United States Department of the Interior

FISH AND WILDLIFE SERVICE
Anchorage Fish & Wildlife Field Office
605 West 4th Avenue, Room G-61
Anchorage, Alaska 99501-2249

In reply refer to: AFWFO

June 28, 2012

Colonel Reinhard W. Koenig
District Engineer, Alaska District
U. S. Army Corps of Engineers
Post Office Box 6898
Anchorage, Alaska 99506-6898

Re: Cottonwood Bay/Diamond Point Quarry (POA-2008-523)

Dear Colonel Koenig:

Thank you for your letter of February 14, 2012, requesting formal consultation for the proposed development of the Diamond Point granite quarry. The enclosed document transmits the U.S. Fish and Wildlife Service (the Service) biological opinion based on our review of the proposed Diamond Point granite quarry located at the confluence of Cottonwood Bay and Iliamna Bay in Cook Inlet, Alaska, and its effects on the southwest distinct population segment of northern sea otter (*Enhydra lutris kenyoni*; listed as threatened in 2005) and the North American breeding Steller's eider (*Polysticta stelleri*; listed as threatened in 1997). The action will occur within sea otter critical habitat, which was designated in 2009. This biological opinion is issued in accordance with section 7(a)2 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.).

This biological opinion is based on information provided by the Army Corps of Engineers (the Corps) and by Diamond Point, LLC (the Applicant). This information includes the draft and final Biological Assessments (BAs), the Corps Public Notices (PNs), various response letters submitted by the Applicant to the Corp or the Service (e.g., Diamond Point LCC 2009a, 2009b, 2010); and various meetings, telephone conversations and other sources of information (see Consultation History). A complete administrative record of this consultation is on file at the Anchorage Fish and Wildlife Field Office.

Section 7 Consultation History

- July 20, 2009: the first Corps Public Notice was issued (USACE 2009).
- September 17, 2009: the Service submitted comments to the Corps in response to the Public Notice.

- December 16, 2010: the Corps submitted a Draft BA (HDR Alaska Inc. 2011a), dated August 12, 2010, to the Service.
- April 27, 2011: a final BA was issued (HDR Alaska Inc. 2011b).
- June 28, 2011: the Second Corps Public Notice was issued (USACE 2011).
- August 25, 2011: the Service submitted comments to the Corps in response to the second Public Notice.
- October 7, 2011: the Corps submitted a request for formal consultation to the Service along with a revised BA (HDR Alaska Inc. 2011c).
- October 7, 2011: the Service contacted the Corps via telephone and email to discuss additional information needs. The Corps indicated that a response to the Service's comments submitted August 25, 2011, would be forthcoming for inclusion in consultation.
- December 1 and 5, 2011: the Applicant submitted letters to the Service expressing concern about the review timelines.
- December 12, 2011: the Service submitted a request to the Corps for additional information.
- January 31, 2012: the Service responded to the Applicant's letter regarding timelines, committing to an expeditious review.
- February 14, 2012: the Corps issued a letter initiating formal consultation, and conveying additional information received from the Applicant in response to comments from the second Corps Public Notice.
- February 16, 2012: the Service held the first of several coordination meetings with the Corps and the Applicant.

This biological opinion finds that the proposed activities will not jeopardize listed species or result in adverse modification of critical habitat. Our initial evaluation of the proposed action revealed several pathways by which this project may result in take of listed species. Close coordination with the Corps and the Applicant during the consultation period resulted in the inclusion of numerous avoidance and minimization measures into the proposed project, which significantly lowered the probability that take of listed species will occur. With the inclusion of these measures, we conclude that take of individuals is not likely to occur. A biological opinion was prepared to document how we reached this conclusion. Furthermore, the biological opinion provides an assessment of the effects to critical habitat.

We thank you for your cooperation in meeting our joint responsibilities under section 7 of the ESA. If you have any questions concerning our review, please contact Endangered Species Branch Chief, Ellen Lance, at Ellen_Lance@fws.gov or 907-271-1467, or me at Ann_Rappoport@fws.gov or 907-271-2787.

Sincerely,

A G Rappoport

Ann G. Rappoport
Field Supervisor

Enclosure: Biological Opinion

cc:

T. Mortensen, Agent
H. Boyer, USACE
M. Ingle, ADF&G
M. Daigneault, ADF&G
T. Otis, ADF&G
G. Hollowell, ADF&G
R. Thompson, DNR
P. North, EPA
J. Hanson, NMFS
B. Smith, NMFS
M. Magura, NMFS

BIOLOGICAL OPINION

For

Diamond Point Granite Rock Quarry

Consultation with
U.S. Army Corps of Engineers

Prepared by:

Anchorage Fish and Wildlife Field Office
U. S. Fish and Wildlife Service
605 W. 4th Avenue
Anchorage, AK 99503
June 28, 2012

TABLE OF CONTENTS

APPENDICES

FIGURES

TABLES

DATA FORMS

INTRODUCTION

This document transmits the U.S. Fish and Wildlife Service's (Service) Biological Opinion (BO) in accordance with section 7(a)2 of the Endangered Species Act of 1973, as amended (ESA), on effects of the proposed Diamond Point quarry on the listed Alaska-breeding Steller's eider (*Polysticta stelleri*), the Southwest Alaska Distinct Population Segment of the Northern sea otter (*Enhydra lutris kenyoni*, hereafter "sea otter"), and designated critical habitat for the sea otter. The Kittlitz's murrelet (*Brachyramphus brevirostris*, listed as a candidate species in 2004), and yellow-billed loon (*Gavia adamsii*, listed as a candidate species in 2009) may be found in the project area. The U.S. Army Corps of Engineers (the Corps) is the lead federal agency and has submitted a determination that the project is not likely to adversely affect the Kittlitz's murrelet. As candidate species, Kittlitz's murrelets and yellow-billed loons receive no formal protection against "take". Take is defined by the ESA [50 CFR 17.3] as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct involving a species listed under the ESA. We have therefore refrained from conducting a complete analysis of effects, or concurring with your determination that this project is not likely to adversely affect these species at this time. Throughout this document, the term "listed species" refers only to Steller's eiders and sea otters.

PROPOSED ACTION

Project Description

Diamond Point LLC (the Applicant) proposes to develop a granite quarry at Diamond Point, located on the west side of Cook Inlet at the convergence of Cottonwood and Iliamna bays, at approximately Latitude 59.641905°, Longitude -153.646895° (Figure 1). Diamond Point, LLC owns approximately 30 acres of undeveloped land containing an estimated 15 million cubic yards of material. The site is currently only accessible by boat, airplane, or helicopter. Shorelines adjacent to the project area belong to the State of Alaska. The Corps proposes to authorize the project under section 404 of the Clean Water Act (CWA).

Development

Extensive modification of the shoreline will be necessary to construct a staging area and dock facility in support of quarry operations. The staging area will be constructed in the intertidal shoreline at the base of the Diamond Point bluff (Figure 2). To construct this fill pad, the bluff face will be cast-blasted into the intertidal zone below the bluff, where the blasted rock would be left in place or moved to another onsite location. The shoreline fill pad will be constructed from 470,000 cubic yards of material placed in 20 acres of tidelands and marine waters to an elevation of +24-feet MLLW. This fill pad would be used to gain access to additional areas on the bluff face, to remove, stockpile and sort quarry materials, and to load materials onto barges. Additional support structures will be constructed, including an upland staging area and a haul route between the upland staging area and the shoreline fill pad.

Operation

Quarrying operations will include rock being blasted, then crushed or screened and transported to the dock area for barge loading and export. Volumes of material to be extracted annually are estimated to be 123,000 cubic yards per year, but will depend on market demands. Materials may be stockpiled for shipment at a later time. Initial development and operation of the quarry is planned for summer, 2012. Operations will continue for the foreseeable future, subject to authorization by the State of Alaska Department of Natural Resources (ADNR) for use of the Diamond Point shoreline. A 55-year tideland lease will be issued, and may be renewed thereafter.

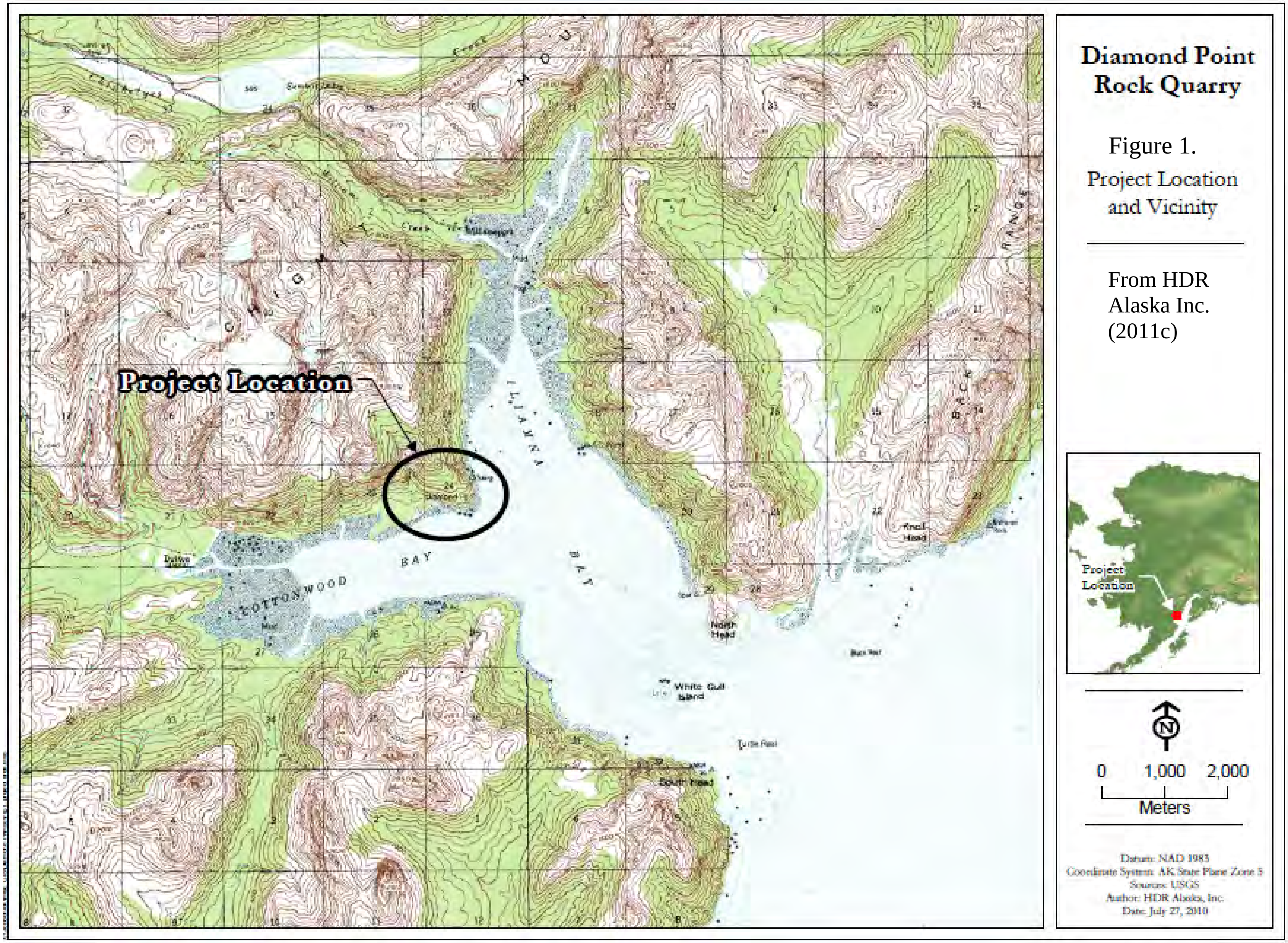


Figure 1. Project Location and Vicinity from HDR Alaska Inc. (2011c).

[Top]

Figure 2. West-facing view of Diamond Point with Cottonwood Bay in the background from (USACE 2010). [Top]

Project Components

Upland Staging Area -- An 8-acre upland staging area west of the quarry site would be cleared, leveled, and graded to provide an area for additional material stockpiling, fuel storage, equipment staging, and for personnel safety and support facilities. A haul route would be developed to connect the shoreline fill pad and the upland staging area. Two breakwaters would extend perpendicular to the shoreline at the east end of the shoreline fill pad: one 500 feet (ft) long and the other, 200 ft long. Combined, these breakwaters would fill 2 acres of marine habitat with 300,000 cubic yards of shot-rock. A 50-foot gap would be left between the 500-foot breakwater and the fill pad to facilitate fish passage by allowing fish to travel along the edge of the fill pad without swimming around the breakwater. A bridge would span the gap to provide vehicle access and allow the breakwater to be used as a barge loading platform.

Docking Area -- Marine waters adjacent to the fill pad and breakwater would be dredged to create docking areas deep enough to support all barge and vessel traffic. An estimated 20,000 cubic yards of sediment would be dredged from within a 3-acre area. Additional maintenance dredging of 1,000 – 5,000 cubic yards of material would occur annually. Dock area depth would be maintained at -18 to -20 ft relative to mean lower low water levels (MLLW). Up to 70 single pipe-piles would be driven using a vibratory hammer to stabilize fill and/or provide dock and mooring structures.

Quarry mining -- Quarry operations will include blasting to remove rock from the bluff, use of heavy equipment to move and sort rock, and use of barges to transport rock. Blasting frequency is expected to range from once a week to once every three weeks during the operation season. Geotechnical testing will be conducted on the rock deposit in order to identify specific characteristics of rock products and to determine where to mine on the granite deposit and how to conduct effective blasting to produce desired products. Rock products will range in size from armor stone, the largest riprap size (class IV), through riprap classes III, II, and I (larger to smaller), to processed rock and crushed aggregate. A variety of heavy equipment may be used to move and break rock, including excavators, crushers, and drills. Quarried rock may be stockpiled on site over winter. A detailed mining plan will be developed prior to commencement of quarry operations.

Transportation -- During initial construction, a floatplane would be used to transport crews and materials. Following initial development, a 1,600-foot gravel airstrip will be developed on the shoreline fill pad, allowing use by wheeled aircraft. Personnel and small equipment may be transported on boats and skiffs. Vehicles and wheeled equipment may be used on shore. Large equipment will be delivered and rock will be exported from the quarry site by tug-assisted barges in the 3,000- to 5,000- ton range. Fully loaded barge draft depth is about 10 to 12 ft below the surface of the water. Loaded barges leaving Diamond Point would likely only be able to navigate the shallow waters in Iliamna Bay during high tides approximately 10 to 15 times per month. The vessels would transit the middle of Iliamna Bay to avoid shallow areas near shore. Diamond Point LLC estimates transporting 30,000 to 60,000 cubic yards of granite rock product per month during the operation season.

Seasonal Operations -- Construction and operation at the quarry would take place between May 1 and October 31 each year. No permanent buildings will be constructed, but mobile housing units, work areas, fueling and staging pads, fuel storage tanks and other structures may be installed. Crews will be on site during the operation season only. Barges would be removed and stored off site between November and April.

Expansion Phases and Project Lifespan -- Work would occur in three phases. Phase 1 includes initial site preparation, development of the first 12-acre section of fill pad, construction of the shoreline haul route, construction of the breakwaters, initial dredging of the docking area, installation of all support facilities (housing, fuel pads, etc.), and initial quarry excavation. Phase 2 activities would occur as the quarry is developed and more material is extracted. During Phase 2, fill would be placed to create a 3-acre expansion of the Phase 1 fill area, dredging would be conducted adjacent to the Phase 2 fill pad, and quarry operations would continue. Phase 3 activities would include placement of fill into a 5-acre area to allow for increased ongoing quarry excavation. Dredging would be conducted adjacent to the Phase 3 fill pad to expand the docking area. See Figure 3. No end date is proposed for quarry operations. The minimum term of the tideland lease issued by the ADNR is 55 years, which constitutes the foreseeable future for this analysis. Detailed reclamation plans will be developed and carried out after project completion.

Applicant-Proposed Impact Avoidance and Minimization Measures

The following measures have been incorporated into the project by the Applicant to reduce potential impacts to Steller's eiders and sea otters.

- Seasonal Work
    - Work will occur seasonally between May 1 and October 31. This will reduce potential impacts to overwintering Steller's eiders and sea otters. Steller's eiders are migratory and generally do not use the area during the proposed May-October work window. Sea otters in the area also show seasonal movement patterns, and fewer are present during this time (ABR, Inc. 2008, ABR, Inc. 2012).

Figure 3. Proposed Diamond Point project footprint showing development phases (from USACE (2011a). [Top]

- Noise Impacts
    - A trained observer shall be on site during blasting, pile driving and in-water dredging activities and will be authorized to halt the activity if sea otters or Steller's eiders are observed within a designated "hazard area"—the area in which high noise levels may cause injury. Although the observer protocols were designed for the protection of sea otters, they will also be applied to the Steller's eider. If the observer cannot identify male and female Steller's eiders in nonbreeding plumage, observer protocols will be applied to all unidentified ducks.
    - Observers will follow observer protocols, meet training requirements, fill out data forms and report findings in accordance with protocols reviewed and approved by the Service (Appendix A).
    - Ramp-up procedures will be conducted prior to pile-driving, in-water dredging, blasting, and in-water fill placement to allow marine mammals to leave the area prior to exposure to maximum noise levels. For vibratory hammers, the soft start technique will initiate noise from the hammer for 15 seconds at reduced energy

  - followed by 1-minute waiting period and repeat the procedure two additional times (NMFS 2009).
  - Blasting noise will be reduced at the source by industry standard use of in-hole detonators for initiation and adequate burden and stemming.
  - Blast monitoring will be conducted using portable instrumentation to assure that noise and vibration velocities are kept below thresholds that will be detailed in a Blasting Plan.
- Vessel Operations
  - Vessels operated in the project action area should not exceed 12 knots in order to avoid collisions with marine mammals and birds.
  - Standard operating procedures for barge operators shall include training to identify and avoid listed species during transit in Iliamna Bay.
- Release of Sediments
  - In-water work will be effectively isolated to contain and minimize turbidity and sedimentation.
  - In-water work will be completed at 5-foot MLLW tide stage or lower to reduce in-water sediment disturbance.
  - Dredged materials will be disposed of within the proposed fill areas or on the uplands to reduce impacts to unaltered marine areas.
  - The Applicant has agreed to provide the construction and operation Storm Water Pollution Prevention Plans (SWPPPs) to the Service for review and to incorporate further recommendations as appropriate.
- Human Waste
  - Solid waste will be shipped offsite monthly or as needed on barges or tugs to an approved Alaska Department of Environmental Conservation (ADEC) disposal facility.
- Fuels Management
  - Fuel and other petroleum products for construction equipment will be stored on barges or in transportable fuel tanks stored in upland staging areas located at least 100 ft from any waterbody.
  - Transportable double-walled tanks or single-walled tanks set within impermeable secondary containment will be used to store fuel on site in the uplands.
  - No vessel fueling will take place on site.
  - Any small volumes of fuel stored between seasonal operations (left over the winter) would be within secondary containment.
  - Leaks from parked equipment would be caught in portable containment berms and disposed of according to ADEC regulations.
  - Barges would be removed and stored off site during the winter months (September –April).
- Spill Response and Prevention
  - Anchor points for oil spill containment booms will be established and constructed within the docking area to facilitate rapid boom deployment in the event of an on-water fuel spill from a vessel.
  - Spill response supplies adequate in type and quantity for the equipment being used on the property shall be on-site and readily accessible at all times.

- Barges will transit the bay during higher tide cycles only to reduce grounding potential.
- Best Management Practices/Regulatory Compliance
  - Best management practices and compliance with applicable ADEC, Environmental Protection Agency and U.S. Coast Guard (USCG) requirements on contaminants and spill response will minimize the potential for fuel spills and contamination.
  - Mobile and temporary fuel storage, potable water, wastewater, solid waste management, housing and other facilities will be self-contained and operated in accordance with the applicable regulatory requirements.
  - All waste treatment and disposal would comply with USCG and ADEC regulations.

Action Area

The action area is all acreage in Iliamna Bay (inclusive of Cottonwood Bay) between a point just east of North Head, and South Head. This area approximates the extent of Steller's eider and sea otter habitat that may be affected, either directly or indirectly by development at Diamond Point. Much of the action area will be affected by vessel traffic, and any part of the action area could be affected in the event of a fuel or oil spill. The action area does not include areas outside of the mouth of Iliamna Bay because additional barge traffic associated with Diamond Point quarry would not appreciably increase the amount of vessel traffic relative to that already occurring elsewhere in Cook Inlet, and the volumes of fuel used and transported for the quarry will not likely result in spills extending beyond this area. [Top]

STATUS OF THE SPECIES

Steller's eider (*Polysticta stelleri*)

Species Description and Critical Habitat

The Steller's eider is a sea duck with a circumpolar distribution and the sole member of the genus *Polysticta*. The Steller's eider is the smallest of the four eider species, weighing approximately 700–800 grams (1.5–1.8 pounds). Adult male Steller's eiders in breeding plumage have a black back, white shoulders, and a chestnut brown breast and belly. The males have a white head with black eye patches; they also have a black chin patch and a small greenish patch on the back of the head. Females and juveniles are mottled dark brown (Figure 4).

Steller's eiders are divided into Atlantic and Pacific populations; the Pacific population is further divided into the Russia-breeding population, which nests along the Russian eastern arctic coastal plain, and the Alaska-breeding population. In Alaska, Steller's eiders breed almost exclusively on the Alaska Coastal Plain (ACP). While they historically nested on the Yukon-Kuskokwim Delta (YKD), only a few nests have been found there in recent years. During the molt and over winter, they mix with the majority of the Russia-breeding population in southcentral Alaska (Figure 5).

The Alaska breeding population of the Steller's eider was listed as threatened on July 11, 1997 based on substantial contraction of the species' breeding range in Alaska, reduced numbers of

Steller's eiders breeding in Alaska, and the resulting vulnerability of the remaining breeding population to extirpation (USFWS 1997). Periodic non-breeding of the entire population of Steller's eiders breeding near Barrow, Alaska, the species' primary breeding grounds, coupled with low nesting and fledging success, has resulted in very low productivity (Quakenbush et al. 2004) and may make the population particularly vulnerable to extirpation. In 2001, the Service designated 2,830 miles^2 (7,330 km^2) of critical habitat for the Alaska-breeding population of Steller's eiders at historic breeding areas on the YKD, a molting and staging area in the Kuskokwim Shoals, and molting areas in marine waters at Seal Islands, Nelson Lagoon, and Izembek Lagoon (USFWS 2001). No critical habitat for Steller's eiders has been designated on the ACP.

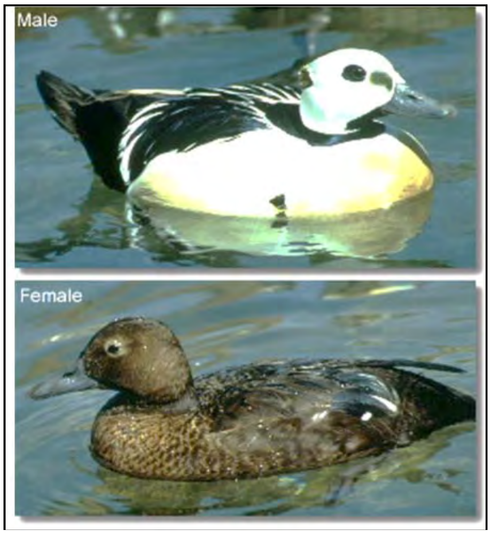


Figure 4. Adult male and female Steller's eiders in breeding plumage. [Top]

Figure 5. Steller's eider distribution in the Bering, Beaufort, and Chukchi seas. [Top]

Life History

Breeding Ecology

Steller's eiders are thought to develop pair bonds on the wintering grounds in early spring (Metzner 1993). They begin to arrive in small flocks of breeding pairs on the ACP in early June. Nesting on the ACP is concentrated in tundra wetlands near Barrow, AK and occurs at lower densities elsewhere on the ACP from Wainwright east to the Sagavanirktok River (Quakenbush et al. 2002). Nesting eiders often occupy shallow coastal wetlands in association with tundra (Quakenbush et al. 1995, Solovieva 1997) but have been observed well inland on the ACP. This species establishes nests near shallow ponds or lakes, usually close to water.

Long-term studies of Steller's eider breeding ecology near Barrow indicate periodic non-breeding by the entire local breeding population. Since 1991, Steller's eiders nests were detected in 12 of 20 study years (1991–2010; Safine 2011). Periodic non-breeding by Steller's eiders near Barrow may be associated with fluctuations in lemming populations and related breeding patterns in pomarine jaegers (*Stercorarius pomarinus*) and snowy owls (*Nyctea scandiaca*) (Quakenbush et al. 2004). In years with high lemming abundance, Quakenbush et al. (2004) reported that Steller's eider nesting success was a function of a nest's distance from pomarine jaeger and snowy owl nests. These avian predators nest only in years of high lemming abundance and defend their nests aggressively against arctic foxes (*Vulpes lagopus*). By nesting within jaeger and owl territories, Steller's eiders may benefit from protection against arctic foxes even at the expense of occasional partial nest depredation by the avian predators themselves (Quakenbush et al. 2002, Quakenbush et al. 2004). Steller's eiders may also benefit from the increased availability of alternative prey for both arctic foxes and avian predators in high lemming years (Quakenbush et al. 2004).

Mean clutch size at Barrow was 5.4 ± 1.6 SD (range = 1–8) over 5 nesting years in 1992–1999 (Quakenbush et al. 2004). Hatching occurs from mid-July through early August (Rojek 2006, 2007, 2008). Observations of known-age ducklings indicate that fledging occurs 32–37 days post hatch (Obritschkewitsch et al. 2001, Quakenbush et al. 2004, Rojek 2006, Rojek 2007 After hatching, hens move their broods to ponds within 0.3–3.5 km from the nests where they feed on aquatic insect larvae and crustaceans until fledging (Quakenbush et al. 2000, Rojek 2006, 2007).

Nest survival (the probability a nest will hatch at least one egg) is affected by predation levels. Predators include snowy owls, short-eared owls (*Asio flammeus*), peregrine falcons (*Falco peregrinus*), gyrfalcon (*Falco rusticolus*), pomarine jaegers, rough-legged hawks (*Buteo lagopus*), common ravens (*Corvus corax*), glaucous gulls (*Larus hyperboreus*), Arctic fox, red fox (*V. vulpes*), and bald eagles (*Haliaeetus leucocephalus*) (Quakenbush et al. 1995, Rojek 2008, Safine 2011). Nest depredation by a family group of polar bears was documented in 2011 (Safine 2011) Nest survival averaged 0.23 (±0.09, standard error [SE]) from 1991–2004 before fox control was implemented near Barrow and 0.49 (±0.10 SE) from 2005–2011 during years with fox control (U.S. Fish and Wildlife Service [USFWS], Unpublished Data; Rojek 2008).

Seasonal Distribution Patterns

<u>Breeding Distribution</u> -- Steller's eiders breed on the western ACP in northern Alaska, from approximately Point Lay east to Prudhoe Bay, and in extremely low numbers on the YKD. On the ACP, anecdotal historical records indicate that the species occurred from Wainwright east,

nearly to the Alaska-Canada border (Anderson 1913; Brooks 1915). There are very few nesting records from the eastern ACP, however, so it is unknown if the species commonly nested there or not. Currently, the species predominantly breeds on the western ACP, in the northern half of the National Petroleum Reserve-Alaska (NPR-A). The majority of sightings in the last decade have occurred east of the mouth of the Utukok River, west of the Colville River, and within 90 kilometers (km) or approximately 56 miles of the coast.

Steller's eiders were considered locally "common" in the central YKD by naturalists early in the 1900s (Murie 1924; Conover 1926; Gillham 1941; Brandt 1943), but nesting was reported in only a few locations. By the 1960s or 70s, the species had become extremely rare on the YKD; only six nests were found in the 1990s (Flint and Herzog 1999). Given the paucity of early-recorded observations, only subjective estimates can be made of the Steller's eider's historical abundance or distribution on the YKD. A few Steller's eiders were reportedly found nesting in other locations in western Alaska, including the Aleutian Islands in the 1870s and 80s (Gabrielson and Lincoln 1959), Alaska Peninsula in the 1880s or 90s (Murie and Scheffer 1959), Seward Peninsula in the 1870s (Portenko 1972), and on Saint Lawrence Island in the 1950s (Fay and Cade 1959).

Post-Breeding Distribution –Prior to migration in both nesting and non-nesting years, some Steller's eiders rest and forage in Elson Lagoon, North Salt Lagoon, Imikpuk Lake, and the Chukchi Sea in the vicinity of the northern most point of the Barrow spit. Males depart the nesting grounds soon after incubation begins, but females linger longer. From mid-July through September single hens, hens with broods and small groups of two to three birds have been observed in North Saltwater Lagoon, Elson Lagoon and near shore on the Chukchi Sea.

Molt Distribution – After breeding, Steller's eiders move to marine waters where they mix with birds from the Russian breeding population and undergo a three-week flightless molt. After the populations mix on the molting and wintering areas, there is no way to confirm whether an individual belongs to the Alaskan breeding population. We therefore assume that 0.8% of all Steller's eiders occurring on the molting and wintering grounds in Alaska are from the listed Alaska breeding population. This estimate is derived by taking the most recent North Slope breeding bird estimate (576; Stehn and Platte 2009), adding 1 for the Y-K Delta population (=577), and then dividing by the population estimate of Pacific-wintering Steller's eiders from 2010 (74,369; Larned 2012). Thus, 577 ÷ 74,369= (0.0078 * 100) = 0.8%.

The Pacific-wintering population molts in several main areas along the Alaska Peninsula: Izembek Lagoon (Metzner 1993; Dau 1991; Laubhan and Metzner 1999), Nelson Lagoon, Herendeen Bay, and Port Moller (Gill et al. 1981; Petersen 1981). Over 15,000 Steller's eiders have also been observed in Kuskokwim Bay (Larned and Tiplady 1996). Smaller numbers of molting Steller's eiders have been reported around islands in the Bering Sea, along the coast of Bristol Bay, and in smaller lagoons along the Alaska Peninsula (e.g., Dick and Dick 1971; Petersen and Sigman 1977; Wilk et al. 1986; Dau 1987; Petersen et al. 1991). Larned (2005) reported >2,000 eiders molting in lower Cook Inlet near the Douglas River Delta.

A few band recoveries indicate that the Alaska-breeding birds molt in Izembek Lagoon and Kuskokwim Shoals. The best available information is from the satellite telemetry studies described in Martin et al. (in prep) and Rosenberg et al. (2011). Martin et al. (*in prep*) marked 14 birds near Barrow, Alaska (within the range of the listed Alaska-breeding population) in 2000 and 2001. Although samples sizes were small, results suggested disproportionately high use of Kuskokwim Shoals by Alaska-breeding Steller's eiders during wing molt compared to the Pacific population as a whole, but Alaska-breeding birds were not found to preferentially use specific wintering areas. The second study marked Steller's eiders wintering on Kodiak Island, Alaska and followed birds through the subsequent spring (n = 24) and fall molt (n = 16) migrations from 2004–2006 (Rosenberg et al. 2011). Most of the birds marked on Kodiak migrated to eastern arctic Russia prior to the nesting period and none were relocated on land or in nearshore waters north of the Yukon River Delta in Alaska (Rosenberg et al. 2011).

<u>Winter Distribution</u> -- After molt, many of the Pacific-wintering Steller's eiders congregate in select near-shore waters throughout the Alaska Peninsula and the Aleutian Islands, around Nunivak Island, the Kodiak Archipelago, and in lower Cook Inlet, although thousands may remain in lagoons used for molting (Bent 1987, Larned and Zwiefelhofer 2002; Larned 2000a, Martin et al. *in prep*). Winter ice formation often temporarily forces birds out of shallow protected areas such as Izembek and Nelson Lagoons. Wintering Steller's eiders usually occur in shallow waters (< 10 meters deep), which are generally within 400 meters (m) of shore or at offshore shallows (USFWS 2002). However, Martin et al. (*in prep*) reported substantial use of habitats >10 m deep during mid-winter. Use of these habitats by wintering Steller's eiders may be associated with night-time resting periods or with shifts in the availability of local food resources (Martin et al. *in prep*).

<u>Spring Migration</u> -- In the spring, Steller's eiders form large flocks along the north side of the Alaska Peninsula and move east and north (Larned et al. 1993, Larned 1998, Larned 2000b). Larned (1998) concluded that Steller's eiders show strong site fidelity to "favored" habitats during migration, where they congregate in large numbers to feed before continuing their northward migration. Spring migration usually includes movement along the coast, although birds may take shortcuts across water bodies such as Bristol Bay (William Larned, USFWS, pers. comm.). Several areas receive consistent use during spring migration, including Bechevin Bay, Morzhovoi Bay, Izembek Lagoon, Nelson Lagoon/Port Moller Complex, Cape Seniavin, Seal Islands, Port Heiden, Cinder River State Critical Habitat Area, Ugashik Bay, Egegik Bay, Kulukak Bay, Togiak Bay, Nanwak Bay, Kuskokwim Bay, Goodnews Bay, and the south side of Nunivak Island (Larned et al. 1993, Larned 1998, and Larned 2000b). Like other eiders, Steller's eiders probably use spring leads for feeding and resting as they move northward, but there is little information on habitat use after departing spring staging areas. Interestingly, despite many daytime aerial surveys, migratory flights of Steller's eiders have never been observed (William Larned, USFWS, pers. comm.).

<u>Summer Distribution in Southern Alaska</u> -- A small number of Steller's eiders are known to remain along the Alaska Peninsula and Kachemak Bay during the summer; approximately 100 have been observed in Kachemak Bay, while a few may spend the summer at Izembek Lagoon (Chris Dau, USFWS, pers. comm.).

Site Fidelity

In many species of waterfowl, female philopatry to breeding grounds is high (Anderson et al. 1992). Banding data from the Barrow area suggests some level of site fidelity for Steller's eiders breeding there (Quakenbush et al. 1995; P. Martin, cited in USFWS 2011). Evidence of nest site philopatry has also been reported on the YKD. In 2003, 2004, and 2005, a single female Steller's eider nest was found in the same area each year. Nests were located as little as 124 m apart between years (Paul Flint, U. S. Geological Survey, pers. comm.). Interestingly, natal philopatry has not been observed in Steller's eiders nesting in Russia (D. Solovieva, Zoological Institute, Russian Academy of Science, pers. comm.).

There is good evidence to suggest that individual eiders return to the same seasonal use areas each year, but individual fidelity to wintering areas is unknown. Eiders are known to overwinter in select near-shore waters year after year (Larned 2000a, Bent 1987, Larned and Zwiefelhofer 1995). Flocks of Steller's eiders also use the same molting areas each year (Larned 1998). About 95 percent of recaptured molting Steller's eiders were found at the same site at which they were banded (Flint et al. 2000). Telemetry data from Steller's eiders captured near Unalaska showed high within-season site fidelity on wintering areas (Reed and Flint 2007, P. Martin, cited in USFWS 2011). Other species of waterfowl show high rates of individual fidelity to wintering areas as well (Robertson et al. 1999). This suggests that overwintering groups of Steller's eiders may belong to individual discrete subpopulations, although no information is available to confirm this.

Diet and Energetics

Steller's eiders spend most of the year in shallow, nearshore marine waters feeding on a variety of benthic (seafloor) invertebrates including gastropods, bivalves, crustaceans, echinoderms, and macrobenthic invertebrates (Petersen 1980; Petersen 1981 Quakenbush et al. 1995 Bustnes et al. 2000). Although considered a diving seaduck, Steller's eiders employ a variety of foraging strategies, including diving to depths up to 9 m (30 ft) or more, bill dipping, body tipping, and gleaning food items from the surface of water, plants, and mud. Metzner (1993) concluded that Steller's eiders were opportunistic generalists.

The Steller's eider is a relatively small-bodied sea duck, intermediate in size between the harlequin and long-tailed duck (Bellrose 1980). It overlaps harlequins and long-tails in its choice of foraging areas and prey items, and may, like these two species, exist near its energetic limits, especially during winter and the breeding season. Unlike other larger eiders, Steller's eiders must continue to feed during egg laying and incubation, to build and maintain energy reserves (D. Solovieva, Zoological Institute, Russian Academy of Science, pers. comm.).

Steller's eiders show a pattern of life-history traits indicating their life-history strategy is "K-selected." They can survive up to 21 years in the wild (C. Dau, cited in USFWS 2011) and show a pattern of deferred reproduction, site fidelity, and low annual recruitment. Such "K-selected" species minimize the importance of annual reproduction, and maximize the importance of annual survival, relying instead on only a few successful years of reproduction (Wilson 1980). This strategy would only be expected to evolve in environments with predictable and stable resources (Stearns 1992). Robertson et al. (1999) concluded that long-lived species of waterfowl would be expected to show strong site tenacity in areas with stable resources, to allow animals to develop and use local knowledge about resource distribution to ensure high long-term survival. They suggest that site fidelity would be expected of long-lived species that are sensitive to adult mortality and depend, at least in part, upon habitat stability for survival. Under this life history strategy, species are vulnerable to perturbations within their habitat. As a K-selected species that is thought to spend at least part of the year surviving at the edge of its energetic limits, the Steller's eider is likely to be susceptible to habitat impacts resulting in loss of food resources.

Population Dynamics

Population Size

Population sizes are only imprecisely known. The Pacific wintering population is estimated to be about 74,369 birds (Larned 2012). The threatened Alaska-breeding population is thought to number approximately500 individuals on the ACP (Stehn and Platte 2009), and possibly tens on the YKD (USFWS, Anchorage Fish and Wildlife Field Office, Unpublished Data).

Arctic Coastal Plain (ACP)/North Slope -- Steller's eider population and trends have been obtained from the following three aerial surveys on the ACP: the USFWS ACP survey, 1989–2006 (Mallek et al. 2007) and 2007–2008 (new ACP survey design; Larned et al. 2008, 2009); the Service's North Slope eider survey 1992–2008 (Larned et al. 2009) and 2007–2008 (NSE strata of new ACP survey; Larned et al. 2008, 2009); and the Barrow Triangle (ABR) survey, 1999–2007 (Obrishkewitsch et al. 2008). In 2007, the ACP and NSE surveys were combined under a new ACP survey design.

The aerial survey efforts provide a range of estimates of the North Slope breeding population size. Estimates, including results from previous analyses of the ACP and NSE survey data, are summarized in Table 1 and Table 2. Caution must be used when interpreting the survey results. Neither the surveys conducted by Mallek et al. (2006) nor Larned et al. (2010) were originally designed to estimate Steller's eider populations. Surveys differed in spatial extent, seasonal timing, sampling intensity, and duration. Most observations of Steller's eider from both surveys occurred within the boundaries of the NSE survey (Figure 6).

Table 1. Aerial population estimates for Steller's eiders, from the North Slope.

Year	Population Estimate	Nesting Status Near Barrow	Year	Population Estimate	Nesting Status Near Barrow
1986	0[4]	Non-nesting	1998	281[4]/0[5]	Non-nesting[1]
1987	0[4]	Non-nesting	1999	1250[4]/785[5]	Nesting[1]
1988	0[4]	Non-nesting	2000	563[4]/0[5]	Nesting[2]
1989	2002[4]	Nesting	2001	176[4]/288[5]	Non-nesting[2]
1990	534[4]	Nesting	2002	0[4]/0[5]	Non-nesting[2]
1991	1118[4]	Nesting[1]	2003	0[4]/93[5]	Non-nesting[2]
1992	954[4] /0[5]	Non-nesting[1]	2004	0[4]/48[5]	Non-nesting[2]
1993	1313[4]/262[5]	Nesting[1]	2005	110[4]/99[5]	Nesting[2]
1994	2524[4]/47[5]	Non-nesting[1]	2006	96[3]/112[5]	Nesting[2]
1995	931[4]/281[5]	Nesting[1]	2007	96[6]	Nesting[2]
1996	2543[4]/0[5]	Nesting[1]	2008	576[7]	Nesting[2]
1997	1295[4]/189[5]	Nesting[1]			

[1] Quakenbush et al. 2001; [2] Nora Rojek, USFWS, pers. comm.; [3] Ritchie et al. 2006; [4] Mallek et al. 2005; [5] Larned et al. 2009; [6]Obritschkewitsch et al. 2008; [7]Stehn and Platte 2009 [Top]

Table 2. Steller's eider males, nests, and pair densities recorded during ground-based and aerial surveys conducted near Barrow, Alaska 1999–2010 (modified from Safine 2011, 2011 data from Safine 2011).

