ~250 mm by the end of the century—a 30% increase over baseline levels) and form (snow to rain) of precipitation, increased evaporation, increasing lake stratification, changes in streamflow (magnitude, intensity, and timing), changing seasonal water levels in lakes, and changing ocean currents. (Harvell 1999, Battin *et al.* 2007, Rich *et al.* 2009, Aicher, Todd & Ebersole 2012). All of these have the potential to negatively affect Iliamna Lake seals.

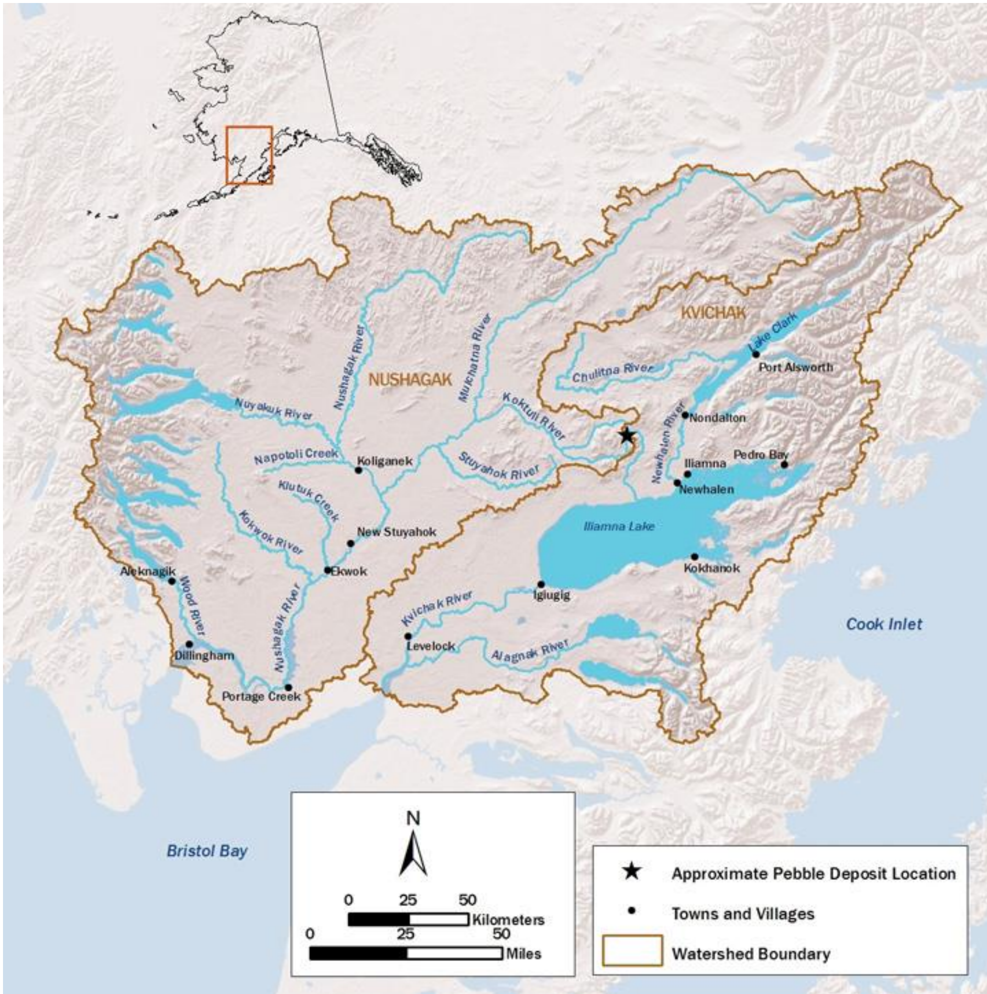

Fig. J. Bristol Bay Watershed Map, courtesy of Environmental Protection Agency. *Available at* https://www.epa.gov/bristolbay.

For example, warming temperatures, changes in precipitation, and altered hydrology likely will mean less ice (both temporally and spatially) on Iliamna Lake—a shift that will reduce critical winter habitat for this ice-associated harbor seal population. The sheltered under-ice spaces and caves that Iliamna Lake seals use as winter haul-out sites may not form or could collapse. Ice caves could flood. Preferred summer haul-out sites also may flood due to higher temperatures and run-off rates. This could force seals to use less optimal areas, *i.e*. ones that may be more vulnerable to predators[19] or that provide reduced access to salmon or other prey. As habitat quality declines, Iliamna Lake seals are likely to suffer higher mortality and lower reproductive success.

As a general rule, harbor seals time energetically expensive activities (*e.g.* pupping) to occur synchronously with periods of high prey availability. In Iliamna Lake, seals appear to time such activities to coincide with salmon runs. (*See* Withrow *et al.* 2011.) Climate change may shift the timing of Bristol Bay salmon runs (Hodgson *et al.* 2006), leading to lack of synchronicity between prey availability and

[19] Predation pressure on Iliamna Lake seals may also be intensified by reduced salmon availability, as species including bears, wolves, and wolverines seek alternative prey species.

seal pupping, potentially reducing reproductive success and increasing the chances for population decline or demise.

iv. Climate Change Impacts on Iliamna Lake Seal Prey Species

The ecological implications of climate change on Iliamna Lake seals are complex, adversely affecting both the seal itself and its prey base. Climate change impacts to fish species targeted by Iliamna Lake seals, including anadromous salmon, are expected to be significant with potentially serious implications for survival and persistence of this small lake seal population. (*See generally* Crozier *et al.* 2008, Schindler *et al.* 2008, Rich *et al.* 2009, Aicher, Todd & Ebersole 2012, Leppi *et al.* 2014, Shanley & Albert 2014, Muñoz *et al.* 2015, Hovel, Carlson & Quinn 2017, Schindler 2017, Williams *et al.* 2019.) Studies have found that population fluctuations of Pacific salmon are highly correlated with changes in climate regimes (Mantua *et al.* 1997, Rich *et al.* 2009.) Warming waters limit thermally suitable areas for cold water dependent species like salmon and also affect their prey base (Schindler *et al.* 2005, Carter, Schindler & Francis 2017.) Changes in precipitation regime associated with climate change (*e.g.,* earlier snowmelt, less snow and more rain) will alter regional hydrology (*e.g.,* changes in mean and peak winter flows, increased flooding, lower summer and fall flows, increased temperatures), affecting suitability of salmon habitat by, *e.g.,* scouring streambeds, destroying salmon eggs, reducing spawning habitat, and inducing both juvenile and pre-spawning mortality. (Schindler *et al.* 2005, Battin *et al.* 2007, Wobus *et al.* 2015.)