Year	Overall ground-based survey area			Standard Ground-based Survey Area[a]		Aerial survey of Barrow Triangle		Nests found near Barrow
	Area (km^2)	Males counted	Pair density (males/km^2)	Males counted	Pair density (males/km^2)	Males counted	Pair density (males/km^2)[b]	
1999	172	135	0.78	132	0.98	56	0.04	36
2000	136	58	0.43	58	0.43	55	0.04	23
2001	178	22	0.12	22	0.16	22	0.02	0
2002	192	1	<0.01	0	0	2	<0.01	0
2003	192	10	0.05	9	0.07	4	<0.01	0
2004	192	10	0.05	9	0.07	6	<0.01	0
2005	192	91	0.47	84	0.62	31	0.02	21
2006	191	61	0.32	54	0.4	24	0.02	16
2007	136	12	0.09	12	0.09	12	0.02	12
2008	166	114	0.69	105	0.78	24	0.02	28
2009	170	6	0.04	6	0.04	0	0	0
2010	176	18	0.1	17	0.13	4	0.01	2
2011	180	69	0.38	59	0.44	10	0.01	27

[a]Standard area (the area covered in all years) is ~134 km^2 (2008 – 2010) and ~135 km^2 in previous years.
[b]Actual area covered by aerial survey (50% coverage) was ~1408 km^2 in 1999 and ~1363 km^2 in 2000 – 2006 and 2008. Coverage was 25% in 2007 and 2010 (~682 km^2) and 27% in 2009 (~736 km^2). Pair density calculations are half the bird density calculations reported in ABR, Inc.'s annual reports (Obritschkewitsch and Ritchie 2011). [Top]

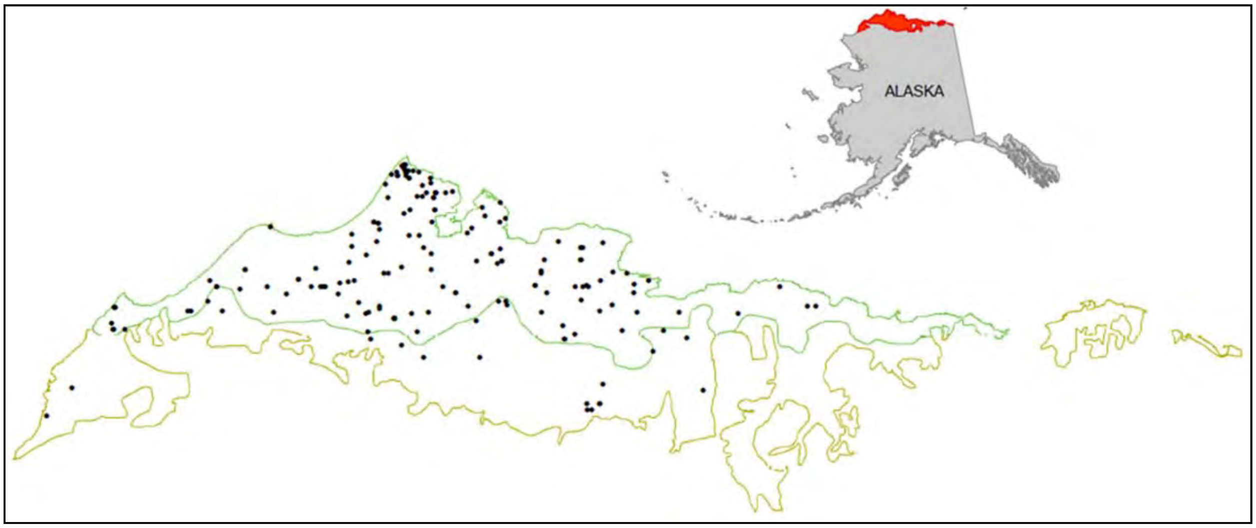


Figure 6. All sightings from the Arctic Coastal Plain (ACP) survey (1989–2008) and the North Slope eider survey (1992–2006).The ACP survey encompasses the entire area shown (61,645 km^2); the NSE includes only the northern portion outlined in green (30,465 km^2). (Modified from Stehn and Platte 2009). [Top]

Following assessment of potential biases inherent in the two Service surveys, Stehn and Platte (2009) identified a subset of the NSE survey data (1993–2008) that they determined was "least confounded by changes in survey timing and observers." Based on this subset of the NSE survey, the average geographically-extrapolated population index total for Steller's eiders was 173 (90% CI 88–258) with an estimated population growth rate of 1.011 (90% CI 0.857–1.193). The average population size of Steller's eiders breeding in the ACP was estimated at 576 (292–859, 90% CI; Stehn and Platte 2009), assuming a detection probability of 30%. The 30% detection probability and associated visibility correction factor of 3.33 was selected based on evaluation of estimates for similar species and habitats (Stehn and Platte 2009).

Currently, this analysis provides the best available estimate of the Alaska-breeding Steller's eider population size and growth rate from the ACP. Surveys of the northernmost portion of the ACP conducted annually by ABR, Inc., provide more intensive coverage of the nesting area (50%, 1999–2004; 25–50%, 2005–2010; Obritschkewitsch and Ritchie 2011). Based on ABR survey data, Stehn and Platte (2009) estimated that the average population index for Steller's eiders residing within the Barrow Triangle was 99.6 (90% CI 55.5–143.7) with an estimated population growth rate of 0.934 (90% CI 0.686–1.272). If we also assume the same 30% detection probability, the average population size of Steller's eiders breeding in the Barrow Triangle survey area would be 332 (185–479, 90% CI).

Near Barrow -- The vicinity immediately near Barrow supports the largest known concentration of nesting Steller's eiders in North America. Standardized ground surveys of 135 km^2 near the Barrow road system conducted since 1999 found an average density of 0.66 birds per km^2 (Rojek 2006) and estimated a Steller's eider breeding population of 84 birds (Rojek 2008). The highest numbers of Steller's eiders observed during ground surveys at Barrow occurred in 1999 with 135 males and in 2008 with 114 males (Table 2; Safine 2011). Total numbers of nests found (those found viable [containing one or more viable eggs] and post-failure) ranged from 0–78 during 1991–2011, while the number of viable nests ranged from 0–27. Steller's eider nests were found in 12 or 60% of years between 1991 and 2010 (Safine 2011).

Yukon-Kuskokwim Delta -- Since the early 1990's, only a few pairs of Steller's eiders have nested on the YKD (Paul Flint, U.S. Geological Survey [USGS], pers. comm.; Brian McCaffery, USFWS pers. comm.). In no single year have more than three nests been found, despite extensive ground-based nest search efforts throughout the Steller's eider critical habitat area. No nests have been confirmed on the YKD since 2007.

Population Structure

There are often genetic gradients or differences that correspond to the geographic distribution of the species (Lande and Barrowclough 1987). The Alaska-breeding population of Steller's eiders may contain unique geographic sub-populations arising from: 1) the distance between breeding populations on the YKD and the ACP [about 804 km (500 miles)], and 2) the anticipated site fidelity of nesting adult females (Anderson et al.1992). In contrast, the similarly distributed North Slope and YKD populations of spectacled eiders (*Somateria fischeri*) possess distinct mitochondrial DNA markers, implying limited maternal gene flow between these two areas for that species (Scribner et al. 2001). However, genetic analyses by Pearce et al. (2005) found little evidence for differentiation among and between nesting groups of Steller's eiders across their range using both nuclear and mitochondrial DNA. Pearce et al. (2005) also observed little evidence for genetic differentiation within the Pacific breeding distribution (Russia vs. Alaska) of Steller's eiders, suggesting that female gene flow is sufficiently high between the two locales, or that divergence of Russian and Alaskan breeding groups has occurred relatively recently.

Pearce and Talbot (2009) observed that the mean level and variance of genetic relatedness among all nests at Barrow in 1999 (n = 19; R_{XY} = -0.07, var = 0.082) was nearly identical to the mean for 45 samples collected from Steller's eiders molting along the Alaska Peninsula (R_{XY} = -0.02, var = 0.075). The molting samples represent the broadest possible distribution of relatedness values since molting groups of Steller's eiders are thought to contain birds from multiple breeding areas (Dau et al. 2000). These findings corroborate conclusions by Pearce et al. (2005) of limited genetic differentiation among breeding areas. Greater differentiation would be expected if Barrow females were more closely related genetically in comparison to a larger group composed of multiple breeding areas, such as those molting and overwinter along the Alaska Peninsula.

Status and Distribution Range-wide

Reasons for Listing

The Alaska breeding population of Steller's eiders was listed as a threatened population on June 11, 1997 (USFWS 1997). It was listed due to: 1) its recognition as a distinct vertebrate population segment; 2) a substantial decrease in the species' nesting range in Alaska; 3) a reduction in the number of Steller's eiders nesting in Alaska; and 4) the vulnerability of the remaining breeding population to extirpation (USFWS 1997).

Habitat Loss: Critical habitat was designated for the Steller's eider on February 6, 2001. The direct and indirect effects of future gas/oil development within the NPR-A, and future village expansion at Barrow, were cited as potential threats to the Steller's eider (USFWS 1997). Within the marine distribution of Steller's eiders, perceived threats included marine transport, commercial fishing, and environmental pollutants (USFWS 1997).

Hunting -- Although not cited as a cause in the decline of Steller's eiders, the take of this species by subsistence hunters was cited as a factor in the decision to list the population of Steller's eiders near Barrow (USFWS 1997). Hunting for Steller's eiders was closed in 1991. In 2003, spring/summer subsistence harvest of migratory birds in Alaska was opened by Alaska State regulations and the Service's policy, but harvest of Steller's eiders remained prohibited. Before this regulation took effect, it was estimated that approximately 97 Steller's eiders were shot each year (USFWS 2006). After 2003, it was predicted that approximately 59 Steller's eiders were killed each year (USFWS 2007). Shooting mortality during 2004-2008 was estimated to be 23 birds (USFWS, Fairbanks Fish and Wildlife Field Office, Unpublished Data, 2010).

Lead Poisoning -- Lead poisoning of Steller's eiders has been documented on the ACP (Trust et al. 1997). Female Steller's eiders nesting at Barrow in 1999 had blood lead concentrations that reflected exposure to lead (>0.2 ppm lead), and six of the seven tested had blood lead concentrations that indicated poisoning (>0.6 ppm lead; Pattee and Pain 2003). Additional lead isotope tests confirmed the lead in the Steller's eider blood was of lead shot origin, not that of the background sediments (Angela Matz, USFWS, Fairbanks Fish and Wildlife Field Office, Unpublished Data). Because this species continues to feed near the nesting site before and during incubation (D. Solovieva, Zoological Institute, Russian Academy of Science, pers. comm.), it may be subjected to an increased risk of exposure to lead shot compared to other tundra waterfowl species that largely forego feeding at this time.

Spectacled eiders do not seem to engage in feeding activities as much as Steller's eiders once breeding has commenced, but have higher rates of lead exposure than any other species sampled on the YKD (Flint et al. 1997). The proportion of spectacled eiders on the YKD's lower Kashunuk River drainage that contained lead shot in their gizzards was high (11.6%, n = 112) compared to other waterfowl in the lower 48 states from 1938-1954 (8.7%, n = 5,088) and from 1977-1979 (8.0%, n = 12,880). Blood analyses of spectacled eiders indicated elevated levels of lead in 13% of pre-nesting females, 25.3% of females during hatch, and 35.8% of females during brood rearing. Nine of 43 spectacled eider broods (20.9%) contained one or more ducklings exposed to lead by 30 days after hatch (Flint et al. 1997). Thus, if spectacled eiders have experienced population level effects on the YKD due to lead poisoning, then it is reasonable to conclude that Steller's eiders may have similar or greater lead-induced effects, since they continue to feed during the nesting period.

<u>Predation</u> -- Changes in predation levels are thought to affect Steller's eider populations by reducing nesting success. There is some evidence that predator and scavenger populations may be increasing on the North Slope (Eberhardt et al. 1983, Day 1998). Reduced fox trapping, anthropogenic food sources in villages and oil fields, and nesting/denning sites on human-built structures may have allowed fox, gull, and raven numbers to increase (Day 1998). Poor breeding success at Barrow has been attributed to high predation rates (Obritschkewitsch et al. 2001). In years where arctic fox removal was conducted at Barrow prior to and during Steller's eider nesting, nest success appears to have increased significantly (Rojek 2008). Increased predation by arctic foxes occurring when goose populations crashed was cited as a possible contributing factor to the decline of the Steller's eider on the YKD as well (USFWS 1997).

<u>Ecosystem Change</u> -- Direct and indirect changes in the marine ecosystem caused by increasing populations of Pacific walrus (*Odobenus rosmarus*), gray whale (*Eschrichtius robustus*), and sea otter, were cited as potential causes of the decline of Steller's eiders (USFWS 1997). Subsequent declines in the southwestern Alaska sea otter population (65 FR 67343) in conjunction with the continued decline in Steller's eider populations suggest that otters were not responsible for a decline in eider numbers. In addition, changes in the commercial fishing industry were also cited as perhaps causing a change in the marine ecosystem, with possible effects upon eiders (USFWS 1997). However, we are unaware of any link between changes in the marine environment and contraction of the eider's breeding range in Alaska (USFWS 1997).

Threats Not Assessed At the Time of Listing

<u>Petroleum Spills</u> – The acute or chronic release of petroleum hydrocarbons near large concentrations of Steller's eiders is a threat not considered at the time of listing. Because of the gregarious behavior of Steller's eiders during the non-breeding months, a spill event may result in acute and/or chronic toxicity in large numbers of birds. Indeed, Larned (2000b), expressed concern for the survival and reproductive success of the large number of Steller's eiders observed in harbors. Fuels and oils are toxic to Steller's eiders (Holmes et al. 1978, Holmes et al.

1979, McEwan and Whitehead 1980, Leighton et al. 1983, Holmes 1984, Leighton 1993, Rocke et al. 1984, Yamato et al. 1996, Glegg et al. 1999, Trust et al. 2000a, Esler et al. 2000) and their prey (e.g., amphipods and snails; Newey and Seed 1995 as cited in Glegg et al. 1999, Finley et al. 1999), and exposure of Steller's eiders to oil in harbors in Alaska has been documented (Miles et al. 2007). Therefore, we believe that petroleum hydrocarbons entering the marine environment from anthropogenic sources are likely to adversely affect Steller's eiders and their habitats.

Seafood Processor Waste -- Discharge from seafood processors may affect the water column, sea floor, or shore directly or indirectly through burial and smothering, putrification and decay, eutrophication, nutrient loading and alteration of habitats, aquatic communities and food webs. Although wave action in shallow, near-shore habitat may keep particles suspended and prevent waste deposition, contaminants, parasites, viruses, and other pathogens may be present and/or concentrated in these wastes and may bioaccumulate in prey items consumed by eiders. Furthermore, fish waste directly or indirectly supplies food to scavenging seabirds (Furness et al. 1992), seaducks, and eagles that tend to congregate in the vicinity of processing facilities and outfalls (Reed and Flint 2007, Ellen Lance, USFWS, pers. observation). Therefore, fish-waste from seafood processing plants can harm Steller's eiders indirectly by degrading foraging habitat, and directly by exposing individuals to contaminants, disease, and increased predation.

Collisions with Manmade Structures -- Steller's eiders collide with wires, communication towers, and other on-land structures (Table 3). Most collisions are likely to involve one or two birds, but "bird storms" have been documented to occur when fishing vessels use bright lights during inclement nighttime weather. The actual number of birds injured and killed through collisions is likely higher than reported: many injured and killed birds are believed to go undetected, unreported, or become scavenged before humans detect them. For example, carcass removal rates from scavengers on the Alaska Peninsula could be as high as 50% per 24 hours (Flint et al. 2010). Therefore, unless obstructions are checked every day, few carcasses would ever be documented. Searcher efficiency can also affect bird mortality estimates, for example following oil spills (Ford 2006).

Accelerated Climate Change -- This global phenomenon, defined by a drastic change in climatic parameters including air and water temperature, is believed to be caused by atmospheric carbon enrichment, otherwise known as the greenhouse effect. Some greenhouse gasses are produced naturally, but since the industrialization of the modern world, the production of these gasses may be accelerated by the burning of fossil fuels and other anthropogenic means.

Fueled by warming air and sea temperatures, glaciers and other permanent or semi-permanent ice sheets melt and cause the sea level to rise. While ocean level seemingly rose a minute amount over the past 100 years (0.1-0.2 m), it is projected to rise at double or quadruple the rate over the next 100 years (IPCC 2001). If sea level rises at the high end of the projection, thousands of square miles of coastal wetland could be covered by water (Inkley et al. 2004). In some areas, such as those surrounding tidewater glaciers in Alaska, sea level rise will have minimal effect on coastal wildlife areas due to the subsequent glacial rebound (from the melting glaciers) offsetting the rising waters (Shaw et al. 1998). Conversely, in coastal urban areas, intertidal habitat availability may be limited to wildlife following a rising sea (Parmesan and Galbraith 2004).

Already scientists are able to detect range changes in wildlife species and correlate those changes with rising temperatures (Root et al. 2003). Expansions of spring waterfowl ranges have been correlated with a significant increase in the number of April and May days with temperatures above 6°C (Prop et al. 1998). Milder springs can enhance reproductive success (Boyd and Diamond 1994, Alisauskas 2002, Fischer et al. 2004) with average date of egg laying growing earlier (Dunn and Winkler 1999). Milder weather leads to later migratory departure dates (Able 1973). Migration routes have shifted, apparently in response to changing sea surface temperatures (Spear and Ainley 1999). However, more plastic taxa may have the ability to change in place, rather than shift their range (Smith and Betancourt 1998).

Table 3. Summary of reported Steller's eiders' collisions with structures and vessels (USFWS, Anchorage Fish and Wildlife Field Office, Unpublished Data, 2007).

Season/ Year	Type	Number of Steller's eiders dead or injured	Location	Comments
December 1980	Collision with M/V Northern Endeavor	≥150	False Pass (Bering Sea side)	Crab lights illuminated, stormy night
September 1991	Collision with tower	1	Togiak NWR	as cited in Henny et al. 1995
February, 1991	Collision with P/V Wolstad	2	Unknown	Crab lights illuminated
February, 1997	Collision with vessel Elizabeth F	2	Unknown	One bird struck vessel on Feb. 14 and the second struck the vessel on Feb. 15.
April, 2003	Collision with power line	1	Bristol Bay Coast, near intersection of road to lake Camp and road to Rapids Camp	Rainy with low ceiling.
Pre 1974 and 1983	Collision with Grant Point DEW site tower	90 and 38 (respectively)	Izembek Lagoon, Alaska Peninsula	Strikes occurred during low viability events and storms, primarily in winter.
Unknown	Collision with vessel	Many	Nelson Lagoon, Alaska Peninsula	Villager reported to Service personnel that he recalls sweeping Steller's eiders off the deck of his fishing boat.
Unknown	Collision with power line	150	Pilot Point, Alaska Peninsula	Pilot Point resident recalls that shortly after erecting a power line, 150 Steller's eiders flew into it and died. The power line runs approximately 600 ft along the shoreline.
June 21, 2008	Wire Collision	1	Barrow	Female, broken wing

[Top]

In some parts of Alaska, average annual temperatures have increased by 2-4 °C (4-7 °F) since 1900 (Oechel et al. 1993, IPCC 2001). Increased nighttime temperatures could markedly influence range patterns of species with life histories especially influenced by ice cover (Inkley et al. 2004). The warming trend is more pronounced during winter than summer (Houghton et al. 1996, Inkley et al. 2004). Arctic sea-ice thickness decreased 1-2 m during the past few decades (Rothrock et al. 1999). During winter, groups of Steller's eiders move in response to ice floes (Flint and Lance, USGS and USFWS, unpublished data), but this behavior has not been modeled relative to ice-cover predictions within their wintering distribution.

It is not known what role the rapidly warming environment played in the significant population declines of Steller's eiders in the past or what role climate change will play in the future for this species. Increases in atmospheric CO_2 will likely result in increased ocean acidification in Arctic and subarctic regions (IPCC 2007). Acidification may impact marine organisms that create shells and hard body parts from calcium carbonate. These types of organisms are eaten by Steller's eiders. Global climate change is linked to shifts in global and regional weather patterns. Coastal areas are likely to be subjected to increased frequency of unpredictable, stochastic weather events including extreme storms and storm surges, flood events, and coastal erosion (IPCC 2007, 2012). Such events may affect eiders.

<u>Stochastic Events</u> -- Steller's eiders on the YKD and the ACP comprise a small population size. As discussed by Gilpin (1987), small populations have difficulty surviving the combined effects of demographic and environmental stochasticity. Demographic stochasticity refers to random events that affect the survival and reproduction of individuals (e.g., shifts in sex ratios, striking wires, being shot, oil/fuel spills; Goodman 1987). Environmental stochasticity is due to random, or at least unpredictable, changes in factors such as weather, food supply, and populations of predators (Shaffer 1987). If not already extirpated, Steller's eiders nesting on the YKD are at high risk of local extirpation due to the low number of birds that breed there. The world population of Steller's eiders is probably not at high risk of extinction due to environmental stochasticity alone, but local groups of wintering birds may be vulnerable to starvation due to stochastic events (e.g., unusually heavy ice-cover in their feeding habitats).

<u>Allee Effect</u> -- "Allee effect" refers to the destabilizing tendency associated with inverse density-dependence as it relates to population size and birth rate. One form of this occurs when the ability to find a mate is diminished (Begon and Mortimer 1986). For the Steller's eider, males are estimated to have higher mortality rates than females (Flint et al. 2000). The annual survival rate for Steller's eiders molting and wintering in Alaska is estimated to be 0.899 ± 0.032 for females and 0.765 ± 0.044 for males (Flint et al. 2000). The observed difference in annual survival between sexes may be manifested in a skewed sex ratio. Female Steller's eiders notably out-numbered male eiders in Akutan, False Pass, Unalaska, and Izembek (John Burns, U.S. Army Corp of Engineers, pers. comm.; Lanctot and King 2000a, Lanctot and King 2000b). However, observations of a skewed sex ratio vary across the range of the species and show shifts through time (Dau et al. 2000; Flint et al. 2000; Lanctot and King 2000a; Lanctot and King 2000b). Skewed sex ratios may be resulting in reduced breeding populations, as adult females are effectively removed from the breeding population if they are unable to find a mate. It is not known to what degree (if any) that skewed sex ratios may be contributing to low breeding rates on the ACP.

<u>Incidental Take: Research</u> -- The Service has issued permits under section 10 of the ESA to authorize take of endangered or threatened species for purposes of enhancement of propagation or survival. Annual reporting requirements associated with §10 permits for Steller's eiders (Table 4) reveal that 1,179 adults and 89 eggs were authorized to be taken as an indirect result of research activities since 1997. Due to the numerous amended actions and permits, and because of the variation and inconsistencies in reporting, accomplishing a precise tally of incidental take proved difficult. It was sometimes unclear if the 0.8% correction factor for listed Steller's eiders

was used when permits were issued for the incidental take of individuals from the Pacific wintering population. As previously noted, we assume that 0.8% of Pacific wintering Steller's eiders are also from the listed North American breeding population.

Table 4. Incidental (i.e., unintentional), lethal take permitted by the Service for Steller's eiders under §10 of the ESA.

	1997	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012*
Adult	965	12	18	26	29	16	14	24	28	18	25	0	3	1	0
Chick	5	4	5	19	7	7	7	7	7	7	0	0	7	7	0
Egg	0	0	108	114	0	24	24	24	44	20	0	0	0	0	0
Nest	0	0	0	20	3	3	3	5	5	5	2	0	<1	0	0

*As of May 1, 2012 [Top]

A total of 37 Steller's eiders were reported as actually taken, incidental to research activities, from 1997 to present. Because those birds were all from the wintering population, we applied the correction factor and determined that approximately 1 bird from the Alaska breeding population has died incidental to research activities. In addition to incidental take, since listing there have been 16 permitted and 16 actual, direct and intentional takings of Steller's eider adults on the wintering grounds. It is unlikely that any of those individuals were from the North American breeding population (i.e., 16 * 0.008 = 0.128). Additionally, permits have been issued to salvage and opportunistically collect up to 68 Steller's eider eggs from the North American breeding population for a captive breeding program at the Alaska SeaLife Center.

Incidental Take: Other Federal Actions (other than §10 research permits) -- Since listing, permits have been issued for the incidental, lethal take of fewer than 97 Alaska breeding Steller's eiders (Table 5). Although reporting is required upon issuance of an incidental take permit, it is not consistently provided by permittees so we do not know how many eiders have actually died as a result of these actions.

Range-wide Trends

The population of Pacific wintering Steller's eiders molting and wintering along the Alaska Peninsula has declined since the 1960s (Kertell 1991). The long-term trend from annual spring aerial surveys (1992-2011) indicates a 2.3% decline per year (R^2=0.34) (Larned 2012). Counts of Steller's eiders conducted during fall surveys for emperor geese indicate a 1.6% per year increase from 1979-2010. Banding data from 1975 -1981 to 1991-1997 indicates a reduction in Pacific wintering Steller's eider survival over time (Flint et al. 2000). Population models for other waterfowl, applied to this species, indicate that reductions in annual survival would have a substantial negative effect on populations (Schmutz et al. 1997; Flint et al. 2000).

While current distribution on the North Slope breeding range has been reduced compared to the historical distribution (Quakenbush et al. 2002), the population trajectory for the North Slope population remains ambiguous (Stehn and Platte 2009). The data from the 1989-2006 ACP aerial surveys indicate that North American breeding Steller's eiders are in decline (λ=0.778, 0.686-0.882, 90% CI; Mallek at al. 2007), while the 1992-2008 NSE survey data suggest that the population is increasing (λ=1.059, 0.909-1.235, 90% CI; Larned et al. 2008). ABR's aerial survey data from 1999-2007 suggest a declining growth rate (λ=0.934, 0.686-1.272, 90% CI; Obrischkewitsch et al. 2008). Analysis of a subset of data from the North Slope Eider aerial survey (1993-2008) estimates that population growth is stable (λ=1.011, 0.857-1.193, 90% CI; Stehn and Platte 2009).

Table 5. Incidental take of Steller's eiders permitted by section 7 of the ESA from 1997 to present.

Action	Year	Incidental Take	Estimated	Life Stage	Lethal
Akutan Mooring Basin	2003	Contaminants	9	Adults	N
Akutan Mooring Basin	2003	Collisions	1	Adults	Y
Akutan Transportation	2007	Disturbance	20	Adults	N
Alaska State's Mixing Zones Regulation	2011	Contaminants	36	Adult	Y
Barrow Airport Expansion	2006	Habitat Loss	29	Eggs/Chicks	N
Barrow Gas Fields Well Drilling Program	2011	Loss of	22	Eggs/ducklings	N
Barrow Global Climate Change Research Facility Phase 1 & 2	2005 & 2007	Collisions	1	Adults	Y
	2005 & 2007	Habitat Loss	25	Eggs/Chicks	N
Barrow gravel pad and 60-man camp	2012	Loss of	22	Eggs/ducklings	N
Barrow Hospital	2004 & 2007	Habitat Loss	17	Eggs/Chicks	N
Barrow Landfill	2003	Habitat Loss	1	Nest/y for 45 y	N
Barrow Tundra Manipulation Exp.	2005	Habitat Loss	1	Eggs/Chicks	N
	2005	Collisions	2	Adults	Y
Barrow Wastewater Treatment	2005	Habitat Loss	3	Eggs/Chicks	N
BLM Northern NPR-A	2008	Disturbance	12	Eggs/Chicks/y	N
	2008	Collisions	<1	Adult	Y
BP Alaska's Northstar Project	2009	Collisions	≤ 1 /year	Adult	Y
Chignik Bay Tank Farm	2002	Contaminants	5	Adults	N
Chignik Dock	2002	Contaminants	4	Adults	N
Chignik Lagoon Tank Farm	2001	Contaminants	14	Adults	N
Chukchi Sea Lease Sale 193	2007	Collisions	1	Adults	Y
Fairweather Seismic	2003	Disturbance	66	Adults	N
False Pass Harbor	2001	Contaminants	4	Adults	N
USFWS Sport-harvest Regulations	2006	Harvest	1	Adults	Y
Goodnews Bay Processor	2008	Disturbance	28	Adults	N
Intra-service on Subsistence Hunting Regulations	2005	Harvest	17	Adults	Y
	2006	Harvest	14	Adults	Y
	2007	Harvest	Unspecified	Adults	Y
	2008	Harvest	Unspecified	Adults	Y
	2009	Harvest	Unspecified	Adults	Y
	2010	Harvest	Unspecified	Adults	Y
	2011	Harvest	4	Adult	Y
	2012	Harvest	4	Adults	Y
Nelson Lagoon Tank Farm	2003	Contaminants	20	Adults	N
	2003	Collisions	1	Adults	Y
NOAA National Weather Service Office in Barrow	2008	Collisions	1	Adults	Y
	2008	Disturbance &	< 10	Eggs/ducklings	N
NPDES-GP	2001	Collisions	1	Adults	Y
Oil and Gas Activities in the Beaufort and Chukchi	2012	Collisions	1	Adults	Y
Sandpoint Harbor	2002	Contaminants	11	Adults	Y
	2002	Habitat Loss	1	Adults	N
	2002	Collisions	1	Adults	Y
Unalaska harbor	2007	Habitat Loss	1	Adults	N
	2007	Contaminants	1	Adults	N
	2007	Collisions	1	Adults	Y

[Top]

Aerial surveys that included the YKD, but did not include the ACP, indicated that the YKD population of eiders has declined by 90% since 1957 (Hodges et al. 1996). For the 1950s and early 1960s, the upper limit of the population, excluding the North Slope, had been estimated to be approximately 3,500 pairs (Kertell 1991). Kertell (1991) concluded that the Steller's eider had been extirpated from the YKD prior to 1990. The numbers of birds currently breeding on the YKD are not likely to be sufficient to sustain a breeding population (Kertell 1991; Quakenbush 2002). This population is most likely dependent on immigration from the Alaska-breeding or Russian breeding populations.

If there is no permanent immigration or emigration between Russian breeding and Alaska-breeding Steller's eiders, if declining trends continue, and if the available estimates of vital rates are accurate and precise, the listed Steller's eiders have a high probability of extinction in the foreseeable future (Swem and Matz 2008).

Recovery

The Steller's eider Recovery Plan (USFWS 2002b) establishes criteria for reclassifying the species from threatened to endangered when either (a) the population has ≥ 20% probability of extinction in the next 100 years for 3 consecutive years; or (b) the population has ≥ 20% probability of extinction in the next 100 years and is decreasing in abundance. The Alaska-breeding population would be considered for delisting from threatened status if it has ≤ 1% probability of extinction in the next 100 years, and each of the northern and western subpopulations are stable or increasing and have ≤ 10% probability of extinction in 100 years. A revision of the population viability analyses (PVA) for both the Alaska-breeding population and the Pacific population of Steller's eiders (Runge 2004) concluded that without reintroduction of breeding birds to the wild population, the listed population is at high risk of extinction (Swem and Matz 2008). Although the PVA model incorporates the best available information, estimates are thought to be imprecise and likely biased in various ways. Regardless, we find the projected population trajectory informative.

Northern sea otter (*Enhydra lutris kenyoni*)

Species Description

The sea otter is a mammal in the family Mustelidae and it is the only species in the genus *Enhydra*. Three subspecies are recognized: 1) the Asian northern sea otter (*E. l. lutris*), which occurs west of the Aleutian Islands; 2) the southern sea otter (*E. l. nereis*), which occurs off the coast of California and Oregon; and 3) the Alaska subspecies of northern sea otter (*E. l. kenyoni*), which occurs from the west end of the Aleutian Islands to the coast of the State of Washington (Wilson et al. 1991). Adult males average 130 cm (4.3 ft) in length and 30 kg (66 lb) in weight; adult females average 120 cm (3.9 ft) in length and 20 kg (44 lb) in weight (Kenyon 1969). Sea otters lack the blubber layer found in most marine mammals and depend entirely upon their fur for insulation (Riedman and Estes 1990). They molt gradually throughout the year (Kenyon 1969).

Life History

Energetics

Sea otters have a relatively high metabolic rate compared to land mammals of similar size (Costa 1978; Costa and Kooyman 1984). To maintain the level of heat production required to sustain them, sea otters eat large amounts of food; estimated at 23– 33% of their body weight per day (Riedman and Estes 1990).

Longevity and Age to Maturity

The maximum life span of a wild sea otter is believed to be 23 years (Nowak 1999). There is variation in age of first reproduction, but generally, male sea otters appear to reach sexual maturity at 5–6 years of age and females reach sexual maturity at 3–4 years (Garshelis et al. 1984, von Biela et al. 2007). The average age of first reproduction for female sea otters from the Aleutian Islands is 4.29 years, which is significantly different from those from Kodiak Island (3.19 years) (von Biela et al. 2008).

Breeding Ecology

The interval between pups is typically 1 year. The presence of pups and fetuses at different stages of development throughout the year suggests that reproduction occurs at all times of the year. Most areas that have been studied show evidence of one or more seasonal peaks in pupping (Rotterman and Simon-Jackson 1988). Similar to other mustelids, sea otters can have delayed implantation of the blastocyst (developing embryo) (Sinha et al. 1966). As a result, pregnancy can have two phases: from fertilization to implantation, and from implantation to birth (Rotterman and Simon-Jackson 1988). The average time between copulation and birth is 6–7 months. Female sea otters typically will not mate while accompanied by a pup (Lensink 1962; Kenyon 1969; Garshelis et al. 1984).

Recruitment

Estimating the rate of recruitment of sea otters into a population is difficult primarily because of asynchronous pupping and an inability to reliably distinguish males from females and juveniles from adults externally. For long-lived species, we expect that survivorship of offspring is related to maternal age and experience, and that recruitment rate is more sensitive than survival rate to environmental fluctuations (Eberhardt 1977).

Distribution and Population Structure

E. l. kenyoni has a range that extends from the Aleutian Islands in southwestern Alaska to the coast of the State of Washington. Three stocks of sea otters are recognized in Alaska: southwest, southcentral and southeast (Figure 7). The southwest Alaska stock ranges from Attu Island at the western end of the Near Islands in the Aleutians, east to Kamishak Bay on the western side of lower Cook Inlet, and includes waters adjacent to the Aleutian Islands, the Alaska Peninsula, the Kodiak archipelago, and the Barren Islands (USFWS 2005). Within the range of northern sea otters (*E. l. kenyon*i), there may be physical barriers to movement across the upper and the lower portions of Cook Inlet, and there are morphological and some genetic differences between sea otters that correspond to the southwest and south-central Alaska stocks (USFWS 2005). Sea otters in Iliamna Bay belong to the southwest stock.

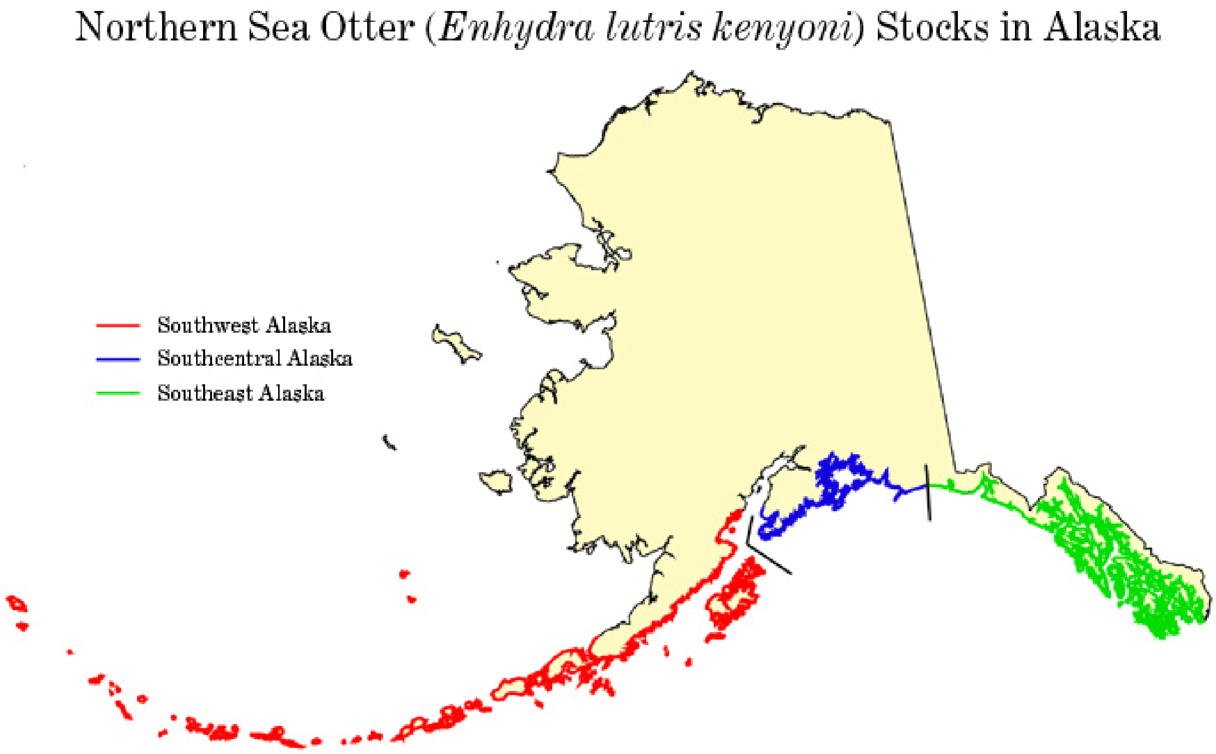


Figure 7. Northern sea otter stocks in Alaska. [Top]

Genetic analyses show some similarities between sea otters in the Commander Islands and Alaska (Cronin et al. 1996), which indicates that movements between these areas has occurred, at least over evolutionary/geologic time scales. All existing sea otter populations have experienced at least one genetic bottleneck caused by the commercial fur harvests from 1741 to 1911. As part of efforts to re-establish sea otters in portions of their historical range, otters from Amchitka Island (part of the Aleutian Islands) and Prince William Sound were translocated to other areas outside the range of what we now recognize as the southwest Alaska distinct population segment, but within the range of *E. l. kenyoni* (Jameson et al.1982).

Movement Patterns and Site Fidelity

Sea otters in Alaska are non-migratory and generally do not disperse over long distances (USFWS 2008a). They usually remain within a few kilometers of their established feeding grounds (Kenyon, 1981), however, translocated populations are known to shift and expand their distribution in favorable habitats (Jameson 2002). The current distribution of sea otters in Alaska has been influenced by the processes of natural population recolonization and the translocation of sea otters into former habitat after they had been extirpated by the fur trade. While sea otters have been known to make long distance movements up to 350 km (217 miles) over a relatively short period of time when translocated to new or vacant habitat (Ralls et al. 1992), the home ranges of sea otters in established populations are relatively small. Once a population has become established and has reached equilibrium density within the habitat, movement of individual sea otters appears to be largely dictated by(a) environmental and social factors, including gender, breeding status, and age; (b) climatic variables, such as weather, tidal state, and season; and (c) human disturbance.

Home range and movement patterns of sea otters vary depending on the gender and breeding status of the otter. In the Aleutian Islands, breeding males remain for all or part of the year within the bounds of their breeding territory, which constitutes a length of coastline anywhere from 100 m (328 ft) to approximately 1 km (0.62 miles). Sexually mature females have home ranges of approximately 8–16 km (5–10 miles), which may include one or more male territories. Male sea otters that do not hold territories may move greater distances between resting and foraging areas than territorial males (Lensink 1962, Kenyon 1969, Riedman and Estes 1990, Estes and Tinker 1996).

Alaskan sea otters are non-migratory and generally do not disperse over long distances, preferring instead to remain within a few kilometers of their established feeding grounds (Kenyon 1981; USFWS 2008a), but sea otters are capable of long distance travel. Routine movements between high-use areas separated by 35 to 60 miles (57 to 97 km) were observed by VanBlaricom et al. (2001). Translocated populations of sea otters have been known to expand their distribution into favorable habitats, sometimes traversing distances up to 350 km (217 mi) over a relatively short period (Ralls et al. 1992; Jameson 2002). Juvenile males (1–2 years of age) are known to disperse up to 120 km (75 mi) from their natal (birth) area; young females traveled up to 38 km (23.6 mi) (Garshelis and Garshelis 1984, Monnett and Rotterman 1988, Riedman and Estes 1990). Otters have shown daily movement distances greater than 3 km, and can travel up to 5.5 km per hour (Garshelis and Garshelis 1984).

Sea otter movements are also influenced by local climatic conditions such as storm events, prevailing winds, and in some areas, tidal states. Sea otters tend to move to protected or sheltered waters (bays, inlets, or lees) during storm events or high winds. In calm weather conditions, sea otters may be encountered further from shore (Lensink 1962, Kenyon 1969). In the Commander Islands, Russia, weather, season, time of day, and human disturbance have been cited as factors that induce sea otter movement (Barabash-Nikiforov 1947, Barabash-Nikiforov et al. 1968).

Critical Habitat –Designation and Use

On October 8, 2009, the Service finalized designation of 15,164 km^2 (5,855 mi^2) of critical habitat for the threatened northern sea otter in southwest Alaska. The Primary Constituent Elements (PCEs) contain the physical and biological features that are essential to the conservation of the species and may require special management considerations. In general, PCEs include but are not limited to:

a. Space for individual and population growth and for normal behavior;
b. Food, water, air, light, minerals, or other nutritional or physiological requirements;
c. Cover or shelter;
d. Sites for breeding, reproduction, or rearing (or development) of offspring; and
e. Habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of a species.

The PCEs for the designated critical habitat of the sea otter are:

1) shallow, rocky areas less than 2 m (6.6 ft) in depth where marine predators are less likely to forage, or

2) nearshore waters within 100 m (328.1 ft) from the mean high tide line (MHT) that may provide protection or escape from marine predators; and
3) kelp forests, which occur in waters less than 20 m (65.6 ft) in depth, that provide protection from marine predators, or
4) prey resources within the areas identified by PCEs 1, 2, and 3 that are present in sufficient quantity and quality to support the energetic requirements of the species.

Sea otters generally occur in shallow water areas near the shoreline. They are most commonly observed within the 40 m (131 ft) depth contour (USFWS 2008a), although they can be found in waters up to 100 m (328 ft) in depth. The majority of all foraging dives take place in waters less than 30 m (98 ft) in depth (Bodkin et al. 2004). As water depth is generally correlated with distance to shore, sea otters typically inhabit waters within 1–2 km (0.62–1.24 miles) of shore (Riedman and Estes 1990). Much of the marine habitat of the sea otter in southwest Alaska is characterized by a rocky substrate. In these areas, sea otters typically are concentrated between the shoreline and the outer limit of the kelp canopy (Riedman and Estes 1990), but they also occur further seaward. Sea otters also inhabit marine environments that have soft sediment substrates, such as Bristol Bay and the Kodiak archipelago. As communities of benthic invertebrates differ between rocky and soft sediment substrate areas, so do sea otter diets.

Food Habits
Sea otters are carnivores that forage in nearshore marine and intertidal habitat. They eat a wide variety of benthic (living in or on the sea floor) invertebrates, including sea urchins, clams, mussels, crabs, and octopus. Most important to the diet are crabs, urchins, and bivalves (clams and mussels). Clams were the most frequently identified sea otter prey item (57-67% of the diet) in the northern Kodiak Archipelago. Mussels, crabs, and green sea urchins contributed ≤25% to the total prey (Doroff and DeGange 1994). Sea otters mainly forage in depths less than 20 m (Bodkin et al. 2004). In some parts of Alaska, sea otters also eat epibenthic (living upon the sea floor) fishes (Estes et al. 1982; Estes 1990).

The sea otter is considered a keystone species that strongly influences the species composition and diversity of the near-shore marine environment it inhabits (Estes et al. 1978). For example, studies of subtidal communities in Alaska have demonstrated that when sea otters are abundant, epibenthic herbivores such as sea urchins will be present at low densities whereas kelp, which is consumed by sea urchins, will flourish. Conversely, when sea otters are absent, grazing by abundant sea urchin populations creates areas of low kelp abundance, known as urchin barrens (Estes and Harrold 1988).

Predators
Sea otter predators include white sharks in the southern range and north to southeastern Alaska, and killer whales (*Orcinus orca*) in all areas. Killer whales may have been a key factor in the decline of the southwestern Alaska stock of sea otters (Estes et al. 1998), but the extent of predation and its potential impact on the population as a whole has not been determined. Sea otter pups may occasionally be taken by bald eagles or Steller sea lions (*Eumetopias jubatus*; Rotterman and Simon-Jackson 1988).

Population Dynamics

Population Size

Aleutian Islands -- The first large-scale population surveys of sea otters in the Aleutian Islands were conducted from 1957 to 1965 by Kenyon (1969). The total unadjusted count for the entire Aleutian archipelago during the 1965 survey was 9,700 sea otters (Table 6). In 1965, sea otters were believed to have reached equilibrium densities throughout roughly one-third of the Aleutian archipelago, ranging from Adak Island in the east to Buldir Island in the west (Estes 1990). Islands in the other two-thirds of the archipelago had few sea otters, and researchers expected additional population growth in the Aleutians to occur through range expansion.

Table 6. Summary of Northern sea otter population surveys in southwest Alaska (USFWS 2005a)

Survey area	Year	Count or Estimate	Adjusted count or estimate (if available)	Source
Aleutian Islands	1965	9,700	--	Kenyon (1969)
	1992	8,048	--	Evans et al. (1997)
	2000	2,442	8,742	Doroff et al. (2003)
North Alaska Peninsula Offshore Areas	1976	11,681	--	Schneider (1976)
	* 1986	6,474 ± 2,003 (JUN) 9,215 ± 3,709 (AUG) 7,539 ± 2,103 (OCT)	--	Brueggeman et al. (1988) Burn and Doroff (2005)
	2000	4,728 ± 3,023 (MAY)	11,253	Burn and Doroff (2005)
South Alaska Peninsula Offshore Areas	* 1986	13,900 ± 6,456 (MAR) 14,042 ± 5,178 (JUN) 17,500 ± 5,768 (OCT)	--	Brueggeman et al. (1988), Burn and Doroff (2005).
	2001	1,005 ± 1,597 (APR)	2,392	Burn and Doroff (2005)
South Alaska Peninsula Islands	1962	2,195	--	Kenyon (1969)
	1986	2,122	--	Brueggeman et al. (1988)
	1989	1,589	--	DeGange et al. (1995)
	2001	402	957	Burn and Doroff (2005)
	2001a	2,190	5,212	Burn and Doroff (2005)
South Alaska Peninsula Shoreline	1989	2,632	--	DeGange et al. (1995)
	2001	2,651	6,309	Burn and Doroff (2005)
Unimak Island	2001	42	100	Burn and Doroff (2005)
South Alaska Peninsula-all combined	2001	--	4,724	Burn and Doroff (2005)
Kodiak Archipelago	1989	13,526 ± 2,350	--	DeGange et al. (1995)
	1994	9,817 ± 5,169	--	(Angie Doroff, USFWS Unpublished Data)
	2001	5,893 ± 2,630	--	(Angie Doroff, USFWS Unpublished Data)
	2004	--	11,005 ± 2,135	(Angie Doroff, USFWS Unpublished Data)
Kamishak Bay	2002	--	6,918 ± 4,271	Bodkin 2003
Katmai	2008	821	7,095	Coletti et al. (2009)
Kodiak, Kamishak, Alaska Peninsula combined	2008	--	28,955	Burn and Doroff (2005), Bodkin (2003)
Current Estimated Total	2012		54,771	USFWS Unpublished Data
Previous Estimated Total	2008		47,676	USFWS (2008a)

*Estimates recalculated by Burn and Doroff (2005) from original data of Brueggeman et al. (1988). [Top]

From the mid-1960s to the mid-1980s, otters expanded their range, and presumably their numbers as well, until they had recolonized all the major island groups in the Aleutians. Although the maximum size reached by the sea otter population is unknown, a habitat-based computer model estimates that the population in the late 1980s may have numbered approximately 74,000 individuals in the Aleutians (Burn et al. 2003). But in a 1992 aerial survey of the entire Aleutian archipelago, only 8,048 otters were counted (Evans et al. 1997); approximately 19% fewer than the total reported for the 1965 survey. Sea otter surveys conducted during the mid-1990s also indicated substantial declines at several islands in the western and central Aleutians (Estes et al. 1998).

In April 2000, 2,442 sea otters were counted; a 70% decline from the count 8 years previous (Doroff et al. 2003). Along the more than 5,000 km (3,107 miles) of shoreline surveyed, sea otter density was at a uniformly low level, which clearly indicated that sea otter abundance had declined throughout the archipelago. Doroff et al. (2003) calculated that the decline occurred at an average rate of 17.5% per year in the Aleutians.

Skiff surveys conducted around five islands in the western Aleutian Islands from 1993 to 2003 indicated that the population trends in this area were strongly negative, with an average rate of decline of approximately 20% per year. Population trends changed during the period 2003 to 2011, with an average growth rate of approximately zero. Some variation was evident but the overall trends were consistent among islands. These results suggest that population declines have stabilized in the western Aleutian Islands over the last 5-8 years, although there is still no evidence of recovery (USGS unpublished data, USFWS unpublished data).

Alaska Peninsula -- Three remnant colonies (at False Pass, Sandman Reefs, and Shumagin islands) were believed to have existed near the western end of the Alaska Peninsula after commercial fur harvests ended in 1911 (Kenyon 1969). During surveys in the late 1950s and early 1960s, substantial numbers of sea otters were observed between Unimak Island and Amak Island (2,892 in 1965) on the north side of the Peninsula; around Sanak Island and the Sandman reefs (1,186 in 1962); and around the Shumagin Islands on the south side (1,352 in 1962) (Kenyon 1969). Schneider (1976) estimated 17,000 sea otters on the north side of the Alaska Peninsula in 1976 (Burn and Doroff 2005), which he believed to have been within the carrying capacity for that area. In 1986, it was estimated that 6,474–9,215 sea otters occurred in this area (Burn and Doroff 2005). In May 2000, an estimated 4,728 sea otters were counted on the north side of the Alaska Peninsula; a 27–49% decline from 1986 (Burn and Doroff 2005).

Several island groups along the south side of the Alaska Peninsula; Pavlof and Shumagin islands, as well as Sanak, Caton, and Deer Islands were surveyed in 1962 (Kenyon 1969; 1,900 otters), in 1986, (Brueggeman et al. 1988; 2,122 otters), and in 1989 (DeGange et al. 1995; 1,589 otters). There were approximately 16–28% fewer sea otters in 1995 than were reported in the earlier counts. This decrease was the first indication of a sea otter population decline in the area of the Alaska Peninsula. Sea otter counts were again conducted in these island groups in 2001, and only 405 individuals were counted (Burn and Doroff 2005); an 81% decline from the 1986 count (Brueggeman et al. 1988).

Estimates of sea otters occupying offshore areas on the south side of the Alaska Peninsula, west of Castle Cape in 1986 (Brueggeman et al. 1988) were 13,900–17,500 (Burn and Doroff 2005). A replication of this 1986 survey route during April of 2001 suggested a 93% decline in abundance (Burn and Doroff 2005). In 1989, DeGange et al. (1995) counted 2,632 sea otters along the southern shoreline of the Alaska Peninsula from False Pass to Castle Cape. In a repeated survey of this route in 2001, 2,651 sea otters were counted (Burn and Doroff 2005), nearly the same as the 1989 count. The results from the different survey areas along the Alaska Peninsula indicate various rates of change. Overall, the combined counts for the entire Alaska Peninsula have declined by 65–72% since the mid-1980s. The estimated number of sea otters along the Alaska Peninsula was 19,821 as of 2001.

The eastern extent of the sea otter population decline in southwest Alaska appears to occur at about Castle Cape. The change in sea otter density in this eastern area is less extreme than in the west. This difference is likely due in part to the fact that populations around Kodiak, Katmai and lower Cook Inlet are still increasing. The equilibrium density of sea otters in this eastern region might also be less than it is in the central and western Aleutians.

Kamishak Bay -- Kamishak Bay is located on the west side of lower Cook Inlet, north of Cape Douglas. In the summer of 2002, the USGS, Biological Resources Division conducted an aerial survey of lower Cook Inlet and the Kenai Fiords area, in part to estimate sea otter abundance in Kamishak Bay. Sea otters were relatively abundant within Kamishak Bay during the 2002 survey (6,918 otters; Bodkin 2003), with numerous large rafts of sea otters observed. See the Sea Otter Status and Distribution in the Action Area section for more information.

Kodiak Archipelago -- One of the remnant sea otter colonies in southwest Alaska is thought to have occurred at the northern end of the Kodiak archipelago, near Shuyak Island. In 1959, Kenyon (1969) counted 395 sea otters in the Shuyak Island area. Over the next 30 years, the sea otter population in the Kodiak archipelago grew in numbers, and its range expanded southward around Afognak and Kodiak Islands (Schneider 1976, Simon-Jackson et al. 1984, Simon-Jackson et al. 1985). In 1994, there were an estimated 9,817 otters in the Kodiak archipelago (USFWS, unpublished data). An aerial survey of the Kodiak Archipelago conducted in 2004 resulted in an estimate of 11,005 sea otters (CV = 0.19; USFWS unpublished data). The methods used in this survey follow those of Bodkin and Udevitz (1999), which include the calculation of a survey-specific correction factor for animals undetected by observers. Unlike in the Aleutian Islands and along the western Alaska Peninsula, sea otters in other areas within the range of the southwest stock do not appear to have undergone a population decline over the past 20 years. Sea otter numbers in the Kodiak Archipelago, the Alaska Peninsula coast from Castle Cape to Cape Douglas, and Kamishak Bay in lower western Cook Inlet are stable and may be increasing (Coletti et al. 2009, Estes et al. 2010, USGS unpublished data, USFWS unpublished data).

Uncertainty in estimates -- Our current estimate of the size of the southwest Alaska population of the northern sea otter, based on surveys in 2000-2011, is 54,771 animals. This estimate is adjusted for animals not detected. As recent site-specific surveys indicate the decline has not abated in the Aleutian archipelago and south Alaska Peninsula study areas, it is possible that the current population size is actually lower. Survey methods vary in different locations. Like survey efforts for most species, detection of all the individuals present is not always possible. Sea otters spend considerable time under water, and it is not possible to detect individuals that are below the surface at the time a survey is conducted. Also, observers do not always detect every individual present on the surface.

Population Variability
Difference in sampling and estimation techniques may be responsible for variabilty in some population estimates (USFWS 2005a). Even with variabilty in population estimates, however, the magnitude of the change in estimates is sufficient to conclude that the population has declined.

Population Stability
Estes (1990) estimated population growth rates ranging from 17–20 % per year for four northern sea otter populations expanding into unoccupied habitat. While Bodkin et al. (1999) also reported similar population growth rates, they noted that population growth rates in translocated populations were significantly greater than for remnant populations. After the initial period of growth, populations typically reach an equilibrium density that can be supported by the habitat (Estes 1990).

Status and Distribution
Reasons for Listing and Threats
The southwestern DPS of the northern sea otter was listed as threatened on August 9, 2005 (70 FR 46366). Recent surveys conducted in 2003 and 2004 indicate that the population decline has not abated in several areas within southwest Alaska. If the decline continues at the observed rates, the population may become extirpated throughout portions of its range within the next decade (Estes et al. 2005).

The southwest DPS of northern sea otter is currently distributed throughout their former range, but at extremely low densities in most areas. Otters are now absent, or nearly so at some of the smaller islands in the Aleutian archipelago to the point where it is possible that Allee effects (reduced productivity at low population densities) may occur (Estes et al. 2005).

Predation -- The weight of evidence of available information suggests that predation by killer whales may be the most likely cause of the sea otter decline in the Aleutian Islands (Estes et al. 1998). Data that support this hypothesis include: 1) a significant increase in the number of killer whale attacks on sea otters during the 1990s, (Hatfield et al. 1998); 2) the number of observed attacks fits expectations from computer models of killer whale energetics; 3) the scarcity of beach cast otter carcasses that would be expected if disease or starvation were occurring; and 4) markedly lower mortality rates between sea otters in a sheltered lagoon (where killer whales cannot go) as compared to an adjacent exposed bay; and 5) the decline was driven by elevated mortality rate, not reduced fertility or redistribution (Laidre et al. 2006).

The hypothesis that killer whales may be the principal cause of the sea otter decline suggests that there may have been significant changes in predator-prey relationships in the Bering Sea ecosystem (Estes et al. 1998; Springer et al. 2003). For the past several decades, harbor seals (*Phoca vitulina*) and Steller sea lions, the preferred prey species of transient, marine mammal eating killer whales, have been in decline throughout the western North Pacific. In 1990, Steller sea lions were listed as threatened under the ESA (55 FR 49204). Estes et al. (1998) hypothesized that killer whales may have responded to declines in their preferred prey species, harbor seals and Steller sea lions, by broadening their prey base to include sea otters. Springer et al. (2003) suggest that modern industrial whaling led to declines in great whale populations in the North Pacific, which in turn resulted in killer whales "fishing down" the marine food web; first harbor seals, then fur seals, sea lions and finally sea otters in succession as preferred prey were depleted.

Subsistence Harvest -- The best available scientific information does not indicate that the subsistence harvest by Alaska Natives has had a major impact on the southwest Alaska DPS of the northern sea otter. Some of the largest observed sea otter declines have occurred in areas where subsistence harvest is either nonexistent or extremely low. The majority of the subsistence harvest in southwest Alaska occurs in the Kodiak archipelago. Given the estimated population growth rate of 10% per year estimated for the Kodiak archipelago by Bodkin et al. (1999), we would expect that these harvest levels by themselves would not cause a population decline. Subsistence harvest has reportedly removed fewer than 1,400 sea otters from the southwest Alaska DPS since 1989 (average = 85 per year; range = 24 to 180 per year; USFWS, Marine Mammals Management, Anchorage, Alaska, Unpublished Data).

Interaction with Commercial Fisheries -- While there are some fisheries for benthic invertebrates in southwest Alaska, there is little competition for prey resources due to the limited overlap between the geographic distribution of sea otters and fishing effort. In addition, the total commercial catch of prey species used by sea otters is relatively small (Funk 2003). Sea otters are sometimes taken incidentally in commercial fishing operations. Information from the 2011 NMFS List of Fisheries indicates that entanglement leading to injury or death occurs infrequently in set net, trawl, and finfish pot fisheries within the range of the southwest Alaska DPS of the northern sea otter (76 FR 73912, November 29, 2011). During the summers of 1999 and 2000, NMFS conducted a marine mammal observer program in Cook Inlet for salmon drift and set net fisheries. No mortality or serious injury of sea otters was observed in either of these fisheries in Cook Inlet (Fadely and Merklein 2001). Similarly, preliminary results from an ongoing observer program for the Kodiak salmon set net fishery also report only four incidents of entanglement of sea otters, with no mortality or serious injury (Manly et al. 2003). Based on Kodiak fisheries data, coupled with self-reporting records from the Bering Sea and Aleutian Island ground fish trawl fishery, it is estimated that fewer than 10 sea otters per year might be killed or seriously injured as a result of entanglement with fishing gear (USFWS 2008b)

Commercial Over-utilization -- Sea otters have rebounded from the estimated 1,000–2,000 individuals that were left after the cessation of commercial hunting (USFWS 2005). Following 170 years of commercial exploitation, sea otters were protected in 1911 under the International Fur Seal Treaty, which prohibited further hunting. There is no commercial use of sea otters in the United States. Recreational, scientific, and educational use have been regulated under the Marine Mammal Protection Act (MMPA) of 1972.

Development -- Habitat destruction or modification is not known to be a major factor in the decline of the southwest Alaska DPS of the northern sea otter. Development of harbors and channels by dredging may affect sea otter habitat on a local scale by disturbing the sea floor and affecting benthic invertebrates that sea otters eat. As harbor and dredging projects typically impact an area of 50 hectares or less, the overall impact of these projects on sea otter habitat is considered to be negligible (USFWS 2008c). However, the cumulative effect of incremental, small losses of critical habitat may affect the population by removing or reducing the availability of PCEs. See Table 7 for a recent accounting of known habitat impacts.

Table 7. Loss of sea otter critical habitat accounted for under section 7 of the ESA from 2002 to present

Year	Action	Incidental Take Type	Amount	Authorization Type
2002	Chignik Boat Harbor	Impacts to Critical Habitat	10.9 acres	Section 7
2007	Akutan Airport	Disturbance	36 sea otters over the life of the project.	Section 7
2007	Akutan Airport	Impacts to Critical Habitat	<1 acre	Section 7
2008	Southwest DPS Sea Otter Research Intraservice USGS	Disturbance/Lethal	250/ lethal take of one sea otter	Section 10
2009	Southwest DPS - Sea Otter Research Permit Intraservice consultation	Precautionary	No direct take without prior authorization from USFWS. Unquantified incidental take through possible response to emergencies.	Section 7
2009	Kodiak Island Port Lions Harbor Project	Impacts to Critical Habitat	<1 acre	Section 7
2009	Unalaska Carl E Moses Boat Harbor road access project	Impacts to Critical Habitat	<1 acre	Section 7
2010	Unalaska Small Boat Harbor Construction	Impacts to Critical Habitat	19.0 acres	Section 7
2010	Unalaska Airport FAA/ADOT&PF runway extension	Impacts to Critical Habitat	2.2 acres temporary loss (pending recolonization by food resources) and 1.6 acres filled to above MHT	Section 7
2010	King Cove Harbor Improvements	Impacts to Critical Habitat	<1 acre	Section 7
2011	Kodiak Shakmanof Cove Rock Quarry	Impacts to Critical Habitat	2.64 acres critical habitat filled/dredged for a barge landing.	Section 7
2011	Homer to Williamsport to Levelock New Fiberoptic Cable	Impacts to Critical Habitat	~7 acres, temporary impacts only	Section 7
2011	Iliamna Bay Williamsport Dredging	Impacts to Critical Habitat	<1 acre	Section 7
2011	Kodiak St. Herman Bay Upland creation	Impacts to Critical Habitat	<1 acre	Section 7
2012	Perryville Barge Ramp	Impacts to Critical Habitat	0.23 acre fill for barge ramp (permanent impact), additional 0.12 acre fill with dredge spoils (temporary impact)	Section 7

[Top]

Research -- Scientific research on sea otters occurs primarily as annual aerial and skiff surveys. When they occur, they last for very short durations of time. Other research includes capture and handling of individuals. During the 1990s, 198 otters were captured and released as part of health monitoring and radio telemetry studies at Adak and Amchitka (T. Tinker, University of

California at Santa Cruz, in litt. 2003). In the past 5 years, 98 sea otters from the southwest Alaska DPS were live-captured and released as part of a multi-agency health monitoring study (USFWS 2005, 2008b). Accidental capture-related deaths have been rare, with research activities carefully monitored by the Service, Division of Management Authority.

Disease -- Parasitic infection was identified as a cause of increased mortality of sea otters at Amchitka Island in 1951 (Rausch 1953). These highly pathogenic infestations were apparently the result of sea otters foraging on fish, combined with a weakened body condition brought about by nutritional stress. More recently, sea otters have been impacted by parasitic infections resulting from the consumption of fish waste. Necropsies of carcasses recovered in Orca Inlet, Prince William Sound, revealed that some otters in these areas had developed parasitic infections and fish bone impactions that contributed to their deaths (Ballachey et al. 2002, King et al. 2000). Valvular endocarditis and septicemia have recently been isolated as a major, proximate cause of sea otter deaths in Alaska (Goldstein et al. 2009). The majority of these deaths are ultimately related to exposure to and infection from *Streptococcus* bacteria.

Chronic Oiling -- The effects of oil on sea otters include short-term acute oiling of fur, resulting in death from hypothermia, smothering, drowning, or ingestion of toxics during preening. While these acute effects are not disputed, a growing body of evidence suggests that oil also affects sea otters over the long term, with interactions between natural environmental stressors and the compromised health of animals exposed to oil lingering well beyond the acute mortality phase (Peterson et al. 2003). The myriad studies that have been undertaken since the 1989 *Exxon-Valdez* Oil Spill (EVOS) provide the most comprehensive data, by which to evaluate the effects to wild populations of sea otters to long-term, low-level exposure to hydrocarbons (Bodkin et al. 2002, Stephensen et al. 2001). But documenting chronic effects of EVOS on sea otters has been difficult due to lack of appropriate controls combined with the natural variability among affected resources. However, without experimental controls, correlation remains our best inferential tool in assessing the impacts of unpredictable environmental perturbations.

Oil persisting in the habitat and uptake by prey continues to affect sea otter recovery in Prince William Sound (PWS) as sublethal exposure compromises health, reproduction, and survival across generations (Bodkin et al. 2002). Sea otters consuming prey in habitats contaminated by residual oil have a high likelihood of encountering subsurface oil while excavating prey from sediments (Bodkin et al. 2002). Unlike vertebrates, invertebrates do not metabolize hydrocarbons; thus they accumulate hydrocarbon burdens in their tissues (Short and Harris 1996). As such, sea otters are potentially exposed to residual oil through two pathways: physical contact with oil while digging for prey, and ingestion of contaminated prey.

Research has confirmed the persistent exposure of sea otters to residual oil in western PWS. Several authors reported higher levels of a biomarker (P450 1A), which indicates exposure to aromatic hydrocarbons in sea otters sampled from oiled areas of PWS compared to animals sampled from un-oiled areas (Ballachey et al. 2000a; Ballachey et al. 2000b; Bodkin et al. 2002). Chronic, persistent exposure to oil appears to cause reduced productivity and reduced survival of young (Mazet et al. 2001, Ballachey et al. 2003). A comparison of body lengths of sea otters that attained adulthood prior to the spill, relative to post-spill measurements, suggests that food resources were approximately equivalent before and after. These results imply that factors other than body condition are affecting pup survival in western PWS (Ballachey et al. 2003).

Trans-generational effects may arise from direct exposure to a mutagen such as petroleum hydrocarbons, and therefore may be realized long after the contaminant exposure has ceased (Bickham and Smolen 1994). Sea otters are long-lived, with relatively low annual reproductive rates and high annual adult survival; factors that result in reduced reproduction, increased mortality, or increased emigration will eventually lead to depressed population growth rates (Riedman and Estes 1990). Finally, exposure to pollutants such as crude oil may affect sea otters at a variety of levels of organization, beginning with somatic or germinal cell mutations and leading to a cascade of alterations that go beyond the individual or community to threaten the long-term survival of the population (Bickham et al. 2000, Clements 2000).

Range-Wide Trend

Historically, sea otters occurred throughout the coastal waters of the North Pacific Ocean from the northern Japanese archipelago around the North Pacific Rim to central Baja California. Commercial hunting of sea otters began shortly after the Bering/Chirikof expedition to Alaska in 1741. Over the next 170 years, sea otters were hunted to the brink of extinction first by Russian, and later American, fur hunters. Prior to commercial exploitation, the worldwide population of sea otters was estimated at 150,000-300,000 animals (Kenyon 1969, Johnson 1982).

Sea otters were protected from further commercial harvests under the International Fur Seal Treaty of 1911. At that time, only 13 small remnant populations are believed to have persisted. The total worldwide population at that time may have been only 1,000-2,000 animals. Two of these remnant populations (Queen Charlotte Island and San Benito islands) declined to extinction (Kenyon 1969, Estes 1980). The remaining 11 populations began to grow in number, and expanded to recolonize much of the former range. Six of these remnant populations (Rat Islands, Delarof Islands, False Pass, Sandman Reefs, Shumagin Islands, and Kodiak Island) were located within the bounds of the southwest Alaska DPS. Because of the remote, pristine nature of southwest Alaska, these remnant populations grew rapidly during the first 50 years following protection from further commercial hunting.

The available survey data indicates that the sea otter population in southwest Alaska had grown in numbers and re-colonized much of its former range by the mid- to late-1980s. At that time, the sea otter population was believed to have numbered between 92,800 - 126,900 animals in southwest Alaska. Recent survey data indicates that sea otters have suffered drastic population declines throughout much of southwest Alaska during the past 10-15 years. The current population appears to have declined by 60-70%.

Recovery

The sea otter recovery plan is currently in development and is available in draft form (USFWS 2010). The goal of the recovery program is to establish a framework within which recovery actions are undertaken to ensure the long-term survival of the southwest Alaska DPS of the northern sea otter and to control or reduce threats to the species to the extent that it no longer requires the protections afforded by the ESA, and therefore warrants delisting. Although subject to change, full recovery of the southwest Alaska DPS is currently envisioned as a cessation of further population declines with viable numbers of sea otters present throughout the current range of the DPS. Threats to the species will be adequately identified, and will have sufficiently abated to ensure the high probability of the survival of the southwest Alaska DPS for at least 100 years. [Top]

ENVIRONMENTAL BASELINE

Iliamna Bay (including Cottonwood Bay) is a shallow bay with extensive mudflats in the upper reaches and deeper channels extending to the outer entrance. Extensive reefs, shoals, offshore rocks, and islands dot the shoreline near the mouth of the bay. Water in the bay is generally well mixed by tidal currents and has minimal fresh water input, except during periods of high seasonal snowmelt runoff when a fresh water surface layer develops. The observed mean tidal range is approximately 3.75 m and the extreme tidal range is approximately 7.6 m with moderate currents (Pentec and SLR 2012). Seasonal ice is present from January through March in most years and tends to scour the intertidal zone (Pentec 2012a). Chemical analysis of marine waters in Iliamna Bay indicated only minor pollution. Heavy metals and petroleum byproducts were below maximum levels specified by the National Recommended Water Quality Criteria (USEPA 2009) and the more restrictive Criteria Continuous Concentration (SQuiRT) (Pentec and SLR 2012).Turbidity levels have been characterized as “moderate” in both Iliamna Bay and nearby Iniskin Bay; the mean of samples collected in both places between March and November was 15.3 nephelometric turbidity units (NTU), and the maximum measurement was 216 NTU. Comparison of monthly mean turbidities showed that in most months, Iliamna Bay was generally more turbid than Iniskin Bay (Pentec and SLR 2012).

Habitat Features in the Action Area

The important habitat types for listed species in the action area include rocky intertidal habitat, mud and sand flats, and marine subtidal zones. These habitat types provide diverse food resources and shelter for sea otters and Steller’s eiders. Shoreline surveys of Diamond Point were conducted by Pentec Environmental/Hart Crowser, Inc. from 2004 to 2008 (Figure 8; Pentec 2012a, b). This information is paraphrased below and describes the diversity and abundance of life found within the project footprint:

> The intertidal zone of the immediate Diamond Point area is composed of rocky outcrops of boulder and bedrock interspersed with mudflats and pockets of silty sand and cobble. The flatter and firmer mudflats with standing water support substantial patches of eelgrass (*Zostera marina*). Mudflat habitats become more prevalent with decreasing elevation below mean lower low water (MLLW). West of the steep rocky cliffs of Diamond Point, is an extended (approximately 0.8-mile long) reach of pebble and sand beach. The western half of this beach forms a spit and encloses a sheltered lagoon. This lagoon is about 5 acres at high tide, but drains completely at low tide.
>
> Polychaete worms, nemerteans (*Paranemertes peregrine*, ribbon worms), and clams (*Mya sp.* and *Macoma sp*.) were numerous in mudflats. Hermit crabs (*Pagurus hirsutiusculus*) were common in the area. Gastropods and limpets were abundant at upper and middle elevations. Small sculpins were found in shallow surface water. Macroalgae and kelp were found where hard substrates such as a cobbles or boulders were present. Algal diversity was particularly high on the bedrock habitat, with 25 species of mainly ephemeral red algae represented in the 2005 survey. Kelps were dominant in exposed lower-elevation rock habitats. Green sponges (*Halichondria panacea)*, mussels, barnacles (*Semibalanus balanoides*), and their predator, the drill (*Nucella lima)* were also

> present on boulders. A megafauna sample collected in silty sandy/cobble substrates found a high abundance and diversity with 22 taxa contributing to a biomass in excess of 2,364 g/m2.

In summary, the habitat at Diamond Point contains abundant and diverse benthic marine and intertidal species, especially algae, barnacles, clams, polychaete worms, and kelp. Clams are important food resources for listed species in the area; *Macoma spp.* are commonly eaten by Steller's eiders and *Mya spp.* are eaten by sea otters (Doroff and DeGange 1994). Eelgrass and kelp beds are present, but their extent is not known. Eelgrass and kelp are important because they provide habitat for sea otters and other marine organisms. Furthermore, eelgrass and kelp enhance habitat values by increasing habitat complexity and stabilizing sediment with resilient root masses. Diamond Point therefore provides important habitat which supports a diversity and abundance of intertidal plant and animal life, including listed species.

Figure 8. From (Pentec 2012b). Low rock and mud habitat at looking northeast past Diamond Head toward head of Iliamna Bay. July 2005. [Top]

Diamond Point is likely to be more productive than adjacent sections of shoreline. After conducting shoreline surveys in the area, Jon Houghton of Pentec Environmental stated,

> "The biomass of megafaunal species at Diamond Point was an order of magnitude higher than samples collected in other parts of the area. The significantly higher biomass may have been attributed to the heterogeneous habitat type of mixed gravel and cobbles in a sand/mud matrix. The megafauna samples were dominated by bivalves both in number and biomass with the principal genera being *Macoma spp.* and *Mya spp.* A distant second in dominance were the annelid worms,

mainly larger worms from the genus *Nephtys*." (as reported by ADF&G 2009; HDR Alaska, Inc. 2011c).

The shoreline habitat in the action area is dynamic and variable, making it impossible to quantify the long term impacts of the proposed action. Temporal and spatial variation is high in both rocky intertidal and subtidal areas. Vertical zones are dominated by diverse organism assemblages with varied tolerances for exposure and inundation. Algae typically decline in cover and robustness later in summer and the epibiota in the littoral zone may be seasonally destroyed by ice scour. Mud and sand flats populated by deposit feeding organisms such as bivalves, small crustaceans, and polychaete worms are continuously shifting according to wave action and currents. Shoreline surveys conducted by Pentec (Pentec 2012a,b) are useful for characterizing the food resources in the area, but do not provide adequate information to quantify impacts due to the limited number of sample sites and the high degree of spatial variability in Iliamna Bay.

Steller's eiders Status and Distribution in the Action Area

The action area for the proposed Diamond Point quarry is occupied by overwintering Steller's eiders. Eiders generally occur in the action area between mid-November and mid-April only (ABR, Inc. 2012), but birds may be present in lower Cook Inlet as early as August or as late as mid-May (Erikson (1977; Larned 2005). Agler et al. (1995) recorded a total of 435 Steller's eiders in Iniskin Bay and Iliamna Bay during an aerial survey in February 1994. ABR, Inc. collected marine wildlife observations in Cook Inlet as part of baseline studies for the proposed Pebble copper mine. Surveys were conducted via boat and helicopter between June 2004 and December 2009, and more than 100 eiders were observed in each monthly survey conducted between January and April of 2006, 2007, and 2008. They were observed in large numbers adjacent to Diamond Point in the center of Iliamna Bay (Day et al. 2008). Groups of between 30 and 675 individuals were observed (Table 8 and Figure 9) (ABR, Inc. 2010, as reported in HDR Alaska, Inc. 2011c). An estimated 0.8% (around 5 or 6) of these birds are likely to be from the listed population.

Shallow, protected areas elsewhere in Cook Inlet also support wintering eiders. Aerial shoreline surveys concentrated on Kachemak Bay and the western shoreline were conducted in Lower Cook Inlet in 1976 (Erikson 1997), 1994 (Agler et al. 1994), and 2005 (Larned 2005). During a survey flight over Kamishak Bay, 1 April, 1976, Erikson (1977) observed a density of 0.1 Steller's eiders/km^2 , along with 2.7 unidentified eiders/km_2 and 6.1 unidentified sea ducks/km^2, which were "most likely eiders". Erikson (1977) also reported seeing eight Steller's eiders on 10 May around Kalgin Island. Agler et al. (1995) conducted both aerial and boat surveys of Lower Cook Inlet February 1994, and recorded 442 Steller's along the southwest and northwest shorelines of Kachemak Bay; 1,363 Steller's eiders were observed from McNeil Cove to Iniskin Bay. Data from the most recent winter surveys (Larned 2005, 2006a,b; ABR, Inc., 2012) suggest that there are 1,000 to 4,300 birds inhabiting western Cook Inlet including the nearshore waters of Kamishak Bay between McNeil Cove and Iniskin Bay. Larned (2005) documented molting Steller's eiders south of the Iliamna Bay area near the Douglas River on August 29 and September 14, but suggested that the shoals and reefs near the Douglas River in Kamishak Bay are the only important milting habitat for Steller's eiders in Cook Inlet. No designated critical habitat for Steller's eiders is located within the action area.

Table 8. Number of surveys and Steller's eiders seen in helicopter surveys conducted in 2006-2009 within 2 km of Diamond Point as reported in HDR Alaska, Inc. (2011c).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
# of surveys	1	5	6	9	3	1	1	2	2	4	6	5
Avg. eiders	0	86	329	47	0	0	0	0	0	0	0	6
Min. eiders	0	0	0	0	0	0	0	0	0	0	0	0
Max. eiders	0	390	675	300	0	0	0	0	0	0	0	30

[Top]

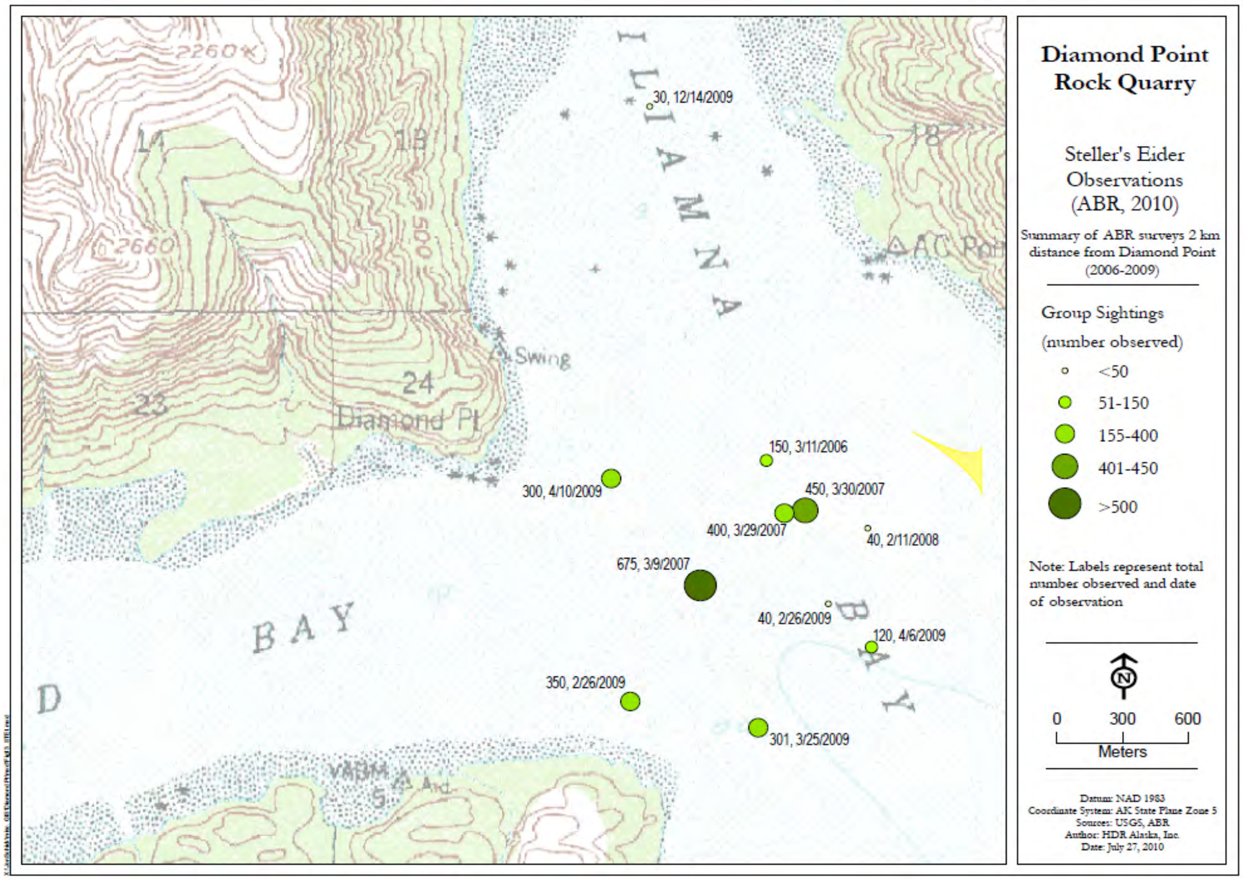


Figure 9. Observations of Steller's eiders near Diamond Point (ABR, Inc. 2010, as in HDR Alaska, Inc. 2011c).

[Top]

Sea Otter Status and Distribution in the Action Area

Sea otters in the action area belong to the Kodiak, Kamishak, and Alaska Peninsula Management Unit (MU). Various surveys have documented otters in western lower Cook Inlet (Schneider 1977, Larned 2005, 2006a, 2006b, Bodkin et al. 2003). The Kamishak Bay subpopulation of sea otters (ranging from Kamishak Bay to Iniskin Bay) was estimated at 6,918 animals (95 percent confidence interval [CI] ± 4,271) in June 2002, with a minimum population estimate of 5,340 (USFWS 2002b, Bodkin 2003).

High numbers of sea otters use Iliamna and Cottonwood bays in winter; while fewer individuals are found here in summer (Bodkin 2007, ABR, Inc. 2012). ABR Inc. collected marine wildlife observations as part of the proposed Pebble Mine baseline studies. Surveys were conducted in Iliamna Bay, Cottonwood Bay, and Iniskin Bay via boat and helicopter between June 2004 and December 2009 (Figure 10). Survey results were presented in Day et al. (2008), ABR, Inc. (2010), and ABR, Inc. (2012). Otters occurred broadly throughout the study area but most otters were found outside Iniskin and Iliamna bays, in offshore habitat and among the islands at the mouths of the bays (ABR, Inc. 2012). Combined counts of sea otters in Iliamna and Iniskin Bays during May 1-October 31 ranged from 0 to a maximum of ~50 observed in May and October 2007. Between November 1 and April 30 each year, survey numbers were commonly >200, up to a maximum of 1,433 recorded in January 2008 (Day et al. 2008; ABR, Inc. 2012). Sea otters have repeatedly been documented on the shoreline next to Diamond Point (Day et al. 2008). The BA reported the presence of up to 39 sea otters within 800 m of the fill area and 112 within 2km of Diamond Point in winter [surveyed by ABR, Inc. (2010), as reported by HDR Alaska, Inc. 2011c)]. Sea otters are mobile animals and have been known to make routine long-distance movements ranging from 35 to 60 miles (57 to 97 km) between high-use areas (VanBlaricom et al. 2001). Animals using Iniskin Bay would easily be capable of traversing the roughly 5 to 10-mile (8 to 16-km) distance to Iliamna and Cottonwood bays. Thus, the limited information available suggests that the total affected population of otters during the winter may be as great as 1,433, and during work season as many as 50 otters.