Scientists posit that large-scale climatic regime shifts have led to changes in eastern North Pacific harbor seal populations. (Burns 2002.) Changes in lake conditions flowing from climate change are expected to be dynamic and complex, but ultimately detrimental to both Iliamna Lake seals and their fish prey base. In an example of this complexity, scientists expect warmer temperatures and reduced ice cover extent in Iliamna Lake to lengthen the lake's growing season, increasing primary and secondary productivity. (Rich *et al.* 2009.) In Iliamna Lake, warmer spring temperatures may accelerate embryonic development of salmon, leading to earlier emergence of fry, a proportionally longer foraging period before the fall, and increased fry length at the end of the first growing season. (Schindler *et al.* 2005, Rich *et al.* 2009.) While this could be beneficial to seals foraging on salmon fry, these larger fry tend to leave the lake after a single year (rather than two years for smaller fry) and overall survival may be lower than for two-year old outmigrants.[20] (Rich *et al.* 2009.) These latter two effects could reduce overall prey base for Iliamna Lake seals. (*See also* Schindler *et al.* 2005 (discussing how higher lake and ocean water temperatures harm salmon during spawning, incubation, and rearing); Cline, Ohlberger & Schindler 2019 (discussing effects of warming waters on life stages of sockeye salmon in Bristol Bay).) In addition to serving as an important prey resource for Iliamna Lake seals in their own right, anadromous salmon provide a key source of marine-derived nutrients to the entire lake ecosystem (through, *e.g.*, decomposition and predator feces) (Cederholm *et al.* 1999.) A loss of this critical resource would rob the Iliamna Lake ecosystem of critical nutrients, reducing overall productivity and impacting both anadromous and resident fish species and, in turn, Iliamna Lake seals.

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[20] This effect may be manifesting already, with 72% of outmigrants age-1 between 1993-2000 compared to 48% age-1 between 1963-1992. (Rich *et al.* 2009.) The trend continues, with the 2018 "Bristol Bay sockeye salmon run … dominated by fish with 1 year of freshwater residence (ages 1.2 and 1.3). Fish with 2 years of freshwater residence (age 2.2 and 2.3) were below preseason expectations, particularly in the … Kvichak river …." (Brennar *et al.* 2019). The 2020 preseason forecast likewise predicts a preponderance of sockeye with one year (ages 1.2 and 1.3) of freshwater residence (82%), with fish with two-years freshwater residence (ages 2.2 and 2.3) making up 17% of the run. (Buck, Head & Vega (2019) (remaining percentages made up of ages 0.3 and 1.4 from the Nushagak River).)

In addition to affecting anadromous salmon during their residence in Iliamna Lake, climate change also is affecting their marine life phase. Anadromous salmonid species are very sensitive to changes in the marine environment, and there exists a complex relationship between climate variability, ocean conditions, and salmon response. (*See generally* Schindler *et al.* 2005, Rich 2006, Rich *et al.* 2009.) For example, coastal temperatures impact survival rates for young salmon, which are especially sensitive to environmental conditions during the early marine life stage. (*See, e.g.,* Daly & Brodeur 2015, Daly, Brodeur & Auth 2017.) Ocean acidification is affecting salmon and their prey base, as described in Part III.1.B.ii, *supra*. Ongoing research will shed light on the myriad, complex ways that climate change affects North Pacific salmon and how those changes, in turn, may affect Iliamna Lake seals.

v. Summary

Climate change in Alaska already is occurring at a rate faster than any other U.S. state, with impacts ranging from melting glaciers and permafrost to increasing erosion and wildfires. Marine systems are undergoing rapid change as well; warming and ocean acidification are affecting species from the base of the food chain through apex predators. Climate change appears to be affecting salmon, in particular, with implications for the Iliamna Lake seal and the freshwater ecosystem in which they live. Iliamna Lake seals also will be affected by changing precipitation and lake ice regimes flowing from climate change, as well as the spread of disease. In short, climate change threatens the continued existence of this unique freshwater seal.

2. OVERUTILIZATION FOR COMMERCIAL, RECREATIONAL, SCIENTIFIC, OR EDUCATIONAL PURPOSES

Iliamna Lake seals are not utilized for commercial, scientific, or educational pursuits. This factor is not expected to be a threat to the Iliamna Lake seal population.

3. DISEASE OR PREDATION

A. Disease Threatens the Iliamna Lake Seal with Extinction

Disease poses an increasing threat to the Iliamna Lake seal. While more research is needed to ascertain the current extent of disease-related morbidity and mortality in the Iliamna Lake seal, disease impacts on this seal population stand to be significant because of its small size and isolated nature as well as its behavior. (Harding 2000.) Specifically, Iliamna Lake seals' congregation in haul-out sites and under-ice caves facilitates the spread of viral, bacterial, and fungal diseases. A disease outbreak could wipe out a large proportion of the population, creating a genetic bottleneck. The low remaining genetic diversity in the even-smaller remnant population would result in a higher vulnerability to other stressors. (*See* Pastor *et al.* 2004; Broquet *et al.* 2010.) Biotic and abiotic forces acting together on such a small population could result in an extinction vortex for Iliamna Lake seals. (Gilpin & Soulé 1986.)