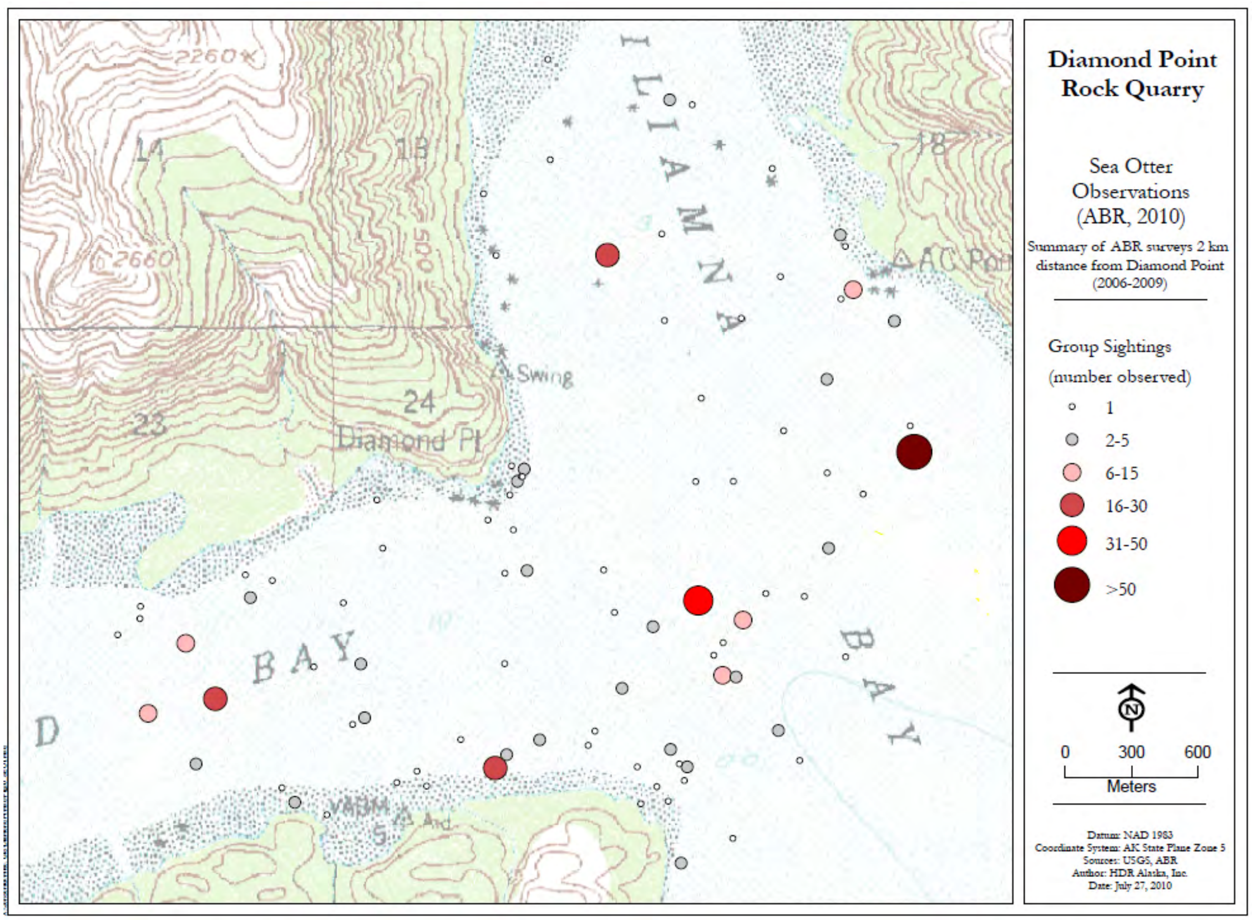


Figure 10. Sea otter observations during surveys conducted by ABR, Inc. between 2006 and 2009, as reported in HDR Alaska, Inc. (2011c). [Top]

No reductions in population levels have been observed among the Kodiak, Kamishak, and Alaska Peninsula MU along the southern coast of the Alaska Peninsula east of Castle Cape (Burn and Doroff 2005), and in lower Cook Inlet (Bodkin et al. 2003). Surveys suggest that numbers between Castle Cape and Cape Douglas, immediately south of Kamishak, have increased between 1989 and 2009 (DeGange et al. 1995, Burn and Doroff 2005, Coletti et al. 2009, USFWS 2010). Although there remains uncertainty about the causes of decline elsewhere in the range, these surveys suggest that the threats to the population in the action area are different and perhaps less severe than those elsewhere.

The action area is important overwintering habitat for high numbers of sea otters, and is thought to be especially important during heavy weather and ice events. Surveys show high numbers of otters in summer near Kamishak Bay and in winter near the mouths of Iniskin and Iliamna bays (Figure 11). The distribution of ice during winter is often heavier in southern Kamishak Bay, and may push otters further north, especially during heavy ice events. Mating usually occurs between October and February (Garshelis and Garshelis 1984), suggesting that Iliamna and Cottonwood bays may also be important breeding grounds.

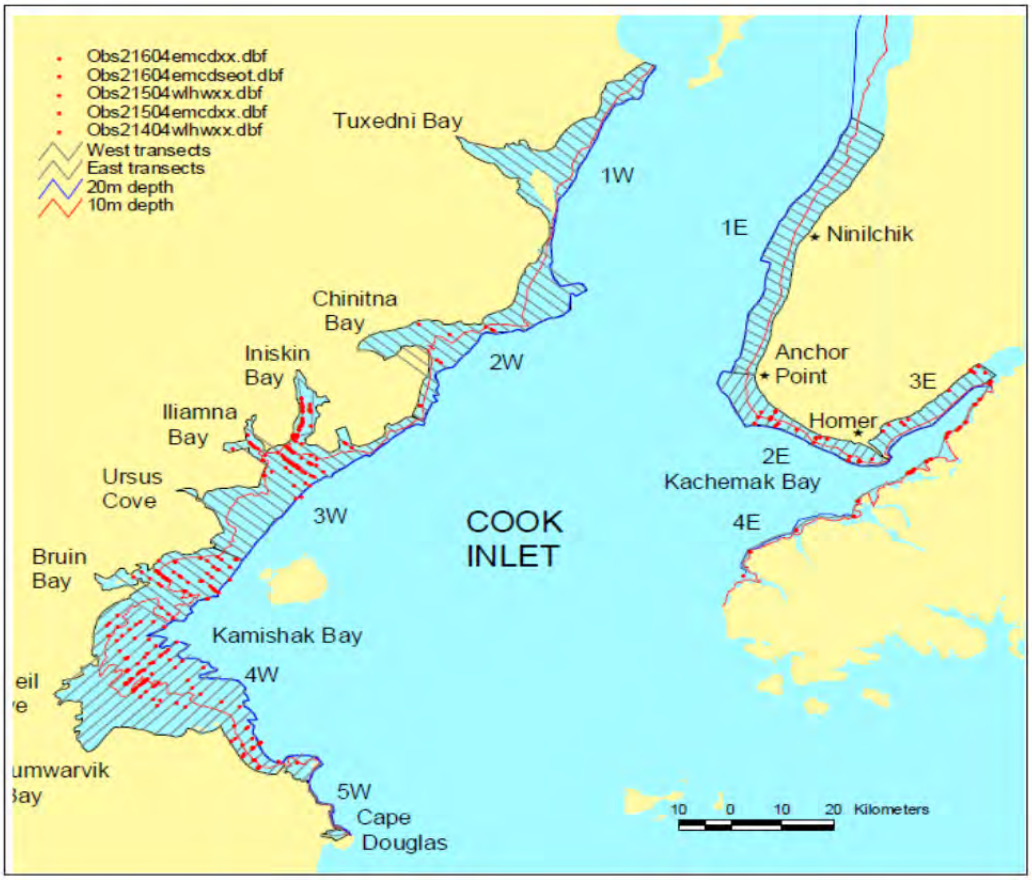


Figure 11. Transect lines and locations of incidental sightings of sea otters observed during an aerial survey for Steller's eiders, conducted February 2004 (Larned 2004). [Top]

The entire action area is designated critical habitat containing PCE 2—nearshore waters within 100 m (328.1 ft) from MHT that may provide protection or escape from marine predators. The remaining PCEs are present within, but not throughout the action area. These include: 1) shallow, rocky areas less than 2 m (6.6 ft) in depth where marine predators are less likely to forage, 3) kelp forests that provide protection from marine predators, and 4) prey resources present in sufficient quantity and quality to support the energetic requirements of the species.

Potential threats in the action area include subsistence harvest, illegal take, and infectious disease. These are considered to be of moderate importance throughout the MU. While habitat is not considered a factor limiting the abundance or distribution of this species, the cumulative effects of habitat loss or degradation due to development, contaminants, or disturbance may affect local populations, especially if their ability to disperse is limited.

Existing Development

Factors affecting listed species' environment in the action area include existing vessel traffic, shoreline development, and impacts to the subtidal and intertidal seafloor. There is currently relatively little shoreline development of the uplands in Iliamna Bay. At the head of Iliamna Bay, a small port site is in operation at Williamsport. Existing boat traffic in Iliamna and Cottonwood bays is generally associated with commercial fishing or the mainly seasonal use of this port. A number of short-term habitat impacts have recently been authorized or conducted: a channel is periodically dredged to provide improved access to Williamsport. In 2011, approximately 9,000 cubic yards of material was excavated from the mudflats at the head of Iliamna Bay to create a 150-foot by 500-foot channel and a 100-foot by 50-foot boat turn. Additional actions in the area include installation of a submarine fiber optic cable along the entire length of Iliamna Bay to expand internet access to southwestern Alaska, and collection of baseline information in the area for the proposed Pebble copper mine.

Climate change

Our analyses under the Endangered Species Act include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). "Climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change

In Iliamna Bay, short-term changes in the ocean climate are likely to continue on a scale similar to those presently occurring. Evidence is emerging that human-induced global climate change is linked to the warming of air and ocean temperatures and shifts in global and regional weather patterns including reduced sea ice cover. Reduced sea ice cover in the Arctic will likely result in increased ocean acidification. Acidification may impact shellfish and other marine organisms that create their shells and other hard parts from calcium carbonate. Sea otters and Steller's eiders rely on these types of organisms for food. It is not clear whether climate change or ocean acidification will affect sea otters or Steller's eiders recovery. [Top]

EFFECTS OF THE ACTION

This section includes an analysis of the direct and indirect effects of the action on listed species and critical habitat together with the effects of other activities that are interrelated or interdependent with the action.

Development and operation of the proposed Diamond Point granite quarry will result in the following impacts to the environmental baseline and habitat features used by listed species:

- Permanent loss of 20 acres of habitat due to placement of fill to construct a fill pad;
- Permanent loss of 2 acres from placement of fill to construct two breakwaters;
- Direct loss of 3 acres of habitat due to initial and annual maintenance dredging and ongoing disturbance due to the use of the area as a barge and boat docking area;
- Potential disturbance by and collisions with vessels;
- Temporary loss of habitat in the transportation corridor when in use by vessels;
- Potential collisions (Steller's eiders only) with guy wires and power lines associated with the installation of upland structures;
- Injury or disturbance associated with noise-generating activities, especially blasting, dredging, pile driving;
- Impacts to habitat through sedimentation into areas adjacent to the fill footprint due to storm water runoff from the quarry, placement of fill, and dredging;
- Exposure to contaminants from periodic releases of small amounts of petroleum contaminants due to spills and leaks; and
- Exposure to contaminants from potentially large fuel spills or other hazardous materials.

Assumptions Used in Analyses of Effects

Proportion of Wintering Steller's Eiders from Listed Population -- Because not all Pacific-wintering Steller's eiders are from the listed population, and because there is currently no way to validate which of the Pacific-wintering Steller's eiders breed in North America, we assume that 0.8% of all Steller's eiders occurring on the wintering grounds in Alaska is from the listed Alaska breeding population (see Molt Distribution for more information).

Factors to be Considered

The probability of Steller's eiders and northern sea otters being harmed or taken as a result of the proposed Diamond Point granite quarry is a function of many factors, including: 1) temporal and spatial overlap of their distributions within the area affected; 2) the nature and duration of effects; and 3) the frequency, intensity, and severity of disturbances.

Temporal and Spatial Overlap

Impacts from quarry development may overlap, both spatially and temporally, with listed species. The work season will occur from May 1-October 31 annually. Steller's eiders will generally migrate out of the area by the end of April, but have been observed in the project vicinity as late as mid-May (Erikson (1977). Direct impacts are therefore likely to be limited to collisions with shoreline structures and cumulative effects of local development. Indirect impacts from habitat impacts will continue after the end of the work season and could therefore affect both eiders and otters. Direct and indirect impacts resulting from the proposed activities will be fairly localized, occurring near the action area. Indirect impacts such as changes in water quality may affect areas outside of the project footprint.

Nature and Duration of Effects

The most likely effects of the project on listed species will arise from placement of fill, quarry excavation, dredging, blasting, and pile driving. These activities will alter habitat, release contaminants (including sediment), and generate noise, which may affect the species' behavior, food resources, and distribution. Injury or mortality could result from collisions with overhead structures or vessels.

Placement of fill in areas of marine intertidal habitat will have direct and indirect impacts to habitat. Fill that creates new surfaces above MHT will cause direct and permanent loss of the existing intertidal habitat. Annual excavation of dredge basins will cause permanent habitat degradation in those areas. Existing habitat adjacent to fill will be permanently altered. Altered habitat will not initially provide food resources for listed species, but may eventually become productive habitat after marine organisms have colonized the new substrate. Placement of fill also has the potential to alter shoreline hydrology and result in impacts to alongshore sediment transport. Changes in erosion or depositional patterns may alter the substrate composition, resulting in shifts in benthic aquatic communities (Feder and Burrell 1982).

Excavation, placement of fill, use of construction equipment and marine vessels, and blasting may introduce contaminants including sediments and petroleum hydrocarbons into marine waters, resulting in degradation of foraging habitat, reduced food resources, and/or reduced survivorship of listed species. Impacts to water quality from dredging and fill placement will cause discrete, short-term effects. Release of contaminants such as runoff and hydrocarbons is expected to be ongoing, with increased impacts during the work season.

Excavation and placement of fill constitute noise-generating activities with the potential to affect wildlife. Use of explosives at the quarry site will result in airborne noise levels which may be sufficient to cause injury if an animal were in the immediate area. Use of heavy equipment and the placement of fill material along the shoreline may cause underwater and airborne noise levels sufficient to disturb animals and to prevent normal behaviors such as feeding, seeking shelter and resting. Noise impacts from construction will be temporary and short term, but may occur at any time in the work season.

Frequency, Intensity and Severity

Potential effects of the project are generally expected to be localized. The duration of the various impacts will be temporary or ongoing. The frequency, intensity, and severity of effects of the action will differ for the various types of impacts.

Types of Effects

Disturbance from Vessel Traffic and Onshore Activities

Otters and eiders are not regularly exposed to a high degree of human disturbance in the project area. The proposed action would increase such exposure; vessel traffic and onshore activities would increase compared to current levels. Large-capacity barges would be used to transport the granite rock material to market. Approximately 10 to 15 round trips per month would be expected during quarry operations. An additional amount of traffic by smaller boats and skiffs would also occur. Sea otters would be subjected to increased exposure to vessel traffic and onshore activities year-round, but Steller's eiders would not generally be present during the May 1 to October 31 work season and would therefore not be directly affected.

Collisions

Development of a granite quarry at Diamond Point could result in death of Steller's eiders due to collision with construction equipment, vessel rigging, guy wires, or overhead towers or lines. Steller's eiders typically fly low (8-28 m above ground/sea level) and fast (84 km/h on average) over water and along the shoreline. They occasionally also fly over land (Day et al. 2004, Boisvert and Sanzenbacher 2011). It is believed that Steller's eiders migrate from Cook Inlet to Bristol Bay following one or more likely routes, one of which is via Lake Iliamna. These flight patterns and behaviors put Steller's eiders at risk of collision with overhead structures on land near the Iliamna Bay shoreline. The risk of collision may be increased if powerful lights are used to illuminate quarry activities on the shoreline. Steady burning bright white or red lights attract night migrants (Gehring et al. 2009). Such collisions have occurred elsewhere: two Steller's eiders died from colliding with power lines along the coast near Naknek (Russell 2004). However, the intensity of the risk is low; the quarry will not be in operation during the winter when eiders are present. Thus, if lighting is used, its impacts it will be minimal.

Collisions between vessels and sea otters may occur. Sea otters occupy waters up to 91 m deep (300 ft, 50 fathoms) and spend several hours a day foraging. Their presence in the marine waters of Iliamna Bay will put them at risk of collisions with vessels. Barge traffic associated with the project is not likely to cause collisions because sea otters will quickly swim away from slow moving barges. However, smaller, fast-moving passenger vessels, including skiffs, pose more of a risk to otters. The Corps has agreed to include the Service's Boat Operation Guidance to Avoid Disturbing Sea Otters (Appendix B) as an advisory to the CWA section 404 authorization for this project to help reduce the risk of vessel collisions.

Noise Impacts

During the May 1 to October 31 work season, quarry activities will produce an increase in noise levels above the ambient conditions in Iliamna Bay. Steller's eiders will not generally be present in the action area during the work season, and will not likely be affected by noise. Sound pressure levels may reach levels that are harmful to sea otters. Noise levels are considered harmful if they cause physical injury or hearing loss, or if they cause biologically significant behavioral effects that impact reproduction or survival. The available scientific literature suggest that pile driving and blasting in the marine environment causes short term behavioral and/or physiological impacts in marine mammals, such as altered headings; increased swimming rates; changes in dive, surfacing, respiration, feeding, and vocalization patterns; and hormonal stress production (Southall et al., 2007). In extreme cases, hearing may be damaged, growth may be slowed and reproduction suppressed.

In this assessment, sound intensity is measured as the sound pressure level (SPL) in decibels (dB). The decibel scale is a logarithmic response, which results in a doubling of sound intensity for each 10 decibel increase. Decibels are given relative to a standard reference level. Reference levels are re: 1 μPa for underwater sound and dB re: 20 μPa for aerial sound. The dB root-mean square (dB RMS) is presented wherever possible. It is calculated as the square-root of the mean-squared pressure of a waveform and is used to describe the mean variance (often loosely referred to as the "mean power") of a sound event. A-weighting (symbolized as dBA) may also be used, and indicates that the dB level has been weighted to emphasize frequencies audible to humans. The equivalent sound level (Leq) is the average sound level over an extended period of time, usually a day.

Ambient noise levels in the area of Williamsport, and Iliamna and Iniskin bays are predicted to range from below 30 dBA Leq to over 60 dBA Leq. During winter, when no humans are in the area, typical noise levels are predicted to range from 28 to 32 dBA Leq (Michael Minor & Associates 2012). High intensity noise-generating work that will be conducted at the quarry includes pile driving, blasting, dredging, and placement of fill. Lower-level noise production will result from drilling, rock crushing, barge traffic, equipment operation, and general activities. High intensity, acute noise including blasting, pile driving, placement of fill, and dredging may cause bodily damage or hearing impairment to sea otters. Low-level noise (e.g., airplane and vessel traffic, use of generators and construction equipment) may cause disturbance or displacement from the project area.

The project will likely generate ongoing noise in the 110-120 dB range associated with use of heavy machinery such as dump trucks. In-water noise levels may be similar to those estimated by NOAA (2008) for work at the Port of Anchorage. In that evaluation, impact pile driving sound production was estimated to be approximately 177 dB re: 1 μp at 19 meters from the source, and vibratory pile driving was 162 dB re: 1 μp at 20 meters. Table 9 provides information summarized by NMFS (2009) for impacts of underwater noise sources include pile driving, vessel operations, and dredging in Cook Inlet.

Frequencies produced will be audible to otters. Controlled sound exposure trials on southern sea otters suggest that otters can hear a range of frequencies between 0.125 and 32 kHz (Ghoul and Reichmuth 2012). Although peak sensitivities are not known, southern sea otters displayed behavioral responses to underwater sounds between 10-40 kHz (Wendell 1995). Dominant frequencies of southern sea otter vocalizations are between 3 and 8 kHz, with energy extending above 60 kHz (Ghoul and Reichmuth 2012, McShane et al. 1995). Pile driving creates frequencies between 0.020 kHz and 12 kHz with pulse energy peaks in the range of 0.050–2 kHz (Blackwell 2005, Illinworth & Rodkin, Inc. 2007). Frequencies generated by blasting depend on the type of explosion, but some peak decibel levels reported during blasting (2 Hz to 200 Hz) overlap with the audible range of the southern sea otter (>125 Hz).

Several measures will be in place to reduce noise impacts. A trained observer will halt noisy activities if a sea otter or Steller's eider is observed (see Appendix B). Ramp-up procedures will be conducted prior to pile-driving, and whenever an otter is within a 300-m radius from project work for dredging and fill placement, to allow animals to leave the area prior to exposure to maximum noise levels. For vibratory hammers, a "soft start" technique will initiate noise from the hammer for 15 seconds at reduced energy followed by 1-minute waiting period and repeat the procedure two additional times. Blasting noise would be reduced at the source by use of in-hole detonators for initiation and adequate burden and stemming. Blast monitoring will be conducted using portable instrumentation to assure that noise and vibration velocities are minimized.

Table 9: Summary of sound generation by various projects in Cook Inlet (NMFS 2009)

Noise Source	Frequency Range (Hz)	Noise Level from Source	Reference
Small vessels	250 – 1,000	151 dB at 1 m	Richardson et al. 1995
Tug docking gravel barge	200 – 1,000	149 dB at 100 m	Blackwell and Greene 2002
Container ship	100 – 500	180 dB at 1 m	Richardson et al. 1995
Dredging operations	50 – 3,000	120 – 140 at 500 m	URS Corporation 2007
Impact driving of 36-inch piles at Port MacKenzie	100 – 1,500	190 dB RMS at 62 m	Blackwell 2005
Vibratory driving of 36-inch piles at Port MacKenzie	400 – 2,500	164 dB RMS at 56 m	Blackwell 2005
Impact driving of 14-inch H-piles at the Port of Anchorage	100 – 1,500	194 dB PEAK at 19 m	URS Corporation 2007
Vibratory driving of 14-inch H-piles at the Port of Anchorage	400 – 2,500	168 dB RMS at 10 m	URS Corporation 2007
Dropping of sheet piles (stabbing) at the Port of Anchorage	data not available	123 dB RMS at 64 m	Scientific Fishery Systems, Inc. 2009
Use of hairpin weight on sheet piles at the Port of Anchorage	data not available	165 dB RMS at 100 m	Scientific Fishery Systems, Inc. 2009

Contaminants

Releases of contaminants into the marine environment are certain to occur due to the development and operation of the Diamond Point quarry. Contaminants may be released into Iliamna Bay directly during placement of fill or settling of dust, or may be carried into the bay in storm water runoff and snow melt. Small amounts of diesel fuel, oil, gasoline, hydraulic fluids, and other hydrocarbons are likely to be released due to the intensive use of heavy equipment and marine vessels. Spills may occur during equipment operation, refueling, or maintenance activities, and are most likely to be caused by operator error or equipment failure. Annual dredging activities to maintain docking basins may re-suspend and redistribute pollutants within and near the immediate project site.

Acids, metals, and hydrocarbons

Contaminants could be released into the marine environment when quarry materials are placed in the intertidal and subtidal areas for development of the fill pad. The high-quality granitic rock at Diamond Point is derived from igneous parent material. It is not expected to generate acid or release high concentrations of heavy metals when quarried (USACE 2010; HDR Alaska Inc. 2011c). However, some increase in the baseline levels of naturally occurring contaminants is expected. Baseline levels were sampled between 2004-2008 (SLR Alaska Inc., 2012; Pentec and SLR 2012) using sediment sampling, water testing, and analysis of tissue samples from a variety of organisms. Mussels were tested for inorganic compounds, PAHs and AHCs. Mussels are sessile filter feeders and can demonstrate bioaccumulation of waterborne contaminants over time. Sampling indicated low levels of metals, trace elements, and hydrocarbons present in water and marine sediments in Iliamna and Iniskin Bay, including zinc, iron, aluminum, manganese, polycyclic aromatic hydrocarbons (PAHs) and aza-heterocyclic compounds (AHCs). But sampling did not show evidence of substantial contamination from human activity or bioaccumulation by marine organisms. Sources of PAHs were not identified; they may be naturally occurring or may be released from vessel traffic in Iliamna Bay or brought in with incoming tidal currents from Cook Inlet.

The most likely source of contamination will be from fuel spills. The risk that the project would result in an acute large fuel or oil spill is low, but there is a high probability that a spill of some magnitude will occur in the action area. Small spills (less than 5 gallons) will certainly occur periodically. Between January 1, 1992 and August 30, 2006 there were 295 minor oil spills reported from vessels operating in Cook Inlet (Eley 2006). Small spills in harbors and docking areas are common. Information reported from 10 harbors in southwest Alaska between 1990 and 1999 showed that 26.3% of spills were one gallon or less, 42% were between one and 15 gallons, 30.3% were 15 to 500 gallons, and 1.5% were greater than 500 gallons in size (Day and Pritchard 2000). Low levels of fuels, lubricants, anti-fouling paints, etc. released in small spills and leaks may accumulate in the project area over the life of the project.

Storm Water Pollution Prevention Plans (SWPPPs) for construction and operations will be implemented to reduce the probabilities and impacts of spills. These plans will specify best management practices (BMPs) to reduce the potential for release of hydrocarbon contaminants. In-water work will be effectively isolated to contain and minimize redistribution of contaminants contained in seafloor sediments. Spill response equipment will be kept on-site. Anchor points for oil spill containment booms will be established and constructed within the docking area to facilitate rapid boom deployment in the event of an on-water fuel spill from a vessel.

Sedimentation

The proposed action will likely result in long-term impacts to habitat due to recurrent releases of sediments into the marine environment and disturbance of existing seafloor sediments. The extent of impact will depend on the timing, duration, and frequency of activities. Initial development will likely cause periods of heavy sediment loading and reduced water quality during and shortly after fill placement and dredging. After the fill pad and dredge basin are complete, runoff, fill pad maintenance, and maintenance dredging will continue to disturb the seafloor and cause periodic increases in turbidity. Dredging of basins in the seafloor can result in lowered current velocities, favoring deposition of fine particles in and near the dredge area (Kaplan et al. 1975). The increased potential for entrapment of suspended materials may make the need for maintenance dredging self-perpetuating (Palmer and Gross 1979).

Impacts from sedimentation can extend much farther than the project footprint and can occur beyond the initial disturbance event. Currents, tides, and storm events affect the dispersal and settlement patterns of sediment-laden water (Hellier and Kornicker 1962, Taylor and Saloman 1968). Construction of a breakwater may affect the water circulation patterns and permanently alter alongshore sediment transport patterns (EPA 1976). Recurring sedimentation will prevent some benthic organisms from recolonizing the affected areas.

Sedimentation will likely affect biological productivity; increased turbidity can reduce dissolved oxygen concentration through increased biochemical oxygen demand (Brown and Clark 1968, Simon and Dyer 1972). Suspended sediments in the water column impair light penetration, resulting in reduced primary production (Simon and Dyer 1972). Reduced light penetration in shallow areas may limit photosynthesis (Etherington et al. 2007), causing reductions in seagrass populations (Simon and Dyer 1972). High turbidity and sedimentation can affect filter feeders such as mollusks by smothering them or overloading their ability to separate food from sediments. Increases in turbidity can block efficient respiration; high levels of suspended materials may harm fishes by clogging gill filaments and filling the opercular cavity (EPA 1976). Coarse particles in suspension may harm organisms through abrasion (Sherk 1971), causing increased susceptibility to parasites or disease (Everhart and Duchrow 1970). Settlement of most invertebrate larvae is impeded by covering natural substrate with silt particles (Grigg 1970). The most likely effect of sedimentation in Iliamna Bay is a decline in the abundance of sessile benthic organisms, followed by a shift in species assemblage and distribution adjacent to the project footprint.

The spatial extent of impacts from sedimentation during fill placement and dredging may be reduced through use of silt curtains or other sediment control techniques. Construction and operation SWPPPs will be in place to reduce the extent of impact.

Impacts to Food Resources

Food resources are the major habitat component that will be affected by the proposed action. Fill placed in the intertidal and subtidal shoreline will bury the benthic invertebrates eaten by otters and eiders within the 25-acre footprint. Food resources will be permanently lost from all areas filled to levels above MHT. Food resources in docking areas will be permanently reduced in quantity or quality relative to that in undisturbed areas due to repeated dredging. Petroleum hydrocarbon contamination from spills and leaks can degrade food sources by being ingested through the food chain or by reducing the availability of food resources (Zhadan and Vaschenko 1993). Exposure to diesel fuel has been shown to reduce the reproductive success of sea urchins (Zhadan and Vaschenko 1993). Activities causing high sediment loading are also likely to degrade food resources or cause shifts in invertebrate species assemblages (Newell et al. 1998). A short-term loss of food resources will occur on the side slopes of newly-placed fill remaining below MHT, although these areas are expected to be recolonized.

The effects of sedimentation on food resources will be determined in part by sediment transport and settlement patterns, which are influenced by circulation patterns in Iliamna Bay. Little information is available regarding oceanography within Iliamna Bay; therefore, the effects of the proposed project on water circulation patterns are unknown. However, conditions in Iliamna Bay are highly dynamic. Turbidity is generally moderate, but occasionally fluctuate to high levels due to wind and ice conditions (Pentec (2012a). All areas of the bay are periodically subjected to ice scouring, which can remove the macrobiotic benthos in different areas at different times (Pentec 2012a). The prevalence of natural disturbances suggests that the benthic organisms comprising food resources for otters and eiders have evolved in, and are adapted to, their dynamic environment.

Early-successional benthic species are adapted for utilizing disturbed habitats, and will reestablish foraging habitat for listed species in those areas adjacent to the project footprint that are not repeatedly disturbed (i.e., by annual dredging). Studies in temperate systems have shown that algal communities can recover to their previous densities within one year of being denuded (Foster 1975; Milazzo et al. 2004); however, colonization in high-latitude Arctic systems appears to be much slower (Dunton et al. 1982). Konar (2007) estimated that recovery of benthic communities in high–latitude, nearshore rocky environments may take more than 10 years. Benthic species density, composition, and distribution in recolonized habitat may differ from the existing condition due to differences in the chemical or physical characteristics of the new substrate materials. Benthic communities colonizing areas with recurring sediment input will likely have lower densities than unaffected areas or those affected only occasionally.

While the quantities of food resources affected cannot be evaluated, the scale of potential impacts from sedimentation deserves consideration. We developed a simple theoretical analysis to assess the spatial scale of impacts to forage availability. Suspended sediment will be generated and released from localized sources in and near the project footprint. Course sand and gravel is expected to settle out of the water column quickly, leaving fine particles to disperse farther. Therefore, the majority of sedimentation and impacts to food resources will occur directly adjacent to the fill and dredge areas, and decreasing levels of impact will occur further from these areas.

EPA-Australia (2006) estimated that medium sands [250–500Hm] settle at over 3 m/minute in calm water, while coarse sands [500–1,000Hm] settle at over 12 m/minute. Substrate at the benthic sampling stations at Diamond Point consisted of bedrock and boulder/cobble, sand and sandy gravel, and firm and soft mud; grain size was highly variable (Pentec 2012 a). Given that most of Iliamna Bay is <12 m deep, and the average maximum ebb current in Iniskin Bay is approximately 37.2 m per minute (1.2 knots) (Nobeltec 2004 as cited in Pentec and SLR 2012), large and medium-grain sand would settle within 150 m of the fill area in approximately 4 minutes. Fine sand would settle more slowly. Suspended sediments released on the ebb current could travel 300 m in eight minutes. Silt and mud would travel 500 m in just over 13 minutes, and 1000 m in 27 minutes. We used these settlement rates to develop 300-, 500-, and 1000-m “impact zones” around the project footprint. Impact zones are intended to reflect the varying degrees of sedimentation and the gradient of effects to benthic organisms that is likely to develop as distance increases from the source of the sediment discharge near the project footprint.

Several authors have described patterns of zonation of species associated with sedimentation discharges; see Airoldi (2003) for a review.

We assumed that a 100% loss of food resources would occur within the project footprint. The footprint includes 20 acres of fill placement in intertidal and subtidal habitat; 2 acres of fill placement for a breakwater; and 3 acres of habitat due to initial and annual maintenance dredging. These areas will be filled to above MHT and will not continue to provide food resources to eiders or otters. We assumed that 50% of food resources would be lost in areas within 300-m of the fill footprint. This is likely to be an overestimate for the amount of seafloor affected by sedimentation in the 300-m zone overall, but areas within this zone may experience this degree of impact. Schroeter et al. (1993) reported that discharges of turbid water from a nuclear power plant caused sedimentation that over time covered more than 40% of the seafloor at 400 m from the source. The proposed project will result in periodic releases of sediment that are relatively small compared to the large, frequent discharges described in Schroeter et al. (1993), suggesting a lower overall level of sedimentation. An estimated 50% loss of food resources is likely an overestimate because it does not account for recolonization. However, in order to assure that this analysis of impacts will err on the side of the species (as required by the ESA), it is preferable to overestimate, rather than underestimate, the degree of food resources lost. Similarly, a 25% and 10% loss of food resources was assumed to occur out to 500 m and 1,000 m, respectively.

This is a very simplistic model of the actual amount of impact due to sedimentation, but is useful for demonstrating the spatial scale of potential impacts. Actual settlement rates will depend on the amount of sediment, weight, and grain size, in addition to other factors (Woolnough et al. 1995). Likewise, the resulting loss of food resources in each zone will depend on unknown parameters, including the volume of sediment released, the characteristics of fill materials and local substrates, specific methods used, timing of activities in relation to tide stage, and the use and effectiveness of in-water isolation devices, and the community structure in any given area of the affected benthic environment. Despite the uncertainty, the “impact zone” model (Figure 12) is useful for demonstrating the potential scale of impacts.

Sea otters -- To estimate the amount of sea otter habitat affected, we calculated the total area affected in the impact zones as a proportion of the action area. The action area consists of Iliamna Bay, inclusive of Cottonwood Bay, ending at the mouth of Iliamna Bay at a line drawn just east of North Head to South Head (Figure 12). The action area was estimated using a GIS area calculator to include 6,706 acres at high tide. The area affected in each impact zone was calculated using a concentric ring buffer tool in GIS. We then multiplied the area of that zone by the theoretical proportion of food affected to determine a coarse assessment of acreage of food resources affected in each zone (Table 10). Summing the area of food resources affected yielded 176 acres, or less than 3% of the action area (176/6,706=0.026).

In this assessment, we assume that the total acreage in the action area serves as sea otter habitat. Although sea otters may be found throughout the action area, they often show higher use of shorelines due to greater abundance and diversity of food resources. To consider the spatial scale of the project’s effects on shoreline habitat, the same model was applied to length of shoreline (Table 11). The length of the shoreline in the action area was measured from a 1:63,000 scale GIS layer (ADNR 1998) to be 25.28 miles at MHT (excluding islands for simplicity). The spatial scale of impacts to food resources was therefore estimated to be 0.9 miles, or approximately 3.6% of the available shoreline habitat in the action area (0.901/25.28=0.036).

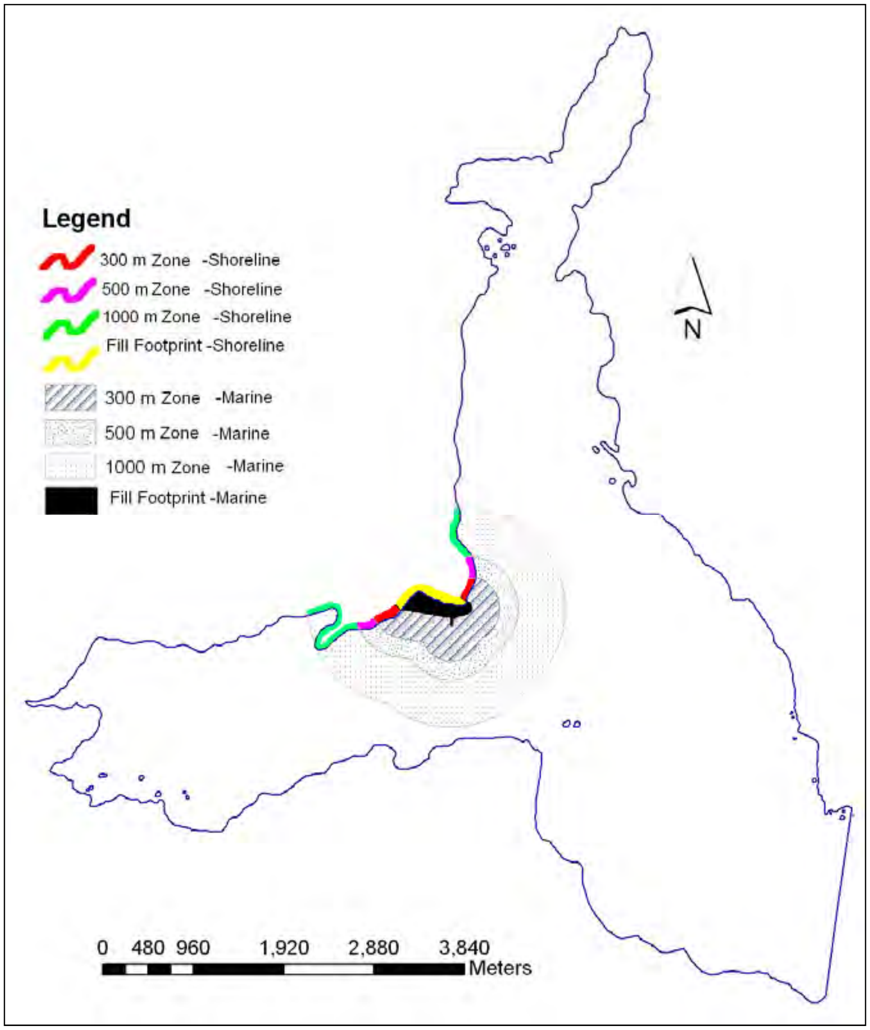


Figure 12. Iliamna Bay showing footprint of Diamond Point project and impact zones. 100% of sea otter and Steller's eider food resources will be affected within the fill footprint. Lesser degrees of impact will occur farther from the project footprint. [Top]

Table 10. Analysis of spatial scale of impacts: Intertidal and Subtidal Area

Radius from project footprint (meters) "Impact Zone"	Area (acres) excluding footprint and smaller zones	% Area affected	Area (acres) of food resources affected
Footprint	25	100	25
300	123	50	61.5
500	130	25	32.5
1000	572	10	57.2
		Total	176.2

Table 11. Analysis of spatial scale of impacts: Shoreline Length

Distance from project footprint (meters): "Impact Zone"	Length of shoreline within the "Impact Zone"	% Food affected	Length of shoreline food resources affected
Footprint	0.55	100	0.55
300	0.33	50	0.165
500	0.24	25	0.06
1000	1.26	10	0.126
		Total	0.901

[Top]

Steller's eiders -- We assumed that the assessment of impacts to the total acreage in the action area could serve as a reasonable proxy for impacts to suitable habitat. This assumption is appropriate for sea otters because they may be found throughout the action area. Steller's eiders, however, are commonly found in the center of Iliamna Bay, indicating infrequent use of the shallow intertidal zones. In order to consider the impacts to the spatial extent of Steller's eiders food resources, we applied the same analysis to the areas below the mean low tide line only. Acreage within the action area below low tide was calculated from a bathymetric GIS layer (NOAA 2005) to be 4,506 acres. The area of impact was calculated in the same manner as for the high tide assessment, yielding an estimated 3.9% (4,506/176=0.039).

This analysis demonstrates that the extent of impacts is likely to be small in relation to the habitat available to listed species. Additionally, some recolonization is expected. Both Steller's eiders and sea otters are forage generalists and are likely to utilize the food resources that become established on the new fill surfaces and in areas subject to increased sedimentation. Reduced food availability is likely to cause species to disperse to unaffected areas.

Impacts to Critical Habitat

This evaluation does not rely on the regulatory definition of "destruction or adverse modification of critical habitat" at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete this analysis with respect to critical habitat.

The Diamond Point quarry will result in an immediate and permanent loss of 25 acres of critical habitat designated for the northern sea otter. Loss will occur from placement of fill in the marine environment. Areas within the fill footprint that will be filled above the MHT will no longer be capable of providing marine or intertidal habitat and thus will be permanently and irrevocably eliminated as critical habitat for sea otters. In addition to the permanent loss of habitat, the project will also have indirect impacts to sea otter critical habitat. Areas of fill below MHT and in dredge basins and docking areas will be permanently altered. The habitat value of these areas may be degraded due to ongoing sedimentation or repeated dredging, but if left undisturbed will likely be able to provide habitat for sea otters after a period of recovery.

The probable impacts to critical habitat are important if they affect the biological and physical features that are essential to the conservation of the species, that is, if they affect the PCEs. Shallow rocky areas less than 6.6 ft (2 m) deep (PCE 1) and within 328 ft (100 m) of MHT (PCE

2) will be altered by fill placement. The physical location of the shoreline will be moved southward into Iliamna Bay. The shoreline will be armored using riprap. Construction of the fill pad and breakwaters will lengthen the shoreline at MHT and change the shoreline characteristics: the slope of the fill will create a steeper shoreline than the existing conditions. Overall, the physical effects of the project on PCEs 1 and 2 will be a permanent loss of 25 acres and permanent modification of additional adjacent areas of critical habitat.

Like rocky shallow areas and nearshore habitat, kelp forests that occur to a depth of 65.6 ft (20 m) (PCE 3) also provide escape cover from marine predators. Kelp is also used for resting habitat (Kenyon 1969; Riedman and Estes 1990) and for defining and establishing territories (Riedman and Estes 1990). California sea otters use kelp for pupping and for nursery habitat (Jameson 1983); Alaskan otters do so also. Kelp forests are also associated with food resources used by sea otters.

The proposed quarry development will result in loss of kelp habitat from areas filled to elevations above the MHT (Houghton and Starkes 2008, as cited in HDR Alaska, Inc. 2011c). Kelp may recolonize in affected areas below MHT, such as side slopes and adjacent to the fill footprint area, in a relatively short period, or may not be reestablished at all. While kelp was dominant on lower-elevation rock habitats at more exposed locations in Iliamna Bay, it was found only occasionally at Diamond Point during sampling (Pentec 2012a). The amount or extent of kelp in and adjacent to the project footprint is not known, but is not expected to be high. The effects on sea otters will likely be minimal, because affected sea otters will likely move to areas with intact kelp beds.

The fourth PCE (prey resources within the areas identified by PCEs 1–3 that are present in sufficient quantity and quality to support the energetic requirements of the species) are present in the project area and are likely to be directly and indirectly affected by the proposed action. Impacts to food resources may affect sea otter survival and reproduction. Effects to food resources are described in detail under the Impacts to Food Resources section.

In addition to the PCEs, other important features can affect the conservation value of critical habitat. These features include haul outs or rest sites and pupping/nursery habitat. Shoreline areas used as haul-outs that are protected from predators and human disturbance are also likely to be important for sea otters. Although no aspect of their life history requires leaving the ocean, sea otters are known to haul out in rocky shoreline areas to rest and groom—especially in winter (Riedman and Estes 1990). Alaskan otters haul out more frequently than those in California (Kenyon 1969). This suggests that use of haul-outs may help them to conserve energy compared with in-water activities (Maldini et al. 2012). Given their high metabolic demands, periods of rest with low energy loss may be critical to survival. In addition to haul outs, other important habitat areas include areas used for pup-rearing. The foraging patterns of females with young are influenced by the age of their dependent offspring (Garshelis and Garshelis 1984). The use of haul outs near the project site may be reduced due to disturbance, but this is not expected to be problematic given the abundant availability of alternate haul out sites nearby. There is no information available that suggest that the shoreline areas affected by the proposed project provide pupping areas for sea otters.

Analysis of Effects to the Species

Disturbance from Vessel Traffic and Onshore Activities

Steller's eiders show variable degrees of tolerance to shoreline activities and vessel traffic. They commonly overwinter in areas of high activity near the Homer spit and the Unalaska airport and do not flee in response to human activities on adjacent shorelines, but are sensitive to boat traffic in Izembek Lagoon. In a study of responses of wintering waterfowl to boat traffic, Ward et al. (1996) found that Steller's eiders flushed when boats came within 300 m. Disturbance from shoreline activities or boat traffic can cause Sellers's eiders to fly away from preferred foraging and resting sites, thereby disrupting foraging or resting periods. Disturbance of sufficient frequency, duration, or severity can lower individual fitness through increased time spent in flight and reduced time spent feeding or resting. However, because the Applicant has proposed construction and operation to occur between May 1 and October 31 each year, the probability of disturbance to overwintering Steller's eiders is low.

Sea otters generally show a high degree of tolerance and habituation to shoreline activities and vessel traffic (Suzann Speckman, USFWS, Marine Mammals Management, pers. obsv.), but disturbance may cause animals to disperse from the local area. Populations of sea otters in southern Alaska have been shown to avoid areas with heavy boat traffic, but return during seasons with less traffic (Garshelis et al. 1984). Sea otters have shown signs of disturbance in response to survey vessels: e.g., sea otters swam away from approaching vessels; hauled-out otters entered the water; resting or feeding otters began to periscope or dive; and groups of otters scattered in different directions (Udevitz et al., 1995). However, sea otters off the California coast showed only mild interest in boats passing within hundreds of meters (Riedman 1983), and Curland (1997) found that sea otters in California became habituated to boat traffic. Their behavior is suggestive of a dynamic response to disturbance, abandoning areas when disturbed persistently and returning when the disturbance ceased. Sea otters reacting to vessels consume energy and divert time and attention from biologically important behaviors such as feeding. Some degree of disturbance from vessel traffic associated with quarry development and operation is probable. But otters may habituate. Furthermore, because operations are limited to the summer season when otter numbers are lower, we expect a reduced probability that vessels will encounter large concentrations of otters.

Collisions

Steller's eiders may collide with construction equipment stored onsite during the overwintering period, guy wires, towers or lines installed along the shoreline. Use of bright lighting would increase the probability of a collision compared to baseline conditions, but it may also allow Steller's eiders to become habituated to the presence of the equipment. Although there is no specific evidence associating lighting conditions with habituation, habituated birds near Unalaska and Homer occur in areas where bright lights area commonly used. Habituated birds would presumably be less likely to collide with the equipment. Although the probability of injury or death of an eider due to collision is impossible to accurately project, it is expected to be so small as to be discountable. Therefore **no direct lethal take is likely to occur from collisions with equipment.**

Sea otter collisions with vessels associated with the proposed project are unlikely. Tugs and barges are slow moving and pose little risk of colliding with otters. Collisions between sea otters and fast-moving passenger vessels do occur but are infrequent and unusual. The risk of collision will be reduced by the Corp's inclusion of the Service's guidelines for avoiding sea otters (Appendix B) as an advisory in the section 404 CWA authorization. Therefore, **no direct lethal take of sea otters is anticipated to occur due to the low probability of collisions with vessels.**

Noise Impacts

We evaluated whether sound produced by proposed quarry activities at Diamond Point will cause take of sea otters or Steller's eiders, as defined by the ESA. We evaluated the possibility that take will result from "harm," where harm is defined as any level of physical injury. Potentially harmful "noise-generating work" includes pile driving, blasting, in-water dredging, and in-water placement of fill. These activities will occur only between May 1 and October 31 when Steller's eiders will not normally be present, and are therefore unlikely to be affected by noise. Sea otters may be harmed by loud noises and the associated sound pressure levels. The first physical manifestation of injury from noise is hearing loss, including either recoverable hearing loss (temporary threshold shift: TTS) or permanent threshold shift (PTS). We also evaluated whether sea otters would be disturbed by noise-generating work to such a degree that take from harassment would result. Take may result from harassment if significant disruption of normal behavioral patterns such as breeding, feeding, and sheltering occur.

Harm -- Whether a specific noise source will cause harm to a sea otter depends on several factors, including the distance between the animal and the sound source, the sound intensity, background noise levels, the noise frequency (cycles per second; Hz or kHz), duration, and whether the noise is pulsed or continuous. Because sea otter hearing abilities and sensitivities have not been fully evaluated, we relied on the closest related proxies to evaluate the potential for harm. Noise thresholds established by the National Marine Fisheries Service (NMFS) for injury to pinnipeds provided the closest related proxy. NOAA's thresholds (Table 12) are further described and justified in 70 FR 1871 (NOAA 2005), 71 FR 3260 (NOAA 2006), 73 FR 41318 (NOAA 2008), and Southall et al. (2007).

We determined that pinnipeds are a suitable proxy for evaluation of noise thresholds that may cause harm to sea otters since all marine mammals evolved from terrestrial ancestors and share the same basic auditory structures and most of the same mechanisms (Southall et al. 2007). There are some important differences between mammals such as cetaceans (i.e., whales) that are exposed to sound only in water and those such as pinnipeds, which exhibit in- and out-of water (amphibious) hearing. The differences are related to pressure, hydrodynamics, and sound reception in water (see Wartzok & Ketten, 1999). Sea otters are most similar to pinnipeds with respect to amphibious hearing. They also use sound in the same way (primarily for communication rather than feeding).

Although information is limited regarding the northern sea otter's hearing abilities, the closely-related southern sea otter has been shown to hear a range of frequencies similar to the audible range for pinnipeds. Southern sea otters can hear in-air frequencies between 0.125 and 32 kHz (Ghoul and Reichmuth 2012). This range is similar to that of harbor seals (*Phoca vitulina*; Suborder Pinnipedia) (0.075 to 30 kHz) (Kastak and Schusterman 1998, Hemilä et al. 2006, Southall et al. 2007). Additionally, sea otters and harbor seals both exhibit amphibious hearing and spend a considerable amount of time above water: southern sea otters spend about 80% of their time at the sea surface, whereas harbor seals may spend up to 60% of their time hauled out of the water (Frost et al. 2001).

Table 12: Marine mammal, fish, and marbled murrelet injury and disturbance thresholds for marine construction activity developed by NOAA Fisheries (also known as NMFS).

Functional Hearing Group	Airborne Noise Thresholds	Underwater Noise Thresholds		
	In air Sound Pressure Level (RMS)	Vibratory Pile Driving Disturbance Threshold	Impact Pile Driving Disturbance Threshold	Injury Threshold
Cetaceans	NA	120 dB RMS	160 dB RMS	180 dB RMS****
Pinnipeds	Disturbance: 90 dB RMS (un-weighted) for harbor seals, and 100 dB RMS (un-weighted) for sea lions all other pinnipeds (re: 20 µPa2sec)**	120 dB RMS	160 dB RMS	190 dB RMS****
Fish ≥ 2 grams	NA	Behavior effect threshold 150 dB RMS***		187 dB Cumulative SEL★★
Fish ≤ 2 grams	NA			183 dB Cumulative SEL★★
Fish all sizes	NA			Peak 206 dB
Foraging marbled murrelets	Injury: 92 dBA*	NA	150 dB RMS★	**Auditory Injury** threshold - 202 dB SEL **Non-auditory injury** threshold - 208 dB SEL **Non-injurious hearing threshold shift** zone out to 183 dB SEL ★

* Noise levels measured in air are typically used to assess impacts on humans and thus are weighted (A-weighting) to reduce the contribution of low and high frequencies and correspond to how humans hear. Noise levels measured underwater are not weighted and thus measure the unaltered frequency range of interest, which may extend below and above audible range of many organisms.
**Email dated March 11, 2009 Jaclyn Daly, Fisheries Biologist, NMFS Office of Protected Resources, 1315 East-West Hwy, Rm 3525, Silver Spring, MD 20910. This is the in-air SPL at which pinniped haulout disturbance has been documented.
***Hastings 2002, as cited in BA Manual (WSDOT 2011)
RMS - Root-mean-square: For pile driving, this is the square root of the mean square of a single pile driving impulse pressure event.
****Source: Southall et al. 2007; 71 FR 3260 (NOAA 2006)
★Although listed as a disturbance threshold, the USFWS considers this to be a noise disturbance threshold guideline, not criteria, for foraging marbled murrelets.
★★Source: Memorandum on the Agreement in Principle for Interim Criteria for Injury to Fish from Pile Driving Activities (available: http://www.wsdot.wa.gov/Environment/Biology/BA#Noise)
Potentially useful websites for calculating underwater noise distance to thresholds: Greeneridge calculator: http://www.greeneridge.com/radii.html (data inputs: Range = 10 [if source level, range =1], B = 15, C = 0.003 for marine mammals, C - 0 for fish); Online math calculator: http://www.easycalculation.com/statistics/root-mean-square.php
For pile driving, these are the thresholds that NMFS has determined would result in Level A Harassment (injury) and Level B Harassment (disturbance) to marine mammals, as described in 70 FR 1871 (NOAA 2005), 71 FR 3260 (NOAA 2006), and 73 FR 41318 (NOAA 2008). [Top]

Noise thresholds for marine mammals, as defined by NOAA, are those levels above which exposure will result in Level A or Level B Harassment under the Marine Mammal Protection Act (MMPA). The MMPA defines Level A harassment (Injury) as "any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild." Any action that would constitute Level A harassment would also constitute take due to harm under the ESA. The thresholds established by NOAA for preventing injury to pinnipeds were developed as precautionary estimates of exposures below which physical injury would not occur. Because of their biological similarities and the shared directives of both NOAA and the Service to protect listed species, we assume that thresholds for injury for pinnipeds would also protect sea otters against harm. Therefore, sea otters are likely to be harmed by project work at Diamond Point if at any time they are exposed to any single noise resulting in underwater sound pressure levels above 190 dB RMS**.** However, harm may also result from repeated or continuous exposure to lower noise levels.

NOAA's thresholds for marine mammals are currently being revised to account for the cumulative effects of repeated or ongoing sound exposure. Animals exposed to ongoing exposure to noise levels show higher degrees of hearing loss than those exposed to single, loud noises (Popper and Hastings 2009). New thresholds for fish have been adopted, which recommend use of cumulative sound exposure levels (SEL) in determining impacts. Cumulative SEL provides a measure for the duration of exposure and reflects the amount of energy accumulated by the organism (Hastings and Popper 2005, Carlson, 2007). Kastak et al. (2005) examined repeated underwater exposure among three pinniped species and reported a significant relationship between sound exposure level (SEL) and the amount of threshold shift. Based on these findings, Kastak et al. (2005) indicated that sound exposure levels resulting in TTS ranged from 183 to 206 dB SEL. The Service has adopted 183 dB re 1μPa2-sec cumulative SEL as the interim guidance level for preventing noise impacts to underwater foraging marbled murrelets, as this is currently the onset of TTS for the most sensitive species for which data exists (SAIC 2011). Because a threshold of 183 dB re 1μPa2-sec cumulative SEL is thought to be a protective limit for cumulative effects from noise for pinnipeds (Kastak et al. 2005), fish (Popper and Hastings 2009; Carlson 2007), and marbled murrelets (SAIC 2011), we used this threshold in our analysis for sea otters.

Southall et al. (2007) recommended a 109 dB re: 20 μPa (peak) threshold for airborne noise exposure for pinnipeds based on behavioral responses that could cause stampeding behavior and result in injury to some individuals or separate mothers from pups. Blackwell et al. (2004) and Moulton et al. (2005) documented pinnipeds that did not react to, or showed tolerant behavior when exposed to unweighted airborne sounds as high as 112 dB peak and 96 dB RMS, which suggests that habituation occurred. Based on these observations, an otter's apparent tolerance to noise, and their ability to habituate, we considered110 dB re: 20 μPa RMS as the injury threshold for the sea otters from airborne noise.

Harassment -- NOAA's thresholds for disturbance to pinnipeds were developed from observations of behavioral reactions to loud noises (Berg et al., 2001, 2002; Holst et al. 2005a, 2005b Ljungblad et al., 1988; Malme et al., 1983, 1984, 1988; Richardson et al., 1985, 1986, 1990; Richardson and Malme, 1993). Level B Harassment (disturbance) is defined as "any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering." Behavioral reactions resulting in disturbance occurred when marine mammals changed course, altered their behavior, departed the area, or departed from a haul out site.

Sea otters are sufficiently similar to pinnipeds to assume that injury will occur at similar noise thresholds, but they demonstrate very different behavioral reactions to sound. ESA defines harassment as, "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it *to such an extent as to significantly disrupt* normal behavioral patterns which include, but are not limited to, breeding, feeding, and sheltering" (50 CFR 17.3). Sea otters demonstrate a high degree of tolerance for noise and for shoreline activity. Field tests conducted in Prince William Sound were used to determine whether the playback of artificial sounds could be used to control the movements of sea otters (Davis et al. 1987, as cited in Wendell 1995). In that study, sea otters were not repelled by airborne sound pressure levels of 120 dB at 1 meter or by narrow-band underwater pulses at frequencies of 500 Hz-20 kHz. Davis et al. 1988 also examined responses of California sea otters to sounds to evaluate effective means of moving sea otters out of an area in the event of an oil spill. Random presentation of synthetic sounds (warble tone and air horns) startled the otters, but they habituated within two hours and did not avoid the sound thereafter. The initial reaction occurred within a limited range (100-200 m) and habituation occurred quickly (within hours or, at most, 3 to 4 days).

Given the sea otter's tolerance for noise and ability to habituate, we conclude that disturbances due to noise are not likely to result in take due to harassment. Sea otters are expected to respond to noise levels below that which will cause harm by temporarily increasing vigilance and decreasing feeding. Sea otters may disperse to areas with lower noise levels. These responses may increase short-term energetic needs or reduce food availability for a sea otter, but these impacts are expected to last only as long as it will take an otter to reach an alternate foraging area, and thus will not constitute significant disruption of normal behavioral patterns.

Impact avoidance measures -- Impacts to sea otters and Steller's eiders from noise may be avoided if it can be determined that no animals are present in a "hazard area"— the area in which high noise levels may cause injury—when noise-generating project activities occur. The use of observers is an effective means for reducing potential impacts if the buffer size completely encompasses the hazard area, if project work is only conducted when no sea otters are inside the buffer, and if observers can consistently detect listed species throughout the buffer. The size of the hazard area depends on the amount of noise generated, the sound attenuation rates, and background noise levels. These are influenced by construction methods and equipment, substrate, bathymetry, topography, currents, and tidal movements. The Applicant will use observers to monitor and implement avoidance measures within a suitable hazard area during blasting, pile driving, in-water fill placement, and in-water dredging to ensure that no listed species are harmed. Observer protocols for the prevention of impacts from noise will be applied for both sea otters and Steller's eiders because it is possible, although unlikely, that eiders may be present during the work season.

To determine a suitable hazard area beyond which airborne and underwater sound levels would attenuate to a 'sub injury' level for the protection of sea otters, we first evaluated the sound levels likely to be produced from the Diamond Point project by compiling available data from studies of sound production during pile driving, blasting, fill placement, and dredging. Typical maximum sound production levels from these studies are shown in Table A.1 in Appendix A.

We used a practical sound propagation model to estimate the range from the activity to various expected sound pressure levels in the water (NOAA 2012). This model uses a geometric calculation to estimate the loss of propagated sound based on the distance from the source. The results are a 4.5 dB reduction in sound level for each doubling of distance from the source. In this model, the sound pressure level at some distance away from the source (e.g., driven pile) is governed by sound measured at a source, minus the transmission loss of the energy as it dissipates with distance. The formula for underwater transmission loss (TL) is:

TL = 15 * log10(R1/R2), where
R1 = the distance of the modeled sound pressure level from the source
R2 = the distance from the source of the initial measurement
[e.g., R1=200 if the modeled sound pressure is 180 dB SEL (cum) at 200 m from a driven pile, and R2=10 if the initial sound level produced was measured at 10 m from the driven pile].

The radii of the hazard areas were calculated for underwater noise from pile driving based on the following cumulative sound impact model:
SEL (cum) = SEL(single strike at ~ 10 meters) + 10 Log * (# strikes)
Effective quiet (EQ) was built into the model at 150 dB. If the distances calculated to the cumulative SEL thresholds were greater than the distance calculated to EQ, then distance defaults to that of EQ. This is based on the assumption that single strike SELs below 150 dB do not accumulate to cause injury (WSDOT 2011). Number of strikes and number of piles were assumed to be four and number of strikes per pile, 1000, based the nature of the proposed project and summary of typical strike data (Jones and Stokes 2009).

For airborne noise, we used a spherical loss model with a 6 dB decrease in sound pressure level over water ("hard-site" condition) per doubling of distance WSDOT (2011). The formula used for calculating spherical spreading loss is:
TL = 20 * log10(R1/R2), where:
TL = Transmission loss
R1 = the distance of the modeled sound pressure level from the source, and
R2 = the distance from the source of the initial measurement.
Ambient noise levels were assumed to be 65 dBA.
Impacts of underwater noise transmission from airborne noise sources was not estimated because noise from atmospheric sources does not transmit well through the air-water interface (Richardson et al. 1995). All airborne distances were less than those calculated for underwater sound thresholds.

Distances necessary to provide protection against noise levels greater than **110 dB re: 20 µPa; for airborne noise or 183 dB re 1µPa2-sec cumulative SEL for underwater noise** ranged from 300 to 1,000 m depending on type of activity. Furthermore, for pile driving, the diameter of the pile influences the size of the hazard area. See radius of hazard area by activity in Table A.1 in Appendix A.

The Applicant has proposed to employ observers to monitor these hazard areas, in accordance with the Observer Protocols in Appendix A, to ensure that listed species are not exposed to sound levels above those identified for the protection of sea otters.

Several other impact avoidance and minimization measures have been incorporated into the project to reduce noise levels or impacts to listed species. These include: 1) developing a blasting plan that will include provisions for monitoring sound using portable instrumentation, to assure that noise and vibration velocities are kept below suitable thresholds; and 2) using ramp-up procedures for pile driving to allow sea otters in the area to vacate the area prior to exposure to full-powered pile driving. For vibratory hammers, the ramp up will be accomplished by initiating noise from the hammer for 15 seconds at a reduced energy level followed by a 1-minute waiting period, and repeating the procedure two additional times.

Employing observer protocols and stop-work action plans if sea otters are in the hazard area should significantly reduce the probability that sea otters will be harmed from noise-generating activities in the area. [Top]

Contaminants

Acids, metals, and hydrocarbons

Short-term exposure to high concentrations of contaminants or prolonged exposure to low levels can have adverse effects on Steller's eiders and sea otters. The most likely source of contamination will be from petroleum hydrocarbons and their byproducts. Accidental petroleum releases can adversely affect wildlife through the following mechanisms: 1) contamination of feathers and fur; 2) direct consumption of petroleum (e.g., during preening and grooming); 3) contamination of food resources; or 4) reduction in prey availability (Ballachey et al. 2000b; Esler et al. 2000). Hydrocarbon contamination can bioaccumulate and reduce the quantity or quality of food resources, causing eiders and otters to be exposed to hydrocarbons or cause reduced food availability for years after visible oil has dissipated (Esler et al. 2000; Trust et al. 2000b). Shellfish can bioaccumulate hydrocarbons and increase the exposure to listed species through the food chain, resulting in immunological suppression, hemolysis, cancer, and/or interference with reproduction (Springman et al. 2005). If listed species are unable to limit their exposure, the effects of hydrocarbon contamination can result in reduced survivorship and subsequent population declines (NOAA 1996).

A large spill (>500 gallons) that would affect sea otters or eiders is possible, but unlikely. This probability is further reduced by limiting the quarry work season to May 1-October 31, when sea otters numbers are low and Steller's eiders are not present. The probability of small spills occurring with sufficient regularity to result in measureable impacts to Steller's eiders or sea otters is low given the ability of both species reduce their exposure by dispersing to areas away from the project footprint. A spill prevention and response plan will be in place to reduce the likelihood of and contain spills, further reducing likelihood of impacts to listed species. Therefore, **contaminant releases are not likely to cause take of Steller's eiders or sea otters.**

Sedimentation

During initial quarry development, suspended sediment loads would increase in sea otter and Steller's eider habitat. Sediment would be directly released into marine waters during placement of fill and indirectly through discharge of sediment-laden runoff from. Sediments can reduce habitat quality by affecting the quality or availability of invertebrate food resources. Increases in sediment loads can impair the survival or reproduction of mollusks and crustaceans adapted to clear-water conditions and can cause shifts in invertebrate species assemblages (Newell et al. 1998). Impacts of sedimentation on sessile benthic organisms are transmitted up through the food chain, affecting wildlife species that eat them, including listed species. For example, mollusks are eaten by sea otters and Steller's eiders. A reduction in water quality that reduces feeding efficiency or limits the size of a cohort of clams may result in a lower energy gain per foraging effort by a Steller's eider or sea otter. Otters and eiders are most likely to respond to changes in food availability by dispersing to unaffected areas. See the Impacts to Food Resources section for further evaluation and conclusions regarding the impacts of sedimentation.

Impacts to Food Resources

The action area is an important overwintering area for Steller's eiders and year-round habitat for sea otters. The greatest risk of harm due to loss of food resources is expected during winter, when high numbers of animals are present and energetic demands are high. If animals are unable to access sufficient food resources to maintain adequate body weight and condition, take will result from direct or indirect mortality or reproductive failure. Of the habitat in the action area currently available to individual otters and eiders, loss of food resources is expected to occur on only a small portion (up to approximately 4%).. We analyzed the effects of loss of food resources of this scale on Steller's eiders and sea otters.

Steller's eiders

Iliamna Bay is an important overwintering area for Steller's eiders. As many as 675 birds have been seen there during winter surveys. The listed population mixes with the non-listed Russian-breeding birds, and is estimated to account for approximately 0.8% of the wintering population. Therefore, the total number of listed birds in the project area is estimated to be 5 to 6 birds (675*0.08=5.4). The development of a granite quarry at Diamond Point may affect Steller's eiders indirectly by degrading forage quantity and quality through the release of sediments and contaminants. Effects to benthic food resources are likely to linger beyond the work season, and may affect eiders during the overwintering period. The effects of loss of food resources on wintering Steller's eiders depends on the sensitivity of the animal to loss of food resources, the amount of loss relative to the availability of other food sources, and the ability of the affected animals to access alternate food sources.

The greatest risk of impact is during winter when high numbers of Steller's eiders are present in the action area and their energetic demands are high. Steller's eiders are small-bodied, northern-latitude sea ducks, and as such, are thought to exist at the edge of their energetic range (Goudie and Ankney 1986), making them sensitive to habitat changes that cause reductions in food resources. Loss of food resources could result in direct take of individuals due to increased energy expended to feed or to move to areas with greater food resources. Significant energy expenditures may cause take of ESA-listed animals directly, due to inadequate nutrition, or indirectly, due to as-yet unknown effects on reproduction: the Alaska-breeding population does not attempt to nest every year, and the factors affecting whether the species nests are not known. Availability of food resources on the wintering grounds could influence the bird's body condition when entering the breeding season and may be a factor in whether the bird nests in a given season.

Although Steller's eiders are sensitive to loss of food resources, the expected level of additional energy needed to accommodate these impacts will be minor. A simplistic assessment of the spatial scale of potential project impacts indicated that approximately 4% of the available habitat containing food resources in and adjacent to the project footprint may be lost due to the indirect impacts of sedimentation. Eiders are likely to compensate for minor reductions in food availability by increasing the time spent foraging. If additional foraging isn't sufficient, birds will disperse to alternate foraging habitat

In lower Cook Inlet, eiders using the affected area within Iliamna Bay would not need to travel far to reach unaffected habitat and food resources. An estimated 96% to 98% percent of the foraging habitat available to Steller's eiders in and near the action area will be unaffected by loss of food resources. Within the action area, the distribution and abundance of benthic organisms comprising the preferred food resources for Steller's eiders are patchy, variable, and highly dynamic. Although food in any one location may be patchy, the overall action area, as characterized from benthic sampling conducted by Pentec (2012a), Dames and Moore (1979), Lees and Houghton (1977), and Lees et al. (1980) is one with a rich and abundant biota at each trophic level, forming a productive food web.

The recurring presence of Steller's eiders in areas close to but outside the action area suggests that nearby locations provide productive habitat within a short 5- to 10-mile (8- to 16-km) travel distance. In annual surveys conducted between 2004 and 2008, large flocks were consistently seen resting and foraging within the center of Iniskin Bay, and a smaller flock was often seen near the Iniskin Islands. Larned (2005, 2006a,b) presented data suggesting that the species occurs primarily in southern Kamishak Bay and moves farther north into Iliamna and Iniskin bays in mid- to late winter, possibly in response to increased ice conditions in Kamishak Bay.

In addition to availability, quality, and proximity of unaffected food resources, another factor affecting energy expenditures associated with dispersal is competition for resources in occupied habitat. This species is highly gregarious on their wintering range, and displaced birds are not likely to be stressed by competition for resources with unaffected birds. The gregarious nature of the Steller's eider, together with the small proportion of affected area and the availability of alternative food resources nearby, indicate that a Steller's eider will not need to expend significant amounts of energy travelling to or searching for alternate prey or consuming lower quality forage in order to cope with the probable loss of food resources expected from the proposed action.

Sea otters

Iliamna Bay is an important habitat area for sea otters, but use of the area varies greatly on a seasonal basis. Surveys of Iliamna and Iniskin bays conducted in summer yielded a maximum combined count of up to 50 otters in summer, but up to 1,433 were observed in winter (ABR, Inc. 2012). Seasonal distribution patterns were documented by Day et al. (2008) and ABR, Inc. (2012) with data from Larned (2006a). In summer, fewer otters used Iliamna and Iniskin bays compared to winter. Sea otters generally appear to occupy distances farther from shore during summer, but remain closer to shore and make greater use of inlets and protected bays during winter and during stormy weather conditions (Garshelis and Garshelis 1984; Bodkin et al. 2003). This behavior is thought to be effective for reducing energetic expenditures during foraging.

Iliamna Bay, Iniskin Bay, and the small islands near the mouths of these bays are high-use wintering areas because they provide the shallow water habitat with abundant food resources required during severe winter conditions. The direct loss of 25 acres of habitat and an additional loss of habitat due to indirect effects of sedimentation of food resources was therefore of concern. (Reduction in food availability would likely have the most significant impact on sea otters during the critical overwintering period when energetic expenditures are greatest. The energetic needs of sea otters are substantial: they eat the equivalent of 25% of their body weight every day (Reidman and Estes 1990). The largest daily energy expenditure of a sea otter is associated with foraging (Yeates et al. 2007). Loss of shallow-water foraging habitat, such as that affected by the proposed action, is likely to cause sea otters to expend greater amounts of energy to forage in deeper water (Estes and Bodkin 2002). Foraging in rough outer seas among ice flows is especially likely to require high energetic expenditures, particularly in winter, since deeper dive depths reduce the insulating properties of sea otter fur, increasing their exposure to cold temperatures.

However, despite the sea otter's potential sensitivity to loss of food resources, the proposed Diamond Point quarry will not likely result in harm to a sea otter. As with eiders, otters eat a variety of marine benthic organisms that are widely available in and near the action area. The two species avoid competing for food resources by partitioning by size, with smaller food items eaten by eiders and larger food items eaten by otters. As a result, the analysis of food availability for otters is the same as that for eiders (see above) due to the considerable overlap in the types of food eaten by these two species and the similarity of probable impacts from the proposed project (see Impacts to Food Resources). As with eiders, only a small proportion (2-4%) of the available habitat in the action area will be affected by reduced forage due to sedimentation from placement of fill, dredging, storm water runoff, and possible changes in hydrology, resulting in altered sediment transport patterns.

Survey results showing recurring overwinter use of areas outside of Iliamna Bay, in Iniskin Bay and in the Iniskin Islands, indicate that otters have suitable, alternative foraging areas outside of, but near the project area (Bodkin et al. 2003; Larned 2005, 2006a,b; Kolton 2011; ABR, Inc., 2012). Loss of food resources resulting from the proposed project is not likely to have a significant effect on sea otters because the loss will be small relative to the unaffected food sources that are readily available within reasonable travel distances.

Otters displaced due to project impacts are likely to be able to reach alternative food resources, but may experience competition with other otters already established in those areas. Sea otters commonly form large social groups during periods of rest, but foraging generally takes place individually. In fact, territorial males will actively exclude other males from existing territories (Riedman and Estes 1990). Territoriality and intraspecific competition could increase due to project effects if food resources were limited and if the population density were at or near carrying capacity. However, sea otters are not generally affected by food limitation in southwest Alaska. The draft sea otter recovery plan states (USFWS 2010, pp. 3-30),

> "At present, sea otter abundance within the Southwest Alaska DPS appears to be far below the carrying capacity of the habitat (Burn et al. 2003). And preferred prey, such as sea urchins, are abundant (Watt et al. 2000, Estes et al. 2004). The loss of extensive kelp beds due to intensive urchin grazing (Estes et al. 2004) has reduced sea otter resting habitat, but this is not known to have affected sea otter population dynamics. Recent estimates of sea otter growth rates, asymptotic (maximum) value of the body mass and length, body condition, and age composition were all indicative of a population below nutritional carrying capacity (Laidre et al. 2006).

Because recent population declines are not likely due to food limitations (Estes et al. 1998), suggesting that competition for resources will not be severe, and because food resources will not generally be affected over a large-enough scale to impair an otter's ability to travel to unaffected food resources in the project area, we believe that under normal conditions, **take of sea otters is not likely to occur due to direct or indirect reduction in food resources.**

Ice Analysis

Ice and rough seas increase the energy needed to travel and forage and may limit the ability of an animal to gain access to important foraging areas. The proposed Diamond Point quarry will result in loss of food resources in the habitat of the northern sea otter and the Steller's eider. These are both mobile animals capable of adjusting to local changes in resource availability by moving to areas with more favorable conditions. Unaffected food resources will be located nearby, and in summer, there are no impediments to unrestricted travel. However, in winter, rough seas and the presence of sea ice may limit animals' ability to travel. Steller's eiders have a much greater ability to access unaffected resources despite poor weather, by flying over, rather than swimming through dense sea ice and heavy seas. For this reason and those given under the "Steller's eiders" subheading, the project is not likely to adversely affect Steller's eiders. Instead, the focus of this analysis is on the less-mobile sea otter.

We investigated the possibility that sea otters may be susceptible to an increased risk of starvation due to the loss of foraging habitat under an ice-entrapment scenario. Under normal conditions, the scale of the impacts from the proposed project will be small, and sea otters would be able to disperse to unaffected habitat. However, the effects of food resource limitation would become more severe if sea otter movements were restricted. If ice prevents the use of other areas or limiting movement out of Iliamna Bay, sea otter survival would depend on the food resources in Iliamna Bay.

The caloric needs of a sea otter are likely to be higher during winter. Sea otters maintain thick fur and an elevated metabolic rate to thermoregulate, and therefore require large amounts of food. Thermoregulatory demands are likely to increase as temperatures decrease, resulting in even greater demand for food in winter. Dense sea ice or shorefast ice could limit an otter's access to food resources during this critical overwintering period.

Lower Cook Inlet's circulation patterns and shoreline bathymetry drive southbound tidal currents from upper Cook Inlet into Kamishak Bay. Sea ice tends to accumulate in Kamishak Bay earlier in the season than in other areas of lower Cook Inlet (NIC 1997-2012). Wind forcing and topography interact with currents, and local mountain ranges funnel stronger winds through gaps in the mountains, further degrading weather conditions in Kamishak Bay (Okkonen et al. 2009). Iliamna and Iniskin bays open to the south and are more protected, and therefore less likely to accumulate sea ice carried on tidal flows. Iliamna and Iniskin bays may therefore provide an area of refuge for sea otters displaced from their preferred summertime foraging habitat.

To analyze the importance of Iliamna and Iniskin bays as winter refuges, the frequency and duration of weather conditions that may restrict movement was evaluated by reviewing the National Ice Center Database (NIC) to identify when ice conditions might restrict access. Ice conditions were evaluated along a "sea otter corridor"—the shoreline corridor in western lower Cook Inlet between Iliamna/Iniskin bays and southern Kamishak Bay, where the Kamishak Bay population of sea otters are commonly found (Bodkin et al. 2003; Larned 2005, 2006a; Kolton 2011; ABR, Inc. 2012). Weekly/bi-weekly ice analysis maps of Cook Inlet were reviewed from 1997 to 2012 (NIC 1997-2012); 978 maps were reviewed, of which 576 showed ice along the sea otter corridor.

The analysis of NIC data for this period indicated that southern Kamishak Bay experiences heavy ice earlier than other areas in this sea otter corridor. If ice was present anywhere in this corridor, it was highly likely to be present in southern Kamishak Bay—only 2% of maps had ice elsewhere when there was no ice in Kamishak Bay. If ice was present only in Kamishak or Iniskin/Iliamna bay, 95% of the time it was in Kamsihak—not Iniskin/Iliamna. However, the theory that Iliamna and Iniskin bays provide a reliable refuge against ice was not supported. Ice was present in Iniskin and Iliamna bays 80% of the time when ice occurred in the corridor.

The frequency and duration of events that could restrict movement were assessed by identifying events in which ice extent was lower inside than outside Iliamna and Iniskin bays. An event in which movement would be restricted occurred in January, 2011, and is depicted in Figure 13. It shows high density sea ice (in red) blocking the deeper waters of Cook Inlet, while much of Iliamna and Iniskin bays have lower sea ice density (yellow). Sea otters could use the areas with lower density ice; they have observed in association with patches of drift ice and hauled out on ice (Schneider 1976). They would be less likely to use the outer areas with high-density ice, however.

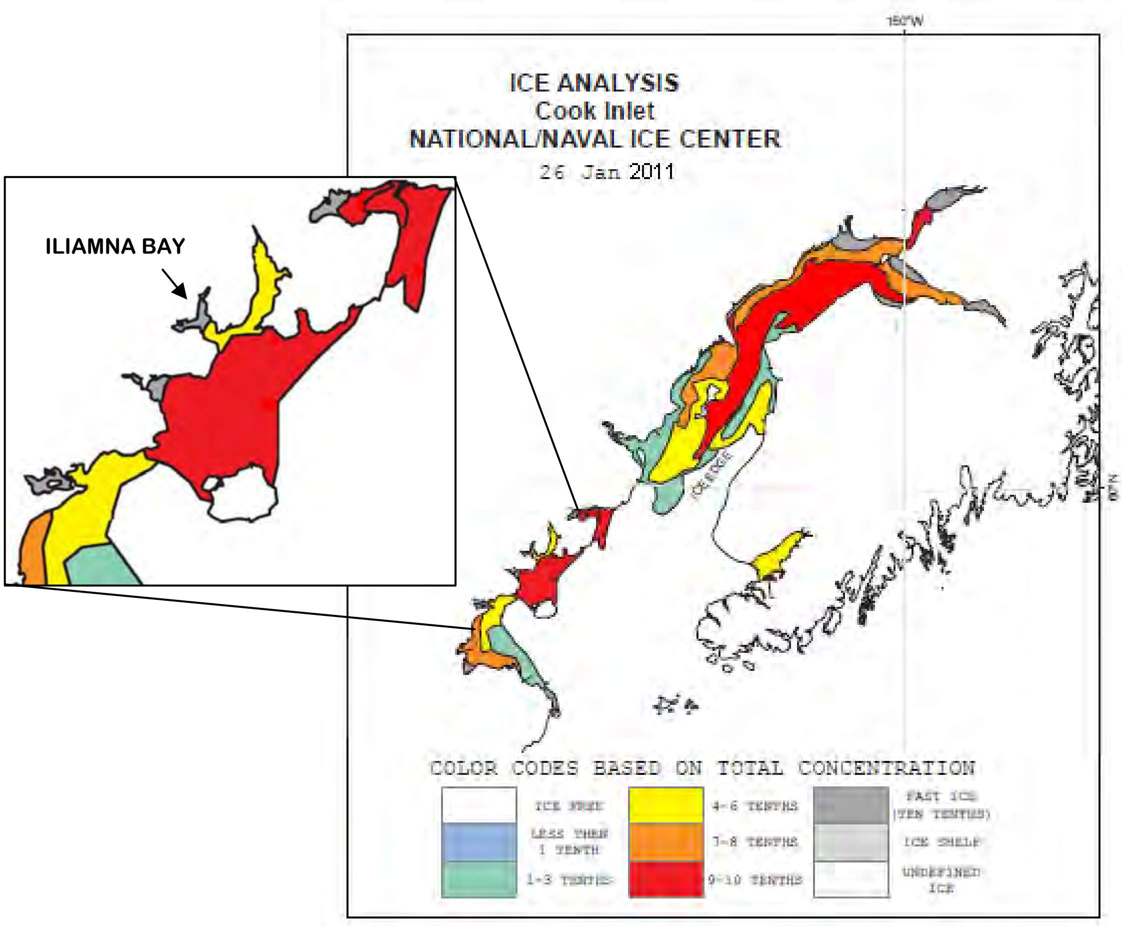


Figure 13. Sea ice coverage data from the National Ice Center showing 40% to 60% ice coverage in Iliamna and Iniskin Bays, while coverage outside of the bays is ≥90%.

[Top]

To evaluate the probability that movement would be restricted near the action area due to sea ice, we considered how often continuous ice coverage with density ≥10% occurred throughout the other coastal areas of the sea otter corridor, with lower density in Iniskin/Iliamna bays. This situation occurred in only 8 out of 576 maps, in years 1999, 2000, 2007, 2008, 2009, and 2011. Sea otter movements in and near the action area were rarely restricted; nevertheless, impacts to sea otters depend not only on the frequency of occurrence, but also on the duration of those events. The analysis of ice data indicated that the longest event in which movement may have been restricted was less than two weeks.