Specific diseases that threaten Iliamna Lake seals include those introduced by wild or domestic canids[21] such as *Morbillivirus* (distemper). (*See* Barrett *et al.* 2003, Kennedy *et al.* 2019.) Canine distemper virus outbreaks killed thousands of freshwater seals in Lake Baikal in 1988 and caused mass die-offs of Caspian Sea seals in 1997 and 2000. (Barrett *et al.* 2003). Scientists believe these outbreaks were caused by seals having contact with infected terrestrial carnivores. (*Id.*) The related phocine distemper virus

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[21] This disease threat would increase with an influx of domestic dogs associated with the Pebble Mine.

(PDV), found in 1% of Gulf of Alaska harbor seals, also leads to high levels of mortality and may underlie a recent unusual mortality event among pinnipeds in the northeastern United States. (*See* Härkönen *et al.* 2006, Zarnke *et al.* 2006, NOAA Fisheries 2019a.) PDV antibodies are found in sea otters in the region, including 40% of those sampled in the eastern Aleutian Islands and Kodiak Archipelago in 2009. (Goldstein *et al.* 2009). These otters could serve as a vector for transmitting the disease to harbor seals. The geographic reach of PDV has been increasing with melting sea ice. (VanWormer *et al.* 2019, NOAA Fisheries 2020.)

Another virus of concern is phocid herpesvirus (PhHV1 and 2), which has been associated with morbidity and high mortality of neonatal and juvenile harbor seals. (Borst *et al.* 1986, Goldstein *et al.* 2003, Himworth *et al.* 2010.) The disease is endemic to North American harbor seals, with antibody rates to phocid herpesvirus-1 of approximately 93% among harbor seals sampled from southeast Alaska, Gulf of Alaska, Prince William Sound, and Kodiak Island from 1976-1999. (Goldstein *et al.* 2003; Zarnke *et al.* 2006.) *Streptococcus phocae* is associated with a variety of diseases in seals, and *Mycoplasma* bacteria were found in a number of seals affected by other diseases including those that died during an unusual mortality event in Northern Alaska. (Geraci *et al.* 1982, Skaar *et al.* 1994, NOAA Fisheries 2013, Taurisano *et al.* 2018.) *Brucella* antibodies were found in 62% (28/45) of Bristol Bay harbor seals sampled between 1975-2001, and it is hypothesized that seals may contract this bacterium from a food source. (Nymo *et al.* 2018; *see also* Hueffer, Gende & O'Hara 2013.) Influenza is known to cause or amplify disease in harbor seals. (*See* Geraci *et al.* 1982, NOAA Fisheries 2019a.) The spread of some of these diseases is expected to hasten with climate change, posing an increasing threat to the Iliamna Lake seal population. (*See, e.g.,* Harvell 1999, VanWormer *et al.* 2019.)

B. Natural Predation May Increasingly Threaten the Iliamna Lake Seal

As discussed in Part I.6.A, *supra*, wolves and wolverines are known predators of Iliamna Lake seals. (Burns, Withrow & Van Lanen 2018.) Local residents have observed both these species searching for lake seals by following pressure cracks on the ice. (*Id*.) Other possible predators include brown bears, which occasionally are seen on or near haul-out sites; coyotes; red foxes; eagles, which are known to prey on freshwater Caspian seals; and gulls and ravens. (*Id.*, Burns 2002, Härkönen *et al.* 2008.) There are no known aquatic predators of Iliamna Lake seals, although Wright (2012a, 2012b) hypothesized that a population of sleeper shark could have colonized the lake. If this is the case, this species theoretically could predate on Iliamna Lake seals.

While predation does not appear to be a significant threat to the Iliamna Lake seal at present, that could change alongside other threats including the Pebble Mine and climate change. Reductions in salmon and other fish populations as the result of these threats could drive existing predator populations to turn to Iliamna Lake seals as an alternative food source. In addition, predation on Iliamna Lake seals—particularly pups—by domestic canids would be expected to increase alongside Pebble Mine development.

C. Summary

In sum, disease poses a real and increasing threat to the Iliamna Lake seal population due to its small size and certain behavioral attributes that facilitate disease spread (*e.g.,* congregation in under-ice spaces). Climate change can be expected to increase exposure of Iliamna Lake seals to disease, and other threats including the Pebble Mine may amplify these threats (by, *e.g.,* bringing infected domestic canids into the region). While predators have not posed a threat historically to Iliamna Lake seals, climate change and the Pebble Mine may lead to increased predation pressure by introducing domestic canids and reducing regional salmon populations.

4. INADEQUACY OF EXISTING REGULATORY MECHANISMS

Existing regulatory mechanisms inadequately address primary threats facing Iliamna Lake seals including the climate change and the Pebble Mine.

A. Inadequate Regulatory Mechanisms Addressing Climate Change Threaten the Iliamna Lake Seal with Extinction

National and international regulatory mechanisms do not adequately protect the Iliamna Lake seal from the existential threat posed by climate change. These mechanisms are non-binding and, even if adhered to by all parties, fail to mandate greenhouse gas emission reductions sufficient to protect the Iliamna Lake seal from climate change-related effects including melting lake ice, ocean acidification, and impacts to important prey species.

NMFS repeatedly has acknowledged that regulatory mechanisms are inadequate to regulate greenhouse gas emissions at levels protective of species. For example, in its 2010 proposed listing rule for the bearded seal, NMFS stated that

> there are currently no effective mechanisms to regulate [greenhouse gas (GHG)] emissions, which are contributing to global climate change and associated modifications to bearded seal habitat. The risk posed to bearded seals due to the lack of mechanisms to regulate GHG emissions is directly correlated to the risk posed by the effects of these emissions.

(75 Fed. Reg. 77,496, 77,508 (Dec. 10, 2010); *see also* 77 Fed. Reg. 76,706, 76,712 (Dec. 28, 2012) (noting that "[c]urrent mechanisms do not effectively regulate GHG emissions, which are contributing to global climate change and associated modifications to ringed seal habitat.").)