Because ice and weather conditions that would restrict access to unaffected food resources rarely last longer than several days to a few weeks, we do not expect that the loss of food resources resulting from the development of the Diamond Point quarry would constitute a large enough portion of the available food resources, even within a restricted-movement area, to affect survival or reproduction of a sea otter. **Loss of food resources is therefore not likely to result in take of a sea otter.**

Summary

Construction and operation of Diamond Point quarry will reduce food availability in Iliamna Bay. Animals will most likely respond to reductions in food resources by dispersing to unaffected areas. Unaffected food resources are available near the project site. Although there are energetic costs associated with travel to other areas, Steller's eiders and sea otters are both mobile animals, and distribution information suggests that they regularly use and travel to unaffected areas nearby. Therefore, neither species is expected to be adversely affected by loss of food resources under normal weather conditions. However, the presence of ice may restrict mobility in winter, limiting the animals' abilities to disperse and increasing their reliance on food resources in the action area. Steller's eiders are more mobile than otters, and are unlikely to experience restricted mobility due to sea ice. For otters, we evaluated the frequency and duration of ice events in lower Cook Inlet to determine the likelihood that access to unaffected food resources would be restricted. Restricted mobility may limit food uptake or cause species to rely on low-quality forage, and if this situation continued for a sufficient length of time, loss of body mass could cause take. The probability that sea ice would restrict movement patterns for a length of time sufficient to cause harm was determined to be unlikely. Based on our assessment of the impacts from the action and the minimization measures included in the project, **we concur with the determination of the U.S. Army Corps of Engineers that the proposed Diamond Point granite quarry is not likely to adversely affect the threatened Alaska-breeding population of the Steller's eider or the northern sea otter.**

Impacts to Sea Otter Critical Habitat

We evaluated the impact of the proposed Diamond Point quarry project on the conservation value of the critical habitat for the southwestern Alaskan population of the northern sea otter to determine whether the project would be likely to adversely affect critical habitat. Habitat impacts are certain to occur across 25 acres of critical habitat containing some or all of the PCEs identified for sea otter critical habitat. The impacts to critical habitat must be evaluated in the context of the existing and future conservation value of the habitat. Otters are long-lived and show high fidelity to habitat use areas. Knowledge of, and access to, specific areas and resources is therefore likely to be important to the survival of individual animals, and loss of food resources may result in take. However, sea otters are highly mobile, have fairly large home ranges, and have access to alternative, high-quality food resources in and near Iliamna Bay and outside of the area affected by the proposed project. These factors indicate that **the project will have only minor impacts to individual animals, and thus will not impair the conservation value of the habitat.**

Species Responses to the Proposed Action

Number of Individuals in the Action Area Affected

Steller's eiders -- The action area for the proposed Diamond Point quarry is occupied by overwintering Steller's eiders, which were observed in large numbers adjacent to Diamond Point, in the center of Iliamna Bay (Day et al. 2008). Groups of between 30 and 675 individuals were observed (ABR, Inc. 2010, as reported in HDR Alaska, Inc. 2011c). An estimated 0.8% (around 5 or 6) of these birds are likely to be from the listed population.

Sea Otters -- High numbers of sea otters use Iliamna and Cottonwood bays in winter, while fewer individuals are found here in summer (Bodkin 2007, ABR, Inc. 2012. Combined counts of sea otters in Iliamna and Iniskin Bays during the May 1 to October 31 proposed operating period ranged from 0 to a maximum of approximately50 (observed in May 2007). Between November 1 and April 30 each year, survey numbers were commonly >200, up to a maximum of 1,433, recorded in January 2008 (Day et al. 2008; ABR, Inc. 2012).

Sensitivity to Change

Both northern sea otters and Steller's eiders are likely to be susceptible to impacts from large-scale development. Both species exhibit some degree of behavioral change with changing environmental conditions, but both are capable of habituating to disturbance in some locations and circumstances. We anticipate some level of disturbance due to construction noise and some displacement due to lost food resources. Individuals of both species have been exposed to disturbances in other area in their range, including Unalaska Bay, Kodiak Island, and Akutan, and both species continue to occupy these areas. Both species are expected to be able to disperse to unaffected areas nearby without experiencing energetic losses that will compromise survival and reproduction.

Resilience

Little information exists regarding the resilience of either of these species to perturbations. The world population of Steller's eider has declined by 80% from 1,000,000 in the 1940's (Tugarinov 1941 as cited in Solovieva 1997) to 200,000 in 1994 (Solovieva 1997). Extensive banding efforts and aerial survey efforts over the past decade indicate that the world population trend continues to decline (Flint et al. 2000, Larned 2000b). Lack of resilience due to low fecundity, low recruitment, high breeding adult mortality, and other unknown causes may be contributing to the continued decline.

The southwest DPS of the northern sea otter once contained more than half of the world's sea otters, but has undergone an overall population decline of at least 55 to 67 percent since the mid-1980s. In some areas within southwest Alaska, the population has declined by over 90 percent during this period (USFWS 2005). The cause for the precipitous decline of this population, and therefore its resiliency to perturbations, is unclear.

Recovery rate

Steller's eider -- The natural recovery rate of Steller's eiders is not known. Long-lived species with low annual fecundity have a relatively slow recovery rate compared to short-lived species with high annual fecundity. Given the Steller's eider's observed low fecundity (i.e., small clutch sizes, high variability in nesting attempts, and generally low nest success) (Quakenbush et al. 1995), the recovery rate for this species is believed to be quite slow. The proposed action is not likely to result in take of a Steller's eider and will therefore not affect the recovery rate of the listed population.

Northern sea otter -- The history of sea otters in southwest Alaska is one of commercial exploitation to near-extinction (1742 to 1911), followed first by protection under the International Fur Seal Treaty (1911), and then by population recovery (post-1911). By the mid-to late-1980s, sea otters in southwest Alaska had grown in numbers and recolonized much of their former range (USFWS 2005). The recovery of sea otters following the cessation of commercial hunting demonstrated that the species has the potential for recovery once the cause of its decline has been removed. As the cause of the current decline is not known with certainty, the future recovery of the southwest Alaska DPS of the northern sea otter is likewise uncertain (USFWS 2005). The primary impacts of the proposed project will be from disturbance and impacts to habitat. Minimization measures will be in place to prevent take due to disturbance, and the effects of habitat loss are not of a sufficient scale to cause significant concern. **Therefore the project will not affect sea otter recovery.** [Top]

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. Various forthcoming activities in and near Iliamna Bay have the potential to affect listed species.

Vessel traffic/Collisions -- Most of Cook Inlet is navigable and will continue to be used by various classes of vessels, including containerships, bulk cargo freighters, tankers, commercial- and sport-fishing vessels, and recreational vessels. Vessel traffic is likely to increase use in the future. Most of the vessel traffic occurs from May to September, when it is likely that no Steller's eiders are present, and when fewer sea otters are present than in winter. Increased recreational hunting and fishing, including by quarry workers, would contribute to vessel traffic. This could increase the level of disturbance and potential for take of Steller's eiders and sea otters. Sea otters and Steller's eiders can be killed or injured by collisions with vessels. Fast-moving passenger vessels have a higher potential for collisions with wildlife than slower barges and tugs. The probabilities of collisions with all vessel types are thought to be low, however.

Fisheries -- Federal and state-directed commercial fisheries for shellfish, groundfish, herring, and salmon have occurred and will continue to occur in Cook Inlet. The Diamond Point area has been used for mostly for commercial chum salmon fishing (with sockeye, pink and coho salmon caught in much lower numbers), although harvest varies dramatically between years and has been low in recent years. Fishing activities can contribute to collisions between vessels and sea otters or Steller's eiders or entanglement in nets.

Summary -- Increases in development, noise, vessel traffic, and impacts to water quality are incremental and gradual. These activities are not expected to cause a measurable increase in the possibility that take will occur as a result of this project when combined cumulatively with other activities in the action area. [Top]

CONCLUSIONS

After reviewing the current status of the Steller's eider and the southwest DPS of the northern sea otter, the environmental baseline for the action area, the effects of the construction and operation of Diamond Point quarry, and the cumulative effects, we have concluded that **the action, as proposed, is not likely to jeopardize the continued existence of either species, and is not likely to destroy or adversely modify designated critical habitat for the southwest DPS of the northern sea otter.** A conclusion of "jeopardy" for an action means that the action could reasonably be expected to reduce appreciably the likelihood of both the survival and recovery of either the Steller's eider or the northern sea otter. A conclusion of "adverse modification" means that the action could reasonably be expected to appreciably diminish the value of critical habitat for both the survival and recovery of this species. These conclusions are based on a synthesis of information provided in previous sections of this document.

Steller's eider

The **Service concurs with the Corps' determination that the project is not likely to adversely affect the Steller's eider** for the following reasons:

- Most of the direct impacts of the quarry project will occur between May 1 and October 31, when Steller's eiders are typically not present in the action area.
- The carrying capacity of the overwintering population of Steller's eiders in Iliamna Bay is not expected to be reduced due to permanent loss of 25 acres of habitat and reduced food resource availability in an adjacent area.
- The quantity of food resources lost due to fill placement, sedimentation, and contaminants will be small relative to the total quantity in the area.
- Steller's eiders in Iliamna Bay are highly capable of accessing the abundant food resources in various locations in lower western Cook Inlet, including Iniskin Bay and Kamishak Bay. Eiders will not have to travel long distances or expend high amounts of energy to gain access to alternate food resources.
- Displaced birds are not likely to be stressed by competition for resources against unaffected birds.
- There is no indication that the population is at or near carrying capacity.
- Observers will be onsite to stop noise-generating work in the unlikely event that a Steller's eider is in the area when such work would occur.

The number of Steller's eiders molting and wintering along the Alaska Peninsula has declined since the 1960's. At 54,191, the 2002 Pacific population estimate by Larned (2002) was the lowest recorded since aerial surveys were initiated in 1992. Long-term spring survey data suggests a 6.1% annual decline in migrating Steller's eiders, and banding data from 1975-1981 and 1991-1997 indicate a reduction in Steller's eider survival over time. The Alaska-breeding population is estimated to be 0.8% of the total Pacific population of 54,191. At the estimated 6.1% rate of decline, the Alaska-breeding population of Steller's eider is projected, by a simple deterministic population model, to reach functional extinction (125 birds) in 35 years (USFWS 2006). Because take is not expected to occur as a result of the proposed project, the Steller's eider population will not be affected, however. The proposed project will result in no change in the probability of extinction over the baseline model.

Sea otters and Sea Otter Critical Habitat

The Service does not concur with the Corps' determination that the Diamond Point quarry is likely to cause take of a sea otter. We instead find that the proposed project is not likely to adversely affect the southwest DPS of northern sea otters. This conclusion is justified by the following:

- The sea otter population in the action area appears to be healthy.
- Permanent loss of 25 acres of critical habitat may cause displacement of sea otters, but in Iliamna and Iniskin bays, the affected otters are likely to find unaffected food resources without expending large amounts of energy to travel long distances to forage.
- The primary habitat components that are affected by the Diamond Point project are food resources, rocky intertidal areas, and kelp beds; the quantity of these resources in the area affected by the action area is small relative to the total quantity available to sea otters in the area.
- Although areas adjacent to fill placement are likely to be indirectly affected due to contaminants and sedimentation, the food resources will not be permanently impaired in all affected areas. Some recolonization of new fill materials and sediment settlement zones will occur.
- The current population level (i.e., not close to carrying capacity) does not indicate that sea otters displaced due to disturbance or loss of food resources will be harmed from intraspecific competition for alternative resources.
- The affected area is not known to provide unique resources relative to the adjacent habitat: it does not provide known haulout sites, nursery areas, unique food resources, or breeding or pupping areas.
- Observers will be onsite to stop noise-generating work if such work would likely harm sea otters. This will minimize the possibility that noise impacts will result in take of otters.
- The effects of the loss of food resources are not expected to result in reduced survival or reproduction of any individual sea otters.
- There is a sufficiently low probability that the degradation of water quality due to release of sediments or contaminants associated with the project will result in harm or injury to a sea otter that take is not expected.
- The function and conservation role of the affected critical habitat within the Kodiak, Kamishak, and Alaska Peninsula Management Unit would not be significantly modified.
- Additionally, only a small number of individuals relative to the overall population size of both species will be affected.

Although the project will result in loss of critical habitat, the amount of loss expected will not reduce the conservation value of the unaffected critical habitat. In the southwestern Alaskan locations where sea otters populations have declined, habitat loss and development are not known to cause or contribute to declining population trends (USFWS 2008c, 2010).

It is the Biological Opinion of the Service that the proposed action will not jeopardize the southwest DPS of northern sea otters and will not result in adverse modification of designated critical habitat. Furthermore, we have determined that the proposed Diamond Point granite quarry is not likely to result in the taking of Steller's eiders or sea otters.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service recommends the following conservation recommendations be incorporated into the Corps' permitting requirements or into the project description:

1. When operating marine vessels at the quarry site, all employees and contractors for the Diamond Point quarry should abide by "Boat Operation Guidance to Avoid Disturbing Sea Otters," included in Appendix B.
2. Lights/guy wires:
    a. To prevent Steller's eiders from colliding with overhead structures, lower any cranes or towers and remove guy wires and overhead lines during the overwintering period.
    b. Locate all overhead structures as far inland as possible.
    c. Avoid the use of high-intensity lighting, or steady-burning or bright lights, such as sodium vapor, quartz, halogen, or other bright spotlights.
    d. Employ only red, or dual red and white, strobe, strobe-like, or flashing lights, not steady-burning lights.
    e. Lights should be hooded downward and directed to minimize horizontal and skyward illumination.
3. A Hazardous Materials Handling and Storage Plan and a Spill Prevention and Response Plan should be developed to identify and incorporate measures for preventing and dealing with potential contaminants. Incorporate the area's existing Geographic Response Strategy, available at http://dec.alaska.gov/spar/perp/grs/ci/cisw/home.htm.
4. Storm water controls: the following preliminary recommendations are presented in advance of development of the SWPPPs, to reduce the potential for indirect impacts to listed species. The Applicant has agreed to provide draft SWPPPs to the Service for review and to incorporate further recommendations as is appropriate and applicable.
    a. Develop a site plan identifying drainage-ways prior to project development. Incorporate landscape features to slow the flow of storm water and allow sediment to filter out of run-off prior to reaching streams and marine waters. Identify what specific types of landscape features will be utilized and where they will be included. Incorporate permanent drainage pathways, ditches, check dams,

retention basins, bioswales, outfalls, and/or other run-off management features as appropriate.

b. Grade roads, fill surfaces, and upland staging areas to facilitate drainage away from the shoreline and natural drainages.
c. Monitor water quality per ADEC requirements at the point of storm water discharge to determine the effectiveness of the control measures, and respond if they do not demonstrate effectiveness. Develop and describe the monitoring plan, including the locations of outfalls, timing of testing per ADEC requirements, the water quality components to be measured per ADEC requirements, and steps that will be taken if water quality standards are not met.
d. Maintain a 100-foot buffer of undisturbed natural vegetation between the upland staging area and the unnamed stream west of the upland staging area. Maintain a 100-foot buffer of undisturbed natural vegetation between the upland staging area and the beach prior to the placement of fill in this location during phase III.
e. Develop a plan for testing quarry rock for presence of heavy metals and acid producing compounds. Identify testing methods, what compounds will be tested for, and how often testing will be done. Identify specific actions that will be taken if high levels of metals and acid-producing compounds are found. Submit the plan for review to ADEC and USACE.

5. Post-construction monitoring should be conducted adjacent to the fill and dredge areas to determine sediment dispersal and settlement patterns and rates of natural recolonization of the benthic community. Selected stations should be examined regularly on a long-term basis to assess changes in substrate and species diversity, abundance, and biomass. Such long-term data will help evaluate the effectiveness of natural recolonization of the shoreline fill material for restoring the rich and productive assemblage of organisms currently present along the rocky intertidal shoreline.
6. Recommendations for sound reduction
   a. Consider noise-reducing alternatives such as boring instead of pile driving.
   b. Use specialized noise-reducing equipment such as saw blades.
   c. Install and maintain mufflers, silencers, or sound-dampening panels on all compatible vehicles, generators, and other construction equipment.
   d. Construct structures or barriers around noisy equipment or areas where noisy work would occur.

REINITIATION STATEMENT

This concludes consultation on the proposed action. As provided in 50 CFR §402.16, reinitiation of consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) new information reveals effects of the action that may affect listed species or critical habitat in a matter or to an extent not considered here; (2) the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this evaluation; or (3) a new species not covered here is listed or critical habitat designated that may be affected by this action. [Top]

LITERATURE CITED

ABR, Inc. 2008. Observations of threatened and endangered species and species of conservation concern within 2 kilometers of Diamond Point from 2004-2007. Data collected for the Pebble Limited Partnership and presented in Diamond Point LLC (2009b).

ABR, Inc. 2010. Observations of threatened and endangered species and species of conservation concern within 2 kilometers of Diamond Point from 2004-2009 as collected for the Pebble Limited Partnership.

ABR, Inc. 2012. Chapter 44. Marine Wildlife Cook Inlet Drainages. In Pebble Limited Partnership [PLP], editor. Pebble project environmental baseline document 2004 through 2008.

Able KP. 1973. The changing seasons. American Birds 27(1):19-23.

Agler BA, SJ Kendall, PE Seiser, DB Irons. 1994. Monitoring seabird populations in areas of oil and gas development on the Alaskan Continental Shelf: Estimates of marine bird and sea otter abundance in lower Cook inlet, Alaska, during summer 1993 and winter 1994.

Agler, BA, SJ Kendall, PE Sieser, and DB Irons. 1995. Estimates of marine bird and sea otter abundance in lower Cook Inlet, Alaska during summer 1993 and winter 1994. Final Rept. OCS Study MMS 94-0063.

Airoldi, L. 2003. The effects of sedimentation on rocky coast assemblages. Ch. 4 *in* Oceanography and Marine Biology; an annual review, Volume 41. Edited by Barnes, H, RN Gibson, RJA Atkinson. Taylor & Francis Inc. New York, NY.

Alaska Department of Fish and Game [ADF&G]. 2009. Letter Re: POA-2008-523. Addressed to Heather Martinez, Project Manager, Alaska District U.S. Army Corps of Engineers. Signed Michael Daigneault, Regional Supervisor, Anchorage Area Office. Dated September 17, 2009.

Alaska Department of Natural Resources [ADNR]. 1998. Alaska Coastline 1:63,360. Vector digital data from USGS ITM hydrography, 1950-1990. Map projection: Albers conical equal area; horizontal datum name: North American datum of 1983. http://www.asgdc.state.ak.us/.

Alisauskas R. 2002. Arctic climate, spring nutrition and recruitment in mid-continent lesser snow geese. Journal of Wildlife Management 66:181-193.

Anderson RM. 1913. Report on the natural history collections of the expedition. Pages 436-527 *In* My life with the Eskimos. V Stefansson (*ed.*). MacMillan Co., New York.

Anderson BA, SM Murphy, MT Jorgenson, DS Barber, BA Kugler. 1992. GHX-1 water bird and noise monitoring program. Final report prepared for ARCO Alaska, Inc., Anchorage, Alaska by Alaska Biological Research, Inc., Fairbanks, Alaska and BBN Systems and Technologies Corp., Canoga Park, California.

Ballachey BE, CS Gorbics, AM Doroff. 2002. Sea otter mortality in Orca Inlet, Prince William Sound, Alaska, winter 1995-1996. U.S. Fish and Wildlife Service. Marine Mammals Management, Anchorage, Alaska. Technical Report MMM 02-1.

Ballachey BE, JL Bodkin, S Howlin, AM Doroff, AH Rebar. 2003. Correlates to survival of juvenile sea otters in Prince William Sound, Alaska, 1992-1993. Canadian Journal of Zoology 81:1494-1510.

Ballachey BE, JL Bodkin, S Howlin, KA Kloecker, DH Monson, AH Rebar, PW Snyder. 2000a. Hematology and serum chemistry of sea otters in oiled and un-oiled areas of Prince William Sound, Alaska, from 1996-1998. Appendix BIO-01 in Final Report, Exxon Valdez Oil Spill restoration project 95025-99025.

Ballachey BE, JJ Stegeman, PW Stegman, PW Snyder, GM Blundell, JL Bodkin, TA Dean, L Duffy, D Esler, G Golet, S Jewett, L Holland-Bartels, AH Rebar, PA Seiser, KA Trust. 2000b. Oil exposure and health of nearshore vertebrate predators in Prince William Sound following the Exxon Valdez oil spill. Chapter 2 in final report, Exxon Valdez Oil Spill restoration project 95025-99025.

Barabash-Nikiforov II. 1947. Kalan (The sea otter). Soviet Ministry RSFSR. (Translated from Russian by Israel Program for Scientific Translation, Jerusalem, Israel, 1962) 227 pp.

Barabash-Nikiforov II, SV Marakov, AM Nikolaev. 1968. Otters (sea otters). Izd-vo Nauka, Leningrad. 184 pp. [In Russian].

Begon M, M Mortimer. 1986. Population ecology: A unified study of animals and plants. 2nd edition. Blackwell Scientific Publications, Cambridge, Massachusetts.

Bellrose FC. 1980. Ducks, geese, and swans of North America. Stackpole Books, Harrisburg, Pennsylvania. 540 pp.

Bent AC. 1987. Life histories of North American waterfowl. Two parts bound as one. Dover Publications, Inc., New York.

Berg EA, MP Nieto, PH Thorson, JK Francine, G Oliver. 2001. Acoustic measurements of the 21 November 2000 Delta II EO-1 launch and quantitative analysis of behavioral responses of Pacific harbor seals, brown pelicans, and southern sea otters on Vandenberg Air Force Base and selected pinnipeds on San Miguel Island, CA. Los Angeles Air Force Base: Report by SRS Technologies, Systems Development Division, for Space and Missile Systems Center, U.S. Air Force Materiel Command.

Berg EA, MP Nieto, PH Thorson, JK Francine, G Oliver. 2002. Acoustic measurements of the 5 October 2001 Titan IV B-34 launch and quantitative analysis of behavioral responses of Pacific harbor seals on Vandenberg Air Force Base, California. Los Angeles Air Force Base: Report by SRS Technologies, Systems Development Division, for Space and Missile Systems Center, U.S. Air Force Materiel Command.

Bickham JW, MJ Smolen. 1994. Somatic and heritable effects of environmental genotoxins and the emergence of evolutionary toxicology. Environ. Health Perspect. 102(12):25-28.

Blackwell, SB, JW Lawson, MT Williams. 2004. Tolerance by ringed seals (*Phoca hispida*) to impact pile-driving and construction sounds at an oil production island. Journal of the Acoustical Society of America, *115*, 2346-2357.

Blackwell, SB. 2005. Underwater measurements of pile-driving sounds during the Port MacKenzie dock modifications, 13-16 August 2004. Rep. from Greeneridge Sciences, Inc., Goleta, CA, and LGL Alaska Research Associates, Inc., Anchorage, AK, in association with HDR Alaska, Inc., Anchorage, AK, for Knik Arm Bridge and Toll Authority, Anchorage, AK, Department of Transportation and Public Facilities, Anchorage, AK, and Federal Highway Administration, Juneau, AK. 33 p.

Bodkin J. 2007. Trend in sea otter distribution and abundance Kenai Peninsula 1989-2007. Anchorage, Alaska, U.S. Fish and Wildlife Service.

Bodkin JL, DH Monson, GE Esslinger. 2003. A report on the results of the 2002 Kenai Peninsula and Lower Cook Inlet aerial sea otter survey. U.S. Geological Survey, Alaska.

Bodkin JL, GJ Esslinger, DH Monson. 2004. Foraging depths of sea otters and implications to coastal marine communities. Marine Mammal Science 20(2):305-321.

Bodkin JL, BE Ballachey, MA Cronin, KT Scribner. 1999. Population demographics and genetic diversity from remnant and reestablished populations of sea otters (*Enhydra lutris*). Conservation Biology 13:1378-1385.

Bodkin JL, BE Ballachey, TA Dean, AK Fukuyamam, SC Jewett, LM McDonald, DH Monson, CE O'Clair, and GR VanBlaricom. 2002. Sea otter population status and the process of recovery from the Exxon Valdez spill. Marine Ecology Progress Services 241:237-53.

Boisvert JH, PM Sanzenbacher. 2011. Bird Movement Study For A Proposed Wind Farm At The USAF Cape Newenham Long Range Radar Site, Alaska, Spring–Fall 2010. ABR, Inc.-Environmental Research & Services Fairbanks.

Boyd H, A Diamond. 1994. Influences of climate change on arctic migratory birds. Pages 67-75 *In* Biological implications of global change: Northern perspectives. R Riewe, J Oakes (*eds*.). Occasional Publications 33. Canadian Circumpolar Institute, University of Alberta, Edmonton, Canada.

Brandt H. 1943. Alaska bird trails. Bird Research Foundation, Cleveland, Ohio. 464 pp.

Brooks, W. 1915. Notes on birds from east Siberia and Arctic Alaska. Bulletin of the Museum of Comparative Zoology 59:359–413.

Brown, CL, R Clark. 1968. Observations on dredging and dissolved oxygen in a tidal waterway. *Water Resources Research* 4:1381-1384.

Burbank, DC. 1977. "Circulation Studies in Kachemak Bay and Lower Cook Inlet." Environmental Studies of Kachemak Bay and Lower Cook Inlet, Vol. III. L.L. Trasky, L.B. Flagg, and D.E. Burbank, eds. Anchorage, Alaska: Alaska Department of Fish and Game.

Burn DM, AM Doroff, MT Tinker. 2003. Estimated carrying capacity and pre-decline abundance of sea otters (*Enhydra lutris kenyoni*) in the Aleutian islands. Northwestern Naturalist 84(3):145-148.

Brueggeman JJ, GA Green, RA Grotefendt, DG Chapman. 1988. Aerial surveys of sea otters in the northwestern Gulf of Alaska and the southeastern Bering Sea. Minerals Management Service and NOAA Final Report. Anchorage, Alaska.

Burn DM, AM Doroff. 2005. Decline in sea otter (Enhydra lutris) populations along the Alaska Peninsula, 1986-2001. Fishery Bulletin 103: 270-279.Burn, DM, AM Doroff, MT Tinker. 2003. Carrying capacity and pre-decline abundance of sea otters (*Enhydra lutris kenyoni*) in the Aleutian Islands. Northwestern Naturalist 84:145-148.

Bustnes JO, M Asheim, TH Bjorn, H Gabrielsen, GH Systad. 2000. The diet of Steller's eiders wintering in Varangerfjord, Northern Norway. Wilson Bull. 112(1):8-13.

Carlson T, M Hastings, AN Popper. 2007. Memorandum: Update on recommendations for revised interim sound exposure criteria for fish during pile driving activities. Memorandum to Suzanne Theis California Department of Transportation and Paul Wagner Washington Department of Transportation. 8 pp.

Clements WH. 2000. Integrating effects of contaminants across levels of biological organization: An overview. Journal of Aquatic Ecosystem Stress and Recovery (Formerly Journal of Aquatic Ecosystem Health) 7(2):113-116.

Coletti HA, JL Bodkin, TA Dean, KA Kloecker. 2009. Nearshore Marine Vital Signs Monitoring in the Southwest Alaska Network of National Parks. Natural Resource Technical Report NPS/SWAN/NRTR —2009/252. Natural Resource Program Center. National Park Service. Fort Collins, Colorado.

Conover HB. 1926. Game birds of the Hooper Bay Region, Alaska. The Auk 43:162-180.

Costa DP. 1978. The ecological energetics, water, and electrolyte balance on the California sea otter, Enhydra lutris. Ph.D. dissertation, University of California, Santa Cruz.

Costa DP, GL Kooyman. 1984. Contribution of specific dynamic action to heat balance and thermoregulation in the sea otter *Enhydra lutris.* Physiol. Zool. 57: 199-203.

Cronin MA, J Bodkin, B Ballachey, J Estes, JC Patton. 1996. Mitochondrial DNA variation among subspecies and populations of sea otters (*Enhydra lutris*). Journal of Mammalogy 77:546-557.

Curland, JM. 1997. Effects of disturbance on sea otters (Enhydra lutris) near Monterey, California (Master's thesis). Available from ProQuest Dissertations and Theses database. (UMI No. 1384680).

Dames & Moore. 1979. A Preliminary Assessment of Composition and Food Webs for Demersal Fish Assemblages in Several Shallow Subtidal Habitats in Lower Cook Inlet, Alaska." Appendix II in: Blackburn, J. E., K. Anderson, C. I. Hamilton, and S. J. Starr. 1981. Pelagic and Demersal Fish Assessment in the Lower Cook Inlet Estuary System. U.S. Dept. of Commerce, NOAA, OCSEAP Final Rep. 12. Pp. 259-602.

Dau CP. 1987. Birds in nearshore waters of the Yukon–Kuskokwim Delta, Alaska. Murrelet 68:12–23.

Dau CP. 1991. Population size and migratory phenology of Soviet breeding Steller's eiders at the Izembek National Wildlife Refuge. (Abstract) Alaska Bird Conf. and Workshop: Shared avian resources of Beringia. Nov. 19-22, 1991. Anchorage, Alaska.

Dau CP, PL Flint, MR Petersen. 2000. Distribution of recoveries of steller's eiders banded on the lower Alaska Peninsula, Alaska. Journal of Field Ornithology 71:541-548.

Day RH. 1998. Predator populations and predation intensity on tundra–nesting birds in relation to human development. Report prepared by ABR Inc., for Northern Alaska Ecological Services, U.S. Fish and Wildlife Service, Fairbanks, Alaska. 106pp.

Day RH, A Gall, B Lawhead, A Prichard, A Wildman. 2008. Marine Wildlife Surveys. Anchorage, Alaska, Pebble Partnership Agency Information Meeting. 1-62.

Day RH, JR Rose, AK Prichard, RJ Blaha, & BA Cooper. 2004. Environmental effects on the fall migration of eiders at Barrow, Alaska. Marine Ornithology 32: 13-24.

DeGange AR, DC Douglas, DH Monson, CM Robbins. 1995. Surveys of sea otters in the Gulf of Alaska in response to the Exxon Valdez oil spill. Natural Resource Damage Assessment Marine Mammal Study 6-7. Final report. 11 pp.

Diamond Point LLC. 2009a. Responses to USACE letter dated May 28, 2008, USFWS letter dated May 15, 2008, NMFS letter dated May 14, 2008. Letter received by US Fish and Wildlife Service, Anchorage Field Office. Anchorage, Alaska, March 26, 2009.

Diamond Point LLC. 2009b. Project description. Fish & wildlife studies. Responses to federal agency pre-application comments. Submitted to U.S. Army Corps of Engineers June 10, 2009. Anchorage, Alaska.

Diamond Point LCC. 2010. POA-2008-523, Cottonwood Bay. Diamond Point Quarry. Response to USACE RFAI, Alternatives. Letter received by US Fish and Wildlife Service, Anchorage Field Office. Dec. 21, 2010. Anchorage, Alaska.

Dick MH, LS Dick. 1971. The natural history of Cape Pierce and Nanvak Bay, Cape Newenham National Wildlife Refuge, Alaska. U.S. Fish and Wildlife Service. Unpublished report. Bethel, Alaska. 77 pp.

Doroff AM, AR DeGange. 1994. Sea otter, *Enhydra lutris*, prey composition and foraging success in the northern Kodiak Archipelago. Fishery Bulletin 92:704-710 92(1994): 704-710.

Doroff AM, JA Estes, MT Tinker, DM Burn, TJ Evans. 2003. Sea Otter Population Declines in the Aleutian Archipelago Journal of Mammalogy 81(1): 55-64.
Dunn PO, DW Winkler. 1999. Climate change has affected the breeding date of tree swallows throughout North America. Proceedings of the Royal Society of London Series B(266):2487-2490.
Dunton KH, E Reimnitz, S Schonberg. 1982. An Arctic kelp community in the Alaskan Beaufort Sea. Arctic 35:465–484.
Eberhardt LL. 1977. Optimal management policies for marine mammals. Wildlife Society Bulletin 5:162-169.
Eberhardt, LE, RA Garrott, WC Hanson. 1983. Winter movements of Arctic foxes, *Alopex lagopus*, in a Petroleum Development Area. The Canadian Field Naturalist 97:66–70.
Environmental Protection Agency 1976. Impacts of construction activities in wetlands of the United States. EPA/600/3-76-045.
Eley WD. 2006. Cook Inlet Vessel Traffic Study. Report to Cook Inlet Regional Citizens Advisory Council. 49 pp.
Erickson D. 1997. Distribution, abundance, migration and breeding locations of marine birds Lower Cook Inlet, Alaska, 1976. Pp 101- 181 *In* Environmental studies of Kachemak Bay and Lower Cook Inlet, L.L. Trasky, L.B. Flagg, and D.C. Burbank editors. Volume VIII. Unpublished document, Alaska Department of Fish and Game, Marine/Coastal Habitat Management, Anchorage, Alaska.
Esler D, JA Schmutz, RL Jarvis, DM Mulchay. 2000. Winter survival of adult female harlequin ducks in relation to history of contamination by the Exxon Valdez oil spill. J. Wildl. Manage. 64(3):839-847.
Estes JA. 1980. *Enhydra lutris*. American Society of Mammalogists. Mammalian Species 133. 8 pp.
Estes JA.1990. Growth and equilibrium in sea otter populations. Journal of Animal Ecology 59:385 401.
Estes JA, JL Bodkin. 2002. Marine otters. Pages 842–858 in W. F. Perrin, B. Wursig, J. G. M. Thewissen and C. R. Crumly, eds. Encyclopedia of marine mammals. Academic Press, San Diego, CA.
Estes JA, EM Danner, DF Doak, B Konar, AM Springer, PD Steinberg, MT Tinker, and TM Williams. 2004. Complex trophic interactions in kelp forest ecosystems. Bulletin of Marine Science 74:621-638.
Estes JA, C Harrold. 1988. Sea otters, sea urchins, and kelp beds: Some questions of scale. Pages116-150 *In* The community ecology of sea otters. GR VanBlaricom, JA Estes (*eds.*). Springer-Verlag, Berlin, West Germany.
Estes, JA, RJ Jameson, EB Rhode. 1982. Activity and prey selection in the sea otter: Influence of population status on community structure. American Naturalist 120:242-258.
Estes JA, NS Smith, JF Palmisano. 1978. Sea otter predation and community organization in the western Aleutian islands, Alaska. Ecology 59:822-833.
Estes JA, MT Tinker. 1996. The population ecology of sea otters at Adak Island, Alaska. Final report to the Naval Facilities Engineering Command, 19917 7th Ave. NE, Poulsbo, Washington 98370. 37 pp.
Estes JA, MT Tinker, AM Doroff, DM Burn. 2005. Continuing sea otter population declines in the Aleutian archipelago. Marine Mammal Science 21:169-172.
Estes JA, MT Tinker, TM Williams, DF Doak. 1998. Killer whale predation linking oceanic and near-shore ecosystems. Science 282:473-476.

Etherington L, P Hooge, E Hooge, D Hill. 2007. Oceanography of Glacier Bay, Alaska: Implications for Biological Patterns in a Glacial Fjord Estuary. Estuaries and Coasts 30(6): 927-944

Evans TJ, DM Burn, AR DeGange. 1997. Distribution and relative abundance of sea otters in the Aleutian Archipelago. U.S. Fish and Wildlife Service, Marine Mammals Management Office, Anchorage, Alaska. Technical Report, MMM 97-5. 29 pp.

Everhart WH, R M Duchrow. 1970. Effects of suspended sediment on aquatic environments. NTIS. U.S. Department of Commerce, PB- 196-641.

Fadely BS, M Merklein. 2001. Update of preliminary analysis of marine mammal interactions, entanglements and mortalities observed during the Cook Inlet salmon drift and set gillnet fisheries, 1999-2000. National Marine Mammal Laboratory, Alaska Fisheries Science Center report. 10 pp.

Fay FH, TJ Cade. 1959. An ecological analysis of the avifauna of St. Lawrence Island, Alaska. University of California Press, Berkley, California. 149 pp.

Feder HM, DC Burrell. 1982. Impact of seafood cannery waste on the benthic biota and adjacent waters at Dutch Harbor, Alaska. Report R82-1, Inst. Mar. Sci., Univ. Alaska, Fairbanks.

Finley DB, GI Scott, JW Daugomah, SL Layman, L Reed, M Sanders, SK Sivertsen, ED Strozier. 1999. Case study: Ecotoxicological assessment of urban and agricultural nonpoint source runoff effects on the grass shrimp, *Palaemonetes pugio*. Pages 243-273 *In* Ecotoxicology and risk assessment for wetlands. MA Lewis, FL Mayer, RL Powell, MK Nelson, SJ Klaine, MG Henry, GW Dickson (*eds.*). A special publication of SETAC.

Fischer JB, RA Stehn, TD Bowman, G Walters. 2004. Nest populations and potential production of geese and spectacled eiders on the Yukon-Kuskokwim Delta, Alaska. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska. Unpublished report. 25 pp.

Flint PL, JB Grand, JA Morse, and TF Fondell. 2000. Late summer survival of adult female and juvenile spectacled eiders on the Yukon–Kuskokwim Delta, Alaska. Waterbirds 23:292–297.

Flint PL, MP Herzog. 1999. Breeding of Steller's eiders (*Polysticta stelleri*) on the Yukon–Kuskokwim Delta, Alaska. Can. Field Nat. 113:306–308.

Flint PL, EW Lance, KM Sowl, TF Donnely. 2010. Estimating carcass persistence and scavenging bias in a human-influenced landscape in western Alaska. Journal of Field Ornithology, 81:70-78.

Flint, PL, MR Petersen, JB Grand. 1997. Exposure of spectacled eiders and other diving ducks to lead in western Alaska. Can. J. Zool. 75:439-443.

Ford RG. 2006. Using beached bird monitoring data for seabird damage assessment: The importance of search interval. Marine Ornithology 34:91–98.

Foster MS. 1975. Algal succession in a *Macrocystis pyrifera* forest. Marine Biology 32:313–329. Frost, KJ, MA Simpkins, LF Lowry. 2001. Diving behavior of subadult and adult harbor seals in Prince William Sound, Alaska. Marine Mammal Science, 17(4):813-834

Frost K, MA Simpkins, LF Lowry. 2001. Diving behavior of subadult and adult harbor seals in Prince William Sound, Alaska. Marine Mammal Science 17(4): 813-834

Funk F. 2003. Overview of state-managed marine fisheries in southwest Alaska, with reference to northern sea otters. Alaska Department of Fish and Game, Juneau, Alaska. Regional Information Report 5J03-02.

Furness RW, DG Ainley. 1984. Threats to seabird populations presented by commercial fisheries. The Status and Conservation of the World's Seabirds, ICBP Technical Publication #2:701-708.

Gabrielson IN, FC Lincoln. 1959. Birds of Alaska. The Stackpole Company, Harrisburg, Pennsylvania, and the Wildlife Management Institute, Washington, DC. 922 pp.

Garshelis DL, JA Garshelis. 1984. Movements and Management of Sea Otters in Alaska. The Journal of Wildlife Management 48(3): 665-678.

Garshelis DL, AM Johnson, JA Garshelis. 1984. Social organization of sea otters in Prince William Sound. Alaska. Can. J. Zool. 62:2648-2658.

Gehring J, P Kerlinger, A Manville. 2009. Communication towers, lights, and birds: successful methods of reducing the frequency of avian collisions. Ecological Applications 19(2): 505-514

Ghoul A, C Reichmuth. 2012. Sound Production and Reception in Southern Sea Otters *(Enhydra lutris nereis).* Pages *157-159 in* A.N. Popper and A. Hawkins (eds.) The effects of Noise on Aquatic Life, Advances in Experimental Medicine and Biology 730. Springer Science+Business Media.

Gill VA, K Burek, P Tuomi, AM Doroff, D Jenski, C Goertz, L Slater, A Kettle, L Comerci, B Byrne, M Miller, W Miller, C Field, In. Prep. The first baseline pathologic and demographic study of northern sea otter carcasses in Alaska.

Gill RE, MR Petersen, and PD Jorgensen. 1981. Birds of Northcentral Alaska Peninsula, 1978–80. Arctic 34:286–306.

Gillham CE. 1941. Report on waterfowl investigations, summer 1941, lower Yukon River, Chevak, Hooper Bay. Unpublished report. U.S. Fish and Wildlife Service, Washington, DC.

Glegg GA, L Hickman, SJ Rowland. 1999. Contamination of limpets (*Patella vulgator*) following the Sea Empress oil spill. Marine Pollution Bulletin 38(2) :119-125.

Goldstein T, JAK Mazet, VA Gill, AM Doroff, KA Burek, JA Hammond. 2009. Phocine distemper virus in northern sea otters in the Pacific Ocean, Alaska, USA. Emerging Infectious Diseases. Vol. 15(6):925-927. www.cdc.gov/eid.

Goodman D. 1987. The demography of chance extinctions. Pages 11-34 *In* Viable populations for conservation. ME Soule (*ed.*). Cambridge Univ. Press, New York.

Goudie RI, CD Ankney. 1986. Body Size, Activity Budgets, and Diets of Sea Ducks Wintering in Newfoundland. Ecology 67(6): 1475-1482.

Grigg DI 1970. Some effects of dredging on water quality and coral reef ecology. Caribbean Conservation Environmental Newsletter 1:22-27.

Hastings MC, AN Popper. 2005. Effects of sound on fish. Unpublished report prepared for California Department of Transportation. Available at: http://www4.trb.org/trb/crp.nsf/reference/boilerplate/Attachments/$file/EffectsOfSoundOnFish1-28-05(FINAL).pdf

Hatfield BB, D Marks, MT Tinker, K Nolan, J Peke. 1998. Attacks on sea otters by killer whales. Marine Mammal Science 14:888-894.

HDR Alaska, Inc. 2011a. Draft biological assessment for Diamond Point granite rock quarry on Steller's eider (*Polysticta stelleri*), Kittlitz's murrelet (*Brachyramphus brevirostris*), and Southwest Alaska Distinct Population Segment of the Northern sea otter (*Enhydra lutris kenyoni*). Prepared for: Diamond Point LLC. Anchorage, Alaska. August, 2010.

HDR Alaska, Inc. 2011b. Biological Assessment For Diamond Point Granite Rock Quarry On Steller's eider (*Polysticta stelleri*), Kittlitz's murrelet (*Brachyramphus brevirostris*), and

Southwest Alaska Distinct Population Segment of the Northern sea otter (*Enhydra lutris kenyoni*). Prepared for: Diamond Point LLC. Anchorage, Alaska. April, 2011.

HDR Alaska, Inc. 2011c. Biological Assessment For Diamond Point Granite Rock Quarry On Steller's eider (*Polysticta stelleri*), Kittlitz's murrelet (*Brachyramphus brevirostris*), and Southwest Alaska Distinct Population Segment of the Northern sea otter (*Enhydra lutris kenyoni*). Prepared for: Diamond Point LLC. Anchorage, Alaska. October, 2011.

Hellier, TR, LS. Kornicker. 1962. Sedimentation from ahydraulic dredge in a bay. Institute of Marine Science, University of Texas. Publication No. 8:212-215.

Hemilä S, S Nummelaa, A Berta, T Reuter 2006. High-frequency hearing in phocid and otariid pinnipeds: An interpretation based on inertial and cochlear constraints. J. Acoust. Soc. Am. 120 (6): 3463–3466.

Henny CJ, DD Rudis, TJ Roffe, E Robinson-Wilson. 1995. Contaminants and sea ducks in Alaska and the circumpolar region. Environmental Health Perspectives 103:41-49.

Hodges JI, JG King, B Conant, HA Hanson. 1996a. Aerial surveys of water birds in Alaska 1957-94; Population trends and observer variability. National Biological Service Information and Technology Report #4. U.S. Geological Survey, Information Services, Box 25286, Denver, Colorado. 24 pp.

Holmes WN 1984. Reviews in environmental toxicology 1. E Hodgson (*ed.*). North Carolina State University. Elsevier Science Publishers, New York.

Holmes WN, J Cronshaw, J Gorsline. 1978. Some effects of ingested petroleum on seawater-adapted ducks (*Anas platyrhynchos*). Environmental Research 17:177-190.

Holmes WN, J Gorsline, J Cronshaw. 1979. Effects of mild cold stress on the survival of seawater-adapted mallard ducks (*Anas platyrhynchos*) maintained on food contaminated with petroleum. Environmental Research 20:425-444.

Holst M, CR Greene Jr., WJ Richardson, TL McDonald, K Bay, RE Elliott, 2005b. Marine mammal and acoustical monitoring of missile launches on San Nicolas Island, California, August 2001-May 2005 (LGL Report TA2665-5). Report from LGL Ltd., King City, Ontario, for Naval Air Warfare Center Weapons Division, Point Mugu, CA, and National Marine Fisheries Service, Silver Spring, MD. 165 pp.

Holst M, JW Lawson, WJ Richardson, SJ Schwartz, G Smith. 2005a. Pinniped responses during Navy missile launches at San Nicolas Island, California. In D. K. Garcelon & C. A. Schwemm (Eds.), Proceedings of the 6th California Islands *Symposium* (Ventura, CA) (National Park Service Technical Publication CHIS- 05-01) (pp. 477-484). Arcata, CA: Institute of Wildlife Studies.

Houghton JT, LG Meira Fihlo, BA Callender, N Harri, A Kattenberg, K Maskell. 1996. Climate change 1995: The science of climate change. Cambridge University Press, Cambridge, UK.

Houghton J, J Starkes. 2008. Results of sampling activities near Diamond Point, Iliamna/Cottonwood Bays - 12644-03.

Illinworth & Rodkin, Inc., 2007. Compendium of Pile Driving Sound Data. The California Department of Transportation Sacramento, CA. Available: http://www.dot.ca.gov/hq/env/bio/files/pile_driving_snd_comp9_27_07.pdf

Inkley DB, MG Anderson, AR Blaustein, VR Burkett, B Felzer, B Griffith, J Price, TL Root. 2004. Global climate change and wildlife in North America. Wildlife Society Technical Review 04-2. The Wildlife Society, Bethesda, Maryland. 26 pp.

Intergovernmental Panel on Climate Change [IPCC]. 2001. Climate change 2001: The science of climate change, contribution of working group 1 to the intergovernmental panel on climate change third assessment report. *Edited by* JT Houghton, Y Ding, DJ Griggs, M Noguer, PJ van der Linden, X Dai, K Maskell, CA Johnson. Cambridge University Press, Cambridge,UK.

Intergovernmental Panel on Climate Change [IPCC]. 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. *Edited by* Pachauri, R.K., and A. Reisinger. IPCC, Geneva, Switzerland, 104 pp.

Intergovernmental Panel on Climate Change [IPCC]. 2012. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation . *Edited by* Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 1-19.

Jameson RJ. 2002. Trans-located sea otter populations of the Oregon and Washington coasts. U.S. Geological Survey Biological Resources Division, California Science Center. Sea Otter Project, 200 S.W. 35th Street, Corvallis, Oregon 99773.

Johnson AM. 1982. Status of Alaska sea otter populations and developing conflicts with fisheries. Pages 293-299 *In* Transactions of the 47th North American Wildlife and Natural Resources Conference, Washington DC.

Jones & Stokes. 2009. Final Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish. Prepared by Illingworth and Rodkin for: California Department of Transportation http://www.dot.ca.gov/hq/env/bio/files/Guidance_Manual_2_09.pdf Sacramento, CA.

Kaplan, EH, JR Walker, MG Kraus, S McCourt. 1975. Some factors affecting the colonization of a dredged channel. *Marine Biology* 32:193-204.

Kastak D, BL Southall, RJ Schusterman, CR Kastak. 2005. Underwater temporary threshold shift in pinnipeds: Effects of noise level and duration. Journal of the Acoustical Society of America 118(5): 3154-3163.

Kastak D, RJ Schusterman.1998. Low-frequency amphibious hearing in pinnipeds: Methods, measurements, noise, and ecology. J. Acoust. Soc. Am. Volume 103, Issue 4, pp. 2216-2228 (1998); (13 pages)

Kenyon KW. 1969. The sea otter in the eastern Pacific Ocean. U.S. Dept. Interior. N.A. Fauna, No. 68. 352 pp.

Kenyon, KW. 1981. Sea otter (*Enhydra lutris*). Handbook of marine mammals, Vol 1. The walrus, sea lions, fur seals, and sea otter. Academic Press, San Diego, CA. 235 pp.

Kertell K. 1991. Disappearance of the steller's eider from the Yukon-Kuskokwim Delta, Alaska. Arctic 44:177–187.

King M, K Williams, D Willoya. 2000. Summary of sea otter mortality in Orca Inlet of Prince William Sound, Alaska, years 1995-2000. Internal report. Alaska Sea Otter and Steller Sea Lion Commission.

Kolton J. 2011. Southwest Alaska sea otter study; sea otter population hotspot analysis. Unpublished Final Report, prepared by Geographic Resource Solutions for U.S. Fish & Wildlife Service, Region 7. Anchorage, AK

Konar B. 2007. Recolonization of a high latitude hard-bottom nearshore community Polar Biology 30:663–667.

Laidre KL, JA Este, MT Tinker, L Bodkin James, DH Monson, and KB Schneider. 2006. Patterns of growth and body condition in sea otters from the Aleutian archipelago before and after the recent population decline. Journal of Animal Ecology 75:978-989.
Lanctot RB, JC King. 2000a. Abundance and distribution of steller's eiders and other water birds at False Pass, Alaska, January through March of 2000. Unpublished report. LGL Alaska Research Associates, Inc., 4175 Tudor Centre Drive, Suite 202, Anchorage, Alaska 99508.
Lanctot RB, JC King. 2000b. Steller's eider and other water bird numbers and distribution at Akutan Harbor, Alaska, winter of 1999/2000. Unpublished report. LGL Alaska Research Associates, Inc., 4175 Tudor Centre Drive, Suite 202, Anchorage, Alaska 99508.
Lande R, GF Barrowclough. 1987. Effective population size, genetic variation, and their use in population management. Pages 87-123 *In* Viable populations for conservation. ME Soule (*ed.*). Cambridge University Press, New York.
Larned WW. 1998. Steller's eider spring migration surveys, 1998. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska.
Larned WW. 2000a. Steller's eider spring migration surveys, 2000. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska.
Larned WW. 2000b. Aerial surveys of steller's eiders and other water birds and marine mammals in southwest Alaska areas proposed for navigation improvements by the U.S. Army Corps of Engineers, Alaska. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska.
Larned WW. 2002. Steller's Eider Spring Migration Surveys, Southwest Alaska 2002. unpublished: 21.
Larned WW, B Eldridge. 1997. Aerial Survey, Trip Report Cook Inlet, 1/16/97.
Larned WW. 2000a. Aerial surveys of Steller's eiders and other water birds and marine mammals in southwest Alaska areas proposed for navigation improvements by the U.S. Army Corps of Engineers, Alaska. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska.
Larned WW. 2000b. Steller's eider spring migration surveys, 2000. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska.
Larned WW. 2001a. Field report, Steller's eider survey. Unpublished memo to Greg Balogh. U.S. Fish and Wildlife Service, Migratory Bird Management, 1011 E. Tudor Road, Anchorage, AK.
Larned WW. 2001b. Steller's eider spring migration surveys, 2001. U.S. Fish and Wildlife Service, Migratory Bird Management, 1011 E. Tudor Road, Anchorage, AK.
Larned WW. 2002. Field report, Steller's eider survey, 2002. Unpublished memo. U.S. Fish and Wildlife Service, Migratory Bird Management, 1011 E. Tudor Road, Anchorage, AK.
Larned WW. 2003. Field report, Lower Cook Inlet Steller's eider, Pilot survey. Unpublished memo. U.S. Fish and Wildlife Service, Migratory Bird Management, 1011 E. Tudor Road, Anchorage, AK.
Larned WW. 2003. Lower Cook Inlet Steller's eider, pilot survey. Waterfowl Management. Jan. 6 2003
Larned WW. 2004. Seasonal Distribution and abundance of Steller's eider in Cook Inlet. Annual Report: 1-16.

Larned WW. 2005. Trip Report: Aerial Survey of Lower Cook Inlet To Locate Flocks of Steller's Eiders and Mergansers 8. Sept 14, 2005 U.S. Fish and Wildlife Service, Soldotna, Alaska. 9 pp.

Larned WW. 2006a. Winter distribution and abundance of Steller's eiders (*Polysticta stelleri*) in Cook Inlet, Alaska 2004-2005. U.S. Fish and Wildlife Service, Waterfowl Management Branch .Anchorage, Alaska. OCS Study, MMS 2006-066. 37 pp

Larned W.W. 2006b. Distribution and abundance of selected waterbirds and sea otters in Cook Inlet, Alaska, winters 2004-2005. Unpublished report prepared by U.S. Fish and Wildlife Service, Anchorage, AK. (appendix to Larned, 2006b).

Larned WW. 2012. Steller's Eider Spring Migration Surveys Southwest Alaska, 2011. U.S. Fish and Wildlife Service Anchorage. 24 pp.

Larned WW, T. Bowman. 2000. Trip report for 3/14/2000 aerial survey of eastern Lower Cook Inlet shoreline. Unpublished memo. U.S. Fish and Wildlife Service, Migratory Bird Management, 1011 E. Tudor Road, Anchorage, AK.

Larned WW, B Butler, G Balogh. 1993. Progress report: Steller's eider spring migration surveys southwest Alaska, 1993. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska.

Larned WW, B Eldridge. 1997. Aerial survey, Cook Inlet, 1/16/97. Unpublished memo to Russ Oats. U.S. Fish and Wildlife Service, Migratory Bird Management, 1011 E. Tudor Road, Anchorage, AK.

Larned WW, R Platte, R Stehn. 2009. Waterfowl breeding population survey, Arctic Coastal Plain, Alaska, 2008. Unpublished report, U.S. Fish and Wildlife Service, Anchorage, Alaska. 42 pp.

Larned WW, R Stehn, R Platte. 2006. Eider breeding population survey arctic coastal plain, Alaska 2006. Unpublished report. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska. 41 pp.

Larned WW, R Stehn, R Platte. 2008. Waterfowl breeding population survey, Arctic Coastal Plain, Alaska 2007. U. S. Fish and Wildlife Service, Division of Migratory Bird Management. Anchorage, Alaska. 44pp.

Larned W, R Stehn, and R. Platte. 2010. Waterfowl breeding population survey Arctic Coastal Plain, Alaska 2009. Unpublished report. U.S. Fish and Wildlife Service, Anchorage, AK. 42 pp.

Larned WW, T Tiplady. 1996. Distribution and abundance of sea ducks in Kuskokwim Bay, Alaska, September 1996. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska.

Larned WW, D Zwiefelhofer. 1995. Distribution and abundance of steller's eiders (*Polysticta stelleri*) in the Kodiak Archipelago, Alaska, 1994. 18 pp.

Larned WW, D Zwiefelhofer. 2002. Distribution and abundance of steller's eiders (*Polysticta stelleri*) in the Kodiak Archipelago, Alaska. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska.

Laubhan MK, KA Metzner. 1999. Distribution and diurnal behavior of steller's eiders wintering on the Alaska Peninsula. Condor 101:694–698.

Lees DC, JP Houghton. 1977. "Reconnaissance of the Intertidal and Shallow Subtidal Biotic, Lower Cook Inlet." Published in U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Outer Continental Shelf Environmental Assessment Program, Final Report 3 (Biological Studies), 1978, pp. 179-506.

Lees DC, JP Houghton, DE Erikson, WD Driskell, and DE Boettcher. 1980. "Ecological Studies of Intertidal and Shallow Subtidal Habitats in Lower Cook Inlet, Alaska." U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Outer Continental Shelf Environmental Assessment Program. Final Report 42. Pp. 1-436.

Leighton FA, DB Peakall, RG Butler. 1983. Heinz-body hemolytic anemia from the ingestion of crude oil: A primary toxic effect in marine birds. Science 220:271-273.

Leighton FA. 1993. The toxicity of petroleum oils to birds. Environmental Review 1:92-103.

Ljungblad DK, B Würsig, SL Swartz, JM Keene. 1988. Observations on the behavioral responses of bowhead whales (*Balaena mysticetus*) to active geophysical vessels in the Alaskan Beaufort Sea. Arctic 41(3):183–194.

Maldini D, R Scoles, R Eby, M Cotter, RW Rankin. 2012. Patterns of Sea Otter Haul-Out Behavior in a California Tidal Estuary in Relation to Environmental Variables. Northwestern Naturalist, 93(1):67-78.

Mallek EJ, R Platte, R Stehn. 2005. Aerial breeding pair surveys of the Arctic Coastal Plain of Alaska 2004. U.S. Fish and Wildlife Service. Fairbanks, Alaska.

Mallek EJ, R Platte, R Stehn. 2006. Aerial breeding pair surveys of the Arctic Coastal Plain of Alaska 2005. U.S. Fish and Wildlife Service. Fairbanks, Alaska.

Mallek, EJ, R Platte, R Stehn. 2007. Aerial breeding pair surveys of the Arctic Coastal Plain of Alaska, 2006. Unpublished report, U.S. Fish and Wildlife Service, Fairbanks, Alaska.

Malme, CI, B Würsig, JE Bird, and P Tyack. 1988. Observations of feeding gray whale responses to controlled industrial noise exposure. *In*: W.M. Sackinger, M.O. Jeffries, J.L. Imm, and S.D. Treacy (eds.), Port and Ocean Engineering Under Arctic Conditions, vol. II. Geophysical Inst., Univ. of Alaska, Fairbanks, AK. pp. 55–73.

Malme, CI, PR Miles, CW Clark, P Tyack, JE Bird. 1983. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior. BBN Rep. 5366. Rep. from Bolt Beranek & Newman Inc., Cambridge, MA, for U.S. Minerals Manage. Serv., Anchorage, AK. Var. pag. NTIS PB86-174174.

Malme, CI, PR Miles, CW Clark, P Tyack, JE Bird. 1984. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior/Phase II: January 1984 migration. BBN Rep. 5586. Rep. from Bolt Beranek & Newman Inc., Cambridge, MA, for U.S. Minerals Manage. Serv., Anchorage, AK. NTIS PB86-218377.

Manly, BFJ, AS Van Atten, KJ Kletz, C Nations. 2003. Incidental catch of marine mammals and birds in the Kodak Island set gillnet fishery in 2002. Western EcoSystems Technolgy Inc. report, Cheyenne, WY 91 pp.

Martin, PD, T Obritschkewitsch, DC Douglas. *in prep.* Distribution and movements of Steller's eiders in the non–breeding period.

Mazet JAK, IA Gardner, DA Jessup, LJ Lowenstine. 2001. Effects of petroleum on mink applied as a model for reproductive success in sea otters. Journal of Wildlife Diseases 37(4):686-692.

McEwan EH, PM Whitehead. 1980. Uptake and clearance of petroleum hydrocarbons by the glaucous-winged gull (*Larus glaucescens*) and the mallard duck (*Anas platyrhynchos*). Canadian Journal of Zoology 58:723-726.

McShane LJ, JA Estes, ML Riedman, MM Staedler. 1995. Repertoire, Structure, and Individual Variation of Vocalizations in the Sea Otter. American Society of Mammalogists 76(2): 414-427.

Metzner, KA. 1993. Ecological strategies of wintering Steller's eiders on Izembeck Lagoon and Cold Bay, Alaska. M.S. Thesis, University of Missouri, Columbia, MO. 193 pp.

Michael Minor & Associates Inc. 2012. Chapter 37. Noise Cook Inlet Drainages. In Pebble Limited Partnership [PLP], editor. Pebble project environmental baseline document 2004 through 2008.

Milazzo M, F Badalamenti S Riggio, R Chemello. 2004. Patterns of algal recovery and small-scale effects of canopy removal as a result of human trampling on a Mediterranean rocky shallow community. Biological Conservation 117:191–202.

Miles AK, PL Flint, KA Trust, MA Ricca, SE Spring, DE Arrieta, T Hollmen, BW Wilson. 2007. Polycyclic aromatic hydrocarbon exposure in steller's eiders (*Polysticta stelleri*) and harlequin ducks (*Histronicus histronicus*) in the eastern Aleutian Islands, Alaska. Environmental Toxicology and Chemistry 26:2694-2703.

Monnett C, LM Rotterman. 1988. Movement patterns of adult female and weanling sea otters in Prince William Sound, Alaska. Pages 131-161 *In* Population status of California sea otters. D.B. Siniff, K. Ralls (*eds.*). Final report to the Minerals Management Service, U.S. Department of Interior 14-12-001-3003.

Moulton, VD, WJ Richardson, RE, Elliott, TL McDonald, C Nations, MT Williams. 2005. Effects of an offshore oil development on local abundance and distribution of ringed seals (*Phoca hispida*) of the Alaskan Beaufort Sea. *Marine Mammal Science*. 21, 217-242.

Murie OJ. 1924. Report on investigations of birds and mammals of the Hooper Bay section of Alaska during the spring and summer of 1924. Unpublished report. U.S. Dept. Agric., Bur. Biol. Surv., Washington DC.

Murie OJ, VB Scheffer. 1959. Fauna of the Aleutian Islands and Alaska Peninsula, with notes on the invertebrates and fishes collected in the Aleutians, 1936-38. North American Fauna No. 61. 406 pp.

National Ice Center [NIC]. 1997-2012. Weekly/bi-weekly ice analysis products; Alaska charts; Cook Inlet. U.S. Navy, National Oceanic and Atmospheric Administration, and the U.S. Coast Guard. http://www.natice.noaa.gov/products/weekly_products.html.

National Marine Fisheries Service. 2009. Biological Opinion on Beluga Whales for the Marine Terminal Redevelopment Project at the Port of Anchorage, Alaska.

National Oceanic and Atmospheric Administration [NOAA]. 1996. Injury Assessment Guidance Document for Natural Resource Damage Assessment Under the Oil Pollution Act of 1990. <http://www.darrp.noaa.gov/library/pdf/iad.pdf>

National Oceanic and Atmospheric Administration [NOAA]. NOAA. 2005. Nautical Chart: 16648. Edition: 5. Office of Coast Survey. May 2005. http://www.nauticalcharts.noaa.gov/staff/chartspubs.html

National Oceanic and Atmospheric Administration [NOAA]. 2005. Notice of intent to prepare an Environmental Impact Statement. FR 70(7)1871. January 11, 2005.

National Oceanic and Atmospheric Administration [NOAA]. 2006. Small takes of marine mammals incidental to specified activities; marine geophysical survey in the eastern tropical Pacific. FR 71(13)3260. January 20, 2006.

National Oceanic and Atmospheric Administration [NOAA]. 2008. Small Takes of Marine Mammals Incidental to Specified Activities; Port of Anchorage Marine Terminal Redevelopment Project, Anchorage, Alaska. Federal Register NMFS. 73 (139):41318-41330. July 18, 2008.

National Oceanic and Atmospheric Administration [NOAA]. 2012. Guidance Document: Sound Propagation Modeling to Characterize Pile Driving Sounds Relevant to Marine Mammals. Memorandum from NMFS Northwest Region and Northwest Fisheries Science Center. January 31, 2012. Seattle, Washington.

Newell, RC, LJ Seiderer, DR Hitchcock. 1998. The Impact of Dredging Works in Coastal Waters; A Review of the Sensitivity to Disturbance and Subsequent Recovery of Biological Resources on the Sea Bed. Oceanography and Marine Biology: an Annual Review 36: 127-178.

Nowak R. 1999. Walker's mammals of the world. Baltimore and London: Johns Hopkins University Press.

Newey SR, Seed. 1995. The effects of the Braer oil spill on rocky intertidal communities in south Shetland, Scotland. Marine Pollution Bulletin 30, 274-280.

Nobeltec. 2004. Tides & Currents for North America East & West Coast. Tides & Currents Pro Software Version 3.1i. Available: http://www.landfallnavigation.com/-enso1.html

Obritschkewitsch, T, P Martin, R Suydam. 2001. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 1999–2000. Northern Ecological Services, U.S. Fish and Wildlife Service, Technical Report NAES–TR–01–04, Fairbanks, Alaska pp 113.

Obrischkewitsch T, RJ Ritchie. 2011. Steller's eider surveys near Barrow, Alaska, 2010. Final Report. ABR, Inc., Fairbanks, Alaska. 13 pp.

Obrischkewitsch T, RJ Ritchie, J King. 2008. Steller's eider surveys near Barrow, Alaska, 2007. Final Report. ABR, Inc., Fairbanks, Alaska. 17 pp.

Oechel WC, SJ Hastings, G Vourlitis, M Jenkins. 1993. Recent change of arctic tundra ecosystems from net carbon dioxide sink to a source. Nature 361:520-523.

Okkonen S, S Pegau, S Saupe. 2009. Seasonality of Boundary Conditions for Cook Inlet, Alaska. Final Report OCS Study MMS 2009-041. Coastal Marine Institute School of Fisheries and Ocean Sciences University of Alaska Fairbanks.

Palmer HD, MG Gross. 1979. Ocean dumping and marine pollution. Dowden, Hutchinson & Ross, Inc., Stroudsburg, PA.

Parmesan C, H Galbraith. 2004. Observed impacts of global climate change in the U.S. Report prepared for the Pew Center on Global Climate Change, Arlington, Virginia. www.pewclimate.org.

Pattee OH, DJ Pain. 2003. Lead in the environment In Handbook of Ecotoxicology, 2nd edition. D Hoffman, B Rattner, GA Burton, Jr., J Cairns (eds.). Lewis Publishers, Boca Raton, Florida. 1290 pp.

PB Consult Inc. 2004. Southwest Alaska transportation plan –revised; a component of the Alaska statewide transportation plan. Prepared for the Alaska Department of Transportation and Public Facilities.

Pearce JM, SL Talbot, MR Petersen, JR Rearick. 2005. Limited genetic differentiation among breeding, molting, and wintering groups of the threatened Steller's eider: the role of historic and contemporary factors. Conservation Genetics 6: 743-757.

Pearce JM, S Talbot. 2009. Population Genetics of Steller's Eiders: Additional Analyses U.S. Geological Survey, Alaska Science Center. Anchorage, Alaska

Pentec Environmental/HartCrowser Inc., [Pentec]. 2012a. Chapter 42. Marine Benthos Cook Inlet Drainages. In Pebble Limited Partnership [PLP], editor. Pebble project environmental baseline document 2004 through 2008. #236

Pentec Environmental/HartCrowser Inc., [Pentec]. 2012b. Chapter 36. Marine Nearshore Habitat Cook Inlet Drainages. In Pebble Limited Partnership [PLP], editor. Pebble project environmental baseline document 2004 through 2008. #235

Pentec Environmental/HartCrowser Inc., SLR International Corporation, [Pentec and SLR]. 2012. Chapter 34. Oceanography and marine water quality Cook Inlet drainages. In Pebble Limited Partnership [PLP], editor. Pebble project environmental baseline document 2004 through 2008. #148

Pepper CB, MA Nascarella, RJ Kendal. 2003. A review of the effects of aircraft noise on wildlife and humans, current control mechanisms, and the need for further study. Environmental Management 32:418-432.

Petersen MR. 1980. Observations of wing-feather moult and summer feeding ecology of Steller's eiders at Nelson Lagoon, Alaska. Wildfowl 31:99–106.

Petersen MR. 1981. Populations, feeding ecology and molt of Steller's eiders. Condor 83:256–262.

Petersen MR, MJ Sigman. 1977. Field studies at Cape Pierce, Alaska 1976. Pages 633–693 in Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators, Vol. 4. NOAA, Boulder, Colorado. 39pp.

Petersen MR, DN Weir, MH Dick. 1991. Birds of the Kilbuck and Ahklun Mountain Region, Alaska. North American Fauna No. 76. 158 pp.

Peterson CH, SD Rice, JW Short, D Esler, JL Bodkin, BE Ballachey, DB Irons. 2003. Long-term ecosystem response to the Exxon Valdez oil spill. Science 302.

Popper AN, MC Hastings. 2009. Review Paper; the effects of anthropogenic sources of sound on fishes *Journal of Fish Biology* (2009) 75, 455–489. Available online at www.interscience.wiley.com.

Poole PW, GL Hufford. 1982. "Meteorological and Oceanographic Factors Affecting Sea Ice in Cook Inlet." Journal of Geophysical Research. Vol. 87, No. C3, Pp. 2067-2070.

Portenko LA. 1972. Birds of the Chukchi Peninsula and Wrangel Island. Vol. 2, Nauka, Leningrad, USSR (in Russian).

Prop J, JM Black, P Shimmings, M Owen. 1998. The spring range of barnacle geese *Branta leucopsis* in relation to changes in land management and climate. Biological Conservation 86**:**339-346.

Quakenbush LT, RH Day, BA Anderson, FA Pitelka, BJ McCaffery. 2002. Historical and present breeding season distribution of Steller's eiders in Alaska. Western Birds 33:99–120.

Quakenbush LT, RS Suydam, KM Fluetsch, CL Donaldson. 1995. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 1991–1994. Ecological Services Fairbanks, AK, U.S. Fish & Wildlife Service, Technical Report NAES–TR–95–03. 53 pp.

Quakenbush LT, R Suydam, T Obritschkewitsch. 2000. Habitat use by Steller's eiders during the breeding season near Barrow, Alaska, 1991–1996. Unpublished report, U.S. Fish and Wildlife Service, Fairbanks AK.

Quakenbush LT, NL Naslund, T Obritschkewitsch, M Johnson. 2001. Breeding biology of Steller's eiders nesting near Barrow, Alaska. Draft technical report. U.S. Fish and Wildlife Service, Fairbanks, Alaska.

Quakenbush L, R Suydam, T Obritschkewitsch, M Deering. 2004. Breeding biology of Steller's eiders (*Polysticta stelleri*) near Barrow, Alaska, 1991–1999. Arctic 57:166–182.

Ralls K, Siniff DB, AM Doroff, A Mercure. 1992. Movement patterns of sea otters relocated along the California coast. Marine Mammal Science 1992(2):179-184.

Rausch R. 1953. Studies on the helminth fauna of Alaska. XIII. Disease in the sea otter with special reference to helminth parasites. Ecology 34:584-604.

Reed JA, PL Flint. 2007. Movements and foraging effort of Steller's eiders and harlequin ducks wintering near Dutch Harbor, Alaska. J. of Field Ornithology 78:124-132.

Riedman ML. 1983. Studies of the effects of experimentally produced noise associated with oil and gas exploration and development on sea otters in California. Final report.

Riedman ML, JA Estes. 1990. The Sea Otter (Enhydra lutris): Behavior, Ecology, and Natural History. U.S. Fish and Wildlife Service, Santa Cruz, California Biological Report 90 (14).

Richardson WJ, and CI Malme. 1993. Man-made noise and behavioral responses. *In*: J.J. Burns, JJ Montague, and CJ Cowles (eds.), The Bowhead Whale. Spec. Publ. 2, Soc. Mar. Mamm., Lawrence, KS. pp. 631–700.

Richardson, WJ, B Würsig, CR Greene, Jr. 1986. Reactions of bowhead whales, *Balaena mysticetus*, to seismic exploration in the Canadian Beaufort Sea. J. Acoust. Soc. Am. 79(4):1117–1128.

Richardson, WJ, MA Fraker, B Würsig, RS Wells. 1985. Behaviour of bowhead whales *Balaena mysticetus* summering in the Beaufort Sea: reactions to industrial activities. Biol. Conserv. 32(3):195–230.

Richardson, WJ, CR Greene Jr., CI Malme, DH Thomson. 1995. Marine Mammals and Noise. Academic Press, San Diego. 576pp.

Ritchie RJ, T Obritschkewitsch, J King. 2006. Steller's eider survey near Barrow, Alaska, 2006. Final report for BLM – Fairbanks, Alaska, and ConocoPhillips Alaska, Anchorage, Alaska. 15 pp.

Robertson GJ, F Cooke, RI Goudie, WS Boyd. 1999. Within-year fidelity of harlequin ducks to a moulting and wintering area. Pages 45-51 *In* Behaviour and ecology of sea ducks. RI Goudie, MR Petersen, GJ Robertson (*eds.*). Canadian Wildlife Service Occasional Paper Series #100, Ottawa, Ontario, Canada.

Rocke TE, TM Yuill, RD Hinsdill. 1984. Oil and related toxicant effects on mallard immune defenses. Environmental Research 33:343-352.

Rojek, NA. 2006. Breeding biology of Steller‘s eiders nesting near Barrow, Alaska, 2005. Technical report for U.S. Fish & Wildlife Service, Fairbanks, Alaska. 61 pp.

Rojek, NA. 2007. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 2006. Technical report for U.S. Fish & Wildlife Service, Fairbanks, Alaska. 53 pp.

Rojek, NA. 2008. Breeding biology of Steller‘s eiders nesting near Barrow, Alaska, 2007. U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Fairbanks, Alaska. Technical Report. 44 pp.

Root TL, JT Price, KR Hall, SH Schneider, C Rosenzweig, AJ Pounds. 2003. Fingerprints of global warming on wild animals and plants. Nature 421:57–60.

Rosenberg, DA, MJ Petrula, D Zwiefelhofer, T Holmen, DD Hill, JL Schamber. 2011. Seasonal movements and distribution of Pacific Steller's eiders (*Polysticta stelleri*). Final Report. Alaska Department of Fish and Game, Division of Wildlife Conservation, Anchorage, Alaska. 44 pp.

Rotterman LM, T Simon-Jackson. 1988. Sea otter. Pages 237-275 *In* Selected marine mammals of Alaska. JW Lentfer (*ed.).* National Technical Information Service. PB88-178462, Springfield, Virginia.

Rothrock D, Y Yu, M Maykut. 1999. The thinning of the ice cover. Geophysical Research Letters 26:3469-3472.

Runge J. 2004. Population viability analysis for Alaska breeding and pacific populations of Steller's eider. Unpublished report. Univ. of Montana, wildlife biology program.

Russell R. 2004 Richard Russell's Alaska Steller's Eider Notes, 1969-Present. . U.S. Fish and Wildlife Service Anchorage, Alaska.

Safine DE. 2011. Breeding ecology of Steller's and spectacled eiders nesting near Barrow, Alaska, 2008–2010. U. S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Fairbanks, Alaska. Technical Report. 66 pp.

Schmutz JA, RF Rockwell, MR Petersen. 1997. Relative effects of survival and reproduction on the population dynamics of emperor geese. Journal of Wildlife Management 61:191-201.

Schneider KB. 1976. Assessment of the Distribution and Abundance of Sea Otters Along the Kenai Peninsula, Kamishak Bay and the Kodiak Archipelago. 333-358 pp.

Schneider KB. 1977. "Assessment of the distribution and abundance of sea otters along the Kenai Peninsula, Kamishak Bay and the Kodiak Archipelago." Environmental Assessment of the Alaskan Continental Shelf, Final Reports of Principal Investigators, 1986. Vol. 37. pp. 529-626. U.S. Department of Commerce, Bureau of Land Management/National Oceanic and Atmospheric Administration, Boulder, CO.

Schroeter SC, Dixon JD, J Kastendiek, RO Smith. 1993. Detecting the ecological effects of environmental impacts: a case study of kelp forest invertebrates. Ecological Applications 3, 331–350.

Schumacher JD [ed.]. 2005. Cook Inlet Physical Oceanography Workshop Proceedings (http://doc.aoos.org/other_meetings/2005/cook_inlet_physical_oceanography_workshop_proceedingscombined% 20sections-final-2006.pdf)

Science Applications International Corporation [SAIC]. 2011. Final summary report environmental sound panel for marbled murrelet underwater noise injury threshold panel conducted July 27–29, 2011 Lacey, Washington. Prepared for U.S. Navy NAVFAC Northwest. Bothell, Washington.

Scribner KT, R Fields, S Talbot, J Pearce, M Petersen. 2001. Sex-biased dispersal in threatened Spectacled eiders: evaluation using molecular markers with contrasting modes of inheritance. Evolution. 55: 2105-2115.

Shaffer M. 1987. Minimum viable populations: Coping with uncertainty. Pages 69-86 *In* Viable populations for conservation. ME Soule (*ed.*). Cambridge University Press, New York.

Shaw JB, S Taylor, Solomon, HA Christian, DL Forbes. 1998. Potential impacts of global sea-level rise on Canadian coasts. Canadian Geographer 42:365-379.

Sherk JA. 1971. Effects of suspended and deposited sediments on estuarine organisms. Chesapeake Biological Laboratory,University of Maryland. Contribution No. 443.

Short JW, PM Harris. 1996. Petroleum hydrocarbons in caged mussels deployed in Prince William Sound after the Exxon Valdez oil spill. SD Rice, RB Spies, DA Wolfe, BA Wright (*eds.*). Proc. Exxon Valdez Oil Spill Symp. Am. Fish. Soc. Symp. 18:29-39.

Simon, JL, JP Dyer. 1972 An evaluation of siltation created by bay dredging and construction company during oyster shell dredging operations in Tampa Bay, Florida. Final Research Report, University of South Florida, Tampa.

Sinha AA, CH Conaway, KW Kenyon. 1966. Reproduction in the female sea otter. Journal of Wildlife Management 30:121-130.

SLR Alaska Inc., Pentec Environmental/HartCrowser Inc.[Pentec]. 2012. Chapter 35. Trace elements and other naturally occurring constituents Cook Inlet Drainages. In Pebble Limited Partnership [PLP], editor. Pebble project environmental baseline document 2004 through 2008.

Smith FA, JL Betancourt. 1998. Response of bushy-tailed woodrats (*Neotoma cinerea*) to late Quaternary climatic change in the Colorado Plateau. Quaternary Research 50:1-11.

Springer, AM, JA Estes, GB van Vleit, TM Williams, DF Doak, EM Danner, KA Forney, and B. Pfister. 2003. Sequential megafaunal collapse in the North Pacific Ocean: An ongoing legacy of industrial whaling? Proceedings of the National Academy of Sciences of the United States of America.

Solovieva D. 1997. Timing, habitat use and breeding biology of Steller's eider in the Lena Delta, Russia. Wetlands International Seaduck Specialist Group Bulletin.

Southall BL, AE Bowles, WT Ellison, JJ Finneran, RL Gentry, CRG Jr., D Kastak, DR Ketten, JH Miller, PE Nachtigall, WJ Richardson, JA Thomas, PL Tyack. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals 33(4): 1-121.

Spear LB, DG Ainley. 1999. Migration routes of sooty shearwaters in the Pacific Ocean. Condor 101:205-218.

Springman KR, G Kurath, JJ Anderson, JM Emlen. 2005. Contaminants as viral cofactors: assessing indirect population effects. Aquatic Toxicology, 71:13-23.

Stearns SC. 1992. The evolution of life histories. Oxford University Press, UK. 249 pp.

Stehn R, R Platte. 2009. Steller's eider distribution, abundance, and trend on the Arctic Coastal Plain, Alaska, 1989–2008. Unpublished report for the U.S. Fish and Wildlife Service, Anchorage, Alaska. 35pp.

Stephensen SW, DB Irons, SJ Kendall, BK Lance, LL MacDonald. 2001. Marine bird and sea otter population abundance of Prince William Sound, Alaska: trends following the T/V Exxon Valdez oil spill, 1989-2000. Restoration Project 00159 Annual report. USFWS Migratory Bird Management, Anchorage, Alaska. 114 pp.

Swem T, A Matz. 2008. Analysis of the current status of the Alaska-breeding population of the Steller's eider. Unpublished report. U.S. Fish and Wildlife Service, Fairbanks Field Office, Alaska. 3 pp.

Taylor JL, CH Saloman. 1968. Some effects of hydraulic dredging and coastal development in Boca Ciega Bay, Florida. *Fishery Bulletin* 67:213-241.

Trust KA, JF Cochrane, and JH Stout. 1997. Environmental contaminants in three eider species from Alaska and Arctic Russia. Technical Report WAES-TR-97-03. U.S. Fish and Wildlife Service, Anchorage, Alaska. 44 pp.

Trust K, D Esler, BR Woodin, JJ Stegeman, 2000b. Cytochrome P450 1A induction in sea ducks inhabiting nearshore areas of Prince William Sound, Alaska. Marine Pollution Bulletin 40(5):397-403.

Trust K, KT Rummel, AM Scheuhammer, IL Brisbin, Jr., MG Hooper. 2000a. Contaminant exposure and biomarker responses in spectacled eiders (*Somateria fischeri*) from St. Lawrence Island, Alaska. Arch. Environ. Contam. Toxicol. 38:107-113.

Udevitz MS, JL Bodkin, DP Costa. 1995. Detection of sea otters in boat-based surveys of Prince William Sound, Alaska. Marine Mammal Science 11(1): 59.

U.S. Army Corps of Engineers [USACE]. 2009. Public Notice of Application for Permit POA-2008-523, Cottonwood Bay, July 20, 2009. U.S. Army Corps of Engineers, Regulatory Division. JBER, Alaska:1-13.

U.S. Army Corps of Engineers [USACE]. 2010. Rock Quality Potential Preliminary Investigation, State of Alaska. U.S. Army Corps of Engineers, Alaska District. November 2010.

U.S. Army Corps of Engineers [USACE]. 2011. Public Notice of Application for Permit POA-2008-523, Cottonwood Bay, June 28, 2011. U.S. Army Corps of Engineers [USACE], Regulatory Division. JBER, Alaska:1-92.

U.S. Environmental Protection Agency [USEPA]. 2009. National Recommended Water Quality Criteria EPA-822-R-02-047). http://water.epa.gov/scitech/swguidance/standards/criteria/current/

U. S. Fish and Wildlife Service [USFWS]. 1997. Endangered and threatened wildlife and plants; Threatened status for the Alaska breeding population of the Steller's eider. Final rule. Published 11 July 1997 by the U.S. Fish and Wildlife Service. Federal Register 62(112):31748–31757.

U. S. Fish and Wildlife Service [USFWS]. 2001. Endangered and Threatened Wildlife and Plants; Final determination of critical habitat for the Alaska–breeding population of the Steller's eider. Final rule. Published 2 February 2001 by the U.S. Fish and Wildlife Service. Federal Register 66(23):8849–8884.

U.S. Fish and Wildlife Service [USFWS]. 2002a. Steller's Eider Recovery Plan. Fairbanks Field Office. Fairbanks, Alaska. 27 pp.

U.S. Fish and Wildlife Service [USFWS]. 2002b. Stock assessment for sea otters (Enhydra lutris): southwest Alaska stock. Marine Mammals Management Branch. Anchorage, Alaska.

U.S. Fish and Wildlife Service [USFWS]. 2005. Endangered and threatened wildlife and plants; Determination of threatened status and special rule for the southwest Alaska distinct population segment of the northern sea otter (*Enhydra lutris kenyoni*). Federal Register 70(152):46371.

U. S. Fish and Wildlife Service [USFWS]. 2006. Managing migratory bird subsistence hunting in Alaska: Hunting regulations for the 2007 spring/summer harvest. Environmental assessment. Migratory Birds and State Programs, Anchorage, Alaska.

U. S. Fish and Wildlife Service [USFWS]. 2007. Biological opinion on the effects of the proposed 2007 spring and summer subsistence harvest of birds on the threatened Steller's (*Polysticta stelleri*) and spectacled eiders *(Somateria fischeri).* March 29. Anchorage Field Office, Alaska.

U. S. Fish and Wildlife Service [USFWS]. 2008a. Stock assessment report. Northern sea otter (*Enhydra lutris kenyoni*): Southwest Alaska stock. August 1, 2008. Accessed 10/6/08. http://edocket.access.gpo.gov/2008/E8- 17804.htm

U. S. Fish and Wildlife Service [USFWS]. 2008b. Biological opinion for Bureau of Land Management for the northern planning areas of the National Petroleum Reserve-Alaska. Unpublished report. Fairbanks Field Office, Alaska.