In a recent synthesis of the literature on point, NMFS stated that "existing regulatory mechanisms with the objective of reducing GHG emissions were inadequate to prevent … climate-related threats." (79 Fed. Reg. 53,852, 53,903 (Sept. 10, 2014).) NMFS conducted "an in-depth analysis of international agreements to curb GHG emissions and their respective progress" and concluded that it was "unlikely that Parties would be able to collectively achieve, in the near term, climate change avoidance goals outlined via international agreements." (*Id.*) In addition, "none of the major global initiatives appeared to be ambitious enough, even if all terms were met, to reduce GHG emissions to the level necessary to" avoid impacts to imperiled species. (*Id.*) To make matters worse, the United States—one of the world's biggest GHG emitters—withdrew from the most recent international climate agreement, the Paris Agreement. (Pompeo 2019.)

As detailed below, the continued failure of the U.S. government and the international community to implement effective and comprehensive greenhouse gas reduction measures places the Iliamna Lake seals at ever-increasing risk of extinction.

i. *International Climate Change Agreements Are Insufficient to Protect the Iliamna Lake Seal*

The primary international agreement on climate action is the United Nations Framework Convention on Climate Change (UNFCCC). Adopted at the Rio Earth Summit in 1992, it has to date been ratified by 195 countries. The most recent agreement covering UNFCCC countries, the Paris Agreement, was ratified in 2016 and will take effect this year. According to the UNFCCC,

> [t]he Paris Agreement builds upon the Convention and for the first time brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects.

(UNFCCC 200.) The "central aim" of the Agreement "is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius." (*Id.*)

Scientists predict increases of 2°C or more would result in "'dangerous' [to] 'extremely dangerous' climate change." (Anderson and Bows 2011). Projected impacts include the disappearance of Arctic summer sea ice, irreversible melting of the Greenland ice sheet, an increased risk of extinction for 20-30% of species on Earth, and "rapid and terminal" declines of coral reefs worldwide (Veron *et al.* 2009; *see also* TEEB 2009, Jones *et al.* 2009, Warren *et al.* 2011, Hare *et al.* 2011, Frieler *et al.* 2012). The Paris Agreement seeks to avoid such dangerous harms by aiming to limit warming to 1.5°C. Humans already have warmed the planet 1.0°C over the pre-industrial level, and at the current rate we likely will reach 1.5°C of warming between 2030 and 2052. (IPCC 2018; UNFCCC 2020.)

This warming occurs largely due to rising atmospheric CO_2 levels. Last year, the global annual atmospheric concentration of CO_2 exceeded 415 parts per million (ppm) for the first time. (Harvey 2019.) This carbon dioxide level—a dramatic increase over the preindustrial level of 280 ppm—has not been seen for 3 million years. (*Id.*) Atmospheric CO_2 has been rising at a rate of nearly 3 ppm per year, and this rate is accelerating (Raupach *et al.* 2007, Friedlingstein *et al.* 2010, Harvey 2019, NOAA 2019a.) But as climate scientists have warned: "[i]f humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, paleoclimate evidence and ongoing climate change suggest that CO_2 will need to be reduced … to at most 350 ppm [equivalent to ~1.5°C], but likely less than that." (Hansen *et al.* 2008). This 350 ppm target must be achieved within decades to prevent dangerous tipping points and "the possibility of seeding irreversible catastrophic effects." (*Id.*)

Despite its adoption of the 1.5°C threshold, the Paris Agreement does not do enough to shield the Iliamna Lake seal from the harmful effects of climate change, including impacts to critical ice habitat and to key prey species. (*See* UNEP 2019.) Additionally, signatories have not yet effected the changes necessary to achieve the Agreement's goals. (*See id*.) Finally, the withdrawal of the United States—one of the world's primary contributors of atmospheric CO_2—from the Paris Agreement will hamper global efforts to rein in the devastating effects of climate change. (*See generally id.*)

ii. *National Climate Change Law Is Insufficient to Protect the Iliamna Lake Seal*

To date, federal agencies have failed to fully capitalize on existing authority under domestic law to reduce greenhouse gas emissions to levels that would be protective of species. The U.S. government repeatedly has acknowledged that its rules do not go far enough to notably reduce the nation's greenhouse gas emissions. (*See, e.g.,* NHTSA 2011 ("these reductions in emissions are not sufficient by themselves to reduce total [commercial medium-heavy duty on-highway vehicle and work truck] emissions below their 2005 levels by 2020"); 77 Fed. Reg. 22,392, 22,401 (April 13, 2012) (conceding that this new power plant rule on greenhouse gas emissions "will not have direct impact on U.S. emissions of greenhouse gases under expected economic conditions"). The government's refusal to utilize existing laws such as the Clean Air Act and Energy Policy and Conservation Act to force needed greenhouse gas reductions renders them inadequate mechanisms to protect the Iliamna Lake seal from the effects of climate change.

B. Existing Regulatory Mechanisms Fail to Protect the Iliamna Lake Seal from the Threats Associated with the Pebble Mine

Just as existing regulatory mechanisms fail to protect the Iliamna Lake seal from threats associated with climate change, so too do they fail to protect the seals from threats posed by the Pebble Mine. Overarching regulatory mechanisms that fall short with respect to the latter include the Clean Water Act, Marine Mammal Protection Act, and Alaska state law.

i. The Clean Water Act

Neither the Environmental Protection Agency nor the Army Corps of Engineers has used its authority under the Clean Water Act in a manner that would alleviate the threats the Pebble Mine poses to Iliamna Lake seals.

a. <u>Environmental Protection Agency</u>

Enacted in 1972, the Clean Water Act provides the Environmental Protection Agency (EPA) with authority to protect U.S. waters threatened with degradation by industrial activity. Section 404(c) of the Clean Water Act authorizes the EPA, after public hearings and a scientific review process, to protect rivers and wetlands from activities that will have "an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas." 33 U.S.C. § 1344(c). EPA can veto such activities at any point before, during, or after the permit application process.

Given the grave threat posed by the Pebble Mine, numerous interested stakeholders including Alaska Native tribes and corporations, commercial fisherman, and environmental organizations petitioned the EPA to use its CWA authority to protect the Nushagak, Kvichak, and greater Bristol Bay watersheds. In January 2014, the EPA released "An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska." This assessment concluded that even absent an accident or tailings dam failure, the Pebble Mine would eliminate, block, or dewater up to 151 km of streams (including up to 36 km of known salmonid spawning and rearing habitat) and remove or bury up to 18 km^2 of wetlands.[22] (EPA 2014a.) This loss "would be significant, because loss of stream habitat leading to losses of local, unique populations would erode the population diversity key to the stability of the overall Bristol Bay salmon fishery." (*Id.*; *see also* Griffiths *et al.* 2014, Bentley *et al.* 2015, Schindler, Armstrong & Reed 2015, Baldock *et al.* 2016, Thorson *et al.* 2018, Brennan *et al.* 2019b, Schindler 2019.) Accidents or failures—inevitable for a mine as complex as Pebble—would lead to "additional habitat loss or degradation," in

[22] The revised scope of the Pebble Mine in the 2019 DEIS, which occurred subsequent to the EPA's assessment, would modify these numbers somewhat. The EPA's overarching conclusions about the effects of large-scale mine development on the region, however, remain qualitatively the same.

turn “increas[ing] effects on salmon, which would further reduce the abundance of their predators” such as Iliamna Lake seals. (EPA 2014a.)

Later in 2014, after considering all available information including its Bristol Bay Assessment, EPA announced that it would proceed under CWA Section 404(c) “to review potential adverse environmental effects of discharges of dredged or fill material associated with mining the Pebble deposit.” (EPA 2014b.) The EPA concluded “that mining of the Pebble deposit at any of these sizes, even the smallest, could result in significant and unacceptable adverse effects on ecologically important streams, wetlands, and ponds and the fishery areas they support.” (*Id*.) The agency then proposed restrictions on the discharge of dredge or fill material related to mining the Pebble deposit that would lead to certain environmental impacts on streams, wetlands, lakes, and ponds. (*Id.*)

The Pebble Partnership sued. In May 2017, EPA entered into a settlement agreement with the Pebble Partnership that effectively suspended this determination, providing the Partnership an opportunity to apply for a CWA permit from the Army Corps of Engineers—something the Partnership did in December 2017. The Corps released its Draft Environmental Impact Statement on the proposed Pebble Mine in early 2019. (*See generally* DEIS.)

As part of its settlement with the Pebble Partnership, EPA also commenced a process to propose to withdraw the then-pending determination. In February 2018, the EPA reversed course, “decid[ing] not to withdraw at this time” its proposed restrictions. (83 Fed. Reg. 8668 (Feb. 28, 2018).) In June 2019, EPA resumed consideration of the withdrawal. In August, it withdrew its proposed determination to restrict use of the Pebble Mine area as a disposal site. (84 Fed. Reg. 45,749 (Aug. 30, 2019).)

While an ultimate EPA determination with restrictions stringent enough to halt the Pebble Mine would ameliorate the threat this mine poses to the Iliamna Lake seal, the agency’s recent actions, including withdrawal of the proposed determination, do not suggest an intention to act in a way protective of the seals. Unless and until EPA invokes such authority and any resulting litigation is resolved in the agency’s favor, the CWA cannot be deemed an adequate regulatory mechanism obviating the need for ESA listing of the Iliamna Lake seal.

b. Army Corps of Engineers

On December 22, 2017, the Pebble Partnership submitted to the Army Corps of Engineers a permit application for the placement of fill associated with development of the Pebble Mine into waters of the United States. (DEIS 2019.) The CWA prohibits such discharges absent an Army Corps permit. According to the DEIS, the Pebble Partnership’s preferred alternative

> would permanently discharge dredged or fill material into 3,560 acres of wetlands and other waters and temporarily discharge dredged or fill material into 510 acres of wetlands and other waters. An additional 1,896 acres of wetlands and other waters would be indirectly impacted by fugitive dust, and 449 acres of wetlands and other waters would be indirectly impacted by dewatering from the mine pit. The discharge would permanently impact 3,443 acres of wetlands, 55 acres of lakes and ponds, 50 acres of streams in 81 miles of channels, and 11 acres of marine waters. The discharge would temporarily impact 510 acres of wetlands and other waters. In terms of extent of impacts, [navigable waters of the United States] permanently affected … *include Iliamna Lake* and Cook Inlet.

(DEIS 2019 (emphasis added).)

While the Corps has authority to deny a 404 permit if its grant would result in significant degradation to the nation's waters, denial of 404 permits is extremely rare, accounting for less than 1% of all permit requests. (EPA—Permit Program Overview; USACE Regulatory Program FAQs.) Unless and until the Corps denies any and all permits necessary for the construction of the Pebble Mine, the CWA cannot be considered a regulatory mechanism that provides adequate protection for the Iliamna Lake seal.

ii. The Marine Mammal Protection Act

Congress enacted the Marine Mammal Protection Act (MMPA), 16 U.S.C. § 1361 *et seq.*, in 1972 to address concerns about anthropogenic causes of decline of marine mammal species. The law protects all marine mammals, regardless of their status under the ESA. The MMPA takes an ecosystem-based approach to marine resource management, "establish[ing] a national policy to prevent marine mammal species and population stocks from declining beyond the point where they cease … to be significant functioning elements of the ecosystems of which they are a part." (NOAA Fisheries—Laws & Policies.)

The MMPA uses the concept of a "stock" as a management unit for marine mammal conservation. Under the MMPA, a marine mammal "stock" is defined as "a group of marine mammals of the same species or smaller taxa in a common spatial arrangement, that interbreed when mature." 16 U.S.C. §1362(11). NMFS recognizes twelve harbor seal stocks in Alaska. (NOAA Fisheries 2017.) Despite their geographic, behavioral, and genetic isolation from the marine population (including lack of interbreeding), NMFS currently manages Iliamna Lake seals as part of the greater Bristol Bay harbor seal stock. (81 Fed. Reg. at 81,075.) The Bristol Bay stock is not managed as a "strategic stock," that is, one

> [f]or which the level of direct human-caused mortality exceeds the potential biological removal level; [w]hich, based on the best available scientific information, is declining and is likely to be listed as a threatened species under the Endangered Species Act within the foreseeable future; or [w]hich is listed as a threatened or endangered species under the ESA, or is designated as depleted under the MMPA.

(NOAA Fisheries 2019c.)

As a result, the MMPA as currently deployed does not afford the Iliamna Lake seal with adequate protection from the threats its faces. First, the failure to recognize and analyze the Iliamna Lake seal as a separate and strategic stock under the MMPA means that NMFS does not have to conduct annual stock assessments of the population or take steps to protect the population from certain threats. (*See, e.g.,* 16 U.S.C. § 1382(e) (measures to alleviate impacts on strategic stocks); *id.* § 1386.) While harassment and other "take" of Iliamna Lake seals from Pebble Mine activities would require MMPA authorization, we have found no examples of situations where NMFS denied industrial take authorization for seal species in Alaska. Furthermore, the MMPA does little to address climate change-related threats. For these reasons, the MMPA as currently interpreted and enforced cannot be considered an adequate regulatory mechanism to protect the Iliamna Lake seal.

iii. Alaska State Law

Alaska state law likewise fails to protect Iliamna Lake seals from threats including the Pebble Mine and climate change. First, the state of Alaska has never rejected a major mining project.[23] (Pebble Watch—Permitting Process.) It thus seems extremely unlikely that the state would block the Pebble Mine. Any mitigation measures required by Alaska through its permitting process will not meaningfully reduce impacts to affected watersheds (*see generally* EPA 2014a), and thus will not adequately ameliorate risk to the Iliamna Lake seal or its prey base. Further, while the state acknowledges the existence of and threats posed by climate change (*see* AK Admin. Order No. 289), no binding regulatory structure exists that would help mitigate climate change impacts to Iliamna Lake seals. Alaska state law thus does not serve as an adequate regulatory mechanism protective of the Iliamna Lake seal.

C. Summary

In sum, existing regulatory mechanisms including (but not limited to) the Clean Water Act, Marine Mammal Protection Act, and Alaska state law are insufficient to protect Iliamna Lake seals from threats including the Pebble Mine and climate change.

5. OTHER NATURAL OR MANMADE FACTORS AFFECTING THE ILIAMNA LAKE SEALS' CONTINUED EXISTENCE

A. Risks of Rarity

Scientists estimate the census size of Iliamna Lake seals to be approximately 400 individuals. (Boveng *et al.* 2016, Boveng *et al.* 2018, Brennan *et al.* 2019a.) The effective population size (*i.e.*, the number of individuals contributing to the next generation) is considerably smaller—likely only 40-56 individuals. (Boveng *et al.* 2016.) This low effective population size coupled with low genetic diversity place the Iliamna Lake seal at increased risk of extinction. (*See* Furlan *et al.* 2012.)

As discussed in more detail in Parts II.1.E and II.2.C, *supra*, genetic information collected on Iliamna Lake seals reveals reproductive isolation and some evidence of a historic bottleneck. NMFS itself has acknowledged that the identification of only one mtDNA haplotype in Iliamna Lake seals "appears to suggest unusually low genetic diversity." (81 Fed. Reg. at 81,081.) Low genetic diversity is a concern because such diversity "generally underpins population resilience and persistence" and "is critical for long-term fitness and adaptation." (Furlan *et al.* 2012.) Losses of genetic diversity can reduce reproductive success (*e.g.,* through decreased sperm quality and smaller litter size), individual fitness (*e.g.,* through increased disease susceptibility, *see also* discussion Parts I.6.A. and III.3.A, *supra*), and adaptive capacity. (Furlan *et al.* 2012.) Reductions in genetic diversity often flow from a combination of small population size, inbreeding, genetic drift, and restricted gene flow. (*Id*.) Iliamna Lake seals likely suffer from all these factors, increasing their risk of extinction. (*See also* Pastor *et al.* 2004, Broquet *et al.* 2010.)

[23] The Large Mine Permitting team (LMPT) is responsible for the permitting activities for large mine projects in the state of Alaska, in accordance with Alaska state law (AS 27.05.010). The Department of Natural Resources (DNR) and Office of Project Management and Permitting (OPMP) coordinate the permitting of large mining projects, like Pebble Mine.

Because of their isolation and small population size, Iliamna Lake seals also are particularly vulnerable to disturbances including stochastic perturbations (*e.g.,* variations in vital rates, environmental fluctuations, genetic drift) and environmental catastrophes. (*See* Harding 2000, Powles *et al.* 2000, Canadian Science Advisory Secretariat 2008, Brennan *et al.* 2019a (noting that "endemic populations [like the Iliamna Lake seal] are more vulnerable to environmental change"), 68 Fed. Reg. at 13,387 ("Semi-isolated populations are more vulnerable to the effects of demographic and environmental population fluctuations.").) Life history traits of the seal, including late maturation, low reproductive capacity, and specific foraging requirements exacerbate these threats, as do anthropogenic hazards including climate change and the Pebble Mine and other factors such as the threat of disease. The rarity of the Iliamna Lake seal thus threatens the population with extinction.

B. Fishing and Hunting

i. Fishing

NMFS has identified entanglement in fishing gear as a threat to harbor seals in general. (NOAA Fisheries—Harbor Seal.) Entangled seals may drown (drowning in fishing gear is a major cause of mortality for the freshwater seal population in Lake Saimaa, Finland), or drag and swim with attached gear for extended periods of time, which may result in fatigue, injury, impaired feeding ability, decreased reproductive success, or death. (Sipila 2003, Canadian Science Advisory Secretariat 2008, NOAA Fisheries—Harbor Seal.)

Neither commercial, recreational, nor subsistence fisheries currently appear to pose a threat to Iliamna Lake seals. Some salmon gillnets set by subsistence fishers in Iliamna Lake are raided by seals, and seals occasionally become entangled in them. (*See* Fall *et al.* 2010 (citing a report from a fisher who freed a young seal from his net in the summer of 2007).) However, while Iliamna Lake seals (especially pups) occasionally may become entangled in fishing gear, this is not considered a major source of mortality. Fishing pressure in the lake is very low, and subsistence hunters generally place nets in areas to avoid interference by seals. (*Id.*) This could change, however, with the projected increase in human population that would accompany development of the Pebble Mine. Increased fishing activity, especially by non-subsistence fishers that do not take seal behavior into account, would increase entanglement risks for Iliamna Lake seals, as well as reduce the seals' prey base.

It will be important to continue monitoring the effects of and interplay among fisheries and other pressures (*e.g.,* climate change, Pebble Mine) on both target fish species and Iliamna Lake seals to ensure that fisheries management regimes provide sufficient resources for this seal population.

ii. Hunting

Local residents engage in annual subsistence harvesting of Iliamna Lake seals at a level that approximates the intrinsic growth rate of the population. (Burns, Withrow & Van Lanen 2018 (noting that the data suggest a low but stable population of ~400 with an intrinsic growth rate of 5%, which is similar to the annual average harvest rate).) Subsistence hunting by Alaska Natives is not a known threat to the population and is unlikely to be affected should the Iliamna Lake seal be listed under the Endangered Species Act. (*See* 16 U.S.C. § 1539(e)).

Increased human population alongside development of the Pebble Mine would increase the risk for illegal hunting of Iliamna Lake seals. (*See* Part III.1.A.i.a, *supra*.) Already, local residents report that Iliamna Lake seals have been shot and left to die by locals and visitors. (Fall *et al.* 2006.) In fall 2005, one subsistence survey respondent reported that three seals had been shot on the beach by an unknown assailant. (*Id.*) Pedro Bay residents reported that they have seen "boatloads of armed tourists" travelling on the lake and shooting at anything that moves, including beaver and birds, and that they may be disturbing or shooting seals as well. (*Id.*) Survey respondents also indicated that non-residents kill Iliamna Lake seals for their uniquely-patterned skins, which make them more valuable. (*Id.*) While current levels of hunting thus do not present a threat to Iliamna Lake seals, that could change alongside development of the Pebble Mine.

C. Illegal Feeding and Harassment

NMFS has identified illegal feeding and harassment as a threat to harbor seal populations. (NOAA Fisheries—Harbor Seal.) Illegal feeding, which may increase with the population influx associated with the Pebble Mine, can lead to a variety of problems for seals including habituation, aggression, injury, and death. (*Id.*)

Harassment, including repeated exposure to vessel traffic and disturbance (*see* discussion Part III.1.A.i, *supra*), can alter behavior, increase stress levels, increase energetic expenditures, and degrade preferred haul-out and nursery areas. (NOAA Fisheries—Harbor Seal.) Displacement of seals from pupping areas puts pups at risk of exposure and maternal separation. (*Id.*; *see also* Part III.1.A.i.b, *supra*.) Should the Pebble Mine proceed, harassment of Iliamna Lake seals also will flow from hazing, which the Army Corps has proposed as a way of moving seals away from project-related construction and infrastructure. (*See, e.g.,* DEIS 2019.) Illegal feeding and harassment thus present a threat to the Iliamna Lake seal alongside industrialization of the landscape.

D. Oil and Gas Exploration and Development

The Bureau of Ocean Energy Management's 2019-2024 National OCS Oil and Gas Leasing Draft Program provides for three offshore oil and gas lease sales in Alaska's Beaufort Sea. Should these lease sales and subsequent exploration and development proceed, they could increase shipping in the North Pacific and Bristol Bay with a concomitant increased risk of oil spills. Any such spills could harm the marine ecosystem, including salmon and salmon prey, with consequent effects on the Iliamna Lake seal.

E. Contaminants

NMFS recognizes chemical contaminants as a threat to harbor seals. (NOAA Fisheries—Harbor Seal.) Chemicals entering the environment from industrial processes including mining (*e.g.,* the Pebble Mine), wastewater discharge, and other sources find their way into the food chain and can accumulate in fatty tissues. (*Id.*) Long-lived, high trophic level species with large fat stores, such as Iliamna Lake seals, are particularly vulnerable to high levels of lipophilic contaminants. (Neale *et al.* 2005).

Harbor seal exposure to environmental contaminants can lead to a host of physiological harms up to and including death. Pathways of harm vary. For Iliamna Lake seals, prey species including salmonids constitute a primary, dietary source of chemical contaminants.[24] Ingestion of prey contaminated with chemicals including organochlorine compounds and polycyclic aromatic hydrocarbons can lead to immunosuppression, endocrine disruption, developmental irregularities, increased tumor incidence, and decreased reproductive success. (*See* Reijnders 1986, Brouwer, Reijnders & Koeman 1989, de Swart *et*

[24] These contaminants also harm the prey species themselves. Harm to prey species resulting in population declines would also affect Iliamna Lake seals through a reduced prey base.

al. 1995, de Swart *et al.* 1996, De Guise, Beckmen & Holladay 2003, Ross, Vos & Osterhaus 2003, Vos *et al.* 2003, Neale *et al.* 2005, Mos *et al.* 2006.) Heavy metals like mercury can serve as toxicants that may have negative effects on seal reproductive, immunological, and neurological systems. (McHuron *et al.* 2014.) Such contaminants likely already affect Iliamna Lake seals to some degree and, as discussed above, construction and operation of the Pebble Mine would significantly increase mobilized contaminants in Bristol Bay ecosystems.

Certain naturally-occurring toxic compounds also may become more problematic for pinnipeds as a result of climate change. For example, toxic compounds associated with certain algal blooms (*e.g.,* domoic acid) occur more frequently in warmer water conditions. (Burns, Withrow & Van Lanen 2018.) These compounds biomagnify up the food chain and are known to adversely affect pinniped survival and behavior. (*Id*.) Contaminants thus present a real and ongoing threat to the Iliamna Lake seal population.

6. SUMMARY OF FACTORS

The Iliamna Lake seal is threatened with extinction due to habitat degradation and destruction from climate change and, should it proceed, the Pebble Mine. Disease and predation threats appear to be increasing. Existing regulatory mechanisms are inadequate to protect this seal from current and looming threats. The Iliamna Lake seal is further threatened by its small population size due to inherent risks of rarity including increased susceptibility to stochasticity and low genetic diversity. Increased hunting and fishing pressure, as well as increased illegal feeding and harassment, stand to threaten the Iliamna Lake seal should the Pebble Mine proceed. Oil and gas exploration may pose a threat, and contaminants—whether from oil and gas spills, the Pebble Mine, or other activities—will increasingly threaten the Iliamna Lake seal alongside industrialization and climate change.

CRITICAL HABITAT DESIGNATION

The ESA mandates that, when NMFS lists a species as endangered or threatened, the agency must also concurrently designate critical habitat for that species. 16 U.S.C. § 1533(a)(3)(A)(i); *see also id*. at § 1533(b)(6)(C). The ESA defines "critical habitat" as:

> i. the specific areas within the geographical area occupied by the species, at the time it is listed . . . , on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and
>
> ii. specific areas outside the geographical area occupied by the species at the time it is listed … , upon a determination by the Secretary that such areas are essential for the conservation of the species.

Id. at § 1532(5)(A). The Center expects that NMFS will comply with this unambiguous mandate and designate critical habitat concurrently with the listing of the Iliamna Lake seal. Critical habitat must include, but should not necessarily be limited to, the islands and shoreline in the northeastern and northcentral portions of Iliamna Lake known to be used by Iliamna Lake seals for hunting, pupping, resting, and other key behaviors.

CONCLUSION

Listing under the Endangered Species Act provides the only mechanism for effectively shielding the small, isolated, and vulnerable Iliamna Lake seal population from imminent threats to its continued existence. Neither the Clean Water Act, Marine Mammal Protection Act, nor Alaska State law sufficiently protect Iliamna Lake seals from ongoing and impending harms including climate change and the proposed Pebble Mine. Should it be built, the massive Pebble Mine would harm Iliamna Lake seals through direct disturbance, harm to the seals' prey base, and severe, long-term impairment of lake habitat. Climate change, too, threatens the Iliamna Lake seal's prey base and habitat, and also places the population at increased risk for disease and predation. The population's small size alone places it an increased risk of extinction due to random demographic and environmental events.

Protection of this unique seal population is both urgent and warranted: urgent due to the threats described in this petition and warranted because the Iliamna Lake seal constitutes a distinct population segment under the ESA. Distinct population segments must be both discrete and significant to the broader taxon. The best available science demonstrates that the Iliamna Lake seal is both.

The Iliamna Lake seal is discrete because the population of Iliamna Lake seals is markedly separated from other populations of eastern North Pacific harbor seal as a consequence of physical factors including the navigability of the Kvichak River; physiological factors including taste, body type and size, pelage, and reproductive timing; ecological factors including a unique foraging ecology; behavioral factors including birth site selection and fidelity, pupping timing and habitat characteristics, novel uses of lake ice, and nocturnal haul-outs; and genetic factors including mtDNA, nDNA, and haplotypes.

The Iliamna Lake seal is significant to the broader eastern North Pacific harbor seal taxon for several reasons. First, the seal persists in an ecological setting unusual for harbor seals and unique for eastern North Pacific harbor seals: a freshwater lake that freezes over nearly completely in the winter. Occupation of this freshwater lake has led to numerous adaptations conferring importance to the taxon as a whole, including phenotypic traits that may confer thermoregulatory advantages (*e.g.,* larger size, darker coloration, and finer pelage); novel use of under-ice air spaces during the winter; and a unique foraging ecology that differs from that of marine populations of eastern North Pacific harbor seal. Additionally, genetic characteristics of the Iliamna Lake seal differ markedly from marine harbor seal populations. These adaptations contribute to the evolutionary potential of the broader *P. v. richardii* taxon.

Since the Iliamna Lake seal is both discrete from other populations of *P. v. richardii* and significant to the broader taxon, it constitutes a distinct population segment under the Endangered Species Act. As described throughout this petition, the Iliamna Lake seal DPS faces high-magnitude and growing threats to its continued existence. NMFS must promptly make a positive 90-day finding on this petition, initiate a status review, and expeditiously proceed toward listing and protecting this unique population of freshwater harbor seals.

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Cited references can be found on the enclosed USB drive. Please consider these references along with the Petition and include them in the administrative record for the 90-Day Finding on the Petition.

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APPENDIX A:
30-DAYS NOTICE TO STATE OF ALASKA

CENTER *for* BIOLOGICAL DIVERSITY *Because life is good.*

October 30, 2019

To: Doug Vincent-Lang, Commissioner
Alaska Department of Fish and Game
doug.vincent-lang@alaska.gov

Eddie Grasser, Director of the Division of Wildlife Conservation
Alaska Department of Fish and Game
eddie.grasser@alaska.gov

CC: chris.w.oliver@noaa.gov
donna.wieting@noaa.gov
jon.kurland@noaa.gov

Dear Alaska Department of Fish and Game:

Pursuant to 50 C.F.R. § 424.14(b), the Center for Biological Diversity hereby provides notice that it intends to file a petition under the federal Endangered Species Act to list and designate critical habitat for the Iliamna Lake seal (*Phoca vitulina richardii*) no sooner than 30 days from the date this notice is provided.

Sincerely,

Kristin Carden
Oceans Program Scientist
1212 Broadway, Suite 800
Oakland, CA 94612
W: 510.844.7100 x327
Email: kcarden@biologicaldiversity.org