U.S. Fish and Wildlife Service [USFWS]. 2008c. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Southwest Alaska Distinct Population Segment of the Northern Sea Otter (Enhydra lutris kenyoni). Federal Register. 73 (242):76454.

U.S. Fish and Wildlife Service [USFWS]. 2010. Southwest Alaska Distinct Population Segment of the Northern Sea Otter (*Enhydra lutris kenyoni*)-Draft Recovery Plan. Marine Mammals Management Office. Region 7, Alaska:171 pp.

U. S. Fish and Wildlife Service [USFWS]. 2011. Biological opinion for approval of the state of Alaska's mixing zones regulation section of the Alaska water quality standards. Consultation with the. U. S. Environmental Protection Agency Seattle, Washington. Prepared by: Anchorage Fish and Wildlife Field Office, Anchorage, Alaska April 25, 2011.

VanBlaricom GR, JA Ames, MD Harris, RA Hardy. 2001 California's Living Marine Resources: A Status Report to California Department of Fish and Game. California Department of Fish and Game. December, 2001.

Von Biela VR, JW Testa, VA Gill, GM Burns. 2007. Evaluating cementum to determine past reproduction in northern sea otters. Journal of Wildlife Management 72:618-624.

Von Biela VR, VA Gill, JL Bodkin, JM Burns. 2008. Evidence of phenotypic plasticity in the average age at first reproduction of northern sea otters (*Enhydra lutris kenyoni*) in Alaska. Contact: VA Gill, U.S. Fish and Wildlife Service, Marine Mammals Management, Anchorage, Alaska.

Ward DH, RA Stehn. 1989. Response of Brant and Other Geese to Air Craft Disturbance at Izembek Lagoon, Alaska Anchorage.

Wartzok D, DR Ketten. (1999). Marine mammal sensory systems. In J. E. Reynolds II & S. A. Rommel (Eds.), *Biology of marine mammals* (pp. 117-175).

Washington State Department of Transportation [WSDOT]. 2011. Construction Noise Impact Assessment. Chapter 7 *in* Biological Assessment Preparation for Transportation Projects. Advanced Training Manual. Updated March 6, 2012. http://www.wsdot.wa.gov/Environment/Biology/BA/BAguidance.htm (March 21, 2011). Olympia, Washington.

Watt J, DB Siniff, JA Estes. 2000. Interdecadal patterns of population and dietary change in sea otters at Amchitka Island, Alaska. Oecologia (Berlin) 124:289-298.

Wendell F, C Pattison, M Harris. 1995. Sea Otter, *Enhydra lutris*, Containment Management: Field Studies and Feasibility Assessment. California Department of Fish and Game Administrative Report 96-5. (Enter the Date Downloaded, if applicable, DELETE if not). Morro Bay, California.

Wilk RJ, KI Wilk, RC Kuntz, II. 1986. Abundance, age composition and observations of emperor geese in Cinder lagoon, Alaska Peninsula, 17 September–10 October 1986. Unpublished report. U.S. Fish and Wildlife Service, King Salmon, Alaska. 41 pp.

Wilson EO. 1980. Sociobiology. The abridged edition. The Belknap Press of Harvard University Press, Cambridge, Massachusetts. 366 pp.

Wilson DE, MA Bogan, RL Brownell, JR, AM Burdin, MK Maminov. 1991. Geographic variation in sea otters (*Enhydra lutris)*. Journal of Mammalogy 72:22-36.

Yamato O, I Goto, Y Maede. 1996. Hemolytic anemia in wild seaducks caused by marine oil pollution. Journal of Wildlife Diseases 32(2):381-384.

Zhadan PM, MA Vaschenko. 1993. Effect of diesel fuel hydrocarbons on embryogensis and Ca uptake by unfertilized eggs of sea urchin, Strongylocentrotus. Comparative Biochemical Physiology 105C(3): 543-548.

[Top]

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Anchorage Fish & Wildlife Field Office
605 West 4th Avenue, Room G-61
Anchorage, Alaska 99501-2249

APPENDIX A.1. Observer Protocols
Diamond Point Granite Quarry
Consultation #2009-0182
June 28, 2012

Northern sea otters (*Enhydra lutris kenyoni*) may be harmed by noise from pile driving and other activities. Steller's eiders are unlikely to be in the project area during the May 1 to October 31 work season, but if present, may also be harmed. Impacts from noise are likely to be avoided if it is confirmed that otters and eiders are not present in the "hazard area" near the source of the noise for the activities specified in Table A.1. The "hazard area" is defined here as the area in which noise levels from construction activities are expected to exceed threshold noise levels that cause harm. The use of one or more observers to "clear" the hazard area is an effective means to assure that no Steller's eiders or sea otters will be harmed. The observer is responsible for communicating the presence of one or more Steller's eider or sea otters in the hazard area to the construction operators, and halting work until the otter voluntarily leaves the area. To "clear" the area means to verify no otters are present; no action may be taken to disturb otters, move them away, or discourage their use of an area.

Because there has been no research conducted to establish noise thresholds for sea otters or Steller's eiders, we used noise thresholds established by the National Marine Fisheries Service National Marine Fisheries Service [NMFS] for pinnipeds to guide development of hazard areas. NMFS determined that thresholds for Level A Harassment (injury) and Level B Harassment (disturbance) would be reached for pinnipeds under the following scenarios (NOAA 2005; NOAA 2006; NOAA 2008; NMFS 2009, Southall et al. 2007):

- Level B Harassment due to airborne noise: 100 dB re: 20 μPa;
- Level B Harassment due to underwater noise: 120 dB re: 1 μPa for vibratory pile driving;
- Level B Harassment due to underwater noise: 160 dB re: 1 for impact pile driving;
- Level A Harassment due to underwater noise: 190 dB re: 1.

The U.S. Fish and Wildlife Service (Service) recommends the size of the hazard area be established according to Table A.1. The hazard area includes all marine areas below mean high tide (MHT) within a specified radius around the source of the noise. Areas blocked by points of land or shoreline contours are not included in the hazard area, but a 10° buffer outside of these areas should be included (see Figure A.1).

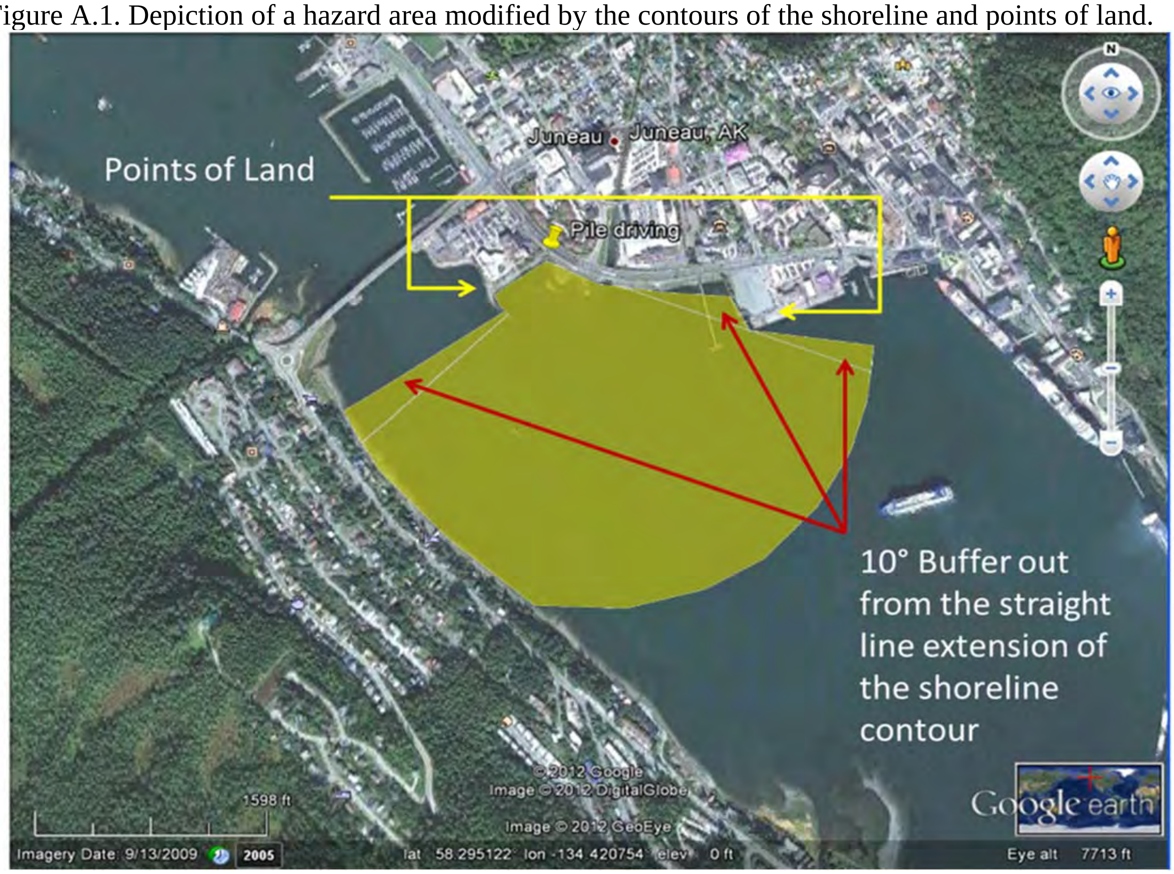
The distances identified in Table A.1 represent the minimum hazard area radii needed to ensure that the typical maximal sound production levels reached during specified activities attenuate to levels below those expected to cause injury. The Service estimates these thresholds to be **110 dB re: 20 μPa for airborne noise, and 183 dB re 1μPa2-sec cumulative SEL for underwater noise**. These distances include a buffer for protection against injury due to cumulative sound exposure.

Table A.1. Hazard area radii for specified activities, based on typical maximal sound levels generated during similar activities to those proposed at Diamond Point quarry[1].

Activity	Details (pile size, etc.)	Sound Production Level			Radius of Hazard Area (meters, m)
		Peak**	RMS**	SEL**	
In-water Vibratory Pile Driving*	Any pile >36"	185-200	170-190	160-180	1000 m
	Any pile 24" to 36"	175-195	165-185	155-175	500 m
	Any pile ≤24"	<190	<180	<170	300 m
Land-based Vibratory Pile Driving	Land-based work includes shoreline work above MHT. Based on in-situ recordings and sound propagation modeling, the distances needed to provide protection from airborne noise impacts would be adequately covered by monitoring the hazard area established for in-water vibratory pile driving.				Same as each category above. Hazard area is limited to areas below MHT.
In-water Fill Placement and Dredging	All in-water use of heavy equipment for manipulating the substrate; including use of hydraulic rock breakers, drills, etc.	140-200	125-185	115-175	300 m
Land-based Blasting	(No underwater blasting will occur)	90-134 dBA re: 20 µPa			500 m

* In-water <20 m ** Underwater sound pressure levels are measured in dB re: 1 µPa.

Figure A.1. Depiction of a hazard area modified by the contours of the shoreline and points of land.



[1] Typical maximal sound levels from Illinworth Rodkin (2007); Blackwell et al. (2004, cited in Navy 2011); Hastings and Popper (2005); Jasco Research Ltd (2005, as cited in Navy 2011); Laughlin (2005, 2010a,b) ; Reyff (2005); Onuu and Tawo (2006); URS (2007); Parvin et al. (2008); Jones and Stokes (2009); NOAA (2009); Navy (2009); Scientific Fishery Systems, Inc. (2009); Thomsen et al. (2009); Mumford (2011); Navy (2011); Robinson et al. (2011); WSDOT (2011); Cardno ENTRIX (2012).

Ramp-up procedures

1. For vibratory pile driving, sound should be initiated for fifteen seconds at reduced energy followed by a 1-minute waiting period. This procedure would be repeated two additional times.
2. Ramp up procedures for in-water fill placement and in-water dredging specified in Table A.1 will be designed by the Applicant to allow noise production to increase gradually from a low level, and to begin at locations farthest from marine areas. For example, a 5-minute period following startup of a single generator located well above high tide could be followed by 5 minutes of operating an excavator near the shoreline, etc. Equipment should be operated at low power, and then gradually increased to noisier, high-power levels. In-water noise production such as placement of fill should occur only after other all other noise-generating activities have ramped up and otters and eiders have had the opportunity to leave the area of their own accord.

Monitoring the "hazard area"

A. Quarry blasting and pile driving: 300 to 1000-m "hazard area"

1. Observers will watch for Steller's eiders and sea otters within the appropriate hazard area as specified in Table A.1 for 30 minutes prior to start of work. Observations will continue for the full duration of these activities.
2. If one or more Steller's eider or sea otter occurs within the hazard area before or at any time during blasting or pile driving, the observer will report the presence of the animal and work will immediately cease or be postponed until the animal leaves the hazard area on its own.

B. Fill Placement and Dredging: 300-m "hazard area"

3. Prior to commencing in-water fill placement, in-water dredging, and any other in-water use of heavy equipment for manipulating the substrate (including use of hydraulic rock breakers, drills, etc.) observers will clear a 300-m hazard area. Additionally, observers will clear the hazard area before recommencing work after any break greater than 30 minutes.
4. If an otter or eider is seen within the hazard area during the 30-minute observation period prior to start-up, the observation period need not start over once the animal moves out of the hazard area, but work may not commence until the observation period is complete.
5. If a sea otter or eider enters the 300-m hazard area during fill placement or dredging, after the observation period has ended, work may continue.
6. If an otter or eider is seen in the 300-m buffer during the observation period prior to start of work and does not leave the area prior to the completion of the 30-minute observation period, ramp up procedures will be applied.

C. ALL noise-generating activities specified in Table A.1 (applies to both A and B)

7. All observers must be capable of spotting and identifying sea otters and Steller's eiders and recording applicable data during all types of weather in which pile driving, blasting, in-water fill placement, or in-water dredging will be conducted.
8. All observer protocols will be applied to any unidentified duck whenever the observer cannot identify whether a duck is a male or a female Steller's eiders in breeding or nonbreeding plumage.
9. Observers will be given the authority to halt project activities if a sea otter or Steller's eider is present and to provide clearance for work to resume after the animal leaves on its own.
10. Observers will have no other duties during the observation period in order to ensure that watching for protected species remains the observer's main focus.

11. A lead observer will be responsible for implementing the protocols. The lead observer may select and train additional observers, but should remain accountable for their performance throughout the work season.
12. All observers must be trained in the monitoring methods to include the following topics:
    - Types of construction activities that require monitoring
    - Observation methods and equipment
    - Observation locations
    - Distance estimation
    - Data to record (parameters) and field forms
    - Species identification
    - Procedures to Stop Work
13. Tools, such as a laser range finder or buoys placed at 300 m intervals away from the shoreline should be used to aid the observer in estimating distances out to 1,000 m.
14. The following are examples of standard equipment recommended for use by observers:
    - High power, reticle binoculars 10 x 50 Bushnell
    - Range finder equivalent to Leica LRF 1200
    - GPS and compass
    - High power spotting scope
15. Observation stations will be established to maximize visibility of the hazard areas. Elevated observation stations will provide better visibility than those at sea level.
16. Observation stations may be established aboard moored vessels and stationary skiffs.
17. Use of a particular station may depend upon weather conditions. If the observable range from any one vantage point is limited due to weather or construction activity, the observer should use an established station that has a better vantage point for monitoring.
18. If visibility is poor due to weather or low light, pile driving and blasting will not commence until viewing conditions make it possible to clear the entire hazard area. In-water fill placement and in-water dredging may commence after ramp up procedures are conducted.
19. During periods of low visibility, pile driving and blasting may commence if additional observers can be added in multiple stations to provide complete visual coverage of the "hazard area".
20. Observers will record basic metrics such as start and end times, date, GPS location of the observation station, name of observers, type of work occurring, numbers and locations of observed sea otters, environmental conditions (air temperature, wind speed and direction, sea state, swell height, tide stage, visibility, percent cloud cover, and precipitation), documentation of work shut downs or postponements due to presence of sea otters, and length of time work was shut down or postponed.
21. Other data that may be useful include: records of sea otter and Steller's eider movements (direction and distance of travel), the times during which the movements occur, and a categorical assessment of behaviors during the observation period. For example, indicate whether sea otters or eiders are resting, feeding, grooming, engaging in social interactions, or travelling from one place to another. Record behavioral changes during the observation period, and comment on whether these behaviors appear to be associated with the work being conducted, and if so, what indications lead to that conclusion.
22. All observation records will be made available to the Service at the end of each calendar month.
23. A summary report will be provided to the Service by December 1 each year.

Optional Considerations:

Monitoring: Whenever possible, sound level testing should be conducted to determine the size of the "hazard area". A more accurate size of the "hazard area" for pile driving/blasting and for fill placement/dredging can then be used for these two categories of work instead of the buffers in Table A.1. A smaller impact area can be monitored more easily and more accurately by fewer observers. To accomplish this, we recommend the following procedures:

1. Prior to sound monitoring, observers should clear an appropriate hazard area for the activity to be conducted (see Table A.1). In-air and in-water sound pressures should be measured with portable instrumentation placed in intervals in multiple directions from the noise source as shown in Figure A.2.
2. For best results, measurements should be taken at multiple water depths.
3. Measurements should be completed in marine waters out to a 500-m radius for blasting, a 300-m, 500-m, or 1,000-m radius for pile driving, and a 300-m radius fill placement and dredging, according to Table A.1.
4. Monitoring should be timed to record peak sound pressures. Sound pressure should be monitored during two categories of work (if both types of work will occur):
   a. Blasting and pile driving
   b. Dredging and fill placement
5. If possible, sound measurements should be taken at various locations simultaneously.
6. If actual noise levels are greater than **110 dB re: 20 µPa; for airborne noise or 183 dB re 1µPa2-sec cumulative SEL for underwater noise** at either a 1,000-m or 300-m radius from the source, testing should be conducted at additional points at 300-m intervals further from the source site to determine the full extent of the area in which threshold pressure levels are reached. If the hazard area is larger than 1,000 m, the Service should immediately be notified, and a 50% larger hazard area should be cleared by the observers prior to continuing work. All observer protocols will be applied to the expanded hazard area.
7. Sound level monitoring results should be reported to the Service. All estimates of sound pressure levels should be reported in dB re: 1 µp for in-water and dB re: 20 µp in air.

Modeling: Acoustic modeling may be conducted by a qualified engineer or hydrologist as an alternative to acoustic monitoring. The models selected should be capable of predicting underwater noise production and attenuation at various distances from the proposed noise-generating activities. Models should be customized to incorporate the specific techniques to be used, and the local bathymetry and substrate information. Modeling methods, assumptions, outputs, and uncertainties should be reported to the Service. The hazard area should be defined as wherever pressure levels are predicted to exceed **110 dB re: 20 µPa; for airborne noise or 183 dB re 1µPa2-sec cumulative SEL for underwater noise**. All observer protocols should be applied to those areas. When possible, noise levels should be tested upon startup of work for comparison with model outcomes. If actual noise levels exceed predicted values, work should follow protocols outlined here, or should stop until sound level testing can be completed.

Videography: The use of video documentation of sea otter or Steller's eiders observations in or near the hazard area during pile driving, blasting, dredging or placement of fill is recommended to assist observers in recording and characterizing responses to noise. We are interested in developing a systematic videographic study. Please notify the Service if you intend to record wildlife near the hazard area as part of your project.

If warranted by new information, observer protocols may be revised by the USFWS.

Contact the Anchorage Fish and Wildlife Field Office with any additional questions or concerns.

Ellen W. Lance, Branch Chief
Endangered Species Branch
Anchorage Fish and Wildlife Field Office
605 W. 4th Room G-61
Anchorage, AK 99501

Ellen_Lance@fws.gov
907-271-1467
Main Office
907-271-2888

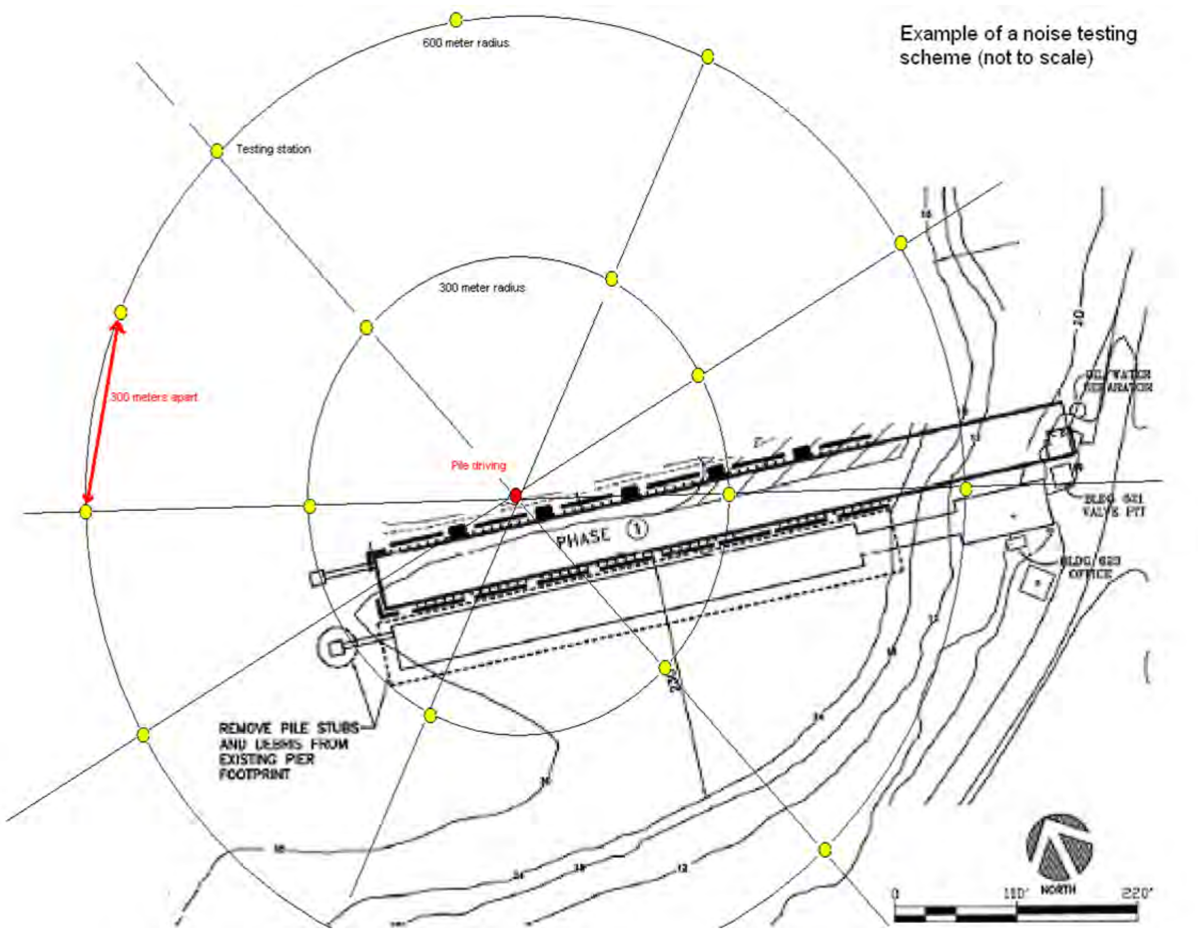


Figure A.2. An example plan for noise testing. Test points are placed in intervals around the work site and each other (it is not to scale) to provide complete coverage of all areas of in-water work.

Literature Cited:

Blackwell SB, JW Lawson, MT Williams. 2004. Tolerance by ringed seals (*Phoca hispida*) to impact pile-driving and construction sounds at an oil production island. Journal of the Acoustical Society of America, *115*, 2346-2357.

Cardno ENTRIX. 2012. Marine Mammal Monitoring and Mitigation Plan for Cook Inlet Exploratory Drilling Program Prepared for Buccaneer Alaska Operations, LLC Anchorage, Alaska.Hastings MC, AN Popper. 2005. Effects of Sound on Fish. Prepared for Jones & Stokes Under California Department of Transportation Contract No. 43A0139, Sacramento, California.

Illingworth and Rodkin. 2007. Compendium of Pile Driving Sound Data. Report. Prepared for the California Department of Transportation. September 27, 2007.

JASCO Research Ltd. 2005. Sound pressure and particle velocity measurements from marine pile driving at Eagle Harbor maintenance facility, Bainbridge Island WA. Prepared by JASCO Research Ltd., Victoria, BC. Prepared for Washington State Department of Transportation, Olympia, WA http://www.wsdot.wa.gov/NR/rdonlyres/1F219171-FB7D-4754-AE7B-C23D7EAA28F0/0/EagleHarborMaintFacRpt.pdf.

Jones & Stokes. 2009. Final Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish. Prepared by Illingworth and Rodkin for: California Department of Transportation http://www.dot.ca.gov/hq/env/bio/files/Guidance_Manual_2_09.pdf Sacramento, CA.

Laughlin J. 2005. Underwater Sound Levels Associated with Restoration of the Friday Harbor Ferry Terminal. Washington State Department of Transportation, Office of Air Quality and Noise, Seattle, WA.

Laughlin J. 2010a. Vashon Ferry Terminal Test Pile Project– vibratory pile monitoring technical memorandum. Technical memorandum. Washington State Department of Transportation. Prepared by Jim Laughlin for John Callahan and Rick Huey. May 4, 2010. http://www.wsdot.wa.gov/NR/rdonlyres/5868F03F-E634-4695-97D8-B7F08C0A315B/0/VashonVibratoryPileReport.pdf.

Laughlin J. 2010b. Keystone Ferry Terminal – vibratory pile monitoring technical memorandum. Washington State Department of Transportation. To John Callahan and Rick Huey. May 4, 2010. http://www.wsdot.wa.gov/NR/rdonlyres/B42B02E3-713A-44E1-A4A6-B9DDD0C9D28A/0/KeystoneVibratoryPileReport.pdfLensink CJ. 1962. The history and status of sea otters in Alaska. Purdue University, Indiana. Ph.D. dissertation. 188 pp.

Mumford S. 2011. Measurement of underwater noise arising from marine aggregate dredging operations-MEPF report 09/P108, Marine Aggregate Levy Sustainability Fund.

National Oceanic and Atmospheric Administration [NOAA]. 2005. Notice of intent to prepare an Environmental Impact Statement. FR 70(7)1871. January 11, 2005.

National Oceanic and Atmospheric Administration [NOAA]. 2006. Small takes of marine mammals incidental to specified activities; marine geophysical survey in the eastern tropical Pacific. FR 71(13)3260. January 20, 2006.

National Oceanic and Atmospheric Administration [NOAA]. 2008. Small Takes of Marine Mammals Incidental to Specified Activities; Port of Anchorage Marine Terminal Redevelopment Project, Anchorage, Alaska. Federal Register NMFS. 73 (139):41318-41330. July 18, 2008.

National Marine Fisheries Service. 2009. Biological Opinion on Beluga Whales for the Marine Terminal Redevelopment Project at the Port of Anchorage, Alaska.

Naval Facilities Engineering Command Northwest [NAVY]. Navy. 2009. Results of acoustic monitoring of pile driving operations: Carlson Spit, Bangor Subbase, Washington. Prepared by Naval Surface Warfare Center – Carderock Division, Detachment Bremerton, Bremerton, WA.

Naval Facilities Engineering Command Northwest [NAVY]. 2011. Request for incidental harassment authorization for the incidental harassment of marine mammals resulting from the Trident support facilities second explosives handling wharf on Naval Base Kitsap at Bangor, Washington.

Onuu MU, AN Tawo. 2006. Industrial noise studies in quarries and neighbouring communities. International Journal of Natural and Applied Sciences. VOL. 1, No. 1: pp. 94 – 100.

Parvin SJ, JR Nedwell, J Kynoch, J Lovelland, AG Brooker, et al. 2008. Assessment of underwater noise from dredging operations on the Hastings Shingle Bank. SubAcoustech Report No. 758R0137 for United Marine Dredging Ltd.

Reyff JA. 2005. Underwater Sound Pressure Levels Associated with Marine Pile Driving Assessment of Impacts and Evaluation of Control Measures. Transportation Research Record: Journal of the Transportation Research Board CD 11-S: 481-490.

Robinson SP, PD Theobald, G Hayman, LS Wang, PA Lepper, V Humphrey, S Mumford. 2011. Measurement of underwater noise arising from marine aggregate dredging operations- MEPF report 09/P108, Marine Aggregate Levy Sustainability Fund.

Scientific Fishery Systems, Inc. 2009. 2008 underwater noise survey during pile driving, Port of Anchorage Marine Terminal Redevelopment Project, in support of Alaska Native Technologies, LLC/ Prepared for U.S. Dept. Transportation Maritime Administration, Port of Anchorage, and Integrated Concepts & Research Corp.

Southall BL, AE Bowles, WT Ellison, JJ Finneran, RL Gentry, CRG Jr., D Kastak, DR Ketten, JH Miller, PE Nachtigall, WJ Richardson, JA Thomas, PL Tyack. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals 33(4): 1-121.

Thomsen F, SR McCully, D Wood, P White, F Page. 2009. A generic investigation into noise profiles of marine dredging in relation to the acoustic sensitivity of the marine fauna in UK waters: PHASE 1 Scoping and review of key issues, Aggregates Levy Sustainability Fund / Marine Environmental Protection Fund (ALSF/MEPF), Lowestoft, UK

URS. 2007. Port of anchorage marine terminal development project underwater noise survey test pile driving program anchorage, Alaska. Prepared for Integrated Concepts & Research Corporation Infrastructure Support Services. Anchorage, AK.

Washington State Department of Transportation [WSDOT]. 2011. Construction Noise Impact Assessment. Chapter 7 *in* Biological Assessment Preparation for Transportation Projects. Advanced Training Manual. Updated March 6, 2012. http://www.wsdot.wa.gov/Environment/Biology/BA/BAguidance.htm (March 21, 2011). Olympia, Washington.

[Top]

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Anchorage Fish & Wildlife Field Office
605 West 4th Avenue, Room G-61
Anchorage, Alaska 99501-2249

APPENDIX A.2. Training Requirements
Diamond Point Consultation #2009-0182
June 28, 2012

Wildlife observers will be employed prior to and/or during pile driving, blasting, fill placement, and dredging at the Diamond Point Granite Quarry. Observer protocols identify the procedures observers will follow. This document describes qualifications and training requirements for the observers.

A lead observer will remain responsible for implementing the protocols throughout the entire season in which pile driving, blasting, fill placement, or dredging activities will occur. The lead observer need not be on site during the entire season, but should be on site no less than once per year. Whether present or absent, the lead observer must ensure that all observer protocols are carried out by well-trained observers at the work site.

The lead observer shall have education or experience which demonstrates his or her qualifications to serve as a lead observer. A lead observer will submit documentation (resume, certificates of training, etc.) documenting his or her qualifications to the U.S. Army Corps (Corps) and the U.S. Fish and Wildlife Service (Service) for approval prior to serving as lead observer. Qualifications may include one or more of the following:

- Formal training in wildlife observation through a marine mammal observer training program or other venue. Various programs are offered by public and private agencies and vendors; information is available by searching online or by contacting the National Oceanic and Atmospheric Administration.
- Education in wildlife observation techniques from a University, College, or other formal education program. Please provide evidence of any education received and the institution providing the training.
- Previous job experience serving as a wildlife observer.
- Demonstrated capabilities in wildlife observation techniques, verified by a wildlife biologist or other wildlife expert.

The lead observer may select and train additional observers, but should remain accountable for their performances. If the lead observer changes, the replacement lead observer shall submit his/her qualifications to the Corps and the Service prior to serving in this capacity.

All observers must be capable of spotting and identifying sea otters as well as Steller's eiders in breeding and non-breeding plumage. Observers must be able to record applicable data during all types of weather in which pile driving, blasting, in-water dredging, and in-water placement of fill will be conducted. Observers must have the authority to immediately stop work when a sea otter, Steller's eider, or unidentified duck is within the pile-driving and blasting hazard areas. It is recommended that all observers work in 2-person teams to increase probability of detecting sea otters and Steller's eiders and to confirm sightings.

The lead observer must verify the abilities of the non-lead observers prior to conducting work, and will be responsible for providing additional training to non-lead observers as needed to accurately and effectively carry out the observer protocols. The lead observer must provide training to all other observers regarding:

- Observation methods and equipment
- Observation locations
- Distance estimation
- Data to record (parameters) and field forms
- Species identification
- Stop Work Protocols

Contact the Anchorage Fish and Wildlife Field Office for verification of lead-observer qualifications and with any additional questions or concerns.

Ellen W. Lance, Branch Chief
Endangered Species Branch
Anchorage Fish and Wildlife Field Office
605 W. 4th Room G-61
Anchorage, AK 99501

Ellen_Lance@fws.gov
907-271-1467
Main Office
907-271-2888

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Anchorage Fish & Wildlife Field Office
605 West 4th Avenue, Room G-61
Anchorage, Alaska 99501-2249

APPENDIX A.3. Reporting Requirements

Diamond Point Consultation #2009-0182

June 28, 2012

Wildlife observers will be employed prior to and/or during pile driving, blasting, in-water fill placement, and in-water dredging at the Diamond Point Granite Quarry. Observer protocols identify the procedures observers will follow. This document describes how and when observation data will be reported to the U.S. Fish and Wildlife Service (the Service).

1. The project manager shall formally notify the Service at least 1 week prior to the seasonal commencement of noise generating work such as pile driving, blasting, in-water fill placement, and in-water dredging.
2. Copies of data forms shall be submitted to the Service at the end of each calendar month unless no pile driving, blasting, in-water fill placement, or in-water dredging was conducted during the preceding month.
3. A summary report of seasonal activities shall be submitted by December 1 each year. This report shall include:
   a. Dates of observations.
   b. Length of observation periods
   c. Location of observation stations and dates used.
   d. Dimensions of hazard areas observed by activity type.
   e. Numbers, dates, group sizes, and locations of sea otters or Steller's eiders seen.
   f. Locations of otters and eiders and descriptions of work activities by type of work occurring when otters and eiders are present within the hazard area or outside of, but near the hazard area.
   g. Summary of noise producing work events; type of work, daily duration, any comments on notable noise producing events while otters or eiders were present in and near the hazard area.
   h. Results of any acoustic monitoring conducted to determine sound production levels.
   i. Descriptions of the type and duration of any noise-generating work occurring and ramp up procedures used while otters were present in and near the hazard area.
   j. Details of all shut down events, and whether they were due to presence of marine mammals, inability to clear the hazard area due to low visibility, or other reasons.
   k. Tables, text, and maps to clarify observations.
   l. Although not a requirement, the Service recommends recording observations of Kittlitz's murrelets, Steller's eiders, and yellow-billed loons seen while conducting marine mammals. Include a summary of any incidental observations of these species.
   m. Names and contact information for observers.
   n. Names, contact information, and qualifications of lead observers.
   o. Names, contact information for site foremen and lead project engineers.

Submit reports to:

Ellen W. Lance, Branch Chief
Endangered Species Branch
Anchorage Fish and Wildlife Field Office
605 W. 4th Room G-61
Anchorage, AK 99501

Ellen_Lance@fws.gov
907-271-1467
Main Office
907-271-2888

Daily Sea Otter/Steller's Eider Observation Form – Diamond Point Quarry

Date:__________________________ Start Time________ End Time_______ Observers:____

Temperature:________ Visibility Distance out to 1000 Meters (m): ☐ Good [1] ☐ Fair ☐ Poor[2] Observation Station (Lat./Long):__________________

Activity	Hazard Area Radius Monitored	Otters Seen? (Y/N)		Action Taken Stop work? (# Minutes/Hrs) Ramp up procedures? Describe	Comments: Group size, Time observed, Any comments on animal movements, Information about any work delays, Notes on noise levels, Other notes
		Distance	Number		
In-Water Vibratory Pile Driving	☐ <300 m ☐ 500 m ☐ 1000 m	☐ <300 m ☐ 300-500 m ☐ 500-1000 m ☐ >1000 m			
Land-based Vibratory Pile Driving	☐ 300 m ☐ 500 m ☐ 1000 m	☐ <300 m ☐ 300-500 m ☐ 500-1000 m ☐ >1000 m			
In-Water Dredge/Fill	300 m	☐ <300 m ☐ 300-500 m ☐ 500-1000 m ☐ >1000 m			
Land-based Blasting	500 m	☐ <300 m ☐ 300-500 m ☐ 500-1000 m ☐ >1000 m			
Other (Any source of noise you wish to note)	☐ 300 m ☐ 500 m ☐ 1000 m	☐ <300 m ☐ 300-500 m ☐ 500-1000 m ☐ >1000 m			

[1] Visibility is influenced by lighting conditions, fog, precipitation, wind/wave action. A reference buoy at a 1000-meter distance from the observation station is recommended.

[2] **Pile driving and blasting shall not be conducted under conditions of poor visibility when hazard area cannot be fully monitored. If visibility is limited, ramp-up procedures must be applied prior to commencing in-water dredging or in-water fill placement.**

Sea Otter/Steller's Eider Monthly Summary Observation Form – Diamond Point Quarry Month_____Year____

Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Weather conditions																															
Start and stop times																															
# otters or eiders seen inside buffer																															
# otters or eiders seen outside buffer																															
Was work stopped because of otters or eiders? Y/N																															
If Yes, what type of work was stopped and for how long?																															

Diamond Point Wildlife Observations Form

US Fish and Wildlife Service. May 7, 2012. 907-271-2066, 907-271-2888-Kimberly_Klein@fws.gov

This map shows distances depicted from the outer footprint of the project. The hazard area may be adjusted for the locations of specific activities and line-of-sight limitations due shoreline contours. Areas blocked by points of land are not included in the hazard area, but a 10° buffer outside of these areas should be included. See observer protocols for details.

Start Time__________ End Time_________ Date:____________

Observers:____

Observation Station

(Lat/Long):________________________/____________________

- ☐ **Mark the location of the project work**
- ☐ **Mark the location of any sea otter(s) and/or Steller's eider(s)**
- ☐ **Draw the outline of the hazard area**

Table A.1. Typical maximal sound production levels and hazard area radii for specified activities.

Activity	Details (pile size, etc)	Sound Production Level			Radius of Hazard Area
		Peak**	RMS**	SEL**	
In-water Vibratory Pile Driving	Any pile >36"	185-200	170-190	160-180	1000 m
	Any pile 24" to 36"	175-195	165-185	155-175	500 m
	Any pile ≤24"	<190	<180	<170	300 m
Land-based Vibratory Pile Driving	Land-based work includes shoreline work above MHT. Based on in-situ recordings and sound propagation modeling, the distances needed to provide protection from airborne noise impacts would be adequately covered by monitoring the hazard area established for in-water vibratory pile driving.				Same as each category above. Hazard area is limited to areas below MHT.
In-water Fill Placement and Dredging	All in-water use of heavy equipment for manipulating the substrate; including use of hydraulic rock breakers, drills, etc.	140-200	125-185	115-175	300 m
Land-based Blasting	(No underwater blasting will occur)	90-134 dBA re: 20 μPa			500 m

* In-water <20 m deep ** Underwater sound pressure. levels are measured in db re: 1 μPa

This page intentionally left blank.
Record the location of each individual or groups of sea otters observed on reverse.
Note also the location from where the observation period was conducted (the observation station).

APPENDIX B. Boat Operation Guidance to Avoid Disturbing Sea Otters

Because the southwest Alaska Distinct Population Segment (DPS) of the northern sea otter (Enhydra lutris kenyoni) is listed as threatened under the Endangered Species Act (ESA), and because the listed population and all other sea otter populations are protected under the Marine Mammal Protection Act (MMPA), the US Fish and Wildlife Service has developed guidance to boat operators to avoid the risk of disturbing or striking sea otters. Collectively, the ESA and MMPA make it illegal to take[1] sea otters.

Sea otter habitat is broadly defined as all near shore maritime waters within their range. Sea otters occupy waters up to 91 m deep (300 ft, 50 fathoms) and spend several hours a day foraging in waters usually less than 40 m deep (132 ft, 22 fathoms). Boats operating in sea otter habitat run the risk of disturbing sea otters, which is considered harassment, or of killing sea otters by striking them with the boat propeller or hull. To avoid the risk of such takings, please follow these guidelines:

- While operating boats in near shore areas, scan the water surface ahead of the boat vigilantly for otters. In choppy water conditions sea otters are difficult to spot. If you are boating with another person, place them in the bow to help search. You may encounter otters as individuals, a mother and a pup, or rafts of 10 or more.

- When you see an otter(s), alter your course and slow down to avoid disturbance and collision. Once you have spotted an otter(s), you should not assume that the otter(s) will dive and get out of the way. Even if they are alert, capable, and do dive, your action of knowingly staying your course would be considered harassment.

- Do not operate a vessel at ANY rate of speed heading directly at the otter(s). A good rule of thumb is that your buffer should be great enough that there is ample room for the otter(s) to swim away without startling them. It is your responsibility to minimize the stimulus and threat of a loud boat approaching quickly.

- The more otters you see, the wider the berth you need to give. Also, do not pass between otters, but rather go around the outside perimeter, plus add a buffer.

- It is illegal to pursue or chase sea otters. Do not single out or surround an otter(s).

Thank you for your efforts to help conserve Alaska's sea otters. If you have any questions, comments or concerns, please contact Verena Gill (907-786-3584) at the US Fish and Wildlife Service's Marine Mammals Management Program or Ellen Lance (907-271-1467) at the Anchorage Fish and Wildlife Field Office's Endangered Species Program.

[Top]

[1] take under the ESA means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct; take under the MMPA means to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal.