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Memorandum

To: Regional Director – Minerals Management Service

From: Regional Director – Region 7 *Thomas O. Melum*

Subject: Chukchi Sea Lease Sale 193: Endangered Species Act Section 7 Consultation

This document transmits the U.S. Fish and Wildlife Service's (Service) Biological Opinion (BO) in accordance with Section 7 of the Endangered Species Act of 1973, as amended (Act), on the effects of the Mineral Management Service's proposed Chukchi Sea Lease Sale 193 to listed and candidate species (attached). The BO evaluates effects of the action on the threatened spectacled eider (*Somateria fischeri*), threatened Steller's eider (*Polysticta stelleri*), and the Ledyard Bay Critical Habitat Unit designated for spectacled eiders. At your request, we have also evaluated potential effects on the candidate species Kittlitz's murrelet (*Brachyramphus brevirostris*) to aid in planning in the event that it is listed under the Act during this project's life, but the current document does not represent a formal BO for the Kittlitz's murrelet.

Lease Sale 193 would authorize the sale of oil and gas leases in 34 million acres of Federal waters in the Chukchi Sea, and may ultimately result in development and production of oil and gas in this area. The MMS has statutory authority to complete its OCS energy development actions as incremental step consultations under the Act. In accordance with this authority and the applicable regulations, this BO includes analyses and conclusions as to whether: 1) the incremental step of leasing and exploration (including seismic surveys and exploratory drilling) would violate Section 7(a)(2) of the Act (i.e., whether these steps would likely jeopardize listed species or cause destruction or adverse modification of critical habitat); and 2) there is a reasonable likelihood that the entire action of leasing, exploration, development, and production that may result from Lease Sale 193 would violate Section 7(a)(2) of the Act. Additionally, for the first incremental step, we have estimated and authorized incidental take, and provided reasonable and prudent measures, and associated terms and conditions intended to reduce take.

Based on the available information, it is the Service's BO that it is unlikely that leasing and exploration activities will violate Section 7(a)(2) of the Act. Incidental take of a small number of Steller's and spectacled eiders is anticipated from collisions during exploratory drilling; this incidental take and potential impacts from spills are mitigated through the reasonable and prudent measures, and terms and conditions, which are mandatory for the MMS to implement. It is also our BO that the entire action, which may also include development and production, would

not jeopardize the continued existence of the spectacled or Steller's eider, or destroy or adversely modify designated critical habitat. This conclusion is based upon the fact that population-level impacts, although possible depending upon what is proposed at a later date, are not reasonably expected to occur based on the information available at this time.

We caution, however, that consultation at future incremental steps in this phased oil and gas process is crucial in order to fully evaluate project specific information about particular development and production plans, and whether or not they are likely to jeopardize listed species or destroy or adversely modify critical habitat. We wish to provide clear notification that consultation on subsequent incremental steps may reach different conclusions depending on the scope, location, and nature of what is proposed. Based on our analyses, we believe that some potential development proposals, while not reasonably likely at this time, could ensue from Lease Sale 193 that would jeopardize listed species or cause destruction or adverse modification of critical habitat. Therefore, consultation on subsequent incremental steps will require careful consideration of all information available at that time, including up-to-date evaluations of listed species status, the environmental baseline, and project-specific considerations such as spill risk assessments and spill trajectory models to evaluate risk to listed species. To this end, we have provided guidance on ways to minimize the likelihood of conflict between listed species and proposed development, and we have identified information needs that will provide for well-informed consultation on subsequent incremental steps.

We commend you for taking a proactive approach to Kittlitz's murrelet conservation, and we also appreciate the considerable efforts made by your staff to provide all the information necessary for our consultation. We look forward to working with you to implement the terms and conditions of the BO, address our shared information needs, and assess future phases of the project.

As you are aware, the Service published a 12-month finding and proposed rule in the Federal Register on January 9, 2007, that found listing of the polar bear as threatened under the Endangered Species Act (Act) to be warranted. For proposed species, such as the polar bear, the Act requires action agencies to *confer* with the Service. Conference is a process of early interagency cooperation designed to identify potential conflicts between an action and species conservation, and to minimize or avoid adverse effects to proposed species or proposed critical habitat. Several key distinctions between the consultation and conference processes are important to identify. First, the "trigger" for consultation and conference is different. While agencies are required to consult with the Service when their actions "may affect" the continued existence of listed species or critical habitat, action agencies are only required to confer with the Service for those actions "likely to jeopardize" the continued existence of the proposed species or result in the "destruction or adverse modification" of proposed critical habitat. Based on our experience to date with agency consultations in northern Alaska, including those related to oil and gas development, and given that Alaska comprises only a small portion of the circumpolar range inhabited by the species proposed for listing, we believe that conference will technically be required in few if any instances in the coming months. As we have discussed, we look forward to working with your staff in the near future on this issue.

A complete administrative record of this consultation is on file at the Fairbanks Fish and Wildlife Field Office, 101 12th Ave., Room 110, Fairbanks, Alaska 99701. A chronology of the consultation history is provided in Appendix 1. If you have any questions, please call Ted Swem at (907) 456-0441.

Attachment



BIOLOGICAL OPINION

For

CHUKCHI SEA PLANNING AREA

OIL AND GAS LEASE SALE 193

AND

ASSOCIATED SEISMIC SURVEYS

AND EXPLORATORY DRILLING

Consultation with the

Minerals Management Service – Alaska OCS Region
Anchorage, Alaska

March 2007

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1. INTRODUCTION

This document transmits the U.S. Fish and Wildlife Service's (Service) Biological Opinion (BO) in accordance with section 7 of the Endangered Species Act of 1973, as amended (Act), on effects to the species discussed below of the Mineral Management Service's (MMS) proposed Chukchi Sea Lease Sale 193. The proposed action (Fig. 1) involves the sale of oil and gas leases on 34 million acres of the Chukchi Sea Outer Continental Shelf (OCS). MMS, the action agency, has statutory authority (under Chapter 345 of the OCS Lands Act of August 7, 1953, 43 USC 1331 et. seq.) to complete its OCS energy development actions in a tiered approach for review under the National Environmental Policy Act (NEPA), including an incremental step consultation process under the Act. Under this authority MMS asked the Service to perform an incremental step consultation for the project, including the first step referred to in this document as leasing and exploration (including seismic surveys and exploratory drilling).



Figure 1.1. Area of Lease Sale 193 and surrounding features.

Regulations at 50 C.F.R. 402.14(k) outline the procedures to be used in conducting incremental step consultations. The regulation states that “the Service shall, if requested by the Federal agency, issue a biological opinion on the incremental step being considered, including its views on the entire action.” The regulation further states that upon issuance of the biological opinion, the Federal agency may proceed with or authorize the incremental steps of the action if the following five requirements are met:

1. The BO does not conclude that the incremental step would violate section 7(a)(2) of the Act (i.e., it is not likely to jeopardize listed species or result in the destruction or adverse modification of critical habitat);
2. The action agency continues consultation with respect to the entire action, and obtains BOs, as required, for each incremental step;
3. The action agency fulfills its continuing obligation to obtain sufficient data upon which to base the final BO on the entire action;
4. The incremental step does not violate section 7(d) of the Act concerning the irreversible or irretrievable commitment of resources; and
5. There is a reasonable likelihood that the entire action will not violate section 7(a)(2) of the Act.

In accordance with the applicable regulations, this BO includes analysis and conclusions as to whether (1) the incremental steps on leasing and exploration (hereafter referred to as the first incremental step) would violate section 7(a)(2) of the Act (i.e., whether these steps would likely jeopardize listed species or destroy or adversely modify critical habitat), and (2) there is a reasonable likelihood that the entire action of leasing, exploration, development, production, and field abandonment that may result from Lease Sale 193 would violate section 7(a)(2) of the Act. The leasing of tracts pursuant to Lease Sale 193 and subsequent exploration, development, production, and abandonment would entail consultation between the Service and MMS at each incremental step in the process, providing opportunities for each agency to refine conservation measures for listed species as project plans develop and listed species status or information changes. Hereafter in this BO, the term “exploration” is used to include seismic surveys and exploratory drilling, and “production” is used to include production and post-production abandonment of facilities.

The proposed lease sale may affect the threatened spectacled eider (*Somateria fischeri*), the threatened Steller’s eider (*Polysticta stelleri*), and the Ledyard Bay Critical Habitat Unit (LBCHU) designated for spectacled eiders (Fig. 2). At MMS’s request, the Service also evaluated potential effects on the candidate Kittlitz’s murrelet (*Brachyramphus brevirostris*) to aid planning in the event it becomes listed during this project’s life, but the current document does not represent a formal BO for Kittlitz’s murrelets.

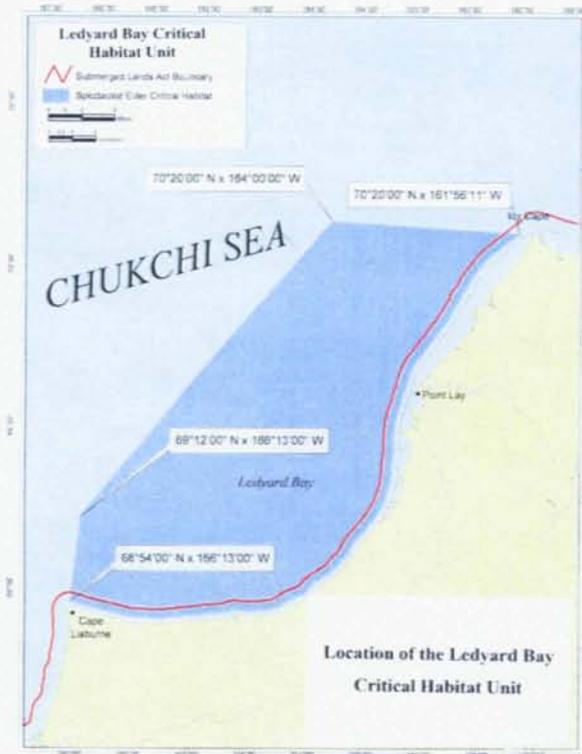


Figure 1.2. Boundaries and corner points of the Ledyard Bay Critical Habitat Unit.

This BO was prepared using the “Biological Evaluation of Spectacled Eider, Steller’s Eider, and Kittlitz’s Murrelet for Chukchi Lease Sale 193” (BE) (MMS 2006a), received from MMS on September 25, 2006; the Chukchi Sea Planning Area Draft EIS Volume I (MMS 2006b); the Chukchi Sea Planning Area Draft EIS Volume II (MMS 2006c); published literature, agency and consultant biological surveys and reports; other information in our files; and personal communication with species experts in the Service and the U.S. Geological Survey (USGS). Formal consultation began on October 23, 2006. Supplemental information was requested on January 23, 2007 and received on February 6, 2007. The complete administrative record of this consultation is on file at the Service’s Fairbanks Fish and Wildlife Field Office.

For each species, the BO addresses whether the incremental step of leasing and exploration would be likely to jeopardize the continued existence of listed species or destroy or adversely modify critical habitat. The BO also addresses whether there is a reasonable likelihood that the entire action, which may also include development and production, would jeopardize listed species or result in the destruction or adverse modification of critical habitat.

The Service concurs with MMS’s determination that the proposed action for the incremental step of leasing and exploration may adversely affect spectacled and Steller’s eiders, and determines that incidental take would be minimized with the specified

Reasonable and Prudent Measures (RPMs), which would be implemented under the prescribed terms and conditions. However, based on the limited number of Steller's and spectacled eiders likely to be affected, and MMS measures that regulate seismic and exploratory drilling activities, the Service has determined the incremental step of leasing and exploration is not likely to jeopardize listed spectacled or Steller's eiders, and is not likely to destroy or adversely modify designated critical habitat.

To assist the Service in evaluating possible impacts of the entire action, including potential development and production, MMS provided a hypothetical, 1 billion barrel (bbl) oil development scenario that included one major production platform in the eastern Chukchi Sea; a new seafloor pipeline from the platform to a new shore base; and a new land-based pipeline (with access road and pump stations) which crosses the North Slope to connect to the existing Trans-Alaska Pipeline System (TAPS). Based on the best scientific and commercial data available to date, the Service concludes that there is a reasonable likelihood that the entire action would not jeopardize listed species or result in the destruction or adverse modification of critical habitat. This non-jeopardy/non-adverse modification conclusion is based on information provided by MMS that indicates that while possible, population-level impacts are not reasonably likely to occur. Specifically, population-level impacts could occur if infrastructure is placed in areas where large concentrations of eiders occur. However, given the implications of doing so, and the availability of viable alternatives, we believe this is unlikely. Our greatest concern for potential population-level impacts is from large marine oil spills that could reach concentrations of eiders, but we believe this also is not reasonably likely to occur. Based on information provided by MMS and analyzed in this BO, we do not believe that it is likely that development will occur, *and* a large spill will result, *and* that spill will occur at such a time and place that it reaches large numbers of eiders. Thus, we conclude that there is a reasonable likelihood that the entire action would not jeopardize listed species or result in the destruction or adverse modification of critical habitat.

This non-jeopardy/non-adverse modification conclusion is based on the low probability of population-level effects occurring. However, as additional information about the nature, location, and timing of proposed oil and gas activities becomes available during this phased leasing, exploration, development, and production process, the Service could later determine that proposed activities are likely to jeopardize listed species or result in destruction or adverse modification of critical habitat. Threats most likely to lead to jeopardy or destruction/adverse modification conclusions include, for spectacled eiders, oil spills that could result in high mortality during molt in Ledyard Bay or staging in spring leads during spring migration, or that could impact the quantity and quality of the Ledyard Bay invertebrate community, a principle constituent element of designated critical habitat. For Steller's eiders, primary threats include an oil delivery pipeline landfall sited at Barrow that could result in substantial loss of Steller's eider nesting habitat, and oil spills that could result in high mortality of migrating Steller's eiders in spring leads or adjacent nearshore waters.

2. DESCRIPTION OF THE PROPOSED ACTION

This BO was prepared as part of an incremental step consultation on Lease Sale 193 in the Chukchi Sea. Activities that could ensue from the leasing of tracts pursuant to Lease Sale 193 include potential exploration, development, and production of offshore oil and gas reserves. The first incremental step includes leasing and exploration (which includes seismic surveys and exploratory drilling). This BO also provides an evaluation of whether it is reasonably likely that the entire project, including development and production (including field abandonment), that may result from Lease Sale 193, would violate section 7 (a)(2) of the Act. This section includes descriptions of the action area; activities proposed under the first incremental step (leasing and exploration); and development, production, and abandonment activities that may result from Lease Sale 193.

The Chukchi Sea OCS is viewed as one of the most petroleum-rich provinces in the country, with MMS assessments indicating the mean recoverable oil resource is 12 billion barrels (Bbbl) with a 5% chance of 29 Bbbl (MMS 2006a). MMS concludes it is reasonable to assume exploration of the area could lead to significant oil discoveries. To date there have been 5 exploration wells drilled in the Chukchi, and no active leases since 1998. The likelihood of oil development depends upon many factors in the remote, high-cost location. MMS's current analysis (MMS 2006b), based upon oil prices \geq \$30.00 per barrel (bbl) oil, indicates the realistic probability for commercial success in the Chukchi Sea is less than 10%. However, MMS predicts when the first project overcomes the cost, logistical, and regulatory hurdles, more projects are likely to follow. Typical of many frontier areas, development usually starts with a relatively large project that supports the cost of initial infrastructure; progressively small fields are developed after using this infrastructure, and the industrial footprint expands away from the core area (MMS 2006a). MMS also indicates Chukchi Sea OCS development would have a synergistic effect on the level of offshore activities in the adjacent Beaufort Sea and field development in the NPR-A (MMS 2006a).

The action area is that area in which direct and indirect effects of the proposed action may occur. Lease Sale 193, part of the current 5-year OCS leasing program, encompasses approximately 137,600 km² (34 million acres) of the Chukchi Sea (Fig. 1). The boundaries of the lease sale area do not limit or define the action area of the entire project, however, as some structures would be constructed in marine waters outside the lease sale boundaries (e.g., platform-to-shore pipelines) and in the terrestrial environment (e.g., shore facilities, pump stations, and a pipeline connecting to the TAPS) if oil leasing occurred. Because the specific location of future development is unknown, we have defined the action area for the purposes of this analysis to include the lease sale area, all marine waters between the eastern boundary of the lease sale area and the Alaskan coastline, and the North Slope of Alaska from Point Hope north to the Beaufort Sea, and east to the Alpine satellite development (currently, the closest TAPS tie-in point). Additionally, areas identified by MMS's spill trajectory model as being potentially affected by large oil spills from Lease Sale 193 are considered to be within the action area.

Leasing & Exploration Activities

Following the lease sale, exploration for oil and gas reserves may occur. Exploration begins with seismic surveys and may proceed to exploratory drilling.

Seismic Surveys

Seismic surveys, including two- and three-dimensional (2-D and 3-D), may be conducted at various resolution (distance between transects) in the lease sale area to locate geological structures with petroleum accumulation potential. MMS estimates that approximately 100,000 line-miles of low-resolution 2-D surveys have been conducted in the Chukchi Sea, suggesting that most future surveys would be 3-D, and focused on potential development sites. Before development occurs, high-resolution site-clearance surveys would be conducted on 300 x 900 m grid transects (or 50 x 900 m grid transects for archeological resources) to locate shallow hazards, obtain engineering data, and detect archeological resources.

Seismic surveys use source and receiving arrays to generate and record sound energy, towed often (but not always) from the same boat. Towed source arrays are air guns fired at short, regular intervals; 2-D surveys generally use fewer guns than 3-D. While most of the sound energy is focused down into the water column, it can also propagate horizontally for several kilometers. Sound energy reflected from the water column and off the bottom is recorded by a series of passive hydrophones in the receiving arrays, from 600 m to 3-8 km behind the source array. Receiving arrays are attached by streamer cables, which are often filled with liquid, solid, or gel paraffin to provide buoyancy, and may have tail buoys. Total array width may be 1,500 m.

Marine seismic survey vessels are designed to operate for several months without refueling or re-supply, although guard or chase boats and limited helicopter support may be used for crew changes or vessel support. Surveys can commence as soon as ice conditions allow, and continue throughout the ice-free period, approximately early June through mid-October.

To avoid disturbing spectacled eiders molting in the LBCHU, MMS would not permit seismic surveys in this area after July 1 of each year (MMS 2006a, email dated 11/21/06 from Mark Schroeder, MMS).

Exploratory Drilling

Five test wells have been drilled in the lease sale area and MMS estimates that 7-14 additional test wells would be required to discover and delineate the first commercial field. Drilling operations are expected to range from 30-90 days at each well site, so up to four wells could be drilled by each drill rig in each open water season. Currently, there are only two drill rigs capable of operating in the Chukchi and Beaufort Seas, and no

other exploratory drilling proposals have been announced (Kristen Nelson, *Petroleum News*, pers. comm.).

MMS anticipates exploratory drilling would be conducted by paired drill ships, and support vessels. Drill ships would be able to move off the drill site if sea or ice conditions require, unlike platforms. Drill ships are attended by at least two icebreakers and up to seven other support vessels for re-supply, anchor handling, and oil spill response.

Air activity associated with exploratory drilling is anticipated to include helicopter support for crew changes and other activities (including search and rescue), conducted via 1-3 daily helicopter flights from Barrow or other land base. Daily (weather permitting) marine mammal surveys would be conducted by up to three fixed-wing aircraft in the area. Survey methods, set by the National Marine Fisheries Service (NMFS), would include monitoring the presence of bowhead whales during their migration (August 1-October 1) in relation to noise isopleths out from drill ships. The altitude of these flights has not been specified except over the LBCHU after July 1 when aircraft must maintain an altitude of 1,500 feet above sea level (ASL) unless safety or poor weather demand a lower flight level, as explained below.

Specifically, because exploratory drilling may potentially be allowed in the LBCHU, MMS developed the following stipulations to reduce disturbance effects from any associated activities. These stipulations would be in effect between July 1 and November 15 when eiders may be present.

- (a) Except in cases to protect human safety or respond to an oil spill, vessels associated with drilling operations will avoid operating within the LBCHU to the maximum extent practicable. Support vessels must enter the LBCHU from the northwest and proceed directly to the drill rig, remain in close proximity to the drill rig while providing support, and exit the drill rig vicinity to the northwest until out of the LBCHU.
- (b) Except in cases to protect human safety, when landing, or to participate in an oil spill response, aircraft supporting drilling operations will not operate below 1,500 feet ASL when operating over the LBCHU. If weather prevents attaining this altitude, aircraft will use pre-designated flight routes at the outer margin of the LBCHU. Pre-designated flight routes will be established by the lessee and MMS, in collaboration with the Service, during review of the Exploration Plan.
- (c) An Oil Spill Response Vessel must be on-site when a drill rig is within the LBCHU. The lessee will also pre-stage wildlife hazing equipment (including at least 3 *Breco* buoys or similar devices) either on the Oil Spill Response Vessel or in Point Lay or Wainwright. The lessee will ensure on-site oil-spill response personnel are trained in the use of wildlife hazing equipment.

Future Activities

To determine if it is reasonably likely that activities that may result from Lease Sale 193 would not violate section 7(a)(2) of the Act, we evaluated the development scenario provided by MMS in their BE (MMS 2006a), where additional details can be found. The scenario includes likely activities, based on current understanding of resources and environmental conditions, associated with development of one large (1 billion bbl) oilfield in the lease area, with an estimated lifespan (exploration through abandonment) of 30-40 years. MMS describes the development scenario in three phases: construction, estimated at 3-5 years once a commercial field has been delineated; production; and abandonment. Each phase includes activities in both marine and terrestrial environments, but at unknown locations. Marine facilities would include a central production facility; satellite wells linked to the central production facility by flowlines; and a pipeline from the central production facility to a shore base. Terrestrial facilities would include the shore base and a pipeline connecting to TAPS, with associated pump stations and an access road.

Construction

Marine facilities would include a large bottom-founded platform as the likely type of central production facility, due to the deep waters and ice movement in the Chukchi Sea. Because no platform has operated yet in environmental conditions equivalent to those on the Chukchi Shelf, platform design is conceptual at this time, but includes a circular concrete structure with a wide base, constructed in several component sections transported separately and mated at the site. The platform would be pinned to the seafloor and stabilized by its wide base, anchoring system, and ballast. The platform would support one or two drill rigs, production and service (injection) wells, processing equipment, fuel and production storage capacity, and personnel quarters. Transportation of materials and personnel during the offshore construction phase would be by helicopter, barge, or other vessel from Barrow, the shore base, or West Dock (vessels only).

MMS estimates that half the production wells would be drilled from the central production facility; this drilling could occur year-round. Oil would flow from the central production facility to the mainland through a main pipeline, which would probably be trenched into the seafloor to avoid ice damage. Other wells would be drilled by drill rigs in the open-water season. These “subsea” wells (no structures above the surface of the ocean) would be developed in templates of four. Oil from these wells would be transported to the central production facility by trenched pipelines (called “flowlines” when coming from subsea wells to the central production facility) up to 15 miles long. Pipeline installation (main and flowlines) would occur during open-water season while the platform is being constructed.

Terrestrial facilities would include a new shore base and an oil pipeline with pump stations connecting to TAPS. The new shore base, estimated by MMS at 50 acres with an

additional 50-acre staging area, would support offshore operations and be the first pump station. An additional four pump stations are estimated at 40 acres each. The pipeline and its adjacent access road may be up to 300 miles long. Much of the terrestrial infrastructure would be within the National Petroleum Reserve – Alaska (NPR-A) and would therefore require authorization from the Bureau of Land Management (BLM).

For the shore base, heavy equipment and materials would be transported using barges, marine vessels, aircraft (C-130 Hercules, smaller planes, and helicopters), and possibly via a winter ice road. Gravel material for the pads and access road would likely be mined from an unspecified number of unknown upland material sources along the route and possibly from coastal areas such as barrier islands.

Production

The estimated time from leasing to full production capability is expected to be 10-15 years. Once in operation production rates are estimated at 200,000 to 250,000 bbl/day. The entire field, including subsea wells, could be approximately 30 miles (48 km) in diameter (based on 15 mile flowline length from subsea wells to the central production facility).

At the central platform facility production, slurry (oil, gas, and water) would be separated before gas and produced water are re-injected. Some gas recovered during oil production may be used as fuel for the facility. Non-recycled drill cuttings and mud wastes from the on-platform wells would be placed in shallow disposal wells, while those from the subsea wells would be barged to an onshore treatment and disposal facility.

Other operations would largely involve re-supply of materials and personnel, inspection of systems, and maintenance and repair. Processing equipment may be upgraded to remove bottlenecks in production systems. Well workovers would be made every 5-10 years to restore flow rates in production wells. Pipelines would be inspected and cleaned regularly, and weekly crew changes are likely. MMS estimates that during production up to three helicopter flights per day from the shore base to the offshore platform would be made, and vessel traffic would be one to two trips per week.

Abandonment

Once the oil reserve has been depleted, production costs exceed production income, or the central production facility is no longer useful as a hub for satellite developments or natural gas production facility (which may extend the life of the project), the operation would be shut down. Wells would be permanently plugged with cement and equipment removed. Subsea pipelines would be decommissioned (cleaned, plugged at both ends, and left in place). The central production platform would be dismantled and removed, and seafloor restoration would occur at the site. Post-abandonment surveys would confirm that no debris remained following abandonment.

3. STATUS OF THE SPECIES AND CRITICAL HABITAT

This section presents biological and ecological information relevant to formation of the BO. Appropriate information on the species' life history, habitat and distribution, and other factors necessary for their survival is included for analysis in later sections.

Spectacled Eider

Spectacled Eider Life History and Distribution

Spectacled eiders are large sea ducks that inhabit the North Pacific. Males in breeding plumage have a white back, black breast, and pale green head with large white "spectacles" around the eyes. In late summer and autumn, males molt into a mottled brown plumage that lasts until late fall, when they re-acquire breeding plumage. Females are mottled brown year round, with pale tan spectacles. Juveniles attain breeding plumage in their second (female) or third (male) year; until then they are mottled brown (Petersen et al. 2000). Both males and females have long sloped bills, giving them a characteristic profile (Fig. 3.1).



Figure 3.1. Male and female spectacled eiders in breeding plumage.

All spectacled eider breeding populations were listed as threatened on May 10, 1993 (Federal Register 58(88):27474-27480) because of documented population declines. The Yukon-Kuskokwim Delta (Y-K Delta) population declined 96% between the 1970s and early 1990s (Stehn et al. 1993, Ely et al. 1994). Anecdotal information indicated that populations in the other two primary breeding areas, the Russian and Alaskan Arctic Coastal Plains (ACP), also declined, along with the much smaller breeding population on St. Lawrence Island in the Bering Sea (USFWS 1996) (Fig. 3.2).

Research and spring aerial surveys have provided data on spectacled eider populations on Alaska's ACP (the "North Slope" breeding population) since 1992. Breeding density varies across the North Slope (Fig. 3.3; Larned et al. 2006). Breeding pair numbers peak in mid-June and the number of males declines 4-5 days later (Smith et al. 1994, Anderson and Cooper 1994, Anderson et al. 1995, Bart and Earnst 2005). Male spectacled eiders generally depart breeding areas when females begin incubation, usually in late June, and they apparently make little use of the Beaufort Sea en route to their molting locations (Petersen et al. 1999, Troy 2003).



Figure 3.2. Distribution of spectacled eiders (USFWS 2002a).

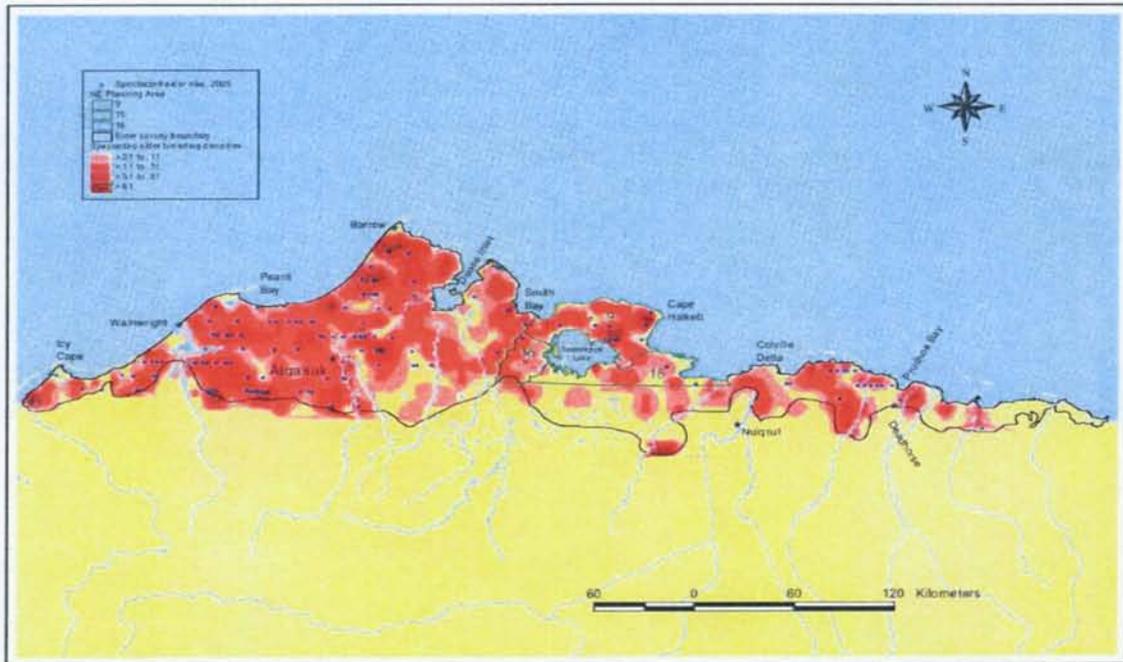


Figure 3.3. Spectacled eider observations in 2005 and density on the Alaska ACP from 1999-2002 (Larned et al. 2006).

North Slope spectacled eider clutch size averages 3.2-3.8, with clutches of up to eight eggs reported (Quakenbush et al. 1995). Incubation lasts 20-25 days (Kondratyev and Zadorina 1992, Harwood and Moran 1993, Moran and Harwood 1994, Moran 1995), and hatching occurs from mid- to late July (Warnock and Troy 1992). On the nesting grounds, spectacled eiders feed on mollusks, insect larvae (craneflies and caddisflies), midges, small freshwater crustaceans, and plants and seeds (Kondratyev and Zadorina 1992) in shallow freshwater or brackish ponds, or on flooded tundra. Young fledge approximately 50 days after hatch, and then females with broods move directly from freshwater to marine habitats.

Nest success is variable and greatly influenced by predators, including gulls (*Larus* spp.), jaegers (*Stercorarius* spp.), and red (*Vulpes vulpes*) and arctic (*Alopex lagopus*) foxes. In Arctic Russia, apparent nest success was calculated as <2% in 1994 and 27% in 1995; predation was believed to be the cause of high failure rates, with foxes, gulls and jaegers the suspected predators (Pearce et al. 1998). On Kigigak Island in the Y-K Delta, nest success ranged from 20-95% in 1991-1995 (Harwood and Moran 1993, Moran 1996). Nest success was higher in 1992 than in other years of observation, presumably because foxes were eliminated from the island prior to the nesting season. Apparent nest success in 1991 and 1993-1995 in the Kuparuk and Prudhoe Bay oil fields on the North Slope varied from 25-40% (Warnock and Troy 1992, Anderson et al. 1998).

As with other sea ducks, spectacled eiders spend the 8-10 month-long non-breeding season at sea, but until recently much about the species' life in the marine environment was unknown. Satellite telemetry and aerial surveys led to the discovery of spectacled

eider migrating, molting, and wintering areas at sea. These studies are summarized in Petersen et al. (1995), Larned et al. (1995), and Petersen et al. (1999).

Spectacled eiders use specific molting areas from July to late October. Larned et al. (1995) and Peterson et al. (1999) discussed spectacled eiders' apparent strong preference for specific molting locations, and concluded that all spectacled eiders molt in four discrete areas (Fig. 3.2). Females generally used molting areas nearest their breeding grounds. All transmittered females from the Y-K Delta molted in nearby Norton Sound (n=18), while females from the North Slope (n=15) molted in Ledyard Bay (10), along the Russian coast (4), and near St. Lawrence Island (1). Males did not show strong molting site fidelity; males from all three breeding areas molted in Ledyard Bay, Mechigmenskiy Bay, and the Indigirka/Kolyma River Delta. Males reached molting areas first, beginning in late June, and remained through mid-October. Non-breeding females, and those that nested but failed, arrived at molting areas in late July, while successfully-breeding females and young of the year reached molting areas in late August or September and remained through October.

Avian molt is energetically demanding, especially for species such as spectacled eiders that complete molt in a few weeks. Molting birds must have ample nutritious food sources, and the rich benthic community of Ledyard Bay (Feder et al. 1989, 1994a, 1994b) likely provides these for spectacled eiders. Large concentrations of spectacled eiders molt in Ledyard Bay to utilize this food resource; aerial surveys on 4 days in different years counted 200 to 33,192 molting spectacled eiders in Ledyard Bay (Petersen et al. 1999; Larned et al. 1995). The environmental characteristics of Ledyard Bay are described in the *Ledyard Bay Critical Habitat Unit* section below.

After molting, spectacled eiders migrate offshore in the Chukchi and Bering Seas to a single wintering area in openings in pack ice of the central Bering Sea south/southwest of St. Lawrence Island (Fig. 3.2). In this relatively shallow area, hundreds of thousands of spectacled eiders (Petersen et al. 1999) rest and feed, diving up to 70 m to eat bivalves, mollusks, and crustaceans (Cottam 1939, Petersen et al. 1998, Petersen and Douglas 2004). Twelve spectacled eiders collected in the Bering Sea wintering area in March 2001 contained primarily the bivalve *Nuculana radiata* (Lovvorn et al. 2003).

Although migratory movements between the wintering area and the North Slope are poorly understood, it is likely that spectacled eiders follow open water in order to rest and feed en route. Recent information about spectacled and other eiders indicates that they probably make extensive use of the eastern Chukchi spring lead system between departure from the wintering area in March and April and arrival on the North Slope in mid-May or early June. Limited spring aerial observations in the eastern Chukchi have documented dozens to several hundred common (*Somateria mollissima*) and spectacled eiders in spring leads and several miles offshore in relatively small openings in rotting sea ice (William Larned, USFWS; James Lovvorn, University of Wyoming, pers. comm.). Woodby and Divoky (1982) documented large numbers of king (*Somateria spectabilis*) and common eiders using the eastern Chukchi lead system, advancing in pulses during days of favorable following winds, and concluded that an open lead is

probably requisite for the spring eider passage in this region. Information obtained in 2002-2006 about 57 satellite-transmitted king eiders found that 100% of the birds migrating from the Bering Sea to breeding grounds in North America occupied the spring lead system in the eastern Chukchi (Fig. 3.4) for approximately 3-4 weeks (Steffen Oppel, University of Alaska-Fairbanks, unpubl. data).

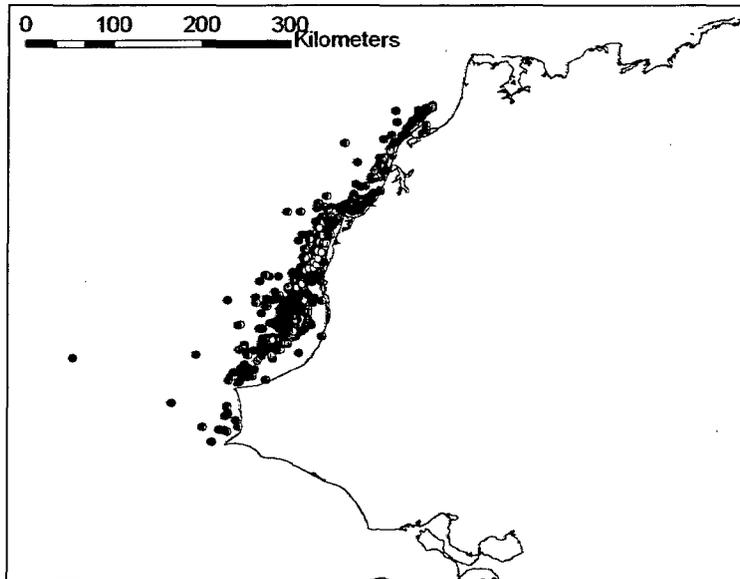


Figure 3.4. Spring migration locations of satellite-transmitted North Slope king eiders, 2002-2006 (Steffen Oppel, University of Alaska-Fairbanks, unpubl. data).

Adequate foraging opportunities and nutrition during spring migration are critical to spectacled eider productivity. Like most sea ducks, female spectacled eiders do not feed substantially on the breeding grounds, so produce and incubate their eggs while living off body reserves (Korschgen 1977, Drent and Daan 1980, Parker and Holm 1990). Clutch size, a measure of reproductive potential, was positively correlated with body condition and reserves obtained prior to arrival at breeding areas (Coulson 1984, Raveling 1979, Parker and Holm 1990). Body reserves must be maintained from winter or acquired during the 4-8 weeks (Lovvorn et al. 2003) of spring staging, and Petersen and Flint (2002) suggest common eider productivity on the western Beaufort Sea coast is influenced by conditions encountered in May to early June during their spring migration through the Chukchi Sea (including Ledyard Bay). Common eider female body mass increased 20% during the 4-6 weeks prior to egg laying (Gorman and Milne 1971, Milne 1971, Korschgen 1977, Parker and Holm 1990). For spectacled eiders, average female body weight in late March in the Bering Sea was $1,550 \pm 35$ g ($n=12$), and slightly (but not significantly) more upon arrival at breeding sites ($1,623 \pm 46$ g, $n=11$) (Lovvorn et al. 2003), indicating that spectacled eiders must maintain or enhance their physiological condition during spring staging.

Spectacled Eider Abundance and Trends

The most recent rangewide estimate of the total number of spectacled eiders was 363,000 (333,526-392,532 95% CI), obtained by aerial surveys of the known wintering area in the

Bering Sea in late winter 1996-1997 (Petersen et al. 1999). For the North Slope breeding population, the most recent (2002-2006) population index¹ of 6458 (5471-7445 95% CI) was adjusted by a factor that accounts for the number of nests missed during aerial surveys² (developed on the Y-K Delta) and used to calculate a North Slope breeding spectacled eider population estimate of 12,916 (10,942-14,890 95% CI), 2002-2006 (Stehn et al. 2006, included in Appendix 2). The spectacled eider population size from 1993-2006 was stable, with an average (n=14) annual growth rate of 0.997 (0.978-1.016 90% CI), a number not significantly different from 1.0 (Stehn et al. 2006).

Spectacled Eider Recovery Goals and Status

The Spectacled Eider Recovery Plan (USFWS 1996) presents research and management priorities with the objective of recovery and delisting so that protection under the Act is no longer required. Although cause of the spectacled eider population decline is not known, factors that affect adult survival may be the most influential on population growth rate. These include lead poisoning from ingested spent shotgun pellets, which may have contributed to the rapid decline observed in the Y-K Delta (Franson et al 2005, Grand et al. 1998), and other factors such as habitat loss, increased nest predation, over harvest, and disturbance and collisions caused by human infrastructure (factors discussed in Section 4 – *Environmental Baseline*). Under the Recovery Plan, the species will be considered recovered when each of the three recognized populations (Y-K Delta, North Slope of Alaska, and Arctic Russia): 1) is stable or increasing over 10 or more years and the minimum estimated population size is at least 6,000 breeding pairs, or 2) number at least 10,000 breeding pairs over 3 or more years, or 3) number at least 25,000 breeding pairs in one year. Spectacled eiders do not currently meet these recovery criteria.

Ledyard Bay Critical Habitat Unit (LBCHU)

Critical habitat for molting spectacled eiders was designated in Norton Sound and Ledyard Bay on February 6, 2001 (Federal Register 66(25): 9146-9185), and nesting and wintering habitat in other locations (none on the North Slope). In accordance with section 3(5)(A)(i) of the Act and regulations in 50 C.F.R. 424.12, critical habitat for a species contains those physical or biological features that are essential for the conservation of the species and which may require special management considerations and protection. Under the Act these features are considered “primary constituent elements” of critical habitat, and include, but are not limited to: space for individual and population growth, and for normal behavior; food, water air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and habitats that are

¹ A standard index used to monitor waterfowl populations based on the number of birds seen during aerial surveys but adjusted for cryptic females that are presumably missed when single males are detected (USFWS and Canadian Wildlife Service 1987).

² The detection correction factor compares the number of eiders observed during aerial surveys with the number of nests located on ground surveys in order to presume actual population size from the number detected in aerial surveys.

protected from disturbance or are representative of the historical geographic and ecological distribution of a species.

The LBCHU was designated because of its importance to migrating and molting spectacled eiders, and includes waters of Ledyard Bay within about 1.85-74 km (1-40 nautical miles [nm]) from shore. Individuals from all three breeding populations molt in Ledyard Bay, including most (77%) females that nest on the North Slope (Petersen et al. 1999). Primary constituent elements identified for LBCHU are marine waters > 5 m and \leq 25 m deep, along with associated marine aquatic flora and fauna in the water column, and the underlying marine benthic community. Conserving the ecosystem processes and physical and biological features of Ledyard Bay may be essential for the conservation of spectacled eiders, so additional detail is provided below to better analyze the potential effects of the project on this critical habitat unit.

Grebmeier and Duncan (2000) summarized the current understanding of processes in the northern Bering and Chukchi seas that contribute to the relatively abundant benthic community found in Arctic sea shelves like Ledyard Bay. The seasonally ice-covered Bering and Chukchi sea shelves are some of the largest in the world, and they support an extremely productive and dynamic benthic system containing some of the highest faunal biomass in the Arctic Ocean. An inflow of nutrient-rich Pacific waters across the shallow shelves supports high primary production, with high edge-ice productivity in regions of limited open water. In general, the high primary production is not directly consumed by pelagic secondary consumers so it settles quickly to the underlying benthos, generating a particularly rich macrobenthic community (Grebmeier 1993, Highsmith and Coyle 1992, Grebmeier and Cooper 1995). As a result, large populations of benthic-feeding marine mammals and birds are apex predators in relatively short food chains and simple food webs in Arctic sea-shelf ecosystems (Grebmeier and Harrison 1992, Highsmith and Coyle 1992, Hunt 1991, Oliver and Slattery 1985, Oliver et al. 1983). Grebmeier and Dunton (2000) described a representative Chukchi Sea food web in which the spectacled eider is a direct predator on a deposit-feeding benthic mollusk (Fig. 3.5); this likely characterizes the ecosystem of Ledyard Bay.

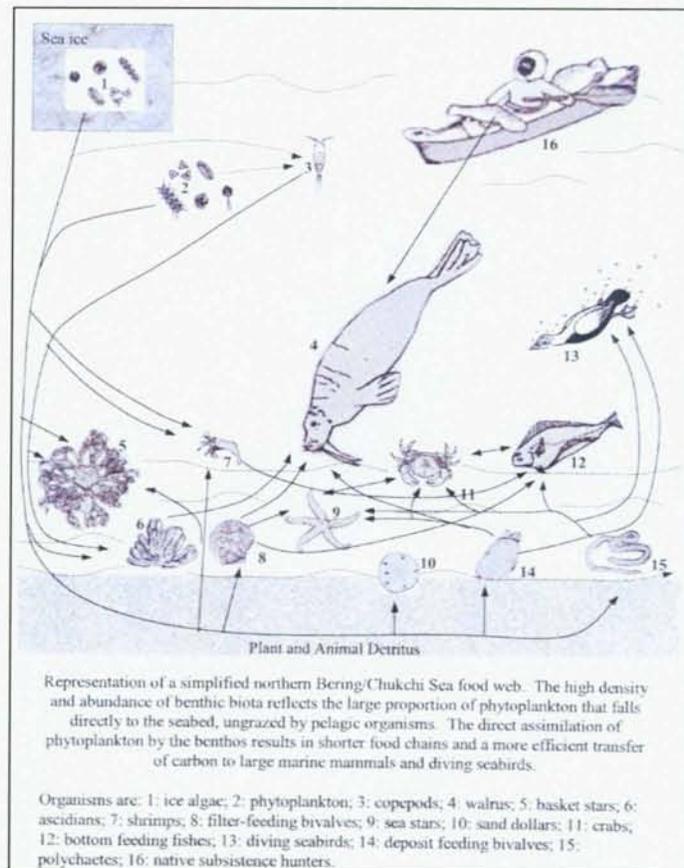


Figure 3.5. Representative Chukchi Sea food web with spectacled eider in apex predator functional role (from Grebmeier and Dunton 2000).

Some specific information exists about the benthic community within Ledyard Bay, as Feder et al. (1989, 1994a and 1994b) sampled sediment and benthic invertebrates at 37 sites in the eastern Chukchi Sea, including six sites within the LBCHU. In the LBCHU, seafloor depth varied from 18-32 m. Five LBCHU sample sites were from two statistically distinct groups: a sand/gravel-bottom assemblage with an infauna (organisms that dwell in the sediment) dominated by a nucloida clam (*Yoldia scissurata*), and epibenthos (organisms that are on or attached to the bottom substrate) dominated by scallops (*Chlamys behringiana*), gastropods (*Neptunea* spp.), and acorn barnacles (*Balanus crenatus*); and a sand-bottom assemblage with an infauna dominated by mussels (*Musculus* spp.) and epibenthos dominated by sand dollars (*Echinarachnius parma*). The sixth site, near the western edge of the LBCHU boundary, was an offshore muddy-gravel assemblage. Feder et al. (1994a and 1994b) noted the relatively high standing stocks of benthos in this area was possible because local carbon was augmented by particulate organic carbon advected by ocean currents from highly productive areas in the Pacific. Feder et al. (1994b) further determined the distribution of infaunal and epifaunal mollusks was related to the environmental variables of bottom substrate and water masses in the northeastern Chukchi Sea. They concluded that abundance and biomass of infaunal mollusks increased from the Bering Shelf towards the coast. Indeed,

some of the Ledyard Bay sites had the highest invertebrate abundance and biomass in the study.

This rich Ledyard Bay benthic community likely provides an important and predictable food resource for spectacled eiders during two energetically demanding portions of their life history: 1) during northward migration immediately prior to egg-laying when females must maintain or increase their body weight; and 2) the post-breeding molt. Although food habits studies have not been conducted for listed eiders in Ledyard Bay, the LBCHU benthic community is likely similar to (or exceeds) the food value of the Bering Sea wintering area benthos.

In summary, a particular set of environmental conditions coincide in the vicinity of Ledyard Bay to create a predictable and abundant food supply for bottom-feeding diving predators like eiders: a shallow ocean shelf with near-shore sandy or gravelly substrates overlain by rich ocean currents; enhanced ice-edge productivity during the brief open water season; short but productive food chains and food webs; high benthic invertebrate biomass and abundance; near-shore spring leads that provide early season access to the food resources for migrating eiders; and open water conditions over those resources during the summer/autumn molt. The Service believes these are the features of the primary constituent elements of Ledyard Bay that provide the conservation value of the critical habitat designated for spectacled eiders.

Steller's Eider

Steller's Eider Life History and Distribution

The Steller's eider is a circumpolar sea duck, and it is the smallest of the four eider species. From early winter until mid-summer males are in breeding plumage - black back, white shoulders and sides, chestnut breast, white head with black eye patches and a greenish tuft (Fig. 3.6). During late summer and fall, males molt to dark brown with a white-bordered blue wing speculum; this plumage is replaced during the autumn molt when males reacquire breeding plumage, which lasts through the next summer. Females are dark mottled brown with a blue wing speculum. Juveniles are dark mottled brown until the fall of their second year, when they acquire breeding plumage (Fredrickson 2001).



Figure 3.6. Male and female Steller's eider in breeding plumage.

Steller's eiders are divided into Atlantic and Pacific populations; the Pacific population is further divided into the Russia-breeding population along the Russian eastern arctic coastal plain, and the Alaska-breeding population. On June 11, 1997, the Alaska-breeding population of Steller's eiders was listed as threatened based on a substantial decrease in the species' breeding range in Alaska and the resulting increased vulnerability of the remaining Alaska-breeding population to extirpation (Federal Register 62(112):31748-31757). The Service concluded the available information did not support listing the species range-wide because counts in 1992 indicated at least 138,000 Steller's eiders wintered in southwest Alaska, and the counts were too imprecise to determine trends with confidence. Although population size estimates for the Alaska-breeding population were also imprecise, it was clear Steller's eiders had essentially disappeared as a breeding species from the Y-K Delta, where they had historically occurred in significant numbers, and that their ACP breeding range was much reduced. On the ACP, they historically occurred east to the Canada border (Brooks 1915), but have not been observed in the eastern ACP in recent decades (USFWS 2002b). The Alaska-breeding population of Steller's eiders now nests primarily only on the ACP, particularly around Barrow and at very low densities from Wainwright to at least as far east as Prudhoe Bay (Fig. 3.7). A few pairs also apparently remain on the Y-K Delta (approximately 9 nests found in the last 14 years).

Steller's eiders arrive in pairs on the ACP in early June, but may be episodic breeders; since 1991, Steller's eiders near Barrow apparently nested in 9 years but did not nest in 7 years (Rojek 2006). Non-breeding years are common in long-lived eider species and is typically related to inadequate body condition (Coulson 1984), but reasons for Steller's eiders non-breeding may be more complex. In the Barrow area Steller's eider nesting has been observed related to lemming numbers and other environmental cues; nest success could be enhanced in years of lemming abundance because nest predators are less likely to prey-switch to eider eggs and young, or because avian predator such as pomarine jaegers (*Stercorarius pomarinus*) and snowy owls (*Nyctea scandiaca*) that nest nearby (and consume abundant lemmings) may protect eider nests from mammalian predators such as arctic fox (Quakenbush and Suydam 1999, and summarized by Rojek 2006).

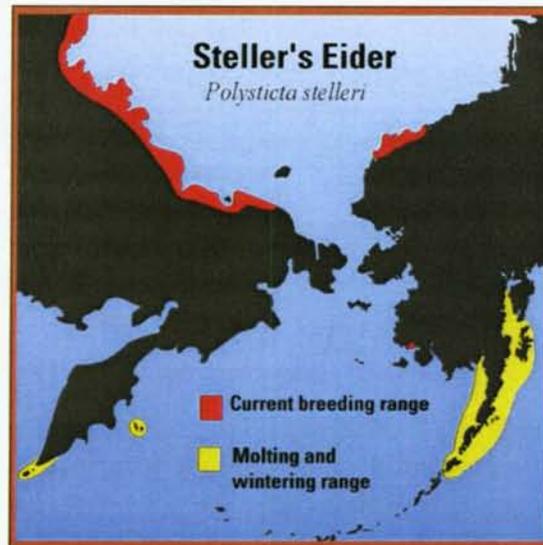


Figure 3.7. Steller's eider distribution in the Bering and Chukchi Seas (USFWS 2002b).

When they do breed, Alaska-breeding Steller's eiders nest on coastal tundra adjacent to small ponds or within drained lake basins, occasionally as far as 90 km inland. Nests are initiated in the first half of June (Quakenbush et al. 1995), and hatching occurs from July 7 to August 3 (Quakenbush et al. 1998). Nests located in the vicinity of Barrow were in wet tundra, in drained lake basins or low-center or low indistinct flat-centered polygon areas (Quakenbush et al. 1998). Average clutch sizes at Barrow varied from 5.3-6.3, with clutches of up to 8 reported (Quakenbush et al. 1998, Rojek 2005). Nest success (proportion of nests with at least one egg hatched) at Barrow averaged 17% from 1991-2002 (Service, unpublished data). As with spectacled eiders, nest and egg loss was attributed to predation by jaegers, common raven (*Corvus corax*), arctic fox, and possibly glaucous gulls (*Larus hyperboreus*) (Quakenbush et al. 1995, Obritschkewitsch et al. 2001).

Immediately after hatch, hens move their broods to adjacent ponds with emergent vegetation, particularly *Carex* spp. (Rojek 2005) and *Arctophila fulva* (Quakenbush et al. 1998). Here they feed on insect larvae and other wetland invertebrates. Broods may move up to several kilometers from the nest prior to fledging (Quakenbush et al. 1998, Rojek 2005). Fledging occurs from 32-37 days post hatch (Obritschkewitsch et al. 2001, Quakenbush et al. 2004, Rojek 2005).

Departure from the breeding grounds differs between sexes and between breeding and non-breeding years. Male Steller's eiders typically leave the breeding grounds after females begin incubating, around the end of June or early July (Quakenbush et al. 1995, and Obritschkewitsch et al. 2001). Females whose nests fail may remain near Barrow later in summer; a single failed-breeding female equipped with a transmitter in 2000 remained near the breeding site until the end of July and stayed in the Beaufort Sea off Barrow until late August (Martin et al. in prep). Successfully-breeding females and fledged young depart the breeding grounds in early to mid-September. In a non-breeding year, satellite-transmitted males and females dispersed across the area between

Wainwright and Admiralty Inlet in late June and early July, with most birds entering marine waters by the first week of July. They were tracked at coastal locations from Barrow to Cape Lisburne, and made extensive use of lagoons and bays on the north coast of Chukotka (Martin et al. in prep.).

After the breeding season, Steller's eiders move to marine waters where they undergo a complete flightless molt for about 3 weeks. The combined (Russia- and Alaska-breeding) Pacific population molts in numerous locations in southwest Alaska, with exceptional concentrations in four areas along the north side of the Alaska Peninsula: Izembek Lagoon, Nelson Lagoon, Port Heiden, and Seal Islands (Gill et al. 1981, Petersen 1981, Metzner 1993). Molting areas are characterized by extensive shallow eelgrass (*Zostera marina*) beds and intertidal sand flats and mudflats, where Steller's eiders forage on marine invertebrates such as mollusks and crustaceans (Petersen 1980, 1981; Metzner 1993).

After molt, many of the Pacific-wintering population of Steller's eiders disperse to winter in the eastern Aleutian Islands, the south side of the Alaskan Peninsula, and as far east as Cook Inlet, although thousands may remain in lagoons used for molt unless or until freezing conditions force them to move (USFWS 2002). Wintering Steller's eiders usually (although not always; Martin et al. in prep.) occur in waters less than 10 m deep, which are normally within 400 m of shore or at offshore shallows.

Prior to spring migration, thousands of Steller's eiders stage in estuaries along the north side of the Alaska Peninsula, including some molting lagoons, and at the Kuskokwim Shoals near the mouth of the Kuskokwim River in late May (Larned 2005, Martin et al. in prep.). Like other eiders, Steller's eider may use spring leads for feeding and resting, but there are few conclusive data about habitat use during spring migration. During winter, Steller's eiders generally use and feed in shallower water than the other eider species, although they may also use deeper (i.e., 20-30 m) habitats if feeding on water-column invertebrates (Philip Martin, USFWS, pers. comm.). They are likely associated with shallow spring leads, therefore, although they possibly also use leads in deeper water if an abundant and nutritious invertebrate community is present in the water column. Alaska-breeding Steller's eiders typically return to breeding areas near Barrow in early June (Rojek 2006).

In 2001, the Service designated 2,830 mi² (7,330 km²) of critical habitat for the Alaska-breeding population of Steller's eiders at breeding areas on the Y-K Delta, a molting and spring-staging area in the Kuskokwim Shoals, and molting areas in marine waters at the Seal Islands, Nelson Lagoon, and Izembek Lagoon. No critical habitat for Steller's eiders has been designated on the ACP.

Steller's Eider Abundance and Trends

Aerial surveys optimized to detect eiders have been conducted on the North Slope since 1992 (Larned et al. 2006), and indicate Steller's eiders occur at very low densities across the ACP, with a higher density in the vicinity of Barrow (Fig. 3.8). Standardized ground

surveys for eiders near Barrow have been conducted since 1999, and have found an average density near Barrow of 0.66 birds/ km² (Rojek 2006) (Fig. 3.9). The Barrow vicinity supports the largest known concentration of nesting Steller's eiders in North America.

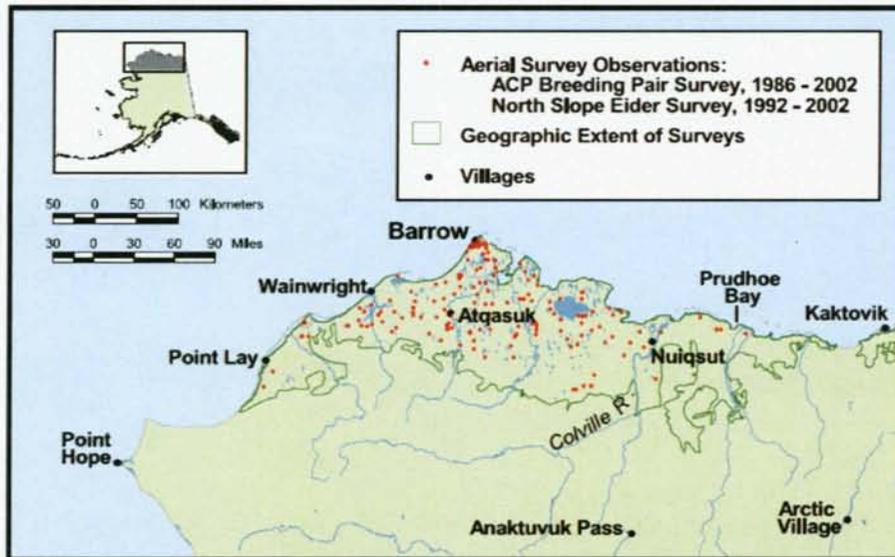


Figure 3.8. Distribution of Steller's eiders from aerial surveys on the Arctic Coastal Plain, Alaska (USFWS 2002b).

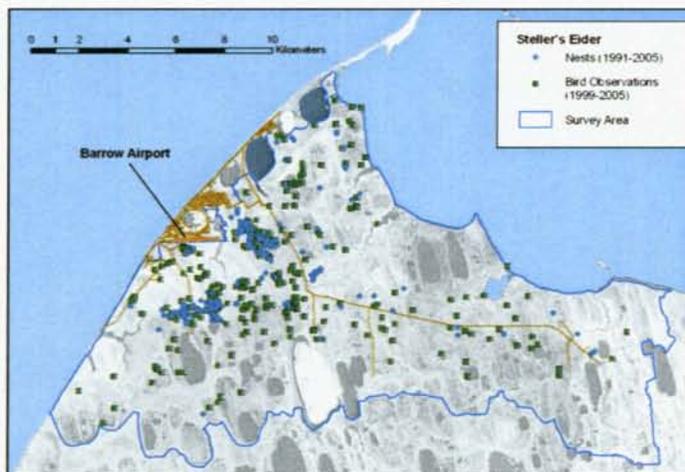


Figure 3.9. Steller's eider bird and nest observations in the vicinity of Barrow, Alaska, 1991-2005 (Rojek 2005).

Because Alaska-breeding Steller's eiders occur at very low densities, there is not sufficient information to estimate population size or detect population trends. The mean

1992-2006 aerial-survey generated population index³ was 116 (n=15, standard deviation [sd] = 204), but the range of indices in these years ranged from 20 (calculated in a year when no birds were seen) to 785 (Larned et al. 2006). The most recent index (2002-2006) was 112 (n=5, sd=98). However, aerial surveys likely undercount Steller's eiders for several reasons. An unknown number are simply missed when observers count from aircraft; this proportion varies by species and is unknown for Steller's eiders. Additionally, because observations at Barrow indicate that many Steller's eiders vacate nesting habitat early in non-nesting years, it is possible that aerial surveys fail to detect some individuals that were present early in the season, at least in some years. Further, the concentration area at Barrow, which contains a significant proportion of Steller's eiders detected on the entire ACP in most years, may be under-sampled because: 1) the scale of the concentration is too small to be adequately represented in the sampling regime; and 2) a portion of the concentration area is excluded because the area near the Barrow airport cannot be flown due to aviation safety concerns. Due to these biases, we cannot precisely estimate Steller's eider abundance on the North Slope, but the best available information leads the Service to estimate that roughly several hundred Steller's eiders occupy the North Slope in most years. For purposes of this consultation, such as estimating incidental take, we assume that there are 500 North Slope-breeding Steller's eiders.

Steller's Eider Recovery Goals

The Steller's Eider Recovery Plan (1992) presents research and management priorities with the objective of recovery and delisting so that protection under the Act is no longer required. When the Alaska-breeding population was listed as threatened, factors causing the decline were unknown, but potential causes identified were predation, over hunting, ingestion of spent shot in wetlands, and changes in the marine environment (factors discussed in Section 4 - *Environmental Baseline*). Since listing, other potential threats have been identified, including exposure to oil or other contaminants near fish processing facilities in southwest Alaska, but causes of decline and obstacles to recovery remain poorly understood.

Criteria to be used in determining when species are recovered are often based on historical abundance and distribution, or on the number needed to ensure the risk of extinction is tolerably low (with extinction risk estimated by population modeling). For Steller's eiders, information on historical abundance is lacking, and life history parameters needed for accurate population modeling are inadequately understood. Therefore, the Recovery Plan for Steller's eiders establishes interim recovery criteria based on extinction risk, with the assumption that numeric population goals will be developed as life history parameters become better understood. Under the Recovery Plan, the Alaska-breeding population will be considered for reclassification to endangered when the population has $\geq 20\%$ probability of extinction in the next 100 years for 3 consecutive years, or the population has $\geq 20\%$ probability of extinction in the next 100 years and is decreasing in abundance. The Alaska-breeding population will

³ We present only an index (no population abundance estimate, as with spectacled eiders) because no aerial survey-ground survey correction factor has been created for Steller's eiders on the North Slope.

be considered for delisting from threatened status when it has $\leq 1\%$ probability of extinction in the next 100 years, and each of the northern and western subpopulations are stable or increasing and have $\leq 10\%$ probability of extinction in 100 years.

Kittlitz's Murrelets

Kittlitz's Murrelet Life History and Distribution

Kittlitz's murrelets are small diving seabirds in the family Alcidae (including puffins, guillemots, and murre) which inhabit Alaskan coastal waters. Breeding plumage is mottled golden-brown and winter non-breeding plumage is more distinct, with a white underbelly and face and dark back and chest band.

On May 4, 2004, the Kittlitz's murrelet was designated a candidate for protection under the Act because its numbers have declined sharply and it may warrant listing as threatened or endangered (Federal Register 69(86):24875-24904). The Service places a species on the candidate list when there is sufficient information on biological vulnerability and threats to warrant proposing to list the species as endangered or threatened. Candidate status signals conservation concern for a species, and the Service encourages agencies, organizations and individuals to participate in research and conservation activities that may preclude the need to list under the Act. The Service will prepare a proposal to list the Kittlitz's murrelet when funding becomes available.

The causes of decline in Kittlitz's murrelets is not known, but may be related to the retreat of tidewater glaciers since the turn of the century. Exactly how glacier retreat might affect the murrelets is unknown, but studies in other regions have recorded low biological productivity in fjords with receding glaciers as a result of increased sedimentation and lowered salinity (Day et al. 1999). Lowered productivity could result in fewer forage fish, or sedimentation that affects feeding efficiency. In addition to changes in fjord habitats, Kittlitz's murrelets may also be affected by changes in their available prey species relative to changes in the greater marine environment (Kuletz 2004). The Kittlitz's murrelet could also be affected by increased marine traffic and tourist helicopter flights in Kenai Fjords, Prince William Sound, and Yakatak and Glacier bays (Kuletz 2004).

Kittlitz's murrelets are often found in association with marine tidewater glaciers and glacial-influenced water and in protected fjords (Kuletz and Piatt 1992, Day and Nigro 1998) as far north as the Chukchi Sea. The entire North American population occurs in Alaskan waters, migrating between winter offshore and summer inshore regions, which are presumably near breeding areas (Fig. 3.11). Lower numbers are scattered along the coast of eastern Russia (Day et al. 1999). Kittlitz's murrelets possibly nest as far north as Cape Sabine and Cape Beaufort, (inland of Ledyard Bay), although suitable habitat may not be available in that location (D.G. Roseneau, pers. comm., reported by Day et al. 1999). Suitable nesting habitat disappears north of Cape Beaufort, so the species rarely

occurs and probably does not breed north of there (from Wainright to Barrow; Huey 1931, Bailey et al 1933, Bailey 1948, Pitelka 1974).



Figure 3.10. Breeding distribution of Kittlitz's murrelet in North America (Day et al. 1999).

Kittlitz's murrelets arrive on their nesting grounds in pairs and nest non-colonially on steep, barren hillsides and talus slopes above timberline, generally near glaciers and cirques. Their nest site is on the ground with little vegetation, as much as 300-1000 m (980-3300 ft) above sea level, and up to several miles inland. The nest is often at the base of a large rock and possibly near a flowing stream (Day et al. 1999). Kittlitz's murrelets lay one large egg in a stone nest bowl, and the same site may be used for nesting year after year (Piatt et al. 1999). Eggs are laid from May 15-June 14 in southern Alaska, and June 16-28 in northern Alaska (Day et al. 1999). Incubation lasts approximately 30 days and young fledge August 9-21 in the northern part of their range, including the Chukchi Sea coast (Day et al. 1999). Both males and females incubate eggs and brood the young. There is no information on annual or lifetime reproductive success but some evidence suggests this species may forego breeding in some years (Day et al. 1999).

Kittlitz's murrelets occur at sea in substantial numbers along the ice edge in late summer and fall, particularly in the central Chukchi Sea, although there is much interannual variation in abundance (fall population in Chukchi Sea estimated as 1,000-5,000 birds by G.J. Divoky, University of Alaska-Fairbanks, unpubl. data). The species is not recorded in the Beaufort Sea (Divoky 1984, Johnson and Herter 1989). Both the timing and migration routes to and from the breeding grounds are unknown. It is likely that Kittlitz's murrelets follow the retreating ice edge, feeding on the biomass associate with ice plankton blooms. There is no information on migration routes.

Principal summer foods are thought to be small fishes and macro-zooplankton; winter foods are unknown, although the stomach of one museum specimen contained macro-zooplankton (Day et al. 1999). This species has been documented to forage extensively in turbid waters near tidewater glaciers and near glacier-fed streams as well as within clear water areas. Kittlitz's murrelets forage singly or in small groups during the day and night (Day et al. 1999).

The Kittlitz's murrelet's winter range is poorly known. Only 31 have been seen on Alaska Christmas Bird Counts from 1967 to 1997, suggesting most leave protected bays and go to sea during winter.

Kittlitz's Murrelet Abundance and Trends

The Kittlitz's murrelet is thought to be one of the rarest seabirds in North America, with a total population estimate of 9,000-25,000 birds. Surveys indicate significant population declines have occurred in three core areas: 84% in Prince William Sound since 1989; 38-75% near Malaspina Glacier; and a rate of decline that could result in extinction in 40 years in Glacier Bay. Recent summer population estimates for Kittlitz's murrelets are $5,408 \pm 7,039$ (95% CI) birds for Southeastern Alaska, $3,368 \pm 4,073$ birds for Prince William Sound, and $3,353 \pm 1,718$ birds for Cook Inlet, for a total of $12,129 \pm 8,312$ (Kendall and Agler 1998). There are no long-term data with which to calculate a range-wide population trend.

4. ENVIRONMENTAL BASELINE

The environmental baseline is the current status of listed species and their habitats, and the current status of critical habitat, as a result of past and ongoing human and natural factors in the area of the proposed action. Also included in the environmental baseline are the anticipated impacts of other proposed Federal projects in the action area.

Spectacled and Steller's Eiders

The North Slope-breeding population of spectacled eiders (approximately 12,916 breeding birds) and Steller's eiders (approximately 500 breeding birds) occupy terrestrial and marine parts of the action area for significant portions of their life history. Spectacled eiders breed, molt, and migrate in the action area, and Steller's eiders breed and migrate in the action area. Spectacled eiders nest throughout much of the ACP, whereas Steller's eiders have limited distribution across the ACP and highest breeding density near Barrow. Neither species is present in the action area from November 15 to April 15. Both species have undergone significant, unexplained declines in their Alaska-breeding populations. Factors that have possibly contributed to the current status of spectacled and Steller's eiders are discussed below and include, but are not limited to, toxic contamination of habitat, increase in predation, over harvest, and habitat loss

through development and disturbance. Factors that affect adult survival may be most influential on population growth rates. Recovery efforts for both species are underway in portions of the action area.

Toxic Contamination of Habitat

The deposit of lead shot in tundra or nearshore habitats used for foraging is a threat for Spectacled and Steller's eiders. Lead poisoning of spectacled eiders has been documented on the Y-K Delta (Franson et al. 1995, Grand et al. 1998) and Steller's eiders on the ACP (Trust et al 1997; Service unpublished data). Use of lead shot for hunting waterfowl is prohibited statewide, and for hunting all birds on the North Slope. Hunter outreach programs are being undertaken to reduce any lingering illicit use of lead shot that may be occurring on the North Slope.

Water birds in arctic regions are also exposed to global contamination, including radiation, and industrial and agricultural chemicals that can be transported by atmospheric and marine transport. Twenty male spectacled eiders wintering near St. Lawrence Island examined for the presence and effects of contaminants apparently were in good condition, but had high concentrations of metals and subtle biochemical changes that may have long term effects (Trust et al. 2000a).

Increase in Predator Populations

It has been speculated that anthropogenic influences on predator populations or predation rates may have affected eider populations, but this has not been substantiated. Steller's eider studies at Barrow suggest that high predation rates explain poor breeding success (Quakenbush et al. 1995, Obritschkewitsch et al. 2001). Researchers have proposed that reduced fox trapping, anthropogenic food sources in villages, oil fields, and nesting sites on human-built structures have increased fox, gull, and raven numbers (R. Suydam and D. Troy pers. comm., Day 1998), but the connection between these factors and increased predation rates has not been proven.

Over Harvest

Hunting for spectacled and Steller's eiders was closed in 1991 by Alaska State regulations and Service policy. Outreach efforts have been conducted by the North Slope Borough, BLM, and Service to encourage compliance. Accurate information on current subsistence harvest rates is not available, but hunter surveys and other observations indicate that shooting of listed eiders continues in northwest Alaska (Paige et al. 1996, Georgette 2000, Service unpublished data).

Habitat Loss through Development and Disturbance

With the exception of contamination by lead shot, destruction or modification of nesting habitat is not thought to have played a major role in the decline of spectacled or Steller's eiders. Until recently eider breeding habitat on the ACP was largely unaltered by

humans, but now limited portions of each species' breeding habitat has been altered by fill of wetlands, the presence of infrastructure that presents collision risk, and other types of human activity that may disturb birds or increase populations of nest predators. There is also increase in scientific field research occurring on the ACP, much of which occurs in the summer nesting season. Table 1 summarizes recent activities within the Lease Sale 193 action area that required a section 7 consultation, and the estimated incidental take of listed eiders. Note that the estimated take is presumably ameliorated to an unknown degree by Reasonable and Prudent Measures in the BOs.

Table 1. Recent projects in Lease Sale 193 action area that required section 7 consultation and estimated incidental take of listed eiders.

Project Name	Impacts	Estimated Incidental Take¹
Barrow Airport Expansion	137.8 acres (includes material site)	14 spectacled eider eggs/chicks 29 Steller's eider eggs/chicks
Barrow Hospital	20 acres	10 spectacled eider 17 Steller's eider
Barrow Landfill	55 acres	1 spectacled eider yearly 1 Steller's eider yearly
Barrow Artificial Egg Incubation	No loss of habitat	Maximum of 24 eggs
Barrow Tundra Manipulation Experiment	111 acres	2 spectacled eiders 2 spectacled eider eggs/chicks 2 Steller's eiders 1 Steller's eider eggs/chicks
Barrow Global Climate Change Research Facility Phase I & II	4.75 acres loss of habitat 25 acres preferred-use habitat disturbed	1 spectacled eider 6 spectacled eider eggs/chicks 1 Steller's eider 25 Steller's eider eggs/chicks
Barrow Wastewater Treatment Facility	4.18 acres loss of habitat 35.24 acres of habitat disturbed	3 Steller's eider eggs/chicks 3 spectacled eider eggs/chicks
BLM Northeast NPRA Planning Area	Habitat loss/disturbance Collisions	104 spectacled eiders 9 Steller's eiders
BLM Northwest NPRA Planning Area	Collisions	14 spectacled eiders 1 Steller's eider
Beaufort Sea Planning Area Lease Sale 186, 195, & 202	Collisions	5 spectacled eiders 1 Steller's eider

ABR Avian Research/USFWS Intra-Service Consultation	Disturbance	5 spectacled eider eggs/chicks
Avian Influenza Survey/USFWS Intra-Service Consultation	Disturbance	6 spectacled eider eggs/chicks

¹ “eggs/chicks” indicates that the estimated level of take will affect either eggs *or* chicks.

Kittlitz’s Murrelet

The principle distribution and breeding range of Kittlitz’s murrelets occurs in southeast Alaska, outside of the action area. The Service believes the species has undergone a sharp population decline and it is a candidate for listing should funds become available. Kittlitz’s murrelets are closely associated with marine tidewater glaciers and their decline may be related to the retreat of glaciers and decreased foraging habitat. Boat tours of tidewater glaciers have increased substantially in southeast Alaska, and this may be increasing disturbance of Kittlitz’s murrelets in foraging areas. Most factors thought to contribute to the Kittlitz’s murrelet decline are occurring outside of the action area, with the exception of changes in the marine environment (discussed below).

Ledyard Bay Critical Habitat

The LBCHU was designated as critical habitat because it is used by large numbers of spectacled eiders during molt, which is an energetically demanding portion of their life cycle (described in Section 3 – *Status of the Species and Critical Habitat*). Its relatively rich and abundant benthic community is food for spectacled eiders when they occupy Ledyard Bay. Therefore, environmental conditions that support the rich and abundant benthic community are ultimately important to Ledyard Bay’s capacity to support spectacled eiders. Due to the lack of industrial development and minimal human presence and vessel traffic in the region, the Chukchi Sea is currently largely in natural condition. A waterbody in its natural condition is free from the harmful effects of pollution, habitat loss, and other negative stressors (MMS 2006b). Several key environmental factors, such as good water quality and lack of contamination, contribute to what can be considered the current good environmental conditions of the LBCHU.

The MMS (2006b) reviewed water quality and sediment assessments of the Chukchi Sea and concluded that the general water quality of the Alaska Arctic region OCS is relatively pristine due to the remoteness, harsh but active ecological system, and limited presence

of human (anthropogenic) inputs. Current industrial impacts are minimal and pollution and/or sediments occur at very low levels in Arctic waters and do not pose an ecological risk to marine organisms in this region. The majority of water flowing into the marine environment is not subject to human activity or stressors and is considered unimpaired (Alaska's Final 2002/2003 Integrated Water Quality Monitoring and Assessment Report). There are no Section 303(d) impaired waterbodies identified within the Arctic Subregion by the State of Alaska. Background hydrocarbon concentrations in Chukchi waters appear to be biogenic (naturally occurring) and on the order of 1 part per billion or less; concentrations in the Hope Basin and Chukchi Sea are entirely biogenic in origin and are typical of levels found in unpolluted marine water and sediments. A study of heavy metals in sediments collected from portions of the eastern Chukchi in the 1990's (Naidu 2005) found concentrations were low and the environment was considered "pristine."

We believe, therefore, that the LBCHU is currently largely in natural condition, free of physical modification or significant pollutants in either its water and sediments; and its physical and biological processes are functioning and promote production of a rich and abundant benthic community upon which spectacled eiders feed when they occupy the LBCHU.

Regional-Scale Environmental Shifts

There are indications regional-scale environmental shifts may be underway in both the Chukchi and the Bering seas, which have important hydrologic and biologic connections. An observed increase in Atlantic water in the western Arctic Ocean (Zangh and Hunke 2001) can warm surface water, which in turn thins arctic sea ice (Manabe and Stouffer 1995). An average 1-m reduction in sea ice thickness has been estimated in the Chukchi and Beaufort seas (Rothrock et al 1999). Late summer arctic sea ice has declined 2-7.7% per decade (Parkinson et al. 1999, Stroeve et al. 2005), and the area of perennial sea ice has declined 9.8% per decade of since 1978 (Comiso 2006). Sea ice and the associated ice-edge productivity is a key factor in the heightened carrying capacity of arctic sea shelves (Grebmeier and Dunton 2000), including the LBCHU. Grebmeier et al. (2006) suggest that an ecological shift from arctic to subarctic conditions is occurring in the northern Bering Sea; this shift resulting in decreased sea ice may have profound impacts on arctic marine mammals and diving seabird populations through ecosystem linkages that change food supplies. A similar trend may be underway in the Chukchi Sea as recent retrospective studies of benthic communities indicate a changing marine system in both the Bering and Chukchi Seas (Iken and Konar 2003, Sirenko and Koltun 1992, Grebmeier and Dunton 2000). There are indications bivalve populations in the northern Bering Sea (where spectacled eiders winter) are in decline (Richman and Lovvorn 2003, Grebmeier and Cooper 2004).

Current understanding of regional-scale shifts in the arctic marine environment is primarily limited to measurements in the physical environment, such as sea ice thickness and water temperatures. Because similar types of changes are recently being linked to ecological shifts in the Bering Sea (Grebmeier et al. 2006), it may be reasonable to conclude unmeasured ecological shifts may be occurring in the Chukchi Sea, or will

occur, if trends continue. Specific effects of environmental shifts in the arctic environment are speculative at this point, so possible effects on listed species or the LBCHU were not considered in this biological opinion. However, it should be noted that the marine environment of spectacled eiders, Steller's eiders, and Kittlitz's murrelets may be changing, and is likely to be a dynamic factor affecting all three species in the future. If future consultations regarding Lease Sale 193 are undertaken, the environmental baseline may have changed considerably due to regional-scale environmental shifts that could cause changes in the status of species or condition of the LBCHU.

5. EFFECTS OF THE ACTION ON LISTED SPECIES AND CRITICAL HABITAT

This section of the BO analyzes direct and indirect effects of the action on listed species, important habitats, and critical habitat (the LBCHU), considering the potential threats identified by MMS (2006a):

- A. Habitat Loss
- B. Disturbance and Displacement
- C. Collisions
- D. Increased Predation
- E. Increased Subsistence Hunting
- F. Toxics Contamination
- G. Crude and Refined Oil Spills

The effects analysis is divided into the current incremental step (leasing and exploration), presented first, and then the entire Lease Sale 193 action (also including development and production). Direct effects are addressed first; indirect effects and effects from interdependent and interrelated actions are discussed at the end of this section.

I. Effects of the First Incremental Step (Leasing and Exploration)

Activities proposed under the first incremental step are seismic surveys and exploratory drilling, and associated vessel and aircraft traffic. They are temporary, largely confined to the marine environment, and have relatively small impact areas.

A. Loss of Habitat – Incremental Step

Structures constructed in high-quality habitats can affect birds by rendering those habitats permanently unsuitable, thus relegating birds to lower quality habitats. The only permanent structures expected to result from seismic surveys and exploratory drilling are abandoned exploratory wells, which are capped below the sea floor and thus would not cause permanent impacts to the sea floor (email dated 3/16/07 from Mark Schroeder, MMS). Thus, the Service concludes that permanent habitat loss from leasing and drilling up to 14 exploratory wells would not occur and would not pose adverse effects to listed eiders or Kittlitz's murrelets.

A small portion of the western LBCHU is in the lease sale area, and this portion has fewer recorded molting eider observations than the central and eastern LBCHU (Larned et al. 1995, Petersen et al. 1999) (Fig. 5.1). Further, Feder et al. (1989, 1994a, 1994b) found a different substrate (muddy-gravel) and invertebrate community in the western LBCHU than sites sampled further east. This information suggests the western portion of LBCHU is less favorable for molting spectacled eiders than the central and eastern LBCHU. Combined with the small impact area of permanent structures from exploratory drilling, the Service anticipates no adverse effects to critical habitat from direct habitat loss due to exploratory drilling in the LBCHU.



Figure 5.1. Location of eiders observed during aerial surveys in Ledyard Bay in relation to the critical habitat unit boundaries and Lease Sale 193 boundaries (Larned et al. 1995).

B. Disturbance and Displacement – Incremental Step

Severity of disturbance and displacement effects depends upon the duration, frequency, and timing of the disturbing activity. Disturbance that results in agitated behavior, flushing, or other movements in response to a stimulus can increase energy costs, especially for birds that are already energetically stressed from cold, lack of food, or physiologically demanding life cycle phases such as molt. Resulting displacement from preferred habitats could increase stress by reducing available resources. Disturbance and displacement to listed eiders and Kittlitz's murrelets during seismic surveys and exploration activities could occur from aircraft, vessel traffic, and seismic survey acoustic sources, especially in important habitats (spring leads and the LBCHU).

Aircraft – Aircraft may disturb molting and flighted eiders. Studies of king eiders in western Greenland found birds dove when survey aircraft approached (Mosbech and Boertmann 1999). Bird response varied with time of day, and increased with decreasing

plane altitude. After a preliminary dive by nearly all birds, over 50% remained submerged until the plane passed. Also, molting king eiders appeared to be sensitive to boat and aircraft engine noise, and flushed, dove, or swam from that disturbance, sometimes leaving the area for several hours (Frimer 1994).

No fixed-wing flights, and limited helicopter support (<1 flight/day), are anticipated during seismic survey work. During exploratory activities, two helicopter flights per day between the drill site and a coastal community, such as Barrow, to allow crew changes and vessel re-supply, would occur. A third helicopter with search and rescue capabilities may also be located in the area. However, the following MMS stipulation (MMS 2007), limits aircraft overflights within the LBCHU from July 1–November 15 when eiders may be present:

Except in cases to protect human safety, when landing, or to participate in an oil spill response, aircraft supporting drilling operations will not operate below 1,500 feet ASL when operating over the Ledyard Bay Critical Habitat Area. If weather prevents attaining this altitude, aircraft will use pre-designated flight routes at the outer margin of the Ledyard Bay Critical Habitat Area. Pre-designated flight routes will be established by the lessee and MMS, in collaboration with the USDO, FWS, during review of the Exploration Plan.

With the low number of anticipated flights and additional protection in the LBCHU, adverse effects to listed eiders or Kittlitz's murrelets from aircraft disturbance are not anticipated.

Vessel transits – Seismic, exploratory, and support vessels may transit through the entire spring lead system, including those areas outside of the lease sale area (Fig. 5.2, Fig. 5.3). Vessels may disturb birds in the spring lead system, but these flight-capable birds can move to alternative locations, and harmful effects are likely minimized by the low frequency and duration of disturbances. Seismic surveys are conducted by one or two self-contained vessels that may be accompanied by a guard boat; during exploratory drilling each pair of drill ships would be supported by two ice breakers and up to seven other vessels. The Service assumes that seismic and exploratory flotillas in the spring leads would consist of a small number of boats and cause few and temporary disturbance episodes.

Exploratory and support vessels may also transit the entire LBCHU, which in summer and autumn is occupied by large numbers of flightless, molting spectacled eiders (seismic surveys are not allowed in the LBCHU after July 1). Molting birds are energetically stressed and less mobile, so the impact of displacing them from preferred habitats are presumably greater than for a flight-capable bird. If so, displacement of a molting bird could reduce survival.

Since available data indicate that molting spectacled eiders concentrate in the central portion of the LBCHU (Larned et al. 1995, Petersen et al. 1999), MMS (2007) developed a stipulation to reduce disturbance from vessel transit in Ledyard Bay. This stipulation is in effect from July 1–November 15 when molting eiders may be present:

Except in cases to protect human safety or respond to an oil spill, vessels associated with drilling operations will avoid operating within the Ledyard Bay Critical Habitat Area to the maximum extent practicable. Support vessels must enter the Ledyard Bay Critical Habitat Area from the northwest and proceed directly to the drill rig, remain in close proximity to the drill rig while providing support, and exit the drill rig vicinity to the northwest until out of the Critical Habitat Area.

Disturbance and displacement from vessel transits would be minimized by several factors. First, we expect the amount of vessel traffic in the region to be limited. Few vessels are used during seismic surveys, and although more are involved in exploratory drilling efforts, the number of efforts underway at any time is severely limited by the number of drill ships available for use (currently only two). Also, the portion of the LBCHU thought to receive the greatest use by eiders is outside Lease Sale 193 boundaries, which would also serve to reduce impact. Finally, an MMS stipulation restricting vessel traffic in the LBCHU from July 1–November 15 will further minimize disturbance of molting eiders and transiting vessels. Based on these factors, adverse effects are not anticipated for listed eiders or Kittlitz's murrelets from vessel transits.

Seismic surveys – The effects of seismic surveys would be similar to those of transiting vessels, although surveys will be longer in duration than vessels simply moving through an area. However, seismic surveys can only occur within the lease sale area, which overlaps only small portions of important spring lead habitat (Fig. 5.2) (or the LBCHU, discussed below), and seismic surveys would not overlap temporally with bird use there. King eider satellite telemetry data indicate males have left the Chukchi Sea and arrived in the Beaufort Sea between April 20 and May 20, while females arrive from May 17 to June 8 (Phillips 2005). Similar timing of spring migration of king eiders was noted by Suydam et al. (2000) in their May 1–June 2 1996 observations at Point Barrow. Based on North Slope tundra arrival dates for Steller's and spectacled eiders (Service, unpubl. data), it is likely that Steller's and spectacled eiders show a similar timing of departure from the Chukchi Sea spring lead system. Seismic surveys cannot commence until the area is ice free (early June), so there may only be a few days in which listed eider use overlaps with seismic survey activity in spring leads.

Temporal separation of seismic activity and energetically stressed molting eiders in the LBCHU is provided by MMS's stipulation that seismic surveys not occur in the LBCHU after July 1. Further, the small portion of the LBCHU within the lease sale area (Fig. 5.1) may be of lower quality than the LBCHU outside the lease sale area boundary (discussed under Habitat Loss, above). Because of natural and stipulated temporal separation of seismic activities and listed eiders or Kittlitz's murrelets, and because seismic activities may only occur in small portions of important habitats (spring leads and the LBCHU),

the Service does not anticipate adverse effects to listed eiders and Kittlitz's murrelets from vessel activities associated with seismic surveys.

Seismic acoustic sources – Seismic survey vessels move slowly through an area, gradually ramping up acoustic sources during the course of a survey. The sounds generated during seismic work may cause disturbance to listed eiders, as these sounds can travel horizontally through the water column. Little is known about avian response to seismic acoustics; however, in a study of long-tailed ducks (*Clangula hyemalis*) in the Beaufort Sea, Lacroix et al. (2003) found no significant difference in numbers of ducks in an area before and after seismic survey work. In some survey areas, long-tailed ducks were observed to dive more frequently than in undisturbed areas, but the cause (vessel or seismic acoustic source) was unclear. In the absence of information on the specific effects of seismic noise on listed eiders or Kittlitz's murrelets, we assume that the reasons used for concluding no adverse effects for other seismic survey activities (temporal separation; small amount of important habitats in the lease sale area) apply here, and anticipate no adverse effects to listed eiders and Kittlitz's murrelets from seismic acoustic sources.

Exploratory drilling – Except in the spring lead system and the LBCHU, disturbance and displacement from exploratory drilling activities (aside from transit activities addressed above), should not cause disturbance of listed eiders or Kittlitz's murrelets, because drilling would occur in a relatively small and stationary impact area. Displacement of listed eiders may occur in the small portions of the spring lead system and the LBCHU that overlap with the lease sale area; however, impact areas would be small, stationary, and occur only once. The Service therefore anticipates no adverse effects to listed eiders and Kittlitz's murrelets from exploratory drilling.

C. Collisions – Incremental Step

Migratory birds suffer substantial mortality from collisions with man-made structures (Manville 2004). Birds are particularly at risk of collision with objects in their path when visibility is impaired during darkness or inclement weather, such as rain, drizzle, or fog (Weir 1976). In a study of avian interactions with offshore oil platforms in the Gulf of Mexico, Russell (2005) found collision events were more common, and more severe (by number of birds) during poor weather. Certain types of lights (such as steady-state red) on structures increase collision risk (Reed et al. 1985, Russell 2005, numerous authors cited by Manville 2000). This is particularly apparent in poor weather when migrating birds appeared to get into circulation patterns around structures after being attracted to lights and becoming unable to escape the “cone of light” (Russell 2005, Gauthreaux & Belser 2002, Federal Communications Commission 2004).

Flight behavior over water of the listed eiders and Kittlitz's murrelets places them at risk of colliding with human-built structures. Day et al. (2005) suggested that eider species may be particularly susceptible to collisions with offshore structures as they fly low and at relatively high speed (~ 45 mph) over water. Johnson and Richardson (1982), in their study of migratory behavior along the Beaufort Sea coast, reported that 88% of eiders flew below an altitude of 10 m and >50 % flew below 5 m. Kittlitz's murrelets also fly

low and fast (>2 m above the water surface, average 94 km/hr) (Day et al. 1999). Their flight was described as having a long and sweeping pattern, which renders them unable to change direction quickly (Kishchinski 1968 cited by Day et al. 1999), further increasing their risk of collision.

MMS (2006a) considered the potential for collisions with aircraft. However, based on the low flight height of eiders over water (Day et al. 1999; Day et al. 2005) and the diving behavioral response to aircraft over flights documented by Mosbech and Boertmann (1999), the Service considers this to be an extremely unlikely event.

Depending upon location and timing of operations, vessels and exploration structures pose a collision risk for Steller's and spectacled eiders migrating to and from Alaska's North Slope, and males of both species as they move between Alaska and Russia. Kittlitz's murrelets may also be at risk for collisions. The Service concludes that there may be adverse effects to listed eiders, and Kittlitz's murrelets, from collisions. Our estimate of the magnitude of this threat is presented in Section 8.0 - *Incidental Take Statement*.

D. Increased Predation – Incremental Step

No activities proposed during leasing and exploration would result in an increase in predators of either listed eider species or Kittlitz's murrelet. The Service anticipates no adverse effects to listed eiders or Kittlitz's murrelets from increased predation.

E. Increased Subsistence Hunting – Incremental Step

Prior to the listing of Steller's and spectacled eiders under the Act, some level of subsistence harvest of these species occurred across the North Slope (Braund et al. 1993). This has continued since listing, even though it is illegal. The Service has been working with several agencies such as the North Slope Borough and BLM to educate local residents about the protected status of the species to reduce subsistence harvest, and will continue to do so. No records were found that suggest either the adults or eggs of Kittlitz's murrelets are used by Alaska Natives for subsistence activities. No activities proposed during leasing and exploration would result in an increase in subsistence hunting. The Service anticipates no adverse effects to listed eiders or Kittlitz's murrelets from increased subsistence hunting.

F. Toxics Contamination - Incremental Step

Toxics contamination from oil extraction activities can result from exploratory well blowouts or other oil spills (addressed below) and from disposal of drilling muds and cuttings. Disposal of drilling muds (used to lubricate drill bits), and cuttings (material removed from drill holes) can result in heavy metal and petroleum hydrocarbon contamination in the disposal area. At exploratory wells, an estimated 80% of drilling muds would be recycled; 20% (approximately 95 tons) would be discharged, as would all rock cuttings (approximately 600 tons) (MMS 2006a). Discharged muds and cuttings are toxic to benthic communities, can alter substrates, and cause physical and bacterial anoxia; these impacts would be expected at the discharge site. However, given the size of the lease sale area (34 million acres) and the low number of exploratory wells expected

(up to 14), the Service does not anticipate adverse effects to listed eiders or Kittlitz's murrelets from drilling mud and cuttings discharges. However, this will be evaluated further under a consultation with the EPA for NPDES permits required to discharge drilling wastes to the ocean.

A small portion of the western LBCHU is within the lease sale area; however, this portion has fewer recorded molting eider observations than the central and eastern LBCHU (Larned et al. 1995, Petersen et al. 1999) (Fig. 5.1). Further, Feder et al. (1989, 1994a, 1994b) found a different substrate (muddy-gravel) and invertebrate community in the western LBCHU than sites sampled further east. This information suggests the western portion of LBCHU is less favorable for molting spectacled eiders than the central and eastern LBCHU. Combined with the small impact areas of exploratory drill sites, the Service anticipates no adverse effects to critical habitat from exploratory drilling mud and cuttings discharges in the LBCHU. However, this will be evaluated further under a consultation with the EPA for NPDES permits required to discharge drilling wastes to the ocean.

G. Crude and Refined Oil Spills – Incremental Step

We evaluated the effects of oil spills on listed eiders and Kittlitz's murrelets using information on important habitats (spring leads and molting areas), bird location and condition throughout the annual cycle (e.g., nesting, molt), and the toxic effects of oil on birds (individuals and populations) and their prey. We assumed the biological effects of oil exposure did not differ between oil sources (crude or refined oil). For the incremental step, we also evaluated spill probability and size estimates developed by MMS for activities associated with vessel movements and exploratory drilling.

The Service has concerns that a spill anywhere in the eastern Chukchi Sea has the potential to contact listed species or impact their habitat. However, certain areas are of particular concern because of their importance to listed species or because large numbers of listed birds congregate there. In the eastern Chukchi Sea these key areas are the LBCHU (Fig. 5.1) and spring leads in sea ice along the Alaska coast (Fig. 5.2, Fig. 5.3). There is little specific information about spring migration routes for either listed species, but it is believed the listed eiders advance northward similarly to other species of eiders as spring leads develop in the eastern Chukchi Sea ice. Both spectacled eiders and Steller's eiders occupy Ledyard Bay seasonally during their north and south migrations, although the duration of each species' use is not documented in detail. In spring they presumably move through Ledyard Bay as spring leads open, and in summer and autumn they return utilizing the open waters of Ledyard Bay, with spectacled eiders remaining in the area to molt. Large numbers of molting spectacled eiders are present in Ledyard Bay from approximately late June until late October (Larned et al. 1995, Petersen et al. 1999). Steller's eiders that breed on the North Slope also use Ledyard Bay and nearshore Chukchi Sea water during their southward migration (Martin et al. in prep.)

Exposure to oil can cause mortality and sublethal effects (Albers 2003). However, because the Arctic marine environment is cold and harsh, sublethal health effects on eiders or murrelets are likely to affect their survival in the marine environment. Therefore, for this analysis, the Service assumed that all birds coming into contact with

oil would either be killed outright (direct mortality) or eventually (indirect effects leading to reduced survival).

Death can be caused in a number of ways after exposure to oil. External oiling disrupts feather structure, causes matting of feathers, and permits wetting of the bird. Death typically results from hypothermia and drowning (Vermeer and Vermeer 1975, Tseng 1993, Jenssen 1994). Ingesting petroleum through feather preening or consumption of contaminated food or water, and inhalation of fumes from evaporating oil, may not be immediately lethal, but debilitating effects include gastrointestinal irritation, pneumonia, dehydration, red blood cell damage, impaired osmoregulation, immune system suppression, hormonal imbalance, inhibited reproduction, retarded growth, and abnormal parental behavior (Jenssen 1994, Hartung and Hunt 1966, Miller et al. 1978, Szaro et al. 1981, Albers 1983, Leighton 1991, Burger and Fry 1993, Fry 1986, Eppley 1992, Fowler et al 1995, Walton 1997, and Briggs et al. 1997). These effects can cause death from starvation, disease, or predation, especially in the harsh arctic environment.

Mortality following exposure to oil is common in waterfowl and alcids, which spend much time in the water and are therefore vulnerable to surface oil (Albers 2003). Clark (1984) found seabird species most vulnerable to population-level effects of oil pollution were those whose life history characteristics include high adult survival, adaptation to stable and predictable marine environments, and high site fidelity, such as the listed eiders and Kittlitz's murrelets.

Because oil, fuel, or other toxic substances would cause mortality to listed eiders and Kittlitz's murrelets, particularly in important habitats (spring leads and the LBCHU) with high densities of birds, we evaluated the probability and likely extent and persistence of either large or small oil spills during leasing and exploration using information provided by MMS (2006c). No exploratory drilling blowouts have occurred in 98 wells in the Arctic offshore region or Alaska OSC. Of the 13,463 exploratory wells that have been drilled in the coastal U.S., there were 66 blowouts during drilling, only four of which resulted in oil spills (range 1 to 200 barrels; average ~78 barrels). Of 35 exploratory wells drilled in the Beaufort or Chukchi OCS, there have been 35 small spills totaling 1,120 gallons, of which 90% was recovered. If a ≤ 50 bbl spill were to occur, MMS estimates it would persist for a two-day period

To reduce potential mortality of molting spectacled eiders in the LBCHU if an exploratory well oil spill occurred, MMS will implement the following stipulation:

An Oil Spill Response Vessel must be on-site when a drill rig is within the Ledyard Bay Critical Habitat Area. The lessee will also pre-stage wildlife hazing equipment (including at least 3 *Breco* buoys or similar devices) either on the Oil Spill Response Vessel or in Point Lay or Wainwright. The lessee will ensure on-site oil-spill response personnel are trained in the use of wildlife hazing equipment.

Due to the high recovery rates of low-volume spills, and the low probability of occurrence of large oil spills during leasing and exploration, the Service anticipates no adverse effects to listed eiders or Kittlitz's murrelets, and no adverse impacts to critical habitat, from oil spills during leasing and exploration.

H. Summary of Effects – Incremental Step

In the incremental step of Lease Sale 193 (leasing and exploration), no adverse effects to listed eiders or Kittlitz's murrelets are anticipated from habitat loss, disturbance and displacement, increased predation, increased subsistence hunting, toxics contamination, or oil spills. No adverse impacts to critical habitat is anticipated from habitat loss, toxics contamination, or oil spills. Adverse effects to listed species are anticipated from collisions; these are further evaluated in Section 8 - *Incidental Take Statement*.

II. Effects of the Entire Action (Development and Production)

In addition to considering the effects of activities permitted under the first incremental step (leasing and exploration), we also analyzed the effects of the entire Lease Sale 193 action, including development and production. While the nature and location of future development activities are unknown, we used MMS's hypothetical development scenario (detailed in Section 2.0 – *Description of the Proposed Action*) to identify the types of impacts that could occur, and examine their effects on the species of concern. Activities associated with development and production would occur in marine and terrestrial environments, and would include construction of permanent facilities (central production facility, satellite facilities, subsea and terrestrial pipelines, pump stations) and associated aircraft and vessel traffic; operation of those facilities over the life of the field; and removal and/or abandonment of facilities.

A. Loss of Habitat – Entire Action

If development occurs and a central platform, satellite wells, and subsea pipelines are constructed, a marine area up to 30 mi in diameter may be permanently impacted, with some structures above the water surface. Given the size of the lease sale area (34 million acres) and that only one central production facility is anticipated, the impact of permanent habitat loss in the marine environment would likely be negligible, unless development facilities were located within the LBCHU, spring leads, or areas important to Kittlitz's murrelets. While the Service concluded that the impact area from subsea capped exploratory wells in the LBCHU was not likely to cause adverse impact to critical habitat, a larger (up to 30 mi in diameter), permanent facility with above-surface structures might. Even though the lease sale area covers only a small portion of spring leads and LBCHU, development may require infrastructure such as pipelines, within both of these important habitats. Indeed, development in much of the lease sale area would require crossing of spring leads or the LBCHU to reach a shore base. Therefore, development and production may result in permanent marine habitat alterations that could adversely affect listed eiders, Kittlitz's murrelets, or critical habitat.

In the terrestrial environment, direct loss of habitat would occur by placement of gravel fill onto the tundra or by excavation of materials at mine sites. In MMS's hypothetical development scenario, a 50-acre shore base with an additional 50-acre storage pad would be constructed in the vicinity of the pipeline landfall. From the shore base an access road and pipeline would connect to the TAPS. The length of the road and pipeline would depend upon where they connect to existing infrastructure, but could be up to 300 miles long. MMS estimates the footprint of the road and pipeline corridor would be 100 feet wide, hence an area of 3,636 acres of habitat would be lost. MMS anticipates that four pump stations would be developed along the pipeline, each 40 acres in size. Gravel material for access road, pipeline, and pad construction could be mined from coastal areas, existing but unspecified material sites, and new borrow pits along the road or pipeline right-of-way (ROW), resulting in 395 additional acres of habitat loss. The total anticipated lost habitat is 4,291 acres (17.4 km²).

Estimating effects of breeding habitat loss on spectacled eiders is dependent upon development location, because spectacled eider density varies across the North Slope (Fig. 3.3). Assuming that the gradient in observed density reflects a gradient in habitat quality, and displacing birds from preferred habitat reduces their reproductive potential, placing fill in areas used by nesting eiders may compromise their reproductive potential. To estimate the number of pairs affected, the footprint size (17.4 km²) was multiplied by the density of birds. If the infrastructure and associated fill were placed in areas of average spectacled eider density (0.223 birds/km²; calculated for 2002-2006; Larned et al. 2003, 2005a, 2005b, 2006), a few pairs would be affected each year. However, given the variation in density (0.01 to >3 birds/km²), the total number of pairs potentially affected ranges from less than one to over 50 pairs, depending on location.

Impacts of terrestrial habitat loss on Steller's eiders are also dependent on location. Aerial surveys optimized to detect eiders since 1992 (Larned et al. 2006) indicate Steller's eiders occur at very low densities across the ACP, with highest density in the vicinity of Barrow (Fig. 3.8). The average density of Steller's eiders observed during ACP surveys in 2002-2006 was 0.0045 birds/km² (Larned et al. 2003, 2005a, 2005b, 2006), but near Barrow was 0.66 birds/km² (Rojek 2006). Thus, the number of pairs potentially affected varies significantly depending on how much habitat loss occurs near Barrow. Terrestrial habitat loss near Barrow could affect a significant portion of the listed population of Steller's eiders; terrestrial habitat loss elsewhere may affect many fewer.

The terrestrial portion of the action area is on the northern edge of the breeding range for Kittlitz's murrelets. This species nests near the coast in steep, rocky habitat, which is presumably unsuitable for a pipeline landfall and associated infrastructure. It also seems likely that a road and pipeline ROW connecting to the TAPS would run predominantly east-west, nearly perpendicular to the coast, which would reduce the amount of possible infrastructure within Kittlitz's murrelet habitat. Given these factors, we conclude that little Kittlitz's murrelet breeding habitat loss would occur with development and production.

B. Disturbance and Displacement – Entire Action

As noted in our analysis of the effects of the first incremental step, the severity of disturbance and displacement effects depends upon the duration, frequency, and timing of the disturbing activity, which are all likely to increase with development and production.

Ships would be operating in the lease sale area during all phases of the project. MMS estimated that several barge lifts of materials would be brought to the shore base site and to the offshore platform during construction. Support vessels would travel to the offshore facilities approximately three times a week during development, decreasing to one trip every 1-2 weeks during production. MMS estimates three daily round-trip helicopter flights between shore and offshore facilities during development and production. During construction of the shore base, up to five daily fixed-wing flights may bring materials; this number would drop to two daily fixed-wing and three daily helicopter flights during production. The amount of activity during abandonment is expected to be much less than during construction because some structures may be left in place and activities can be scheduled for periods when disturbance or other impacts are minimized (email dated 3/21/07 from Mark Schroeder, MMS).

The effects of vessel and aircraft disturbance on listed eiders are not fully understood but escape response behavior occurs at some energetic cost to individual birds. Depending upon the frequency of operations and routes traversed by vessels and aircraft impacts could range from negligible (few listed birds are encountered at irregular intervals) to substantial (vessels or aircraft repeatedly encounter large molting flocks of spectacled eiders in the LBCHU).

It is difficult to assess the effects of this traffic on listed eiders and Kittlitz's murrelets in the marine environment. First, it is unclear what management stipulations will be in place to reduce impacts. An MMS stipulation (MMS 2007) limits aircraft overflights within the LBCHU from July 1 – November 15 when eiders may be present but this stipulation currently applies only to seismic surveys and exploration. It is also currently unclear if management stipulations would be applied in spring leads or other areas outside of the LBCHU. Further, until aircraft routes, which would be determined by the location of the shore base and offshore facilities, are known, it is unclear how many birds would be disturbed, or if disturbance would take place during sensitive times of the life cycle, such as molt or spring staging when adults are acquiring reserves prior to nesting.

In the terrestrial environment, human activities such as the movement of personnel and equipment at the shore base, storage pads, along the access road and pipeline ROW by ground-based activities and aircraft could result in the repeated disturbance of Steller's and spectacled eiders. If disturbance were to occur during the nesting period (approximately June 1 - August 15) it could adversely affect individuals by: 1) flushing females from nests or shelter in brood-rearing habitats, exposing eggs or ducklings to inclement weather and predators; and 2) displacing adults and or broods from preferred habitats during pre-nesting, nesting, and brood rearing, leading to reduced foraging efficiency and higher energetic costs.

The individual tolerance and behavioral response (i.e., habituation) of Steller's and spectacled eiders to disturbance may vary. There doesn't appear to be a clear relationship between the movements of spectacled eiders and oil infrastructure (Troy 1995), but it is possible that females could choose to avoid nesting in habitats near repeated human activities (Troy 1992) (essentially, habitat loss). If this occurred in areas supporting high densities of listed eiders, such as near Barrow, the resulting disturbance during the nesting season could lead to significant impacts to the species. It is difficult to estimate how much habitat would be rendered less suitable for nesting as a result of disturbance, but the Service typically assumes that nesting behavior may be disrupted by human activities within 200 m of nests. If so, the potential for the habitat to support nesting would be compromised. Based upon calculations by MMS, total habitat loss due to disturbance near infrastructure would total 52,379 acres, or 213.58 km² [shore base and storage area (350 acres), road and pipeline ROW (51,397 acres) and pump stations, (632 acres)].

C. Collisions – Entire Action

As described under effects of leasing and exploration, migratory birds suffer substantial mortality from collisions with man-made structures in marine and terrestrial environments. If development were to occur as a result of Lease Sale 193 several structures including an offshore production platform, shore base buildings and equipment, and pump stations could be constructed which may pose a collision risk for listed eiders and Kittlitz's murrelets. Collision risks include Steller's and spectacled eiders migrating north through the Chukchi Sea during the spring migration; south, east, and west during molt migrations, and south during fall migrations; small numbers of listed Steller's and spectacled eiders near the shore base and terrestrial infrastructure during the breeding season (local flights); and Kittlitz's murrelets, particularly in the marine environment.

Without knowing the number, location, and design of structures that may result from Lease Sale 193, it is difficult to estimate with precision the number of listed eiders and Kittlitz's murrelets that may be killed through collisions. Collision data for common eiders at Northstar Island (an artificial offshore oil production island in the Beaufort Sea) averaged 4.2 collisions per year since 2000. This collision rate was used as a surrogate to assess potential impacts to Steller's and spectacled eiders, by converting it to a percentage and applying that to the estimated population sizes of Alaska-breeding Steller's eiders and the North Slope population of spectacled eiders. For each structure, an estimated 0.31 spectacled eiders and 0.024 Steller's eiders could be killed each year. Multiplied by the number of facilities (offshore production platform, shore base, and four pump stations), we roughly estimate 56 spectacled eiders and four Steller's eiders could be killed through collisions over the 30-year lifespan of these structures. Actual collision risk would vary with the proximity of structures to habitats and migratory routes used, however. Although Kittlitz's murrelets may also be vulnerable to collisions, we are not aware of data upon which to base a comparable estimate of potential collisions.

D. Increased Predator Populations – Entire Action

No actions described in MMS's development scenario are likely to result in an increase of marine-based predators of either listed eider species or Kittlitz's murrelets.

In the terrestrial environment, however, predator and scavenger populations may be increasing near sites of human habitation, such as villages and industrial infrastructure. Day (1998) conducted a comprehensive literature review examining four key predators of tundra-nesting birds, and concluded that individual glaucous gulls, grizzly bears (*Ursus arctos*), arctic foxes, and common ravens had increased survival and reproductive success when additional anthropogenic food sources such as garbage dumps were available. A population increase in these species could affect listed eiders and other ground nesting avifauna, including Kittlitz's murrelets, through egg, young, and even adult predation. If development were to occur as a result of Lease Sale 193, solid waste and garbage would be generated. Although practices in the existing North Slope oil fields have not prevented predators and scavengers from accessing human wastes, more recent regulations applied by BLM in NPR-A have required complete control of waste to eliminate this problem. The Service anticipates that similar policies and practices would be applied to any new developments in NPR-A, but the effectiveness of the newer required practices is unproven.

New infrastructure may also lead to an increase in the number of ravens in the area by providing suitable nesting substrate. Ravens appear to have expanded their breeding range on the North Slope by utilizing buildings and other manmade structures for nest sites (Day 1998). While there is little data describing ravens regularly depredating tundra-nesting birds, Day (1998) interviewed a number of biologists who work on the North Slope and many felt that ravens may be highly efficient egg predators. Similarly, new gravel pads could provide additional denning sites for foxes allowing them to increase in density near pads and depredate nearby nests of ground nesting birds. The Service anticipates that standard operating procedures currently being developed on the North Slope would be applied to new development resulting from Lease Sale 193, but the effectiveness of the newer required practices is unproven.

E. Increased Subsistence Hunting – Entire Action

Prior to the listing of Steller's and spectacled eiders under the Act, some level of subsistence harvest of these species occurred across the North Slope (Braund et al. 1993). Harvest continues despite prohibitions against taking spectacled and Steller's eiders, although harvest levels are poorly documented. MMS's development scenario includes a new road into previously undeveloped areas, which could provide access to previously inaccessible areas for hunters. The Service will continue to work with local communities to ensure that hunters are aware of prohibitions on hunting listed eiders to minimize additional impacts from hunting. No records were found that suggest either the adults or eggs of Kittlitz's murrelets are used by Alaska Natives for subsistence purposes.

F. Toxics Contamination - Entire Action

Production wells are estimated to generate approximately 125 tons of spent muds and 825 tons of rock cuttings as drilling wastes (MMS 2006a). Up to 14 production wells, a

central platform and satellite wells could impact a marine area up to 30 mi in diameter. Given the size of the lease sale area (34 million acres), that only one central production facility is anticipated, and that all drilling wastes will be treated and disposed of in shallow wells (production platforms) or barged to shore treatment facilities (subsea wells), impacts to the marine environment would likely be negligible, unless shallow wells or shore treatment facilities were located with the LBCHU, spring leads, or areas important to Kittlitz's murrelets. However, should development be proposed, these potential impacts would be evaluated further under a consultation with the EPA for NPDES permits required to discharge drilling wastes to the ocean.

G. Crude and Refined Oil Spills – Entire Action

The effects of oil on birds were discussed under the incremental step (leasing and exploration) analysis; based on these effects and the harsh arctic environment, we assumed that a listed eider or Kittlitz's murrelet that comes in contact with oil will die. To analyze the effects of spills due to the entire action, we used spill probability, size, and trajectory data (from historical data and MMS's oil spill modeling), and potential location and timing (which affects cleanup potential), to determine impacts from either small or large oil spills associated with development and production.

Effects on bird survival not discussed under the incremental step analysis include persistent environmental contamination by oil and its toxic breakdown products, and reduced food resources, which may occur after a large oil spill. Esler et al. (2000) evaluated the long-term effects of an oil spill on harlequin ducks (*Histrionicus histrionicus*), another northern sea duck. After the Exxon Valdez oil spill in Prince William Sound (PWS), approximately 1,000 harlequin ducks were killed directly (Piatt et al. 1990, and personal communication with J. Piatt reported in Esler et al. 2000). Esler et al. (2000) subsequently found winter survival of adult female harlequin ducks was 5.7 % lower in oiled areas than unoiled areas, primarily due to lower survival in oiled areas during the mid-winter period. Concurrent studies found harlequin ducks were exposed to hydrocarbons from residual oil in intertidal areas of PWS up to nine years after the spill (Trust et al. 2000b).

Large crude or refined oil spills - MMS assumes if a 1-Bbbl development occurs in the lease sale area at least one large crude oil spill (large spill defined as 1,500 bbl from a platform or 4,600 bbl from a pipeline) would occur over the lifetime of the project (MMS 2006a, 2006c). This assumption is based upon their estimate of a 60% chance of zero spills, a 31% chance of one spill, an 8% chance of two spills, and a 1.3% chance of three spills. MMS modeled spill behavior and calculated the probability a large spill from 13 possible launch areas or five possible pipeline routes (Fig. 5.4), would reach different environmental resource areas (ERAs) in the eastern Chukchi Sea. MMS oil spill trajectory modeling indicates the annual conditional probability of a large oil spill entering spring leads ranged from ≤ 0.5 to 26% depending upon spill source (platform or pipeline), time of year, and launch site (MMS 2006c, Table A.2-27). Because the MMS lease sale proposal did not preclude development or pipelines near spring leads, we assumed a platform or pipelines may occur near or in spring leads, and that a spill could occur in those areas. In fact, because all proposed pipeline routes cross spring leads, it is

logical to assume that a nearshore pipeline spill would be almost certain to be in the vicinity of a spring lead. The annual conditional probability of a large summer oil spill reaching the LBCHU (ERA 10) within 30 days ranges from <0.5 to 72%, depending upon oil spill source (platform or pipeline), time of year, and launch site (MMS 2006c, Table A.2-27). Not surprisingly, oil released from launch areas and pipeline routes closest to ERA 10 has the highest probability of reaching Ledyard Bay.

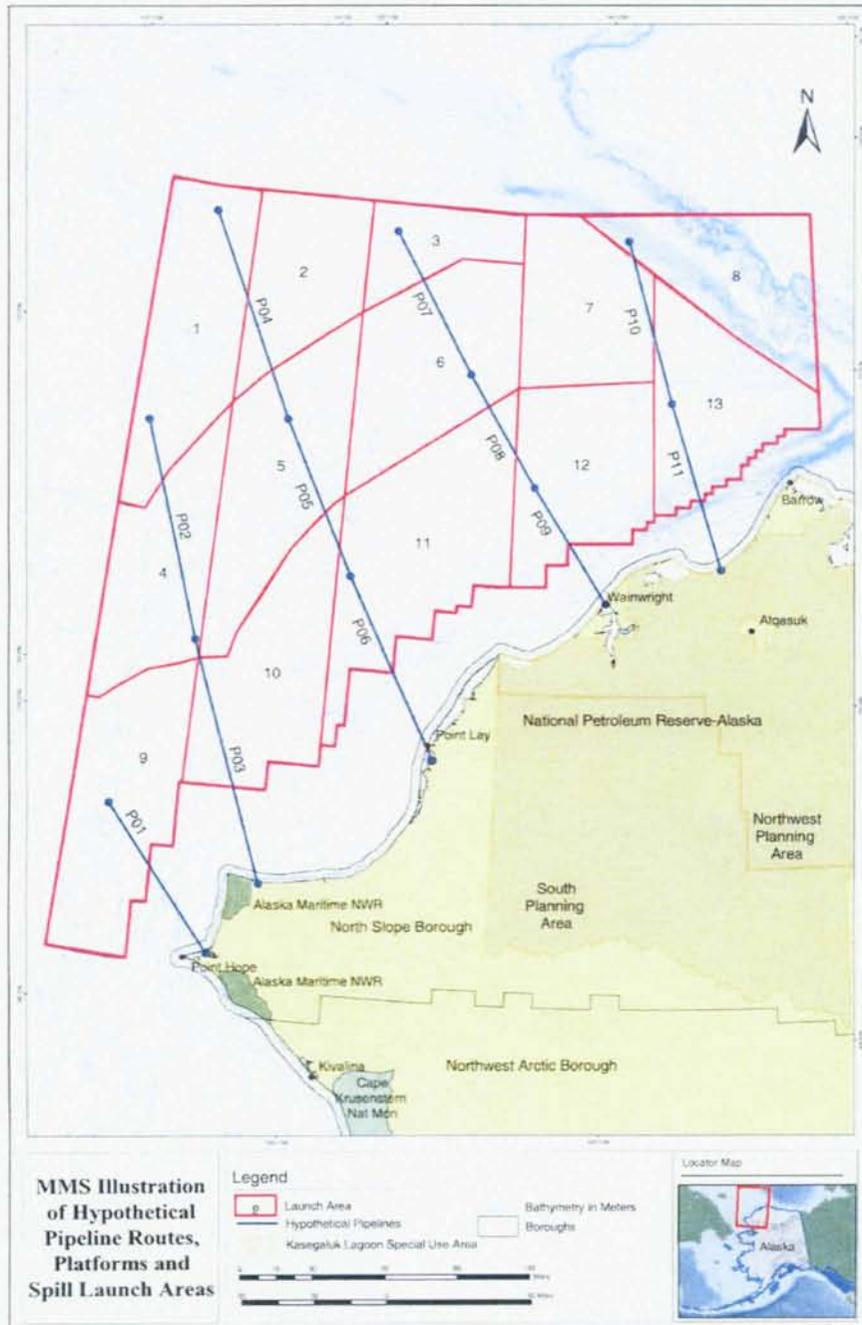


Figure 5.4. MMS illustration of spill launch areas with hypothetical routes and platform locations (adapted from MMS 2006c).

Effect of a large oil spill on spectacled eiders - A population model developed by Dr. Barry Grand, USGS, under contract with MMS, to evaluate the consequences of oil spills on spectacled eiders was run under several scenarios to estimate population-level effects of an oil spill on spectacled eiders in Ledyard Bay. The framework under which these scenarios were run (essentially, the probability of an oil spill contacting the LBCHU) was provided by MMS's oil spill trajectory model. MMS predicted the area of sea surface oiled after a 1,500 bbl or 4,600 bbl summertime crude oil spill would be 577 or 1,008 discontinuous km² area, respectively, after 30 days (MMS 2006c, Table A.1-9). An estimate of the area known to be used by spectacled eiders in Ledyard Bay was 348-709 km² (95 and 100% of counted birds, respectively, from an aerial survey dated September 1, 1995; William Larned pers. comm.). A large oil spill could therefore enter critical habitat and be large enough to impact an area of the size used by all spectacled eiders in Ledyard Bay.

Model assumptions and parameters included endpoints in the Act's definition of "jeopardy," which are "appreciable reduction in likelihood of survival or recovery." For modeling purposes, survival was defined as the opposite of extinction, with extinction approximated as a "quasi-extinction" threshold of fewer than 50 females. The recovery threshold was the lowest population size (6,000 breeding pairs) that would meet recovery goals in the Spectacled Eider Recovery Plan⁴ (USFWS 1996). This equated to 6,000 breeding females, as the model, in common with other avian population models, considered female parameters for population growth projections. The model timeframe of 50 years approximated the anticipated project life as well as 10 spectacled eider generations. (Additional model assumptions and parameters are detailed in Appendix 2.)

To provide baseline population trajectories against which to compare the effects of a catastrophic oil spill, the model was first run assuming no spill and using population demographics (population size and growth rate) summarized by Stehn et al. (2006), and agreed upon by a working group of USFWS and USGS scientists with eider expertise (hereafter referred to as Flint et al. 2006 pers. comm., with deliberations of the group detailed in Appendix 2). Results of this scenario were that the North Slope spectacled eider population had zero probability of extinction, and that the probability of meeting the recovery goal of 6,000 breeding pairs was approximately 0.50. Thus, with no catastrophic oil spill, the stochastic model showed that in 50 years the North Slope spectacled eider population was highly likely to persist but may or may not have reached recovery goals.

Next, the model was run assuming an oil spill contacted molting eiders in Ledyard Bay. The Service estimated that the number of affected eiders could be up to 33,192 (maximum count from four aerial survey conducted on four different dates in four different years; Larned et al. 1995). However, the population ramifications of the death of those birds (all birds contacted by oil are assumed to be killed) depended upon the

⁴ Recovery goals are that all three spectacled eider breeding populations (Arctic Russia, Yukon-Kuskokwim Delta, and North Slope) must: 1) Be stable or increasing over 10 or more years, with a minimum estimated size of at least 6,000 breeding pairs; or 2) Number at least 10,000 breeding pairs over three or more years; or 3) Number at least 25,000 breeding pairs in one year.

origin, and sex and age structure, of the molting birds. At least 2/3 of North Slope nesting females with satellite transmitters molted in Ledyard Bay, and females from the Y-K Delta did not molt there (Petersen et al. 1999). Also, Flint et al. (pers. comm., 2006) concluded that Ledyard Bay was too distant from Russian Arctic breeding areas for females from there to molt, so the model assumption was that all breeding females molting in Ledyard Bay were from the North Slope breeding population.

However, only 4,880 of the 33,192 individual spectacled eiders identified by photographs in Ledyard Bay were brown birds (Larned et al. 1995) and therefore could have been breeding females. Further, the actual proportion was not estimated, as brown birds could be females of breeding age, females younger than breeding age (most two-year olds and all one-year olds), and one-year old males. Flint et al. (pers. comm. 2006) suggested three model scenarios to account for this, each with a different proportion of breeding-age females comprising the brown birds. These were that brown birds: 1) were all females, distributed by age in proportion to the population structure; 2) were females and one-year old males, distributed by age in proportion to the population structure; and 3) were only breeding females (all females aged three and older, and 25% of two-year olds).

Scenarios accommodating long-term effects of oil on spectacled eiders in Ledyard Bay were also needed, because in addition to substantial spill-year mortality (Piatt et al. 1990), female harlequin ducks in PWS had a 5.7% lower overwinter survival in oiled compared to unoiled areas nine years after the Exxon Valdez oil spill (Esler et al. 2000). In the absence of species and region specific data, we used the 5.7% decrease in PWS harlequin female survival as a surrogate for decreases in spectacled eider female survival occurring in years after the oil spill. Three scenarios were used to define the unknown relationship between survival over time (i.e., the shape and length of the survival curve after impact). The first was that there was no long-term impact on survival, and reduction in survival in years after the spill was zero. The second reduced survival by 0.057 for 10 years after the oil spill, then not at all. The third used a sigmoidal decay curve, with initial survival reduced by 0.114 ($0.057 * 2$), dropping to 0.057 at year 10, then to zero by year 20.

Model results from the various scenarios including variations on the proportion of breeding females and reductions in survival rates years after the spill showed similar effects on the probabilities of reaching extinction and meeting recovery goals regardless of the scenarios or combinations run. The chance of reaching extinction increased from zero in the baseline scenario to up to 6.5% in the oil spill scenarios. The chance of reaching the conservative recovery goal of 6,000 breeding pairs (i.e., 6,000 breeding females) went from approximately 50% (baseline) to less than 20% (oil spill scenarios). Thus, a potential oil spill associated with possible oil development in or near the LBCHU may appreciably affect both survival and recovery of the North Slope population of threatened spectacled eiders.

Effect of a Large Oil Spill on the LBCHU - The Service evaluated the potential for a large oil spill to reduce the conservation value of LBCHU for spectacled eiders by affecting the critical habitat constituent elements. These include near-shore sandy or gravelly

substrate, 5-25 m deep, overlain by rich ocean currents; enhanced ice-edge productivity; short, productive food chains and food webs; high benthic invertebrate biomass and abundance; near-shore spring leads over those resources during spring staging and migration, and open water over those resources during the summer and autumn molt (Federal Register 66(25): 9146-9185).

Oil spill effects on marine invertebrates include temporary debilitation, death, population change, contamination of zooplankton and benthic organisms, and invertebrate community change in the water column, deepwater benthic, and tidal areas (Albers 2003, Peterson et al. 2000, Suchanek 1993, Teal and Howarth 1984). The typical response of invertebrate communities to acute catastrophic oil pollution or severe chronic oil pollution (Suchanek 1993) is initial massive mortality and lowered community diversity followed by extreme fluctuations in populations of opportunistic mobile and sessile fauna. Oscillations in population numbers slowly dampens over time and diversity slowly increases to original levels, but recovery time is dependent upon type of oil, extent of contamination, habitat type, weather conditions, latitude, and the species assemblages.

Specific biological effects of an oil spill in the Chukchi Sea have not been predicted, but several studies report on the response of Arctic and Antarctic marine benthos to oil exposure. Percy (1977) demonstrated several benthic crustaceans avoided sediments lightly contaminated with crude oil, but their ability to discriminate diminished when exposed to highly contaminated sediments. *In situ* studies of Prudhoe crude oil simulated oil spills in different arctic ecosystems (Atlas et al. 1978) and demonstrated that although numbers of oil-degrading organisms increased after oil contamination, indigenous invertebrates were killed, petroleum hydrocarbons degraded slowly, and oil contamination was persistent in arctic ecosystems. Experimental releases of oil in arctic nearshore environments of Baffin Island did not necessarily result in invertebrate mortality, although some species bioaccumulated hydrocarbons and had physiological responses to the contamination (Cross and Thomson 1987). At McMurdo Station, Antarctica, species composition and infaunal density decreased dramatically along a steep gradient related to hydrocarbon, metal and PCB contamination (Lenihan and Oliver 1995). The benthic community in highly contaminated areas resembled that of bottom areas gouged by icebergs, and recovery from the chemical contamination was predicted to take many more decades than recovery from a natural disturbance because chemical degradation in polar environments is slow.

The LBCHU would be contacted by a large oil spill under many of the spill trajectory scenarios evaluated by MMS, thereby exposing constituent elements of the critical habitat to effects of an oil spill. Whereas some of the features that contribute to the rich benthic community would not be affected by an oil spill (presence of the ocean shelf, particular water depth, the presence of spring leads and ice edges, and inflow of nutrient-rich Pacific water), other processes and components of the critical habitat would be impacted. The high ice-edge primary productivity that drives the food web of Ledyard Bay could be altered by the physical and toxic effects of oil on the water or ice surface, entrainment in the water column, and direct and indirect effects on primary producers in the water column. The rich benthic invertebrate community that serves as the predictable food

resource for spectacled eiders would probably be impacted both directly and indirectly by a large oil spill. Direct toxicity would reduce the abundance or biomass of benthic invertebrates, and the community composition could be altered by indirect effects. The Ledyard Bay benthic community could be impacted by an oil spill regardless of whether oil reaches the sea floor, due to changes in primary production near the surface that would have ramifications through the relatively simple and direct food chains and food webs occurring in the eastern Chukchi Sea.

The Service concurs with MMS (2006a) that food resources used by eiders in the LBCHU could be displaced or reduced following an oil spill for an unknown length of time, and that the remaining invertebrate prey species could bioaccumulate oil and subsequently contaminate eiders. Therefore, a large oil spill associated with Lease Sale 193 development and production would negatively impact critical habitat. The magnitude of impacts, and the degree to which the LBCHU's ability to support spectacled eiders will be compromised, will be determined, at least in part, by the amount of oil spilled, the amount which actually enters the LBCHU, the degree to which the biotic and abiotic characteristics of the LBCHU are affected, and the duration of the effects.

Effects of a large oil spill on Steller's eiders - Because all North Slope-breeding Steller's eiders may migrate northward in spring leads or broken ice near shore, the Service believes it is possible for an oil spill in the spring lead system to contact and kill a majority of Alaska-breeding Steller's eiders. This would be a catastrophic population-level mortality event for this listed species.

Effect of a large oil spill on Kittlitz's murrelets - The Lease Sale 193 area is on the northern edge of the Kittlitz's murrelet's range in Alaska. Even in years when Bering Sea water and its associated fauna moves north into the Chukchi providing additional prey, the density of Kittlitz's murrelets in the northeast Chukchi is thought to be low (Divoky 1987). When in the marine environment, these birds are generally solitary or found in very small flocks (Day et al. 1999). However, in late summer and fall, substantial numbers have been estimated along the ice edge in the central Chukchi Sea (1,000 to 5,000 birds; G. Divoky unpubl. data, cited by Day et al. 1999). It is not known if Kittlitz's murrelets concentrate in other areas of the eastern Chukchi Sea at other times of year. Due to the general lack of information about Kittlitz's murrelets distribution in the Chukchi Sea, evaluation of specific spill trajectories was not useful. However, the Service believes that Kittlitz's murrelets could be exposed to and killed by spills that occurred in the eastern Chukchi.

To summarize the potential for listed species to be exposed to an oil spill from Lease Sale 193, significant numbers of North Slope-breeding spectacled eiders and Steller's eiders could be exposed to an oil spill that entered important habitats within the Chukchi Sea. In particular, adult spectacled eiders molt in late summer in the LBCHU; during that time the birds are especially vulnerable to a spill because they are flightless and could not be hazed away from oil. The majority of listed Steller's eiders could be killed by an oil spill in spring leads or open water nearshore. In addition, possibly thousands of Kittlitz's

murrelets could be exposed to an oil spill that enters the central or southern portion of the eastern Chukchi Sea. Additionally, the Service concurs with the MMS (2006) assumption that oil spill response in the Chukchi Sea would be ineffective due to the unpredictable response time, proximity of launch sites to bird habitats, known ineffectiveness of response during adverse environmental conditions (such as broken-ice), and the large number of birds that could be impacted in a brief time.

Small crude or refined oil spills - Based upon the North Slope spill record, MMS estimates that 179 small (<1000 bbl) onshore or offshore spills of crude oil or diesel and 440 spills of refined fuels (0.7 bbl each) would occur over the life time of the proposed project, with an average of 25 small-volume spills occurring each year of production. The causes of North Slope crude oil spills were leaks; faulty valves, gauges, or connections; vent discharges; ruptured lines; seal failures; human error; and explosions; and approximately 30% of spills were of unknown causes (MMS 2006c, Appendix A.1).

Although the average small spill size is estimated to be about 3 bbl, MMS estimates that two 500 bbl crude or diesel spills and one 1000 bbl spill would occur over the 30-year life of the project. Spill trajectory analysis was not conducted for small spills, so the Service evaluated the hazard based solely on information provided by MMS on the possible aerial extent of a 1,500 bbl spill. MMS spill models indicated that a summertime 1,500 bbl spill could cover a discontinuous 577 km² area after 30 days, and, if it occurred in landfast ice and moved with meltout, 188 km² after 30 days. Using simple interpolation of those figures, we calculate that a 1,000 bbl spill could cover 384 km² and 125 km² of ocean surface if it occurred in the summer or meltout, respectively, and a 500 bbl spill could cover 192 km² and 63 km² during summer and meltout, respectively.

Dense molting flocks of spectacled eiders could be vulnerable to population-level effects from a 1,000 bbl oil spill because the possible aerial extent of the spill (384 km²) is slightly greater than the 348 km² covered by 95% of the 33,192 spectacled-eider count estimate observed in Ledyard Bay (Larned et al. 1995). Therefore, a 1,000 bbl oil spill may pose nearly as great a potential risk to spectacled eiders in Ledyard Bay as a large oil spill. The risks associated with the two 500 bbl spills predicted to occur during the project also pose substantial mortality risk to spectacled eiders, although we do not know if population-level impacts could occur at that volume. Because molting eiders cannot fly way from a hazard, they would sustain a continuing risk of exposure to even a small-volume oil spill.

If small spills reached spring leads, they could also cause substantial mortality of both spectacled eiders and Steller's eiders using leads during spring migration, especially as oil in broken ice cannot be effectively recovered (MMS 2006a, 2006c). Therefore, even a small-volume spill in the spring lead system could kill a significant portion of Alaska-breeding Steller's eiders and North Slope-breeding spectacled eiders.

H. Summary of Effects – Entire Action

In the unlikely event of oil and gas development and production in the Lease Sale 193 Area, all effects to listed and candidate species, and critical habitat, would be highly dependent upon the precise location and extent of development and production activities. However, adverse effects to listed species and Kittlitz's murrelets could occur from habitat loss, disturbance and displacement, collisions, and oil spills. Potential negative effects of toxics contamination, increased predators, and increased subsistence hunting are reasonably anticipated to be ameliorated by regulations, stipulations, and conservation efforts that already exist. Potential negative effects of toxics contamination on critical habitat are reasonably anticipated to be ameliorated by existing laws and regulations, but adverse effects to critical habitat may occur from habitat loss and oil spills.

III. Indirect Effects

Indirect effects of the action are defined as “those effects that are caused by or will result from the proposed action and are later in time, but are still reasonably certain to occur” (50 C.F.R. 402.02). If development occurs as a result of Lease Sale 193, it may have a synergistic effect on the level of offshore activities in the adjacent Chukchi or Beaufort seas and onshore in the NPR-A (MMS 2006a). While additional development may be “caused by” or “result from” Lease Sale 193, it currently cannot be considered “reasonably expected to occur.” MMS currently estimates the likelihood of commercial development from Lease Sale 193 to be roughly 10%. Secondary development, which is in and of itself not certain to occur, and which must be predicated upon an event that is only 10% likely to occur in order to qualify as an indirect effect, does not meet this standard.

We are able to identify no other effects to listed eiders or Kittlitz's murrelets that are caused by or will result from the proposed action.

IV. Interdependent and Interrelated Actions

Interdependent actions are defined as “actions having no independent utility apart for the proposed action”, while interrelated actions are defined as “actions that are part of a larger action and depend upon the larger action for their justification” (50 CFR §402.02). The Service has not identified any interdependent or interrelated actions that may result from Lease Sale 193 that could result in additional effects to listed eiders or Kittlitz's murrelets.

6. CUMULATIVE EFFECTS

Under the Act, cumulative effects are the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this BO. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation under the Act.

If a large scale oil development project were to occur in the Lease Sale 193 area, such as that described in MMS's development scenario, it is likely to result in further development of smaller oil or gas fields in the action area. These smaller fields would likely use infrastructure developed during the initial project. Future developments could be in either federal or state waters, or in the terrestrial environment near or along the route of the pipeline to TAPS on State, private, Native-owned, or Federal lands. However, because these actions would require federal permits (such as section 404 authorization from the U.S. Army Corps of Engineers (COE), National Pollution Discharge Elimination System permits from the Environmental Protection Agency, or authorization by the Bureau of Land Management) they are not considered cumulative impacts for the purposes of this BO.

Other State or private activities that may take place in the action area include infrastructure development (such as roads, powerlines, or telecommunication towers), community growth, changing land ownership from State to Native Corporation or private individuals, increased tourism or research, etc. Because the majority of the Arctic Coastal Plain is classified as wetlands, a section 404 permit from the COE would be necessary for proposed development and consultation under the Act would be required.

Reduction in the extent and duration of sea ice may increase the potential for commercial fishing or other maritime traffic in the region. However, we are aware of no new commercial fisheries or other increases in vessel traffic that are reasonably expected to occur.

In summary, we anticipate potential increase in development and commercial activity in the region in coming decades, possibly including oil and gas development made possible by construction of infrastructure associated with this proposed action. However, all significant projects in marine and terrestrial environments are expected to require separate consultation under the Act.

7.0 CONCLUSION

This BO is the first step in an expected multiple-step consultation on Chukchi Sea Planning Area Oil and Gas Lease Sale 193 and activities that may result, including leasing, seismic surveys, exploration drilling, development, and production (including abandonment), for which MMS has the authority to consult in incremental steps. The first incremental step of leasing, seismic surveys and other exploration activities is evaluated to determine whether section 7(a)(2) of the Act would be violated, and the BO also examines whether there is a reasonable likelihood that the entire action would violate section 7(a)(2) of the Act. Due to current uncertainty regarding the location of any future developments that could arise from this lease sale and the lack of specific information on proposed project designs, it is possible that potential development proposals that could be submitted following this lease sale could result in determinations of jeopardy or destruction or adverse modification of critical habitat.

Section 7(d) of the Act makes clear that MMS must avoid irreversible or irretrievable commitment of resources that would prevent implementation of reasonable and prudent alternatives to the action (development/production) at a later date. 16 USCA 1536 (d) clearly identifies that the obligation to prevent the irreversible or irretrievable commitment of resources falls upon the action agency (MMS) and permit or license applicant. It is incumbent upon lessees proposing to develop oil/gas resources under Lease Sale 193 to design future production projects that do not result in jeopardy or destruction or adverse modification of critical habitat.

Under the incremental step consultation approach, the MMS must fulfill its continuing obligation to obtain sufficient data upon which to base the final biological opinion for subsequent incremental steps. In this document, we identify information needs that may reduce the likelihood of jeopardy or destruction or adverse modification of critical habitat determinations during consultation on later incremental steps.

Conclusion for First Incremental Step (Leasing and Exploration)

After reviewing the current status of spectacled and Steller's eiders, the environmental baseline for the action area, effects of the proposed Lease Sale 193 and associated exploration activities (including seismic surveys, vessel transit, and exploratory drilling), and cumulative effects, it is the Service's biological opinion that the incremental step of leasing and exploration from Lease Sale 193 is not likely to jeopardize the continued existence of the spectacled or Steller's eider, and is not likely to destroy or adversely modify designated critical habitat.

Although potential exploration activities may adversely affect listed eiders within the action area, we believe that the total number of birds affected would be limited due to several factors, including temporal and spatial separation between concentrations of eiders and potential exploration activities. Additional benefits would be derived from MMS stipulations that regulate seismic surveys and regulate exploratory drilling activities in the Ledyard Bay Critical Habitat Unit. Potential adverse effects, which were discussed in detail in 5.0 - *Effects of the Action*, are briefly summarized below:

Habitat loss – We conclude that there would be no permanent loss of habitat from exploratory activities because the only permanent structures, exploratory wells, would be capped below the level of the seafloor and therefore would occupy no habitat potentially used by listed eiders or Kittlitz's murrelets.

Disturbance or displacement due to seismic surveys or exploratory drilling - Several factors serve to reduce the degree to which potential exploration activities would disturb or displace eiders from preferred areas, including spatial and temporal separation of activities and listed eider concentrations. The lease sale area does not include most of the LBCHU or spring lead habitats, including areas believed most frequently used by concentrations of molting spectacled eiders. Seismic and exploratory activities would be temporary (usually occurring only once within an area) and of limited duration (typically 90 days for exploratory drilling). Also, although seismic activities would be allowed in

the spring lead system, they can safely be conducted only after ice-free conditions have developed (early June), when we believe eiders will have vacated the area. Therefore, we conclude that incidental take of spectacled or Steller's eiders from disturbance or displacement associated with seismic and exploration activities authorized by Lease Sale 193 is not likely to occur.

Collisions – Based on an estimate of collision rates in the Beaufort Sea, we estimate that three spectacled and one Steller's eider would be killed from collisions with drilling structures during the incremental step (leasing and exploration) of this project. Collisions between birds and human-built structures are episodic in nature, so estimates derived from short-term datasets may underestimate long-term average collision rates. Nonetheless, our estimate is based on the best information available at this time and we believe it is unlikely that we have significantly underestimated potential effects. We conclude, therefore, that collisions with drilling structures associated with exploration activities authorized by Lease Sale 193 would kill very few individual spectacled and Steller's eiders. We explain the basis for our estimate of take in Section 8.0 – *Incidental Take Statement*.

Crude and refined oil spills – Based on industry history, the risk of significant impact to spectacled or Steller's eiders from large or small oil spills is very low, because large spills due to exploratory well blowout are unlikely to occur and small spills have more effective spill response rates and lower potential impacts. While we conclude that no adverse effects to listed spectacled and Steller's eiders or critical habitat are likely to occur from an oil spill associated with exploration activities authorized by Lease Sale 193, we also believe it reasonable and prudent to assume that the small potential for an accidental spill warrants additional protective measures to minimize the impacts of spills on listed birds.

Other potential threats, including increased predation and subsistence hunting, and toxics contamination from drilling waste disposal, are unlikely to affect listed eiders. This is because the total impact area would likely be very small (for toxics contamination) or because we believe the effects are not reasonably expected to occur (for increased predation and subsistence hunting). Subsistence hunting and toxics contamination are also either the focus of current conservation efforts or regulatory actions.

Impacts to critical habitat – We identify two mechanisms through which exploratory activities could impact critical habitat: (1) direct loss of habitat that is occupied temporarily by drill ships and permanently by capped, abandoned exploratory wells; and (2) immediate and residual effects of oil spills. Several factors serve to prevent significant impacts that could result from habitat loss. First, most of the LBCHU, including the portion known to be used by large concentrations of molting spectacled eiders, is outside of the lease sale area and therefore is not available for exploratory drilling. Thus, if impacts occur, they will be confined to the small portion of the LBCHU that has not been found to be used by large numbers of spectacled eiders. Second, the amount of area occupied by drill ships at any specific time is limited because only two drilling efforts are expected per year and impacts would be temporary because

exploratory activities would be completed within a single season (MMS 2006a). Even if both drill ships simultaneously occupy the small proportion of the LBCHU that overlaps with the lease sale area, the amount of habitat rendered temporarily unusable would be extremely minimal. Similarly, we expect no habitat to be permanently rendered unusable from abandoned exploratory wells because it is expected that wells would be capped well below the seafloor, leaving no residual structures on or above the seafloor (email dated 3/21/2007 from Mark Shroeder, MMS). Thus, we conclude that the direct loss of habitat would be limited to the area temporarily occupied by drill ships, and no habitat would be permanently lost to exploratory drilling. Finally, although oil spills could potentially impact the constituent elements of the critical habitat, we conclude that oil spills from exploratory drilling are very unlikely (see *Crude and refined oil spills*, above). Thus, we conclude that direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of spectacled eiders is very unlikely.

In summary, we believe that leasing and exploration would result in the incidental take of at most a few individual spectacled and Steller's eiders. While our estimates of impacts are imprecise, they are nevertheless based on our analysis of the best information available at this time, and we believe that it is extremely unlikely that we have underestimated the impacts to the point that population-level impacts could occur. We conclude that the incremental step of leasing and exploration from Lease Sale 193 is not likely to jeopardize the continued existence of the spectacled or Steller's eider, and is not likely to destroy or adversely modify designated critical habitat.

Although the Act does not require consultation for candidate species, by mutual agreement with the MMS, we have evaluated potential impacts to Kittlitz's murrelets in anticipation of possible future listing. Although limited information currently exists regarding the specific distribution of the species in the action area and its ecology in the region, the existing information suggests that Kittlitz's murrelets are widely distributed at low density in the Chukchi Sea and associated with the ice edge. Based on their low density, we believe that exploration activities would likely encounter few individuals, and that individuals encountered could successfully be displaced without significant impact to their survival or reproductive potential. We appreciate the willingness of MMS to proactively consider the conservation needs of Kittlitz's murrelets, and conclude that this incremental step of leasing and exploration is not likely to pose significant threats for this species.

Conclusion for Entire Action

In addition to considering the effects of activities permitted under the first incremental step of leasing and exploration, we also analyzed the effects of the entire action, including potential development and production (including abandonment). After reviewing the current status of spectacled and Steller's eiders; the environmental baseline for the action area; effects of the proposed Lease Sale 193 and possible exploration, development, and production; and cumulative effects; it is the Service's biological opinion that it is reasonably likely that the entire action would not jeopardize the

continued existence of the spectacled or Steller's eider, or destroy or adversely modify designated critical habitat.

It should be noted, however, that at this time, there is considerable uncertainty regarding what specific activities the entire action may entail. We believe that some potential proposals that could ensue from Lease Sale 193 could jeopardize listed species or cause destruction or adverse modification of critical habitat. Therefore, consultation at future incremental steps in this multi-step oil and gas program that closely examines the specific details of proposed projects and carefully evaluates whether jeopardy or adverse modification would result will be essential. A summary of our conclusion follows:

Uncertainty – Evaluating the effects of development and production is made difficult by significant uncertainty in the following areas:

- *The likelihood of development* – MMS (2006a) estimates the probability of commercial development of oil somewhere within the action area is “likely to be less than 10%.” While this is a reasonable estimate based on currently available information, whether development actually occurs will ultimately be determined by a suite of factors that will change over time, including, at the very least, the size and location of resources encountered, the value of oil and gas on global markets, expansion of existing infrastructure in the region that may make extraction more economically viable, availability of alternate energy sources, changes in the public’s tolerance for environmental risk, improvements in offshore technology, etc. Thus, while MMS’s estimate is reasonable in light of current knowledge, it is also imprecise and the actual probability of development occurring will most certainly change over time in response to change in myriad factors.
- *How much development will occur* – MMS (2006a) provides a reasonably foreseeable development scenario, should development occur, of one 1-billion barrel field. While this is a reasonable estimate based on currently available information, the actual amount of development that ultimately occurs will be affected by the factors presented above that can be expected to change over time. Importantly, as MMS (2006a) notes, once development occurs in frontier areas, such as the Chukchi Sea, additional smaller fields become more economically viable and “more projects are more likely to follow.” Thus, it is also difficult to precisely estimate at this time the amount of development that will actually occur.
- *The likelihood of one or more marine oil spills* – The greatest identified population-level risk to listed eiders from development and production is from spilled oil reaching concentrations of eiders during molt or spring migration. MMS (2006a) estimated the probability of large spills (1,500 barrels from a platform and 4,600 barrels from a pipeline) as a 60% chance of zero large spills, 31% chance of one spill, 8% chance of two spills, and 1% chance of 3 spills (these estimates are lower in some cases, depending on the Alternative selected). But this estimate is based on spill rates on the OCS as a whole, so does not reflect

region-specific risks (which are unknowable at this time), and is based on the assumption that one 1-billion barrel field will be developed. So, although MMS has provided a reasonable spill risk estimate, actual spill risk is affected by region-specific factors and is dependent upon the amount of development that ultimately occurs.

- *The likelihood that spilled oil encounters listed eiders* – In the event that oil is spilled in the marine environment, a number of factors would influence whether listed eiders are affected. First, impacts would be affected in part by the amount of oil spilled, and this would be determined by the location of infrastructure, technology used to transport oil, the length of pipelines, and other factors. Also, the location of a spill would have a great bearing on the likelihood that listed eiders would be exposed. For example, the probability that a large summer spill would reach the LBCHU varies from < 0.5% to > 72% and spring leads from ≤ 0.5% to 26%, depending on spill location and source. Finally, the seasonal timing of spills would influence the number of eiders present in the region and their location, the efficacy of spill response, and the likelihood that oil would persist long enough in important habitats to cause lasting impacts to benthic communities or other necessary habitat features.

Potential effects of the action - In this BO, we have evaluated several potential ways in which oil development and production in the Lease Sale 193 area could potentially affect listed eiders. A brief summary follows:

- *Collisions, predation, subsistence hunting, and toxics contamination* – We conclude that collisions with structures (in the marine and terrestrial environments), increased predation as a result of anthropogenic influences on predator population size or distribution, increased subsistence hunting as a result of new roads, and toxics contamination, may adversely affect listed eiders at the individual level. In all cases, however, we also conclude that these potential effects are very unlikely to cause population-level impacts based on the best information available at this time.
- *Habitat loss and Disturbance/Displacement* – We conclude that habitat loss and disturbance in, and displacement from, preferred habitats may adversely affect listed eiders. In both the marine and terrestrial environments, some habitat could be completely and permanently lost when structures or fill render the habitat unusable. Additionally, the capability of immediately adjacent habitat to support eiders may be completely or partially compromised by nearby structures and the associated human activity. The width of this zone of influence remains unknown and it is also unknown whether eiders are simply displaced from this zone (presumably at compromised fitness) or continue to use it but possibly at reduced fitness. The impact of habitat loss and disturbance/displacement on listed eiders could vary substantially, from virtually none to potentially significant at the population level, depending on location and nature of the infrastructure and activity. Disturbance and displacement in the marine environment could have

significant impacts if there is repeated or prolonged vessel and aircraft traffic in spring leads while birds occupy this area (prior to June 10), in the central LBCHU (which is outside the lease sale area), or in the western LBCHU if this region is determined to be used by significant numbers of spectacled eiders. In the terrestrial environment, significant impacts could occur if landfall, storage pads, pipelines, pump stations, and roads are placed in important nesting habitat. The potential for significant impacts to nesting habitat is particularly acute for the Steller's eider, because its numbers appear to be very low and its density varies substantially within its breeding range on the North Slope. Thus, if impacts are concentrated within important nesting habitat (especially near Barrow), there could be a population-level response. While such impacts could be minimized by avoiding the placement of infrastructure within important eider habitat, the project description provided at this time does not provide certainty that this will be done. We conclude that the impacts of habitat loss and disturbance/displacement to listed eiders could range from very little to potentially significant at the population level, depending on the amount and location of development- and production-associated infrastructure and activity.

- *Oil spills* – Based on oil spill risk assessments, spill trajectory models, and population modeling, we conclude that a marine oil spill that contacts a large concentration of listed eiders (defined as either a large number of eiders or a large proportion of the North Slope-breeding population of either species) during molt (spectacled eiders) or spring staging (spectacled or Steller's eiders) could have catastrophic population-level impacts. Further, if one or more large spills occur, there could be long-term impacts to the constituent elements within the LBCHU that compromise the ability of the designated critical habitat unit to support spectacled eiders. The probability of this occurring is influenced by the likelihood, size, location, and timing of spills.

Impacts to critical habitat – We identify two mechanisms through which development and production could impact critical habitat: (1) direct loss of habitat that is occupied temporarily by development/production structures and permanently by abandoned structures; and (2) immediate and residual effects of oil spills. Most of the LBCHU, including the portion known to be used by large concentrations of molting spectacled eiders, is outside of the lease sale area and therefore is not available for development and production. Thus, impacts of habitat loss from possible development and production would be confined to the small portion of the LBCHU that overlaps with the lease sale area and that has not been shown to contain large concentrations of spectacled eiders. Given that MMS estimates < 10% probability of development within the entire 34 million-acre lease sale area (MMS 2006a), we believe that it is very unlikely that development and production will be proposed for the small portion of the LBCHU that overlaps with the lease sale area. Thus, we conclude that, while possible, it is very unlikely that development and production will directly result in the loss of habitat within the LBCHU.

In Section 6 – *Effects of the Action on Listed Species and Critical Habitat*, we evaluated the effects of oil spills upon the constituent elements within the LBCHU. MMS oil spill trajectory models demonstrate that a large oil spill launched in several areas within the lease sale area could reach the LBCHU. If a significant amount of oil reaches the LBCHU, we conclude that the constituent elements of the critical habitat could be adversely affected in several ways. The high ice-edge productivity that drives the food web of Ledyard Bay could be altered by the physical and toxic effects of oil on the water or ice surface, entrainment in the water column, and direct and indirect effects on primary producers in the water column. Direct toxicity would reduce the abundance or biomass of benthic invertebrates, and as noted by MMS (2006a), the benthic food resources in the LBCHU could be displaced or reduced following an oil spill for an unknown length of time, and the remaining invertebrate prey species could bioaccumulate oil and subsequently contaminate eiders. Thus, we conclude that the constituent elements of the critical habitat could be significantly affected by a large spill that reaches the LBCHU, and that this could cause a direct or indirect alteration that appreciably diminishes the value of the critical habitat for the conservation of the species. The likelihood of this occurring, and the magnitude of the impact should it occur, will be determined, at least in part, by whether or not a spill occurs, where it occurs, and its volume, trajectory and timing.

We conclude that the impacts of development and production on spectacled and Steller's eiders and designated critical habitat would range from none, if no development occurs, to negligible, if development occurs in areas or is managed in ways that minimize oil spill risk and the juxtaposition of infrastructure and activity and important eider habitats, to potentially problematic if development is proposed in areas that would compromise the ability of the marine or terrestrial environment to support listed eiders, to potentially catastrophic in the event that one or more oil spills contacts a large number or large proportion of North Slope-breeding spectacled or Steller's eiders or results in long-term impacts to critical habitat. Thus, we conclude that the *possible* effects of development and production range from zero to potentially catastrophic.

Applicable regulations and definitions – The following requirements and definitions from the Act and its implementing regulations (at 50 C.F.R. 402) form the basis for our conclusion:

- When consulting on the first increment in an incremental step consultation, regulations (50 C.F.R. 402.14(k)) require that we look forward to completion of the entire action and conclude that “there is a *reasonable likelihood* that the entire action will not violate 7(a)(2) of the Act” (i.e., result in jeopardy or destruction or adverse modification of critical habitat) (italics added).
- Jeopardy is defined as “to engage in an action that *reasonably would be expected*, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species” (italics added) (50 C.F.R. 402.02)

- This biological opinion does not rely on the regulatory definition of “destruction or adverse modification” of critical habitat at 50 C.F.R 402.02. Instead, we have relied upon the statutory provisions of the ESA to form the basis of our analysis with respect to critical habitat – namely whether there are direct and indirect alterations that appreciably diminish the value of critical habitat for the conservation of the species.

These definitions make clear that in reaching a conclusion on the final action, we must consider and base our conclusion upon what is *reasonably likely* and *reasonably expected* to occur.

Conclusion – Our interpretation of the potential effects of this action, in light of our obligation to evaluate what is reasonably likely, follows:

- 1) Population-level impacts from habitat loss and disturbance/displacement, although possible, are not reasonably expected to occur due to the unlikely juxtaposition of infrastructure and activities onto eider concentration areas. In order to have population-level impacts, we believe that there would need to be significant development or repeated disturbance in listed eider concentration areas in the LBCHU, spring leads, near Barrow, or in spectacled eider breeding concentrations in NPR-A. We believe that conflict is unlikely in the LBCHU because areas known to be used by large concentrations of spectacled eiders are not available for leasing and disturbance can be avoided by routing vessels and aircraft around identified molting habitat. The vast majority of area identified by MMS as containing spring leads is unavailable for leasing, and we believe that significant vessel traffic in spring leads prior to June 10 is unlikely due to lingering sea ice. The necessary terrestrial infrastructure would occupy only a very small proportion of the available landscape, so we believe that it is unlikely that development would be proposed for the limited areas with eider concentrations, and these areas can easily be avoided with appropriate planning. In summary, we conclude that the likelihood of population-level impacts is reduced by the minimal overlap between the lease sale area and eider concentrations in marine areas, and the fact that traffic routes and terrestrial infrastructure could easily be located to avoid important habitat.
- 2) Population-level impacts from oil spills, although possible, are not reasonably likely to occur. For population-level impacts from spills to occur, all of the following events would have to take place: development would have to take place (currently estimated as < 10% likely); one or more oil spills would have to take place (likelihood estimated at ~51% for large spills); spilled oil would have to actually reach an area used by concentrations of spectacled or Steller’s eiders (this probability is highly variable, dependent on spill size, timing, location, and trajectory; and the spill would have to reach eider concentration areas when eiders are actually present (or have significant and lingering effects)). While *any* of these events is possible, based on information presented by MMS, we conclude

that it is not reasonably expected that *all* of these events would occur, based on the information available at this time.

- 3) Destruction or adverse modification of critical habitat, although possible, is not reasonably likely to occur. The direct loss of habitat caused by placing infrastructure in areas of the LBCHU used by concentrations of spectacled eiders is likely to be avoided. The portion of the LBCHU known to be used by concentrations of spectacled eiders is not within the lease sale area, and is therefore not available for development and production. Infrastructure such as pipelines linking production facilities in the lease sale area with landfall can be routed to avoid the known molt concentration areas outside of the lease sale area, and it is likely that it will be given the availability of alternate routes the legal obligation of Federal agencies to minimize impacts to listed species. More importantly, MMS currently estimates the likelihood of commercial development and production within the entire 34-million lease sale area to be < 10% (MMS 2006a). The likelihood that development will occur and would take place in the LBCHU, even absent the incentive to avoid critical habitat, is small.

As with the impacts of oil spills to eiders, we conclude that significant impacts from oil spills to critical habitat are possible but not reasonably likely to occur. In order for spilled oil to appreciably diminish the value of critical habitat for the conservation of the species, development would have to take place (currently estimated as < 10% likely); one or more oil spills would have to take place (likelihood estimated at ~51% for large spills); a sufficient volume of spilled oil would have to reach the LBCHU to cause large-scale impacts; and the oil would need to persist in the area long enough to affect the biotic and abiotic components of the ecosystem. While possible, we conclude that this is not reasonably likely to occur.

- 4) MMS (2006a) identifies that infrastructure developed as a result of Lease Sale 193 may facilitate additional development in the surrounding region. As explained in Section 5 -- *Effects of the Action on Listed Species and Critical Habitat*, MMS estimates likelihood of development and production from Lease Sale 193 to be 10%. Thus, additional development facilitated by this infrastructure is also at most only 10% likely to occur. Thus, we conclude that additional development which is predicated upon Lease Sale 193 is not reasonably likely to occur at this time. If additional development is eventually proposed, we wish to underscore that this proposed development would require separate section 7 consultation, whether in the offshore environment managed by MMS or in the onshore environment managed by the BLM. Any indirect effects that ultimately could result from lease sale 193 will therefore be subject to evaluation for potential impacts to listed species and critical habitat at that time.

In summary, we conclude that it is reasonably likely that the final action resulting from Lease Sale 193 would not violate section 7(a)(2). This conclusion is based on the appropriate regulations and the project description provided.

We caution, however, that consultation at future incremental steps in this phased oil and gas process is crucial in order to fully evaluate project specific information about particular development and production plans and whether or not they are likely to jeopardize listed species or destroy or adversely modify critical habitat. We wish to provide clear notification that consultation on subsequent incremental steps may reach different conclusions depending on the scope, location, and nature of activities actually proposed. Consultation on subsequent incremental steps will require careful consideration of all information available at that time, including up-to-date evaluations of listed species status, the environmental baseline, and project-specific considerations such as spill risk assessments and spill trajectory models to evaluate risk to listed species. Based on our analysis, we believe that some potential development proposals, while not reasonably likely at this time, could ensue from Lease Sale 193 that would jeopardize listed species or cause destruction or adverse modification of critical habitat. Therefore, we believe that MMS and industry must remain fully aware of the need to consult on subsequent increments and the potential for jeopardy or destruction or adverse modification conclusions to be reached at that time. Further, we believe that MMS and industry should recognize that the need to develop reasonable and prudent alternatives to avoid jeopardy or destruction or adverse modification of critical habitat, and reasonable and prudent measures to minimize impacts of development/production and the impacts of potential oil spills, could result in restrictions on future development.

To reduce the likelihood of jeopardy or adverse modification conclusions at later incremental steps, we recommend that MMS and industry:

- Avoid proposing infrastructure in important eider habitats, including the LBCHU, spring leads, nesting habitat near Barrow, and areas with high density of nesting spectacled eiders in NPR-A;
- Avoid proposing development in areas where spilled oil has a high risk of reaching the LBCHU or spring leads;
- Improve technology to reduce the maximum amount of oil that can be spilled in marine areas, which has great bearing on potential risk to wildlife in marine areas;
- Provide support and funding for inventory and research to inform consultation on later increments. Elaboration of currently-identified information needs is presented in Section 9- *Information Needs*.

8. INCIDENTAL TAKE STATEMENT

Incidental take is only authorized for the first incremental step (leasing and exploration) of Lease Sale 193. MMS must continue consultation for each subsequent incremental step, and incidental take for subsequent incremental steps may be authorized when the proposed actions are evaluated.

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. "Harm" is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. "Harass" is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, but not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement (ITS).

The measures described below are non-discretionary, and must be undertaken by the MMS so that they become binding conditions of any grant or permit issued to an applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The MMS has a continuing duty to regulate activities covered by this incidental take statement. If the MMS (1) fails to assume and implement the terms and conditions, or (2) fails to require any applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the MMS must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement.

For Kittlitz's murrelets, prohibitions against taking species found in section 9 of the Act do not apply unless the species is listed; therefore no incidental take is authorized. However, implementation of the reasonable and prudent measures to reduce impacts to Steller's and spectacled eiders may also benefit this candidate species.

As described in Section 5 - *Effects of the Action*, activities during seismic surveys and exploratory drilling may adversely affect Steller's and spectacled eiders through collisions with structures and vessels, disturbance and displacement, and spills of oil, fuel or other toxic substances.

Collisions

During exploratory drilling, drill ships and their support vessels would be present in the marine environment posing a collision risk for listed eiders. Collision risk is a function of proximity of structures to habitats used, including migratory routes. Without information on exploration structure location, the Service assumes the entire North Slope population of each species could conceivably pass by the exploratory drillsite.

A strike rate is required to estimate incidental take, but no specific data on spectacled or Steller's eider collision rates are available. We therefore used the recorded numbers of common eider collisions on Northstar Island, (north of Prudhoe Bay in the Beaufort Sea OCS) as a surrogate. In 2000-2004, respectively, 6, 8, 0, 4, and 3 common eiders struck Northstar, with an annual mean of 4.3 (2000 data reported by BP Alaska to the Service; 2001-2004 data from Day et al. 2005). A strike rate (percent of population killed per year) was then calculated as the annual average of Northstar Island common eider strikes divided by 176,109, the most recent population estimate of common eiders migrating over the Beaufort Sea (Quakenbush & Suydam 2004), according to the following formula:

$$\frac{\text{Annual average number of strikes}}{\text{Population estimate}} \times 100 = \text{Percent of population killed each year by collisions (strike rate)}$$

or:

$$\frac{4.3}{176,109} \times 100 = 0.0024 \%$$

This strike rate was applied to current maximum North Slope population estimates for spectacled and Steller's eiders (12,916 and 500, respectively, as described in Section 3 - *Description of the Species*) using the following formula:

Strike rate x population estimate = number killed per year per structure (mortality rate),
or:

$$0.0024 \% \times 12,916 = 0.31 \text{ spectacled eiders killed by collisions/year/structure, and}$$

$$0.0024\% \times 500 = 0.012 \text{ Stellers eiders killed by collisions/year/structure.}$$

The mortality rate was multiplied by 10, the MMS estimate of the number of well-years of exploratory drilling activity, to give an estimated 3.1 (rounded to 3) spectacled eiders and 0.12 (rounded to 1) Steller's eiders killed by collisions with exploratory drilling structures, including vessels.

Spills

There is always some risk of an oil, fuel, or toxic spill associated with exploratory drilling, but MMS's oil spill analysis indicates a large spill ($\geq 1,000$ bbl) is unlikely (i.e., not reasonably likely to occur). A more likely scenario is one spill ≤ 50 bbl, and if such a spill were to contact eiders the Service assumes they would be killed. However, spills are not an otherwise legal activity, so no incidental take is provided.

Incidental Take Summary

The Service concludes that 3 adult spectacled eiders and 1 adult Steller's eider may be incidentally taken through collisions with structures during activities authorized by this BO on the incremental step of leasing and exploration for Lease Sale 193.

9. INFORMATION NEEDS

Under the procedures for incremental consultations [50 C.F.R. 402 (14)(k)], the action agency must fulfill its continuing obligation to obtain sufficient data upon which to base the BO on the entire action (Requirement #3). The analysis conducted by the Service for this BO revealed two categories of information needs: 1) information to test assumptions made in this BO, and 2), information needed for the BO on the entire action (development and production).

The information needs listed below are presented in general form. The Service proposes that MMS, the Service, and possibly lessees, discuss data gaps and establish an approach to obtaining new information for use in a consultation on the entire action. We believe this will be an iterative process that reflects current and future work conducted in the region as well as evolving perspectives on what subsequent incremental steps may entail. It is possible that MMS's ongoing research program in the Alaska OCS may be addressing some of the information needs, and that it can identify efficient investigation approaches. The Service recognizes research and surveys on species inhabiting Arctic environments are difficult and an expensive undertaking. Accordingly, the information needs are focused on the lease sale action area and information needs that will inform future development recommendations, incidental take calculations, and reasonable and prudent measures that adequately protect species while not being unnecessarily restrictive on development activities.

Information Needed to Test Assumptions Made in this BO

As described in Section 5 - *Effects of the Action*, disturbance of Steller's and spectacled eiders could occur from seismic and exploration activities in spring leads if the timing of eider use and vessel and aircraft traffic overlap. However, if assumptions in our analysis are true (high densities of listed eiders, but low number of flights and vessels due to exclusion by sea ice, temporal or spatial separation of activities, limited duration of disturbance, and implementation of stipulations developed by MMS), impacts from disturbance are anticipated to be minor and no incidental take of spectacled or Steller's eiders is predicted. If this assumption is incorrect and disturbance of listed eiders is not minor, it may be necessary to re-initiate consultation to re-evaluate the magnitude of the effect and possibly estimate and authorize incidental take. To test this assumption, the Service asks that MMS:

1. Quantify vessel traffic in the areas of known high eider use in the spring lead system (Fig 9.1) between April 15 and June 10, and provide an annual report on vessel traffic in these areas to the Service.

Information Needed for Consultation on Subsequent Incremental Steps

Having adequate information during consultation on subsequent incremental steps will provide for more accurate impact assessment and better-informed protective measures. Consultation will be enhanced with better information in the following areas.

In order to better evaluate the potential impacts of oil spills on listed eiders, Kittlitz's murrelets, and designated critical habitat, the following are needed:

2. Up-to-date spill risk assessments, including analysis of the relationship between spill size and spill probability across the full range of possible spill sizes.
3. Up-to-date spill trajectory models, including analysis of possible trajectories of spills across the full range of possible spill sizes.
4. Analysis of maximum possible spill size.
5. Conduct a thorough inventory of the benthic communities in the LBCHU and spring lead system to better understand use of these areas and more accurately predict impacts of oil spills to the ecosystem.
6. Evaluate potential effects of oil spills on the water column and benthic communities within Ledyard Bay and the spring lead system.

In order to better evaluate impacts of disturbance and displacement in the LBCHU and spring leads, the following are needed:

7. Prior to proposing development in the western LBCHU, thoroughly survey the western LBCHU to document numbers, distribution, and timing of use of the area by spectacled eiders.
8. Prior to proposing activities that may disturb molting spectacled eiders, conduct studies to adequately evaluate potential impacts of disturbance and displacement.
9. Documentation of the extent and timing of use of spring leads and near shore open water during spring migration of spectacles and Steller's eiders

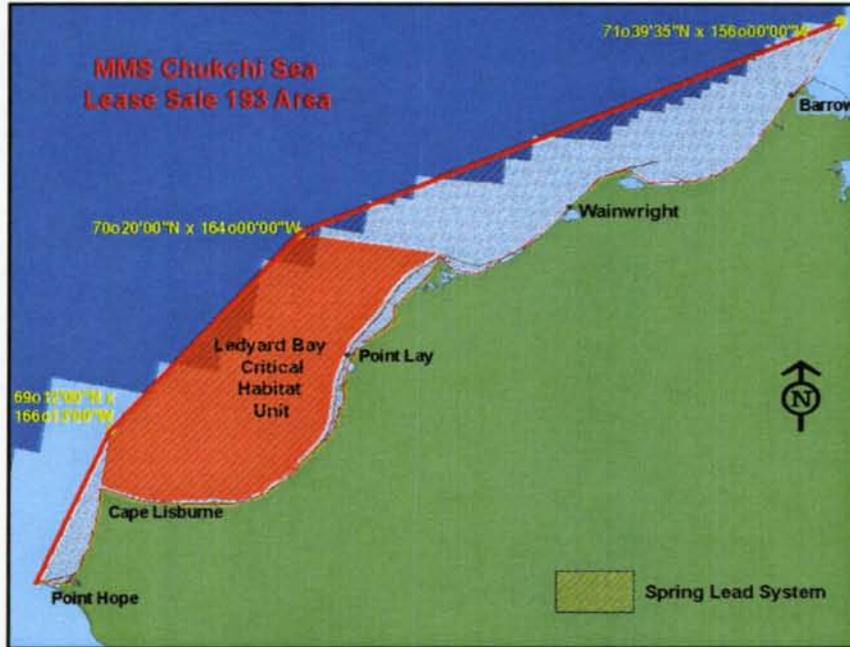


Figure 9.1 Spring Lead System for Information Needs and Terms and Conditions

10. REASONABLE AND PRUDENT MEASURES

These reasonable and prudent measures (RPMs) and their implementing terms and conditions aim to minimize the incidental take anticipated for the first incremental step of the Lease Sale 193 action (leasing and exploration). Additional RPMs will be developed and implemented during consultation on subsequent incremental steps in this project.

Activities authorized under the incremental step of leasing and exploration are anticipated to lead to incidental take of both Steller’s and spectacled eiders through collision mortality. As described in the Section 8 - *Incidental Take Statement*, provided that MMS and their agents follow MMS-developed stipulations for seismic and exploratory drilling activities, and that assumptions on the frequency of disturbance are correct, no incidental take is anticipated from disturbance and displacement. Crude or refined oil or toxic substance spills that result in take of listed eiders are possible, and RPMs have been developed to minimize their effects. However, because spills are not an otherwise legal activity, no incidental take is authorized.

To reduce the likelihood of collisions with structures, evaluate and reduce disturbance, and minimize the impacts of small crude oil, fuel, and toxic substance spills, MMS and their agents are required to:

- A. Work jointly with the Service to develop strategies to reduce light radiating from facilities; and

- B. Implement oil spill response measures in the LBCHU and spring lead system.

11. TERMS AND CONDITIONS

To be exempt from the prohibitions of Section 9 of the Act, MMS and their agents must comply with the following terms and conditions, which implement the RPMs described above. These terms and conditions are non-discretionary.

RPM A – Work jointly with the Service to develop strategies to reduce light radiating from facilities.

To reduce the likelihood of collisions between listed birds and project structures, MMS intends to implement the following stipulations (MMS 2006a):

1. Stipulation 7 from Lease Sales 186, 195 and 202 Biological Opinion will also be applied to the Lease Sale 193 area. This stipulation states that lessees are required to implement lighting requirements aimed at minimizing the radiation of light outward from exploration/delineation structures to minimize the likelihood that migrating spectacled or Steller's eiders, or other coastal and marine birds, would strike those structures. These requirements establish a coordinated process for a performance-based objective rather than pre-determined prescriptive requirements. The performance-based objective is to minimize the radiation of light outward from exploration/delineation structures. Measures to be considered include but need not be limited to the following:
 - Shading and/or light fixture placement to direct light inward and downward to living and work structures while minimizing light radiating upward and outward;
 - Types of lights;
 - Adjustment of the number and intensity of lights as needed during specific activities;
 - Dark paint colors for selected surfaces;
 - Low-reflecting finishes or coverings for selected surfaces; and
 - Facility or equipment configuration.

Lessees are encouraged to consider other technical, operational and management approaches that could be applied to their specific facility and operation to reduce outward light radiation.

If further information on bird-avoidance measures becomes available that suggests modification to this lighting protocol is warranted to implement the reasonable and prudent measures of the Biological Opinion issued by the Fish and Wildlife Service (FWS) under the Endangered Species Act, MMS will issue further requirements, based on guidance from the FWS. Lessees will be required to adhere to such

modifications of this protocol. The MMS will promptly notify lessees of any changes to lighting required under this stipulation.

These requirements apply to all new Outer Continental Shelf oil and gas leases issued pursuant to Chukchi Sea OCS Lease Sale 193 and for activities conducted between May 1 and October 31 of each year.

Nothing in this protocol is intended to reduce personnel safety or prevent compliance with other regulatory requirements (e.g., U.S. Coast Guard or Occupational Safety and Health Administration) for marking or lighting of equipment and work areas.

Lessees are required to report all birds, including spectacled and Steller's eiders, injured or killed through collisions with lease structures to the Fairbanks Fish and Wildlife Service Field Office, Endangered Species Branch, Fairbanks, Alaska, at (907) 456-0499.

Lessees must provide MMS with a written statement of measures that will be or that have been taken to meet the objective of this stipulation. Lessees must also include a plan for recording and reporting to the MMS bird strikes that occur during approved activities. This information must be included with an Exploration Plan when it is submitted for regulatory review and approval pursuant to 30 C.F.R. 250.211. Lessees are encouraged to discuss their proposed measures in a pre-submittal meeting with MMS and FWS.

The Service requires two changes to the above MMS stipulation. This stipulation will be extended until November 15 each year to include the entire period when listed eiders are present in the project area. MMS must report all known bird strikes to the Service, Endangered Species Branch, Fairbanks Field Office as soon as practicable.

RPM B - Implement oil spill response measures in the LBCHU and spring lead system.

B1. During active exploratory drilling in the spring lead system before June 10, or year round in the LBCHU, an Oil Spill Response Vessel must accompany the drill ship. The lessee will also pre-stage wildlife hazing equipment (including at least 3 *Breco* buoys or similar devices) either on the Oil Spill Response Vessel or in Point Lay or Wainwright. The lessee will ensure on-site oil-spill response personnel are trained in the use of the *Breco* buoys or other devices used.

B2. Whenever vessels are in the marine environment, there is a possibility of a fuel or toxic substance spill. If vessels transit through the spring lead system before June 10, they may encounter concentrations of listed eiders. The Service therefore requires that wildlife hazing equipment (including *Breco* buoys or similar equipment) be pre-staged, and readily accessible by personnel trained in their use, at either Point Lay or Wainwright, or on nearby vessels, in order to ensure rapid deployment in the event of a spill.

For the purposes of these stipulations, the spring lead system is defined as the area landward of a line drawn from Point Hope to the corner of the LBCHU at 69°12'00"N x 166°13'00"W, to the corner of the LBCHU at 70°20'00"N x 164°00'00"W to the corner of the Lease Sale 193 area at 71°39'35"N x 156°00'00"W (Figure 9.1).

12. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act 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.

As described in Section 7 - *Conclusions*, under incremental consultation regulations (50 C.F.R. 402.14(k)), MMS is required to fulfill its continuing obligation to obtain sufficient data upon which to base the final biological opinion on the entire action. In addition to management-specific research needs, MMS is encouraged to support research that may provide information to strengthen our understanding of Steller's and spectacled eiders, the reasons for their decline, and assist in focusing and conducting recovery efforts.

In order for the Service to be kept informed of actions affecting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

13. REINITIATION NOTICE

This concludes formal consultation on the actions outlined in the MMS BE and supplemental materials pertaining to Lease Sale 193 in the Chukchi Sea. This BO authorizes activities in the first incremental step (leasing and exploration), and has considered the entire action as required under 50 C.F.R. 402.14(k).

As provided in 50 C.F.R. 402.16, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if:

- 1) The amount or extent of incidental take is exceeded;
- 2) New information reveals effects of the action agency that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion;
- 3) The agency action is subsequently modified in a manner that causes an effect to listed or critical habitat not considered in this opinion;
- 4) A new species is listed or critical habitat designated that may be affected by the action;
- 5) Before authorization of the next incremental step in the action.

Thank you for your cooperation in the development of this biological opinion. If you have any comments or require additional information, please contact Ted Swem, Endangered Species Branch Chief, Fairbanks Fish and Wildlife Field Office, 101 12th Ave., Fairbanks, Alaska, 99701.

14. LITERATURE CITED

- Albers, P.H. 1983. Effects of oil on avian reproduction: A review and discussion. *In* The Effects of Oil on Birds. A Multi-Discipline Symposium, Tri-State Bird Rescue and Research Inc., Wilmington, DE.
- Albers, P. H. 2003. Petroleum and Individual Polycyclic Aromatic Hydrocarbons. Pgs. 341-371 *In*: Handbook of Ecotoxicology. Second Edition. Editors D. J. Hoffman, B.A. Rattner, G. A. Butron, Jr., J. Cairns, Jr. CRC Press, Boca Raton, FL.
- Anderson, B. and B. Cooper. 1994. Distribution and abundance of spectacled eiders in the Kuparuk and Milne Point oilfields, Alaska, 1993. Final report. Prepared for ARCO Alaska, Inc., and the Kuparuk River Unit, Anchorage, Alaska by ABR, Inc., Fairbanks, Alaska, and BBN Systems and Technologies Corp., Canoga Park, CA. 71pp.
- Anderson B., A.A. Stickney, R.J. Ritchie, and B.A. Cooper. 1995. Avian studies in the Kuparuk Oilfield, Alaska, 1994. Unpublished report for ARCO Alaska, Inc. and the Kuparuk River Unit, Anchorage, Alaska.
- Anderson, B., R. Ritchie, A. Stickney, and A. Wildman. 1998. Avian studies in the Kuparuk oilfield, Alaska, 1998. Unpublished report for ARCO Alaska, Inc. and the Kuparuk River Unit, Anchorage, Alaska. 28pp.
- Atlas, R.M., A. Horowitz, and M. Busdosh. 1978. Prudhoe Crude oil in arctic marine ice, water and sediment ecosystems: degradation and interactions with microbial and benthic communities. *Journal of Fish Service Board of Canada* 35:585-590.
- Bailey, A.M. 1948. Birds of Arctic Alaska. Denver Museum of Natural History Population Series 8:1-137.
- Bailey, A.M., C.D. Bower, and L.B. Bishop. 1933. Birds of the region of Point Barrow, Alaska. *Program of Activities of Chicago Academy of Science* 4:14-40.
- Bart, J. and S.L. Earnst. 2005. Breeding ecology of spectacled eiders *Somateria fischeri* in Northern Alaska. *Wildfowl* 55:85-100.
- Braund, S. 1993. North Slope subsistence study Barrow 1987, 1988, 1989. Submitted to U.S.D.I., Minerals Management Service, Alaska Outer Continental Shelf Region. OCS Study MMS 91-0086, Tech. Rep. No. 149. 234 p. + Appendices.
- Briggs, K.T., M.E. Gershwin, and D.W. Anderson. 1997. Consequences of petrochemical ingestion and stress on the immune system of seabirds. *ICES Journal of Marine Science* 54:718.

- Brooks, W. 1915. Notes on birds from east Siberia and Arctic Alaska. *Bulletin of the Museum of Comparative Zoology* 59:359-413.
- Burger, A.E. and D.M. Fry. 1993. Effects of oil pollution on seabirds in the northeast Pacific. *In* Vermeer K. (Ed.) *The Status, Ecology, and Conservation of Marine Birds of the North Pacific*. Canadian Wildlife Service Special Publication, Ottawa.
- Clark, R.B. 1984. Impact of oil pollution on seabirds. *Environmental Pollution (Series A)*. 33:1-22.
- Cottom, C. 1939. Food habits of North American diving ducks. *USDA Technical Bulletin* 643, Washington , D.C.
- Comiso, J. C. 2006. Abrupt decline in the Arctic winter sea ice cover. *Geophysical Research Letters* 33: L18504. DOI :10.1029/2006GL027341.
- Coulson, J.C. 1984. The population dynamics of the Eider Duck *Somateria mollissima* and evidence of extensive non-breeding by adult ducks. *Ibis* 126:525-543.
- Cross, W.E. and D.H. Thomson. 1987. Effects of experimental release of oil and dispersed oil on arctic nearshore macrobenthos. I. Infauna. *Arctic*:40:184-200.
- Day, R.H. 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, AK. 106pp.
- Day, R.H., K.J. Kuletz, and D.A. Nigro. 1999. Kittlitz's Murrelet (*Brachyramphus brevirostris*). *In*: *The Birds of North America*, No. 435 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.
- Day, R.H. and D.A. Nigro. 1998. Status and ecology of Kittlitz's murrelet in Prince William Sound: Results of 1996 and 1997 studies. Exxon Valdez Oil Spill Restoration Annual Report. Restoration Project 97142.
- Day, R.H., A.K. Pritchard, and J.R. Rose and A.A. Stickney. 2005. Migration and collision avoidance of eiders and other birds at Northstar Island, Alaska, 2001-2004: Final Report for BP Alaska Inc., Anchorage, Alaska prepared by ABR Inc, Fairbanks, Alaska. 156pp.
- Divoky, G.J. 1984. The pelagic and nearshore birds of the Alaskan Beaufort Sea: Biomass and trophics. Pp. 417-437. *In* *The Alaskan Beaufort Sea: Ecosystems and Environments*. Academic Press, Orlando, Florida.
- Divoky, G.J. 1987. The distribution and abundance of birds in the eastern Chukchi Sea in late summer and early fall. Final report. Outer Continental Shelf Environmental Assessment Program, Research Unit 196.

- Drent, R. and S. Daan. 1980. The prudent parent: energetic adjustments in breeding biology. *Ardea* 68:225-252.
- Epply, Z.A. 1992. Assessing indirect effects of oil in the presence of natural variation: The problem of reproductive failure in south polar skuas during the Bahai Paraiso oil spill. *Marine Pollution Bulletin* 25:307.
- Ely, C.R., C.P. Dau, and C.a. Babcock. 1994. Decline in population of Spectacled Eiders nesting on the Yukon-Kuskokwim Delta, Alaska. *Northwestern Naturalist* 75:81-87.
- Esler, D., J.A. Schmutz, R.L. Jarvis, and D.M. Mulcahy. 2000. Winter survival of adult female harlequin ducks in relation to history of contamination by the *Exxon Valdez* oil spill. *Journal of Wildlife Management* 64(3):839-847.
- Feder, H.M., A.S. Naidu, J.M. Hameedi, S.C. Jewett, and W.R. Johnson. 1989. The Chukchi Sea Continental Shelf: Benthos-Environmental Interactions. Final Report. NOAA-Ocean Assessment Division, Anchorage. 294 pp.
- Feder, H.M., N.R. Foster, S.C. Jewett, T.J. Weingartner, and R. Baxter. 1994a. Mollusks in the Northeastern Chukchi Sea. *Arctic* 47(2): 145-163.
- Feder, H.M. A. S. Naidu, S. C. Jewett, J.M. Hameedi, W. R. Johnson, and T.E. Whitlege. 1994b. The northeastern Chukchi Sea: benthos-environmental interactions. *Marine Ecology Progress Series* 111:171-190.
- Federal Communications Commission. 2004. Notice of Inquiry comment review avian / communication tower collisions. Final report by Avatar Environmental LLC, EDM International, Inc., & Pandion Systems, Inc. September 30, 2004. 125pp + appendices.
- Flint, P.L, M.R. Petersen, and J. Grand. 1997. Exposure of spectacled eiders and other diving ducks to lead in western Alaska. *Canadian Journal of Zoology* 75:439-443.
- Fowler, G.S., J.C. Wingfield, and P.D. Goersma. 1995. Hormonal and reproductive effects of low levels of petroleum fouling in Magellanic penguins (*Spheniscus magellanicus*). *The Auk* 112:382.
- Franson, J., M.R. Petersen, C. Meteyer, and M. Smith. 1995. Lead poisoning of spectacled eiders (*Somateria fischeri*) and of a common eider (*Somateria mollissima*) in Alaska. *Journal of Wildlife Diseases* 31:268 -271.
- Fredrickson, L.H. 2001. Steller's Eider (*Polysticta stelleri*). In *The Birds of North America*, No. 571 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

- Frimer, O. 1994. The behavior of molting King Eiders *Somateria spectabilis*. *Wildfowl* 45:176-187.
- Fry, D.M. 1986. Reduced reproduction of wedge-tailed shearwaters exposed to weathered Santa Barbara crude oil. *Archive of Environmental Contaminate Toxicology* 15:453.
- Gauthreaux, S.A. Jr. and C. G. Belser. 2002. The behavioral responses of migrating birds to different lighting systems on tall towers. Abstract from the Urban Wildlands Group and UCLA Institute of the Environment Conference: Ecological Consequences of Artificial Night Lighting. February 23 & 24, 2002, Los Angeles, California.
- Georgette, S. 2000. Subsistence use of birds in the Northwest Arctic Region, Alaska. Technical Paper No. 260, Alaska Department of Fish and Game, Division of Subsistence, Juneau.
- Gill, R.E., M.r. Petersen, and P.D. Jorgensen. 1981. Birds of Northcentral Alaska Peninsula, 1978-80. *Arctic* 34:286-306.
- Gorman, M.L. and H. Milne. 1971. Seasonal changes in adrenal steroid tissue of the common eider *Somateria mollissima* and its relation to organic metabolism in normal and oil polluted birds. *Ibis* 133:218-228.
- Grand, J.B., P.L. Flint, M.R. Petersen, and J.B. Grand. 1998. Effect of lead poisoning on spectacled eiders survival rates. *J. Wildlife Management* 62:1103-1109.
- Grand, J., J. Franson, P.L. Flint, and M.R. Petersen. 2003. Concentrations of trace elements in eggs and blood of spectacled and common eiders on the Yukon-Kuskokwim Delta, Alaska, USA. *Envir. Toxic. Chem.* 21:1673-1678.
- Grebmeier, J. M. 1993. Studies on pelagic-benthic coupling extended onto the Russian continental shelf in the Bering and Chukchi Seas. *Continental Shelf Research* 13:653-668.
- Grebmeier, J.M. and N.M. Harrison. 1992. Seabird feeding on benthic amphipods facilitated by gray whale activity in the northern Bering Sea. *Marine Ecology Progress Series* 80:125-133.
- Grebmeier, J. M. and L.W. Cooper. 1995. Influence of the St. Lawrence Island Polynya on the Bering Sea benthos. *Journal of Geophysical Research* 100:4439-4460.
- Grebmeier, J.M. and K.H. Dunton. 2000. Benthic processes in the northern Bering/Chukchi seas: status and global change, pp. 61-71. *In: Impacts of Changes in Sea Ice and other Environmental parameters in the Arctic. Report of the Marine*

- Mammal Commission Workshop, 15-17 February 2000, Girdwood, Alaska.
Available from the Marine Mammal Commission, Bethesda, MD.
- Grebmeier, J. M. and L.W. Cooper. 2004. Abstract SS2.02 in Arctic Climate Impact Assessment, Extended Abstracts (Arctic Monitoring and Assessment Program, Reykjavik, Iceland).
- Grebmeier, J.M., J.E. Overland, S.E. Moore, E.V. Farley, E.C. Carmack, L.W. Cooper, K.E. Frey., J. H. Helle., F.A. McLaughlin, and S.L. McNutt. 2006. A major ecosystem shift in the Northern Bering Sea. *Science* 311:1461-1464.
- Hartung, R. and G.S. Hunt. 1966. Toxicity of some oils to waterfowl. *Journal of Wildlife Management* 30:564.
- Harwood, C. and T. Moran. 1993. Productivity, brood survival, and mortality factors for spectacled eiders on Kigigak Island, Yukon Delta NWR, Alaska, 1992. Unpublished report prepared for U.S. Fish and Wildlife Service, Bethel, Alaska. 11pp + Appendix.
- Highsmith, R.C. and K.O. Coyle. 1992. Productivity of arctic amphipods relative to gray whale energy requirements. *Marine Ecology Progress Series* 83:141-150.
- Huey, L.M. 1931. Three note-worthy bird records from Barrow, Alaska. *Condor* 33:36-37.
- Hunt, G.L., Jr. 1991. Occurrence of polar seabirds at sea in relation to prey concentrations and oceanographic factors. *In: Sakshaug, E, C. Hopkins, and N.A. Øritsland, (eds.). Proceedings of the Pro Mare Symposium on Polar Marine ecology, Trondheim, 12-16 May 1990. Polar Research* 10(2):553-559.
- Iken K. and B. Konar. 2003. Introduction: Arctic Biodiversity Transect. *In: Iken K. and B. Konar (eds). Proceedings of the Arctic Biodiversity Workshop: New Census of Marine Life Initiative. Alaska Sea Grant College Program, University of Alaska Fairbanks, M-26, Fairbanks. 162 pp.*
- Jenssen, B.M. 1994. Review article: Effects of oil pollution, chemically treated oil, and cleaning on the thermal balance of birds. *Environmental Pollution* 86:207.
- Johnson, S.R. and D.R. Herter. 1989. The birds of the Beaufort Sea. BP Exploration Alaska Inc., Anchorage, Alaska.
- Johnson, R. and W. Richardson. 1982. Waterbird migration near the Yukon and Alaska coast of the Beaufort Sea: II. Molt migration of seaducks in summer. *Arctic* 35(2): 291-301.
- Kendall, S.J. and B.A. Agler. 1998. Distribution and abundance of Kittlitz's murrelets in Southcentral and Southeastern Alaska. *Colonial Waterbirds* 21:53-60.

- Klein, D. 1966. Waterfowl in the economy of the Eskimos on the Yukon-Kuskokwim Delta, Alaska. *Arctic* 19:319-336.
- Kondratev, A. and L. Zadorina. 1992. Comparative ecology of the king eider *Somateria spectabilis* and spectacled eider *Somateria fischeri* on the Chaun tundra. *Zool. Zhur.* 71:99-108. (in Russian; translation by J. Pearce, National Biological Survey, Anchorage, Alaska).
- Korschgen, C. E. 1977. Breeding stress of female eiders in Maine. *Journal of Wildlife Management* 41:360-373.
- Kuletz, K. 2004. Kittlitz's murrelet – a glacier bird in retreat. Unpublished report, U.S. Fish & Wildlife Service, Anchorage, AK. 4pp.
<http://alaska.fws.gov/media/murrelet/overview.pdf>
- Kuletz, K. and J. Piatt. 1992. Distribution of Marbled and Kittlitz's murrelets in three bays in Alaska. *Pacific seabird Group bulletin* 19:50.
- Lacroix, D.L., R.B. Lanctot, J.A. Reed and T.L. MacDonald. 2003. Effect of underwater seismic surveys on molting male long-tailed ducks in the Beaufort Sea, Alaska. *Canadian Journal of Zoology* 81:1862-1875.
- Larned, W. 2004. Steller's eider spring migration surveys southwest Alaska, 2005. Unpublished report, U.S. Fish & Wildlife Service, Anchorage, AK. 25pp.
- Larned, W. and T. Tiplady. 1999. Late wintering distribution of distribution of spectacled eiders (*Somateria fischeri*) in the Bering Sea 1998. Unpublished report, U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska. 9pp.
- Larned, W., G. R. Balogh, and M.R. Petersen. 1995. Distribution and abundance of spectacled eiders (*Somateria fischeri*) in Ledyard Bay, Alaska, September 1995. Unpublished progress report, U.S. Fish and Wildlife Service, Anchorage, AK. 11 pp.
- Larned, W., R. Stehn, and R. Platte. 2003. Eider breeding population survey, Arctic Coastal Plain, Alaska, 2003. Unpublished progress report, U.S. Fish and Wildlife Service, Anchorage, AK. 20pp.
- Larned, W., R. Stehn, and R. Platte. 2005a. Eider breeding population survey, Arctic Coastal Plain, Alaska, 2004. Unpublished progress report, U.S. Fish and Wildlife Service, Anchorage, AK. 48pp.

- Larned, W., R. Stehn, and R. Platte. 2005b. Eider breeding population survey, Arctic Coastal Plain, Alaska, 2005. Unpublished progress report, U.S. Fish and Wildlife Service, Anchorage, AK. 49pp.
- Larned, W., R. Stehn, and R. Platte. 2006. Eider breeding population survey Arctic Coastal Plain, Alaska, 2006. Unpublished Report, U.S. Fish and Wildlife Service, Anchorage, AK. 53pp.
- Leighton, F.A. 1991. The toxicity of petroleum oils to birds: An overview. *In* White J. (Ed.). *The Effects of Oil on Wildlife*. The Sheridan Press, Hanover, PA.
- Lenihan, H.S. and J.S. Oliver. 1995. Anthropogenic and natural disturbances to marine benthic communities in Antarctica. *Ecological Applications* 5:311-326
- Lovvorn, J.R., S.E. Richman, J.M. Grebmeier, and L.W. Cooper. 2003. Diet and body condition of spectacled eiders wintering in the pack ice of the Bering Sea. *Polar Biology* 26:259-267.
- Mallek, E.J., R. Platte, and R. Stehn. 2003. Aerial breeding pair surveys of the Arctic Coastal Plain of Alaska – 2002. U.S. Fish and Wildlife Service, Waterfowl Management, Fairbanks, Alaska. 23pp.
- Mallek, E.J., R. Platte, and R. Stehn. 2004. Aerial breeding pair survey of the Arctic Coastal Plain of Alaska – 2004. U.S. Fish and Wildlife Service, Waterfowl Management, Fairbanks, Alaska. 24pp.
- Manabe, S. and R.J. Stouffer. 1995. Simulation of abrupt climate change induced by fresh water input into the North Atlantic Ocean. *Nature* 378:165-167.
- Manville, A.M., II. 2000. The ABCs of avoiding bird collisions at communication towers: the next steps. *Proceedings of the Avian Interactions Workshop*, December 2, 1999, Charleston, SC. Electric Power Research Institute. 15pp.
- Manville, A.M., II. 2004. Bird Strikes and electrocutions at power lines, communication towers, and wind turbines: State of the art and state of the science – next steps towards mitigation. *Proceedings 3rd International Partners in Flight Conference*, March 20-24, 2002, Asilomar Conference Grounds, CA. USDA Forest Service General Technical Report PSW-GTR-191. 25pp
- Martin, P.D., T. Obritschkewitsch, and D.C. Douglas. Distribution and movements of Steller's eiders in the non-breeding period. *In prep.*
- Metzner, K.A. 1993. Ecological strategies of wintering Steller's eiders on Izembeck Lagoon and Cold Bay, Alaska. M.S. Thesis, University of Missouri, Columbia, MO. 193pp.

- Miller, D.S., D.B. Peakall, and W.B. Kinter. 1978. Ingestion of crude oil: Sublethal effects in herring gull chicks. *Science* 199:15.
- Milne, H. 1976. Body weights and carcass composition of the common eider. *Wildfowl* 27:115-122.
- Minerals Management Service. 2006a. Biological Evaluation of spectacled eider (*Somateria fischeri*), Steller's eider (*Polysticta stelleri*), and Kittlitz's Murrelet (*Brachyramphus brevirostris*) for Chukchi Sea Lease Sale 193. 79pp.
- Mineral Management Service. 2006b. Chukchi Sea Planning Area Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea. Draft Environmental Impact Statement. Volume I (Executive Summary, Sections I through IV, and Bibliography). Mineral Management Service, Alaska OCS Region. OCS EIS/EA MMS 2006-060. 810 pp.
- Mineral Management Service. 2006c. Chukchi Sea Planning Area Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea. Draft Environmental Impact Statement. Volume II. (Tables, Figures, Maps and Appendices). Mineral Management Service, Alaska OCS Region. OCS EIS/EA MMS 2006-060. 345 pp.
- Mineral Management Service. 2007. Addendum to Biological Evaluation for Chukchi Sea Lease Sale 193: February 6, 2007. 3pp.
- Moran, T. 1995. Nesting ecology of spectacled eiders on Kigigak Island, Yukon Delta NWR, Alaska, 1994. Unpublished report prepared for U.S. Fish and Wildlife Service, Bethel, Alaska. 8pp + appendix.
- Moran, T. 1996. Nesting ecology of spectacled eiders on Kigigak Island, Yukon Delta NWR, Alaska, 1995. Unpublished report prepared for U.S. Fish and Wildlife Service, Bethel, Alaska. 7pp + appendix.
- Moran, T. and C. Harwood. 1994. Nesting ecology, brood survival, and movements of spectacled eiders on Kigigak Island, Yukon Delta NWR, Alaska, 1993. Unpublished report prepared for U.S. Fish and Wildlife Service, Bethel, Alaska. 33pp + appendix.
- Mosbech., A. and D. Boertmann. 1999. Distribution, abundance and reaction to aerial surveys of post-breeding king eiders (*Somateria spectabilis*) in Western Greenland. *Arctic*. 52(2):188-203.
- Naidu, S. 2005. Trace metals in sediments, northeastern Chukchi Sea. Presentation at the MMS Chukchi Sea Science Update, Anchorage, Alaska. USDO, MMS, Alaska OCS Region.
- Obritschkewitsch, T., P. Martin, and 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 113 pp.
- Oliver, J.S. and P.N. Slattery. 1985. Destruction and opportunity on the sea floor: effects of gray whale feeding. *Ecology* 66: 1965-1975.
- Oliver, J.S., P.N. Slattery, E.F. O'Connor, and L.F. Lowry. 1983. Walrus *Odobenus rosmarus*, feeding in the Bering Sea: a benthos perspective. *Fisheries Bulletin* 81:501-512.
- Parker, H. and H. Holm. 1990. Pattern of nutrient and energy expenditure in female Common eiders nesting in the high arctic. *Auk* 107:660-668.
- Parkinson, C.L., D.J. Cavaliere, P. Gloersen, H.J. Zwally, and J.C. Comiso. 1999. Arctic sea ice extents, areas and trends, 1978-1996. *J. Geophysical Research* 104:20837-20856.
- Paige, A., C. Scott, D. Andersen, S. Georgette, and R. Wolfe. 1996. Subsistence use of birds in the Bering Strait Region, Alaska. Technical Paper No. 239, Alaska Department of Fish and Game, Division of Subsistence, Juneau. 33pp + appendix.
- Pearce, J., D. Esler, and A. Degtyarev. 1998. Nesting ecology of spectacled eiders on the Indigirka River Delta, Russia. *Wildfowl* 49:110-123.
- Percy, J.A. 1977. Responses of arctic marine benthic crustaceans to sediments contaminated with crude oil. *Environmental Pollution* 13:2-10.
- Petersen, M.R. 1980. Observations of wing-feather molt and summer feeding ecology of Steller's eiders at Nelson Lagoon, Alaska. *Wildfowl* 31:99-106.
- Petersen, M.R. 1981. Populations, feeding ecology and molt of Steller's eiders. *Condor* 83:256-262.
- Peterson, M.R. 2000. The Exxon Valdez oil spill in Alaska: acute, indirect and chronic effects on the ecosystem. *Advances in Marine Biology* 39:3-84.
- Petersen, M.R. and P.L. Flint. 2002. Population structure of pacific common eiders breeding in Alaska. *Condor* 104:780-787.
- Petersen, M.R. and D. Douglas. 2004. Winter ecology of spectacled eiders: environmental characteristics and population change. *Condor* 106:79-94.
- Petersen, M.R., J.F. Piatt, and K.A. Trust. 1998. Foods of Spectacled Eiders *Somateria fischeri* in the Bering Sea, Alaska. *Wildfowl* 49:124-128.

- Petersen, M. R., W. W. Larned, and D.C. Douglas. 1999. At-sea distribution of spectacled eiders: a 120-year-old mystery resolved. *The Auk* 116(4):1009-1020.
- Petersen, M.R., J.B. Grand, and C.P. Dau. 2000. Spectacled Eider (*Somateria fischeri*). *In* The Birds of North America, No. 547 (A. Poole and F. Gill, eds.). The Birds of North America, Inc. Philadelphia, PA.
- Piatt, J.F., C.J. Lensink, W. Butler, M. Kendziorek, and D.R. Nyeswander. 1990. Immediate impact of the Exxon Valdez Oil Spill on marine birds. *Auk* 107: 387-397.
- Piatt, J.F., N.L. Naslund, and T.I. Van Pelt. 1999. Discovery of a new Kittlitz's murrelet nest: clues to habitat selection and nest-site fidelity. *Northwestern Naturalist* 80:8-13.
- Pitelka, F.A. 1974. An avifaunal review for the Barrow region and North Slope of arctic Alaska. *Arctic and Alpine Research*. 6:161-184.
- Phillips, L.M. 2005. Migration ecology and distribution of King Eiders. MS Thesis, University of Alaska-Fairbanks, Alaska. 84pp.
- Quakenbush, L.T., R.S. Suydam, K.M. Fluetsch, and C.L. Donaldson. 1995. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 1991-1994. Ecological Services Fairbanks, AK, U.S. Fish and Wildlife Service, Technical Report NAES-TR-95-03. 53pp.
- Quakenbush, L., R. Suydam, K. Fluetsch, and T. Obritschkewitsch. 1998. Breeding habitat use by Steller's eiders near Barrow, Alaska, 1991-1996. Unpublished report prepared for U.S. Fish and Wildlife Service, Fairbanks, Alaska. 19pp.
- Quakenbush, L.T. and R.S. Suydam. 1999. Periodic non-breeding of Steller's eiders near Barrow, Alaska, with speculation on possible causes. Pages 34-40 *In* Behavior and ecology of sea ducks. R.I. Goudie, M.R. Petersen, and G.J. Robertson (eds.) Occasional Paper Number 100. Canadian Wildlife Service, Ottawa.
- Raveling, D.G. 1979. The annual cycle of body composition of Canada Geese with special reference to control of reproduction. *Auk* 96:234-252.
- Reed, J.R., J.L. Sincock, and J.P. Hailman. 1985. Light attraction in endangered procellariiform birds: reduction by shielding upward radiation. *Auk* 102:377-383.
- Richman, S.E. and J.R. Lovvorn. 2003. Effects of clam species dominance on nutrient and energy acquisition by spectacled eiders in the Bering Sea. *Marine Ecology Progress Series* 261:283-297.

- Ritchie, R.J., T. Obritschkewitsch, and J. King. 2006. Steller's eider survey near Barrow, Alaska, 2006. Final Report for BLM – Fairbanks, Alaska, and ConocoPhillips Alaska, Anchorage, Alaska. 15pp.
- Rojek, N.A. 2005. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 2005. Technical report for U.S. Fish & Wildlife Service, Fairbanks, Alaska. 47pp.
- Rojek, N.A. 2006. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 2006. Technical draft report for U.S. Fish & Wildlife Service, Fairbanks, Alaska. 53pp.
- Rothrock, D., Y. Yu, and G. Mayk. 1999. The thinning of the Arctic ice cover. *Geophysical Research Letters* 26:3469-3472.
- Russell, R.W. 2005. Interactions between migrating birds and offshore oil and gas platforms in the northern Gulf of Mexico: Final report. U.S. Department of Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2005-009. 348 pp.
- Sirenko, B.I. and V.M. Koltun. 1992. Characteristics of benthic biocenoses of the Chukchi and Bering Seas. *In: Results of the third US-USSR Bering and Chukchi Seas expedition (BERPAC), Summer 1988.* P. A. Nagel, (ed.). US Fish and Wildlife Service, Washington, DC. P. 251-258.
- Smith, L., L. Byrne, C. Johnson, and A. Stickney. 1994. Wildlife studies on the Colville River Delta, Alaska, 1993. Unpublished report prepared for ARCO Alaska, Inc., Anchorage, Alaska. 58pp.
- Stehn, R., C. Dau, B. Conant, and W. Butler. 1993. Decline of spectacled eiders nesting in western Alaska. *Arctic* 46(3): 264-277.
- Stehn, R., W. Larned, R. Platte, J. Fischer, and T. Bowman. 2006. Spectacled eider status and trend in Alaska. U.S. Fish and Wildlife Service, Anchorage, Alaska. Unpublished Report. 17pp.
- Stroeve, J.C., M.C. Serreze, F. Fetterer, T. Arbetter, W. Meier, J. Malanik, and K. Knowles. 2005. Tracking the Arctic's shrinking sea ice cover: another extreme September minimum in 2004. *Geophysical Letters* 32, DOI: 10.1029/2004GL021810.
- Suchanek, T.H. 1993. Oil impacts on marine invertebrate populations and communities. *American Zoologist*. 33:510-523.
- Suydam, R.S., L.T. Quakenbush, D.L. Dickson, and T. Obritschkewitsch. 2000. Migration of King, *Somateria spectabilis*, and Common *S. mollissima v. nigra*,

- Eiders past Point Barrow, Alaska, during Spring and Summer/Fall 1996. *The Canadian Field Naturalist* 114:444-452.
- Szaro, R.C., G. Hensler, and G.H. Heinz. 1981. Effects of chronic ingestion of No. 2 fuel oil on mallard ducklings. *Journal of Toxicology and Environmental Health* 7:789.
- Teal, J.M. and R.W. Howarth. 1984. Oil spill studies: a review of ecological effects. *Environmental Management* 8:27-43.
- Troy, D. 1995. Distribution and abundance of spectacled eiders in the vicinity of Prudhoe Bay, Alaska: 1991-1993. Report for BP Exploration (Alaska) Inc., Troy Ecological Research Associates Anchorage, Alaska. 17pp + Appendices.
- Troy, D. 2003. Molt migration of spectacled eiders in the Beaufort Sea region. Troy Ecological Research Associates, Anchorage, Alaska.
- Trust, K., J. Cochrane, and J. 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.A., K.T. Rummel, A.M. Schuehammer, I.L. Brisban, Jr., M.J. Hooper. 2000a. Contaminant exposure and biomarker responses in spectacled eiders (*Somateria fischeri*) from St. Lawrence Island, Alaska. *Archives of Environmental Contamination and Toxicology*:38:107-113.
- Trust, K.A., D. Esler, B.R. Woodin, and J.J. Stegeman. 2000b. Cytochrome P450 1A induction in sea ducks inhabiting nearshore areas of Prince William Sound, Alaska. *Marine Pollution Bulletin* 40:397-403.
- Tseng, F.S. 1993. Care of oiled seabirds: A veterinary perspective. *In* Procedures of the 1993 International Oil Spill Conference. Publication 4580, American Petroleum Institute, Washington D.C.. Pp 421.
- Vermeer, K. and R. Vermeer. 1975. Oil threats to birds on the Canadian coast. *Canadian Field Naturalist* 8:278.
- Walton, P. 1997. Sub-lethal effects of an oil pollution incident on breeding kittiwakes, *Rissa tridactyla*. *Marine Ecology Progress Series* 155:261.
- Warnock, N. and D. Troy. 1992. Distribution and abundance of spectacled eiders at Prudhoe Bay, Alaska: 1991. Unpublished report prepared for BP Exploration (Alaska) Inc., Environmental and Regulatory Affairs Department, Anchorage, Alaska, by TERA, Anchorage, Alaska. 20pp.

- Weir, R. 1976. Annotated bibliography of bird kills at man-made obstacles: A review of the state of the art and solutions. Unpublished report prepared for Department of Fisheries and Environment, Canadian Wildlife Service-Ontario Region. 29pp.
- Welch, H.E., M.A. Bergmann, T.D. Siferd, K.A. Martin., M.F. Curtis, R.E. Crawford, R.J. Wilson, K. Hustler, P.G. Ryan, A.E. Burger, and E.C. Noldeke. 1992. Diving birds in cold water: do Archimedes and Boyle determine energetic costs? *American Naturalist* 140:179-200.
- Wooby, D.A. and G. J. Divoky. 1982. Spring migration of eiders and other water birds at Point Barrow, Alaska. *Arctic*: 35:403-410.
- USFWS. 1996. Spectacled Eider Recovery Plan. Prepared for Region 7 - U.S. Fish & Wildlife Service, Anchorage, Alaska. 100pp + Appendices.
- USFWS. 2002a. Spectacled Eider Recovery Fact Sheet. U.S. Fish and Wildlife Service, Anchorage, Alaska.
- USFWS. 2002b. Steller's Eider Recovery Plan. Fairbanks, Alaska. 27pp.
- USFWS and Canadian Wildlife Service. 1987. Standard operating procedures for aerial waterfowl breeding ground population and habitat surveys. Unpublished Manual. U.S. Fish and Wildlife Service, Migratory Bird Management, Washington D.C. 98pp.
- Zhang, Y. and E.C. Hunke. 2001. Recent Arctic change simulated with a coupled ice-ocean model. *J. Geophysical Research* 106:4369-4390.

APPENDIX 1 – SUMMARY OF CONSULTATION ACTIVITIES

This Appendix provides a brief summary of consultation actions between MMS and FWS. A complete administrative record is on file at the Fairbanks Fish and Wildlife Field Office.

- 5/25/06 - MMS submits a species list request for Lease Sale 193 area.
- 6/02/06 - Service responds to species list request
- 9/7/06 - Joint Service and MMS meeting to discuss the BE / BO for Lease Sale 193
- 9/25/06 - Service receives the Biological Evaluation of Spectacled Eider (*Somateria fischeri*), Steller's eider (*Polysticta stelleri*), and Kittlitz's murrelet (*Brachyramphus brevirostris*) for Chukchi Sea Lease Sale 193
- 10/27/06 - Service issues a memo to MMS stating that BE is sufficient to begin formal consultation on Chukchi Sea Lease Sale 193
- 11/20/06 - Service requests clarification on seismic survey activities in the Ledyard Bay Critical Habitat Unit
- 11/21/06 - MMS responds clarifying that no seismic survey work will be permitted within the critical habitat unit after July 1 each year
- 1/11/07 - MMS requesting that the formal consultation for Lease sale 193 be conducted according to 50 C.F.R. Part 402, Subpart B 402.14(k) i.e., as an incremental consultation with leasing and exploration as the first incremental step
- 1/23/06 - Service requests additional information on exploratory drilling in the Ledyard Bay Critical Habitat Unit
- 2/6/06 - MMS provides an addendum to the BE discussing exploratory drilling in the Ledyard Bay Critical Habitat Unit
- 2/23/06 - Service & MMS hold a teleconference to discuss status and general conclusions of the BO
- 2/27/07 - Discussions between MMS and Service regarding proposed reasonable
3/12/07 and prudent measures and terms and conditions
- 3/11/07 - Transmittal of Draft BO

APPENDIX 2

The appendix contains the following documents associated with the spectacled eider experts meeting held in Anchorage on November 14, 2006, and a spectacled eider population matrix model run by Dr. Barry Grand of USGS, University of Auburn:

1. Agenda and materials supplied to participants at an expert meeting convened in Anchorage at the request of the Endangered Species Branch of the Fairbanks Fish & Wildlife Field Office.
2. Draft Paper by Stehn et al. (2006) used during the expert meeting in Anchorage.
3. Notes from the expert meeting in Anchorage.
4. Workflow on spectacled eider models for assessment of potential impacts of a catastrophic oil spill in Ledyard Bay.

AGENDA & QUESTIONS

1. Introduction & Ground Rules (Ted)

- Briefly explain aims of the meeting
- Stay on Task – no blind alley entering or tail chasing!

2. Baseline

Aim: To assess the long term prognosis for the populations, and species as a whole assuming the Lease Sale would not to take place.

Questions:

- (i) What population size and trends should be used for each of the three populations and the species as a whole?

Output: Model the baseline based upon the answers developed by the group. This will allow a comparison when the potential effects of the proposed action are considered.

3. Potential Effects of the Proposed Action (Table 1)

Aim: To assess how impacts associated with development would affect the population in the absence of a spill.

Background: Using procedures in common with other section 7 consultations we have developed a matrix showing the estimated take.

4. Effect of Disturbance

Question: What are the effects (expressed as mortality, reduced productivity, and reduced survivorship) of disturbance to SPEI in the marine environment?

Output: Model the effects of the take; from the matrix and conclusions on effects of disturbance; to assess potential effects of the project even if a spill were not to occur.

5. Oil Spill

Background: Using MMS's data we have concluded that it is possible that an oil spill could reach the Ledyard Bay Critical Habitat molting area when SPEI are present. The spill volumes used by MMS in their scenarios would cover an area which could encompass the entire flock of molting birds present. We intend to model the effect on the population of a range of mortalities.

Questions:

- (i) Are the mortality levels reasonable?

- (ii) What reduction of survivorship and / or reproduction would occur for those birds not killed directly?

6. Allocation of Birds in Ledyard Bay

Background: In order to populate the model, we need to assign the birds present in Ledyard Bay to each of the three breeding populations.

Questions:

- (i) What proportions of SPEI in the molting concentration belong to each population?

7. What are the implications of losing one or two populations?

MMS Lease Sale 193 – Background Information

Background

Under the current Outer Continental Shelf (OCS) 5-year program Minerals Management Service (MMS) proposes to conduct Lease Sale 193. This sale area encompasses 137,600km² (34 million acres) of the Chukchi Sea (Figure 1).

Phases

There are several phases, or stages, involved with the proposed action that may ultimately lead to the development of offshore oil facilities in this area. These are:

- seismic survey work of various degrees of intensity (on-going)
- exploratory drilling
- construction
- production
- decommissioning

Section 7 Consultation

A formal section 7 consultation is being conducted between the Service and MMS. This consultation must determine “whether the proposed Federal action is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat.” Uniquely, section 7 consultations for OCS activities are incremental, with each new step being consulted upon before it occurs. However, prior to these incremental steps, the Service must consider effects of the entire project from seismic activities through decommissioning even though the exact nature (or probability) of future development is unknown. It is this overall, endpoint consultation, which we are currently working on. Evaluating all activities that may occur in the area allows us to better protect listed species, through guiding any development. It also insures that industry is fully aware of any endangered species issues and constraints that may limit their activities in the future before investing in the area.

Species Involved

The Biological Opinion (BO) developed by the Service during this consultation will address threatened Steller’s and spectacled eiders, the candidate species Kittlitz’s murrelets, and the Ledyard Bay critical habitat unit. NOAA Fisheries has also conducted a section 7 consultation for species under their jurisdiction.

Proposed Activities

Obviously, many of the activities which may take place in relation to Lease Sale 193 are unknown. However, using their best professional judgment MMS has developed a hypothetical development scenario which they consider to be “reasonably foreseeable”. The likely activities for each phase are summarized as follows:

Initial Seismic Work

3D and 2D seismic surveys in which vessels tow and fire different types of airgun arrays while the same vessel, or another ship tows recording equipment. These surveys are conducted during ice-free periods and may be supported by helicopters and other small

supply ships. If an exploration well, or development is proposed high resolution seismic surveys maybe conducted in a discrete geographic area. This work will take place in a similar fashion to the extensive surveys.

Exploratory Wells

If exploration wells are developed they will most likely be constructed by drillships with ice breaker support vessels. Drilling operations would again take place during the open-water season. These vessels may be supported via helicopters and other ships.

Development

MMS predicts that development, were it to occur, would consist of one large bottom-founded platform acting as a central facility. A number of subsea well templates within a 15 mile radius would be connected to this central facility. The central facility would separate the three phase product, re-injecting the gas and water, before sending the oil to shore via a subsea pipeline. At the pipeline landfall a shore base will be built. From here a pipeline connecting to the TAPS line will be constructed. MMS estimates that four pump stations and an access road to the shore base will also be required. The location of all of these facilities is completely unknown. The project, as currently proposed, would allow the central facility, satellite hub, and / or pipelines to go through the critical habitat unit, or they could be in the area of the lease sale furthest away from Ledyard Bay. The shore base could be located anywhere from Barrow to Icy Cape, and hence the route, length, and details of the road and pipeline connecting to TAPS are completely unknown.

Further Development

Although MMS's reasonably foreseeable scenario involves the development of one large (billion barrel) field, they do caution that it is likely that if the infrastructure required to support it was constructed, smaller fields would also be developed. Again, the probability of this, their location, number, and duration of operation are completely unknown.

Aims of the Meeting

As we look at this federal action all the way to its end point there is a tremendous amount of uncertainty. However, by law we must evaluate the action to see if it may result in jeopardy of a species, or adverse modification to critical habitat. At the meeting we will gather experts in the field and combine them with the best available scientific information. The group will then work through potential project scenarios provided by the Endangered Species Branch assessing how these scenarios could result in direct mortality, reduction in survival, or a reduction in reproductive potential. These outcomes will then be used to model the population effects of the development scenarios.

“ANSWER SHEET”

BASELINE

North Slope
Population Size =

Y-K Delta
Population Size =

Trend =

Trend =

Russian
Population Size =

Global Population
Population Size = ca. 363,000 birds; 95%CI
333,526 – 392,532 (Petersen et al. 1999
from 1996-1997 aerial survey data)

Trend =

Trend =

EFFECTS OF DISTURBANCE

Reduced Survival:

Reduced Productivity:

OIL SPILLS

Reduced Survival:

Reduced Productivity:

OIL SPILLS – MORTALITY RATES

Suggestions:

100%	75%	50%
25%	10%	5%

ALLOCATION OF BIRDS

Sex / Population	North Slope	Y-K Delta	Russian	Global
Males				
Females				

Sources of disturbance to SPEI in the marine environment from activities associated with MMS Lease Sale 193

The project would take place in a series of phases. As currently proposed, any or all of these activities could take place anywhere within the Lease Sale 193 boundaries (including the Ledyard Bay critical habitat unit and the spring lead system). Obviously, disturbance is only a problem if birds are present in the area, so ice roads, and landing strips etc. are not described here. If construction or development were to occur a shore base would be constructed. The location of this facility, and hence, one would assume the route of much of the aircraft and boat traffic, is unknown.

Seismic Survey Work

Noise from air gun arrays – “ramp up” allowing animals to move away from source of sound.

Seismic survey vessels predominantly operate >10miles offshore. They are large ships and are often accompanied by a smaller vessel. The ships usually operate without the need to re-supply, and previously have been based in Dutch Harbor etc. However, MMS notes that some helicopter traffic between the vessels and the shore is possible.

We understand that at least two companies are interested in conducting seismic work in 2007.

Exploratory Drilling

One helicopter flight per day between a landfall (possibly Barrow or Wainwright) and an exploration well site.

Estimates it takes 90 days to drill a well, and estimated up to three per / year could be drilled = 270 flights.

Support vessels may also operate between the drill ships and their ice breaker support vessels. MMS estimates that one to three trips per week could be conducted, probably from Barrow.

We don't however, know how many years of exploratory drilling will take place.

Construction

Construction of the shore base would require several large barge loads of materials (probably from West Dock or Nome) during the open water period augmented by an estimated “five flights per day with a C-130 Hercules or larger aircraft”

MMS's scenario is based on one, very large offshore production platform with subsea pipelines and other wellheads. Construction of these facilities would be supported by helicopters and supply vessels. An estimated two barge trips per year during construction may also occur.

Production

MMS estimates that two large aircraft flights per day to the shore base, and 1-3 helicopter flights to the offshore facility / day would occur. Marine traffic to and between both locations would also occur during open water periods.

Summary

Seismic – Few large ships towing air gun arrays, with some possible some helicopter support. Large areas of the Lease Sale area may be exposed to low levels of disturbance.

Exploration Drilling – Drillship with ice breaker support vessels in localized areas. These are likely to be supported by helicopter staging in Barrow.

Construction – Barge traffic, other supply ships, large numbers of helicopters and large aircraft. It may take 3+ years to complete construction.

Production – Up to three helicopter flights per day from shorebase to offshore platform and some vessel traffic to offshore platform. Additional flights and vessel traffic to the shorebase. Production may occur for 25 years.

Table 1 – Estimate Incidental Take of Spectacled Eiders for Threats Associated with MMS’s Development Scenario (Except Oil Spills & Marine Disturbance Effects)

Threat / No.	Eggs/ Chicks	Adult (Killed)	Reduced Survivorship	Reduced Reproduction
Chronic Low Level Toxicity	0	0	x ^a	y ^a
Fuel Spills (Diesel etc.)	0		0	0
Collision with Infrastructure	0	25	0	0
Terrestrial Habitat Loss	235 ^c	0	0	Expressed as take of eggs/chicks
Increase Subsistence	0 ^d	0	0	0
Increase Predator Pops.	0 ^e	0	0	0
Disturbance	-			
Oil Spill	-			
TOTAL				

a Analysis limited to consideration of effects of PAH contamination of eiders

^c This includes both direct habitat loss (from road / pad fill, or material site excavation) and indirect loss (buffer of 200m around an activity e.g., a pad, within which we assume nesting is precluded). A density of 1.1 pairs/km² was used (as in the NE NPR-A BO).

^d Not anticipated, although road access will increase it will be controlled. This is also an illegal activity for which the Service has enforcement responsibility.

^e As the terrestrial portion of the project is within NPR-A we assume that the ROPs and STIPs that govern activities in that area would apply, and hence, no increase in predator populations should occur.

Expert Meeting to Populate a Spectacled Eider Model in Relation to MMS Lease Sale 193 in the Chukchi Sea

Venue: Meeting held at USGS in Anchorage on November 14, 2006

Attendees: Ted Swem, Jewel Bennett, Sarah Conn, Karen Laing (all Endangered Species Branch, Fairbanks Fish & Wildlife Service), Bob Stehn, Bob Platte (Migratory Bird Management, USF&WS, Anchorage), Paul Flint and Margaret Petersen (USGS, Anchorage).

Introduction to the Section 7 Process (Ted Swem)

Section 7 consultations are required for any federal actions. The consultation assesses the action to see if it would result in adverse effects or jeopardize listed species. Jeopardy calls are very unusual, and if one is made it needs to be accurate and correct.

The action we are currently consulting on is MMS's proposal to offer 34 million acres of the Chukchi Sea for oil & gas leases (Lease Sale 193). Although the definition of jeopardy is somewhat subjective, i.e., "that will appreciably reduce the likelihood of survival and recovery of a species", a model should help us understand what the spectacled eider population is currently doing (baseline), and compare this to how the population may respond to the activities resulting from the proposed action, and the defined recovery criteria.

We are asking this group of experts to populate the model, which will then be run by Dr. Barry Grand, of USGS at the University of Auburn. We need to establish the following input parameters:

- Baseline population inputs
- Effects of the project on the population
- Allocation of birds (and hence mortality, at Ledyard Bay
- Response of species as a whole to the loss of one or more populations

Introduction to the Spectacled Eider Population Model (Paul Flint)

The model we will be using is a matrix population model, where λ is the balance between mortality and recruitment. The model allows lower level subcomponents (e.g., clutch size, probability that a female breeds etc.) to be used in combination. All models of this type assume an asymptotic population, i.e., that the proportion of birds in each age class is stable. The effect of a perturbation depends upon where your population classes are (i.e., age distribution) and so the model samples stochastically from a range of age distributions so it can see how catastrophic events evolve over time through running a series of iterations of the model.

Discussion

The group discussed the aim of the meeting and the definition of jeopardy. The likelihood of "survival" is really a population viability analysis (PVA), which gives a predicted time to extinction given other parameters, or the likelihood of the population reaching a level defined as recovery.

Baseline

Aim: to assess the current status of the populations, and species as a whole, assuming the Lease Sale did not take place.

Question: What population size and trends should be used for each of the 3 populations and species as a whole?

Output: Model the baseline based upon answers from the group. This will allow a comparison when the potential effects of the proposed action are considered.

Define a timeline for the PVA

The group agreed 50 years was reasonable, for the following reasons:

1. The IUCN uses a chance of extinction in 10 generations to define endangered species. If a spectacled eider generation is considered to be 5 years, 50 years would be compatible with the IUCN formula.
2. Life of the oil development is predicted to end about 50 years from the present.

Determine baseline population size and growth rate for each breeding population (North Slope, Yukon Delta, and Russia) To make these decisions, the group used the draft report produced for the meeting: R. Stehn, W. Larned, R. Platte, J. Fischer, and T. Bowman. 2006. *Spectacled eider population status and trend in Alaska*. USFWS Division of Migratory Bird Management, Anchorage, report in preparation.

Decision for North Slope population estimate: 6458 (5471-7445, 95% C.I.) breeding females, as described on p. 6 of the report. The group agreed it made sense to use recent information (i.e. the last 5 years) for a current population estimate. This figure was derived by dividing the average adjusted aerial index for 2002-2006 by the index ratio developed by comparing the density of birds observed on the aerial survey to the density of nests from the plot survey in a 716 km² area on the Yukon Delta. The use of the index ratio is described in detail in the report.

Decision for North Slope growth rate: 0.997 (0.978-1.016, 95% C.I.) from p. 1 of the report. This is taken from the 14-year 1993-2006 period, representing all the suitable North Slope data. The 1992 data was clearly an underestimate of the population caused by late survey timing and departure of most of the more visible male eiders.

Decision for Yukon Delta growth rate: 1.042 (1.031-1.055, 95% C.I.) from the adjusted aerial survey index on p. 5 of the report. This figure was calculated for 1993-2006, the same 14 years as for the North Slope growth rate. The group felt that this 14 year period was appropriate for several other reasons including: 1) 1993 appears to be an inflection point in growth rate of the YKD population, 2) listing occurred at this time, and 3) observers and their survey experience was not constant before 1993 whereas the same (now experienced) observer has collected data since 1993.

There was some discussion about which growth rate on p. 5 of the report to use. The group chose the rate based on the aerial survey because 1) it would be directly

comparable with the rate for the North Slope, 2) it does not require any assumptions involved with expanding the nest plot survey into areas not sampled by plots based on aerial observations, and 3) it comes very close to the same estimate after removal of 3 years (2001, 2002, 2003) of low nest numbers perhaps related to late chronology or higher predation rate.

Decision for Yukon Delta population estimate: 4503 (3727-5279, 95% C.I.) breeding females, as described on p. 6 of the report. This figure was derived by dividing the average adjusted aerial index for 2002-2006 by the index ratio developed from the comparison of aerial observations and nest plot data over the last 14 years on the 716 km² core nesting areas for eiders on the Yukon Delta. Rather than direct use of nest density from plot surveys, we used the aerial index converted to a nest population to be consistent with the information we have for the North Slope and Russia. This required a critical assumption that the index ratio of aerial observations per nest (similar in some ways to a visibility detection rate) was constant among aerial surveys in all three areas. There were no data to test this assumption.

Decision for Russian population estimate: 137,448 breeding females (don't have 95% C.I.). This was derived by dividing the aerial indexed population result of 146,245 birds from the survey flown 1993-1995 (Hodges, J.I. and W.D. Eldridge. 2001. *Aerial surveys of eiders and other waterbirds on the eastern Arctic coast of Russia*. Wildfowl 52:127-142) by the index ratio of aerial index observations per nest, as for the other populations. There was some discussion on whether to use the winter survey population estimate by subtracting U.S. breeding populations and an estimate of sub-adults, but Paul argued that the breeding survey would be better because the winter survey ratio of males to "brown birds" was so skewed to males that it suggests that many sub-adults were not counted in the winter survey. In other words, the maximum winter count of 360,000 spectacled eiders must be incomplete due to under-representation of some segment (immature, female) of the population

Decision for Russian growth rate: we have no basis on which to determine a trend, so we will use 1.0.

Decision for survival rates: The only rates we have to use are the Yukon Delta survival rates derived from Flint, P.L., J.B. Grand, T.L. Moran and D. Douglas. In prep. *Variation in survival rates of spectacled eiders on the Yukon-Kuskokwim Delta, Alaska*. In common with past uses of the model the breeding propensity of female spectacled eiders is considered to be 0 for one year olds, 26% for two year olds, and 100% for those females ages three or older. With these data we can get the number of sub-adults (total productivity) to have a stable population, and with that we can estimate the total population.

Effects of the Proposed Lease Sale

Effects of the Proposed Lease Sale

Sarah Conn discussed a handout illustrating the mechanisms through which activities resulting from the lease sale may adversely affect spectacled eiders. A preliminary estimate of incidental take for many of these mechanisms was also provided. However, the group was asked to assess the potential effects of disturbance and oil spills within the marine environment.

Would occasional disturbance by vessels, and possibly frequent disturbance by helicopters, result in take of spectacled eiders, and if so to what extent?

Paul noted that there has been a study of the effects of helicopter traffic on king eiders off the coast of Greenland. He recalled that the effects were not large. *A. Mosbech, D. Boertmann* 1999. Distribution, abundance and reaction to aerial surveys of post-breeding King Eiders (*Somateria spectabilis*) in western Greenland. *Arctic* 52: 188–203.

Frimer, O. 1994. The behaviour of moulting King Eiders *Somateria spectabilis*. *Waterfowl* 45: 176–187.

In a study of molting long-tailed ducks, including experimental disturbance, Paul noted there were no major indication of changes in behavior or condition. *D.L. Lacroix, R.B. Lanctot, J.A. Reed and T.L. MacDonald.* 2003. Effect of underwater seismic surveys on molting male long-tailed ducks in the Beaufort Sea, Alaska. *Can. J. Zool.* 81:1862-1875.

In summary, the group agreed that there is insufficient data to support modeling reductions in eider survival or other parameters due to disturbance.

Lunch Time

Oil Spill Model

Jewel Bennett introduced oil spill scenario information provided by MMS, including the probability that oil would reach the Ledyard Bay critical habitat unit. She then posed several questions:

Is the assumption that an oil spill could kill all birds in an area reasonable?

The group agreed that it is possible, and that this scenario should be modeled to see what the effect would be on the population. Down the line, when we know what development is being proposed and where, we can ask what the actual probability is of such a scenario.

How many birds could be killed in a large oil spill?

Margaret noted that it makes a difference whether you have breeding females or males present at the time of the spill (or during the period after the spill when oil is still present); so the answer required for the model is how many birds of each age class would be present.

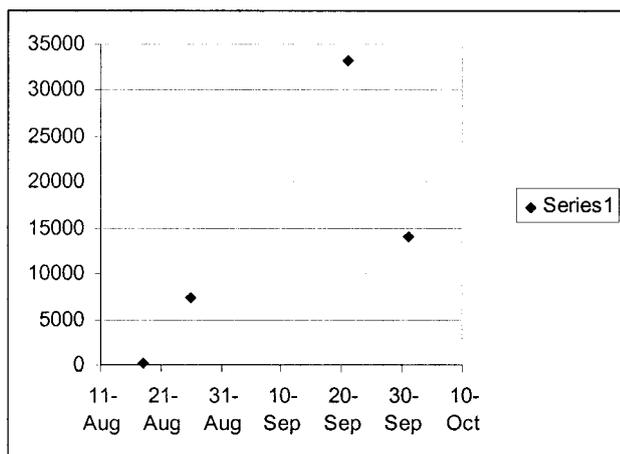
Bob Stehn: one way to look at it is to take the scenario in which, say, in the spring, all North Slope breeding birds and sub-adults (plus Steller's eiders) are in the spring leads.

This is probably also happening in the fall during the molt. Probably all birds going to the North Slope go through the 193 lease area or the adjacent coastline.

Discussion: there is no data on spring use, so we don't know for sure how listed species use the area. However, it is very likely they use the polynyas where food, and open water is available.

Ted: another way to look at it is to take 33,000 birds (the maximum number counted on surveys in 1995) and model that loss.

Paul: another way is to graph all the surveys (1994-1996, see Table 3 on handout "Spectacled Eiders in Ledyard Bay" for data) by date, and extrapolate a peak.



Spectacled eiders are concentrated; essentially held "in place" either by ice in spring or by molting in the fall, so if oil is in these areas, they will go to them and be vulnerable to oiling. This is a different situation from marine mammals, which may have a wider area to use. Decision was made to use 33,192 as a more conservative figure rather than using an extrapolated figure that would be higher.

Do we include 1 and 2 year olds as being vulnerable to these oil spills, or do we assume they molt elsewhere?

Decision was made to run the model two ways:

- a) Assume that 1 year olds stay away, and that 2 year olds follow breeders, and
- b) Include 1 year olds

A secondary benefit of running the model both ways is that it will help identify how much we need this information.

How many of the 33,192 birds molting in Ledyard Bay are females?

As the model only considers females, it is important to understand how many females would be affected by an oil spill or other event. The group decided to use the ratio of 85.3% males to 14.7% females (brown birds) determined by photography taken during the 1995 aerial surveys *W.L. Larned, G.R. Balogh, and M.R. Petersen. 1995.*

Distribution and abundance of spectacled eiders (*Somateria fischeri*) in Ledyard Bay, Alaska September 1995. Unpublished report, Migratory Bird Management, USF&WS, Anchorage, Alaska. November 16, 1995. 11pp.

How to determine what proportion of the brown birds are adult females vs. sub-adult birds from the different populations?

The group discussed the relative contributions of different breeding populations and sub-adults to the Ledyard Bay population. Satellite telemetry data indicated males from all three populations molt there; however, the consensus of the group was it is likely that only those females who breed on the North Slope will molt in Ledayrd Bay. It is the closest molting area for these females who may be depleted of resources after spending all, or part of the summer on the breeding grounds.

Would there be any long-term effects of oil in the area on spectacled eiders?

As well as causing initial mortality to birds who come into direct contact with the oil there may be lingering effects such as degradation of the habitat reducing food quality, long-term toxicity after exposure to small amounts of hydrocarbon etc. The group discussed potential impacts, and how to model them.

For harlequin ducks in Prince William Sound, there was a 5.7% annual reduction in annual survival 6-10 years after the spill, apparently due to ongoing exposure to hydrocarbons. (D., Esler, J.A. Schmutz, R.L. Jarvis, D.M. Mulcahy. 2000. Winter survival of adult female harlequin ducks in relation to history of contamination by the Exxon Valdez oil spill. Journal of Wildlife Management: 64(3):839-847).

After some discussion, the decision was made to use 5.7% as a constant for 10 years after a spill event, noting that this might be underestimating the earlier years' mortality, and that harlequins may have recovered faster as new birds move into the oiled area from surrounding populations which were not affected by the spill.

**Workflow on Spectacled Eider Models for Assessment of Potential Impacts
of a Catastrophic Oil Spill in Ledyard Bay**

For these simulations, I considered the North Slope, Yukon-Kuskokwim Delta (YKD), and Arctic Russia to be 3 closed, independent populations. The population sizes (N_{bf}) provided by the working group in Anchorage were assumed to be for breeding females, where each year breeding females included all females > 3 years old, 26% of 2 year-old females, and none of 1 year-old females (Table 1).

—

Table 1. Population sizes (95% confidence limits), growth rates for deterministic model (λ_d), stochastic model (λ_s), and adjusted deterministic model (λ_a) for Spectacled Eider populations.

Population	N_{bf} (n, SE)	λ (95% CL)	λ_s	λ_a
North slope	6458 (5,504)	0.997 (0.978-1.016)	0.993 (0.991-0.995)	1.001
YKD	4503 (5,396)	1.042 (1.031-1.053)	1.038 (1.036-1.041)	1.046
Arctic Russia	137448	1.0	1.0 (0.9690-1.0199)	1.0

The working group also provided a single estimate of adult female (ages 1-year and older) survival of 0.82 with an estimate of process variation (σ^2) of 0.007 for all 3 populations. I parameterized a 3-stage structured matrix model (Table 2) using the specified survival rate and solved for the fertility values (Table 2, top row of each model) that would yield the appropriate deterministic λ_d .

Stochastic environments that affected only survival were simulated using a β -distribution with the mean and variance specified above. I used the square-root of the variance to approximate the standard deviation of the survival rate (0.0837).

In stochastic environments, λ_a , are always less than those for models based on the same parameterization projected in a deterministic environment. **It was my understanding that the population growth rates provided by the working group assumed were λ_s , the average long term population growth rates for the populations in a stochastic environment.** Therefore, I λ_s for each population from 500 iterations of 5000 years, and estimated a fertility value that would yield a λ_s nearer to the desired values by first calculating $\lambda_a = \lambda_d - \lambda_s + \lambda_d$ and solving for a new fertility value to yield λ_a . These values (Table 3) and the associated age structures were used in all further stochastic projections including simulated catastrophes.

Since the breeding population estimates are assumed to include all females >3-years old and 26% of 2-year old females. The total population of females (N_f) for trials was estimated by the estimated number of breeding females divided by the sum of the portion of females >3-years old and 0.26 times the portion 2-year old females estimated from the asymptotic population age structure. The asymptotic age structure of the female population was estimated from the right eigenvector of the dominant eigenvalue of the matrix model for each population. N_f was estimated at 9,040, 6,793, and 193,379 for NS, YKD, and AR. Under the assumption of equal sex ratios this equates to 18,079, 13,586, and 386,755 birds in the three populations.

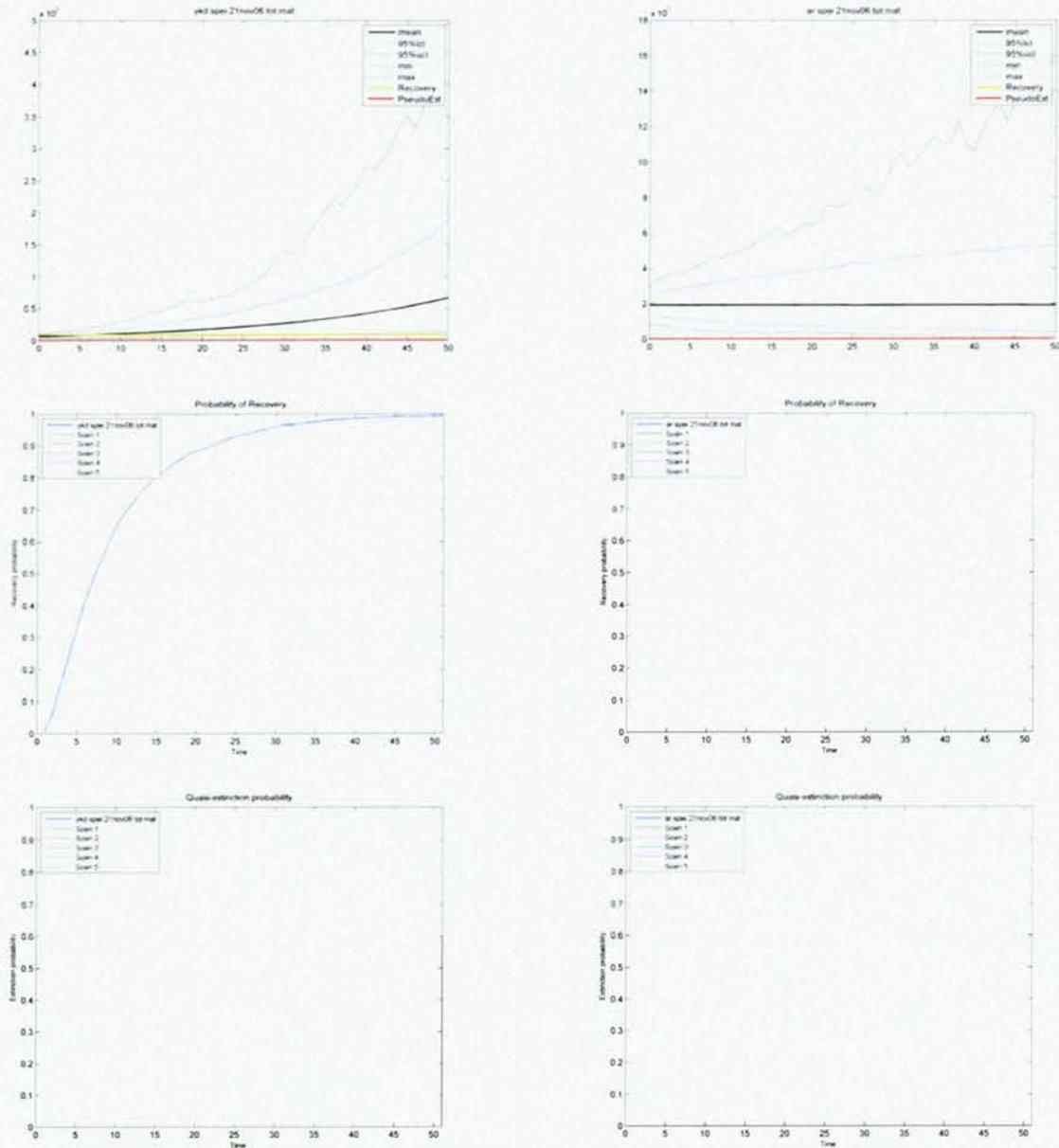
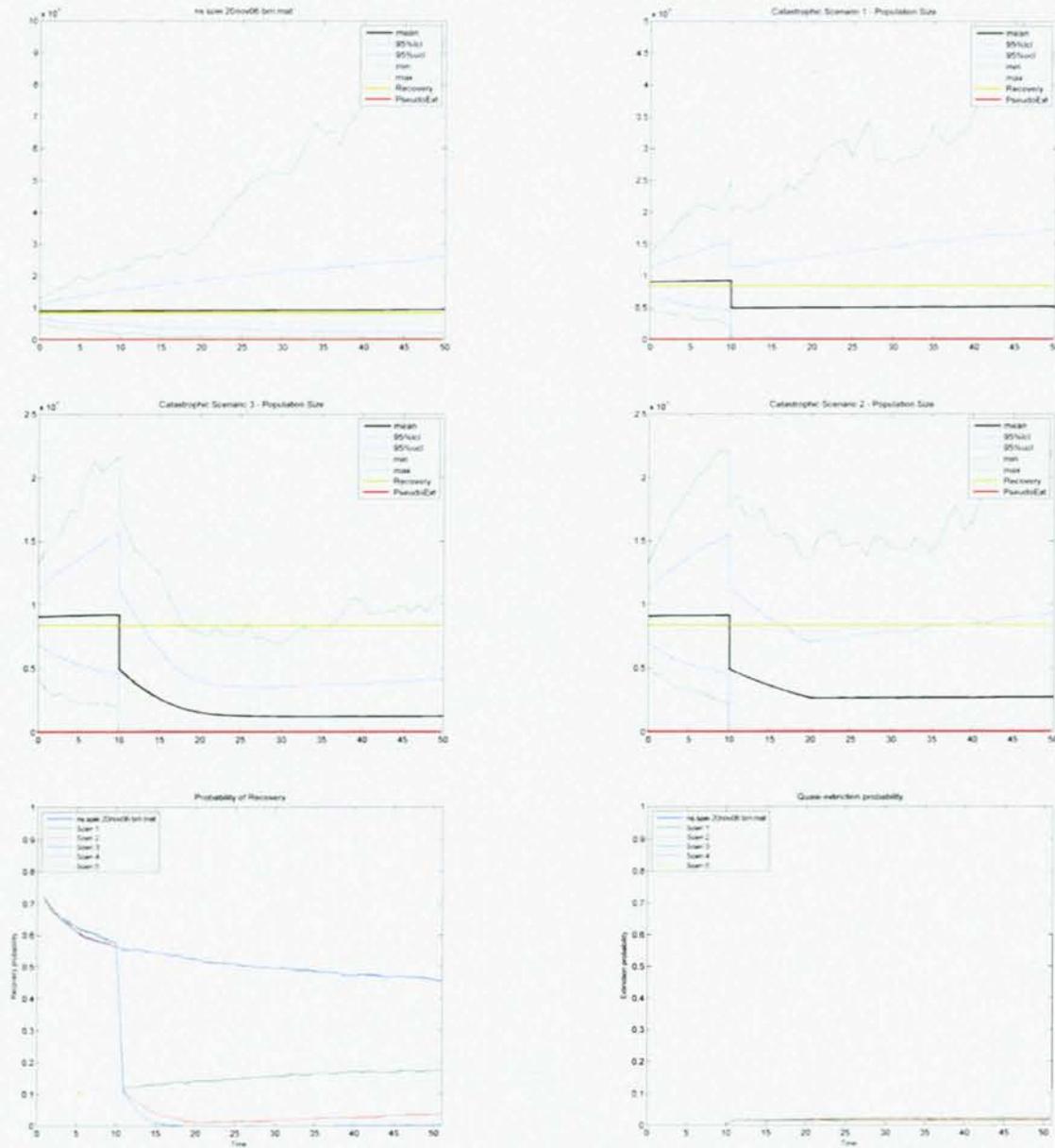


Figure 5. Results of 5000 trials of 50 year projections for Yukon-Kuskokwim Delta (left) and Arctic Russia (right) populations of Spectacled Eiders. Upper-left panel is the 50-year stochastic projection of the population. The lower panels depict the portion of trials (probability) in which the population recovers, i.e. exceeds the population goal of 6000 breeding females each year (middle) or becomes quasi-extinct, i.e. <50 total females remaining (bottom).



es of 50
 projection for North Slope Populations of Spectacled Eiders. (Brown bird losses include females and <1-yr old males in proportion to population structure just prior to census time.) Projections (top 4 panels are for **total** females (y-axis, including nonbreeders) over 50 years (x-axis). Upper-left panel is the 50-year stochastic projection without catastrophic loss. Scenario 1 includes the single catastrophic event (i.e., removal of the birds (Note that fewer than 5000 females are lost). Scenario 2 depicts removal and the reduction of survival by 6.46% for 10 years following removal. Scenario 3 depicts removal and an initial reduction of survival by 13.90% which decays to 6.95% by 10 years post-removal. The lower panels depict the portion of trials (probability) in which the population recovers (exceeds the population goal of 6000 breeding females each year) or becomes quasi-extinct (<50 total females remaining).

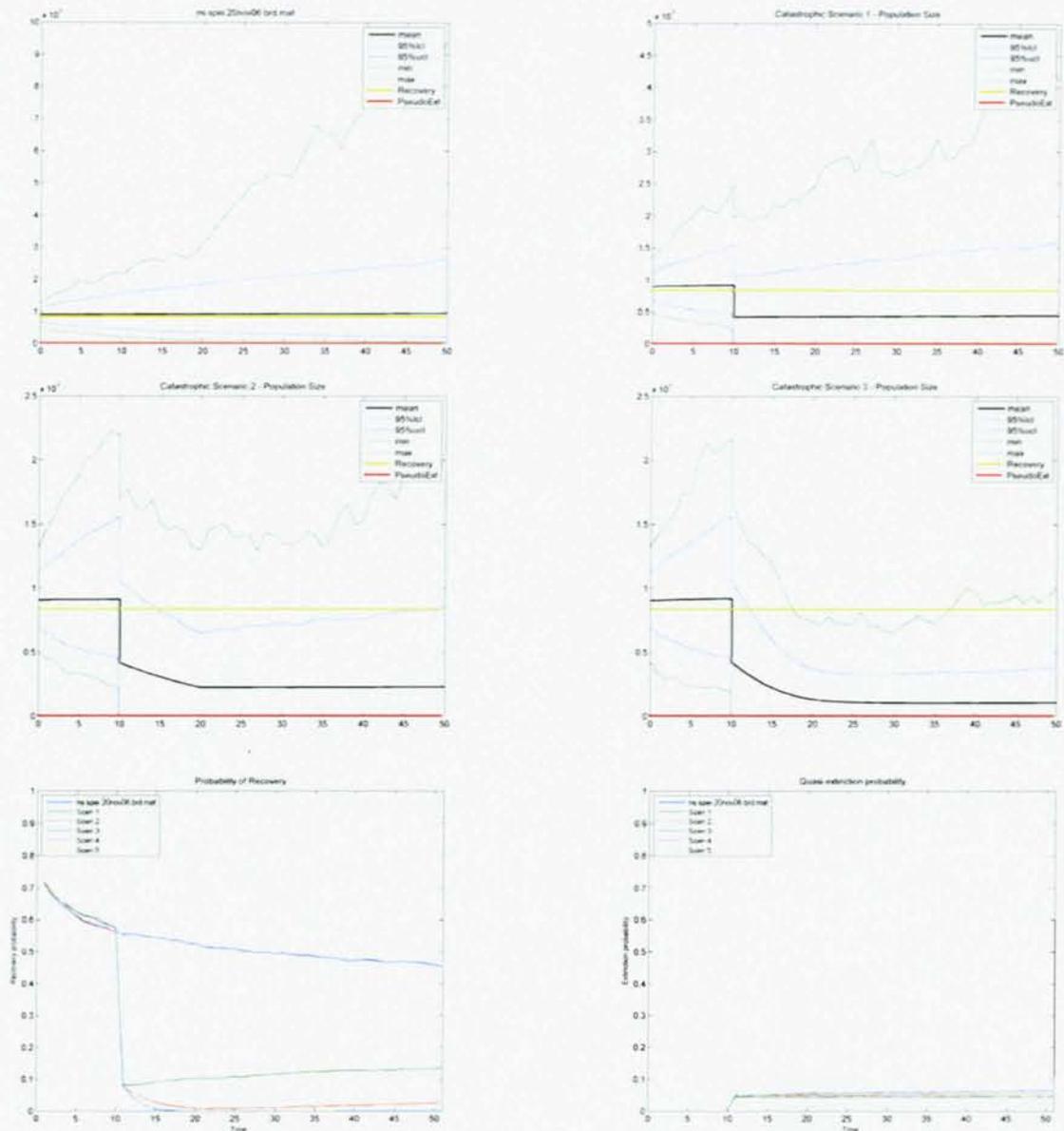


Figure 4. Results of 5000 trials for catastrophic losses of 5000 breeding females and offspring in year 10 of 50-year projection for North Slope Populations of Spectacled Eiders. (Breeding females includes 26% of two-year olds and all >3-year olds and male and female offspring in proportion to population structure just prior to census time.) Projections (top 4 panels are for **total** females (y-axis, including nonbreeders) over 50 years (x-axis). Upper-left panel is the 50-year stochastic projection without catastrophic loss. Scenario 1 includes the single catastrophic event (i.e., removal of the birds (Note that fewer than 5000 females are lost). Scenario 2 depicts removal and the reduction of survival by 6.46% for 10 years following removal. Scenario 3 depicts removal and an initial reduction of survival by 13.90% which decays to 6.95% by 10 years post-removal. The lower panels depict the portion of trials (probability) in which the population recovers (exceeds the population goal of 6000 breeding females each year) or becomes quasi-extinct (<50 total females remaining).

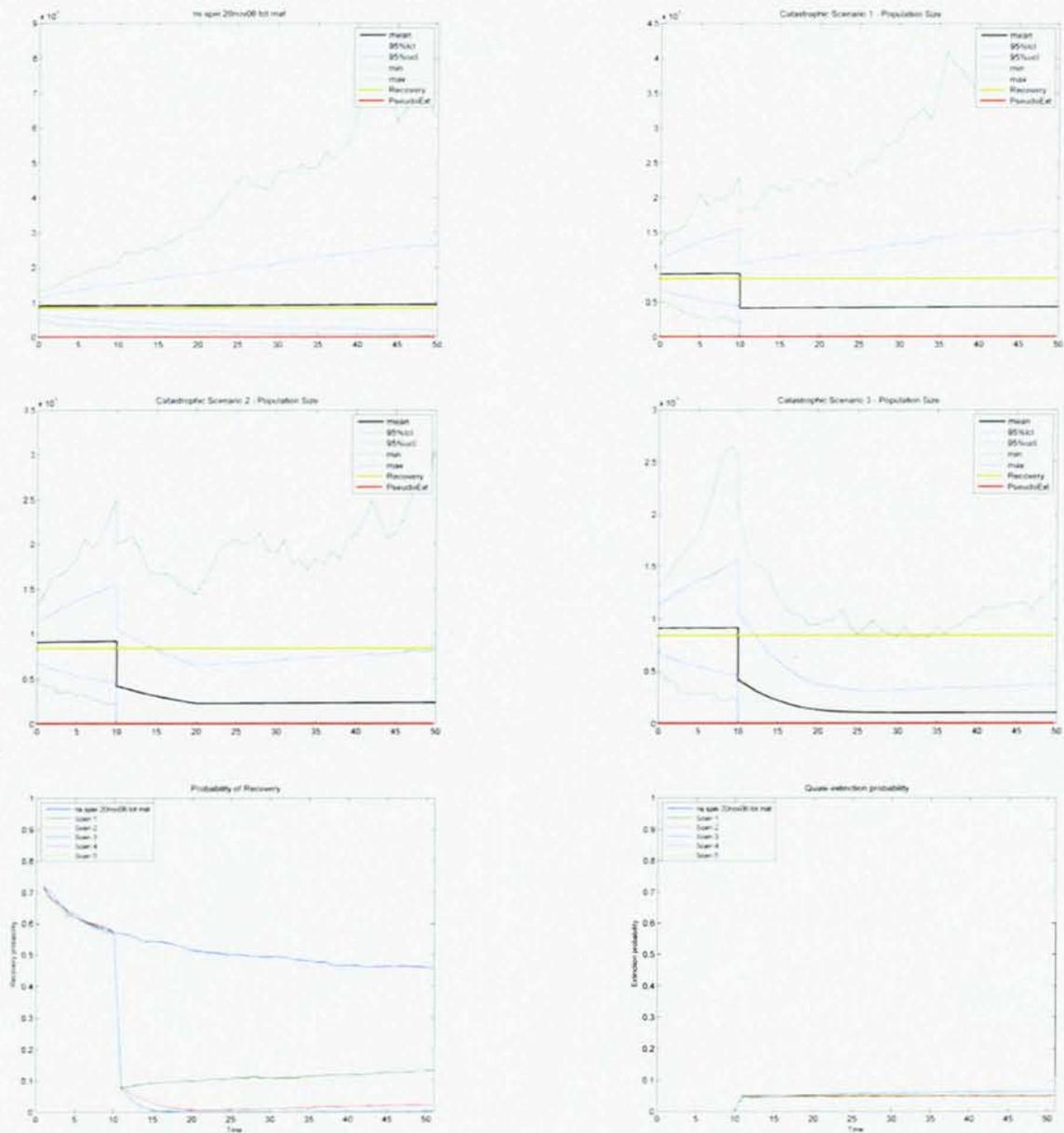


Figure 5. Results of 5000 trials for catastrophic losses of 5000 females in year 10 of 50-year projection for North Slope Populations of Spectacled Eiders. (Losses include females of all ages in proportion to population structure just prior to census time.) Projections (top 4 panels are for **total** females (y-axis, including nonbreeders) over 50 years (x-axis). Upper-left panel is the 50-year stochastic projection without catastrophic loss. Scenario 1 includes the single catastrophic event (i.e., removal of the birds (Note that fewer than 5000 females are lost). Scenario 2 depicts removal and the reduction of survival by 6.95% for 10 years following removal. Scenario 3 depicts removal and an initial reduction of survival by 13.90% which decays to 6.95% by 10 years post-removal. The lower panels depict the portion of trials (probability) in which the population recovers (exceeds the population goal of 6000 breeding females each year) or becomes quasi-extinct (<50 total females remaining).

Each 50-year trial ($n = 5000$) in each simulation was initialized with N_t drawn at random from a normal distribution with mean and standard deviation derived from the parameters in Table 1, except for the population from Arctic Russia, for which the estimate was assumed to have a CV of 0.15 (standard deviation = 29007). All projections begin with the asymptotic stable age structure. I assumed that the population was 50% male and the distribution of males among age classes was equal to that of females. Recovery probabilities are computed at each time step in each simulation as the portion of trials in which the estimated breeding population exceeded 6,000 females. Based on the expected age distribution, this equates to 8,398, 9,051, and 8,441 females in the spring populations for the NS, YKD, and AR. Quasi-extinction probabilities are computed as the portion of trials in which the estimated breeding population was less than 50 females.

Catastrophes

Parameters for simulated catastrophes were provided by the working group in Anchorage. The catastrophes were assumed to only influence the North Slope population. Each scenario simulated killing 5000 birds immediately before the population census year 10 of a 50-year projection.

1. This catastrophe kills females and one-year old males in proportion to the population structure.
2. This scenario kills only females in proportion to their abundance.
3. This scenario kills only breeding females (all females >3-years old, 26% of 2-year olds).
4. Same as Scenario 1, and survival is reduced by 0.057 for 10 years after the catastrophe.
5. Same as Scenario 2, and survival is reduced by 0.057 for 10 years after the catastrophe.
6. Same as Scenario 3, and survival is reduced by 0.057 for 10 years after the catastrophe.

Table 2. Deterministic matrix models (green), eigenvalues (pink) and age structure (yellow) for Spectacled Eider populations.

North Slope		
0	0.064	0.248
0.82	0	0
0	0.82	0.82
Eigenvalues		
Real	Imaginary	Age/stage struct
0.997	0	0.1775
-0.088	0.340	0.1460
-0.088	-0.340	0.6765
YKD		
0	0.087	0.335
0.82	0	0
0	0.82	0.82
Eigenvalues		
Real	Imaginary	Age/stage struct
1.042	0	0.2131
-0.111	0.384	0.1677
-0.111	-0.384	0.6193
Arctic Russia		
0	0.066	0.253
0.82	0	0
0	0.82	0.82
Eigenvalues		
Real	Imaginary	Age/stage struct
1.000	0	0.1800
-0.090	0.343	0.1476
-0.090	-0.343	0.6724

7. Same as Scenario 1, and survival is reduced initially by 0.114, this effect decays (Figure 1) such that by year 10 survival is still 0.057 below the pre-catastrophe rate, and is essentially gone by year 20 post-catastrophe.
8. Same as Scenario 2, and survival is reduced initially by 0.114, this effect decays (Figure 1) such that by year 10 survival is still 0.057 below the pre-catastrophe rate, and is essentially gone by year 20 post-catastrophe.
9. Same as Scenario 3, , and survival is reduced initially by 0.114, this effect decays (Figure 1) such that by year 10 survival is still 0.057 below the pre-catastrophe rate, and is essentially gone by year 20 post-catastrophe.

For scenarios 1, 4, and 7, the number of individuals killed in each segment of the population was determined by first adding the expect portion of one-year old males to the sum of the portions of females of all ages (0.5). The portion of one-year old males and females of each age class were then divided by this number to determine the structure of the simulated kill. The number of birds killed in each class was determined by multiplying the total killed by the resulting portions. The resulting values were then subtracted from the population vector (i.e., the number of individuals of each age class) prior to the population census.

For scenarios 2, 5, and 8, the number of individuals killed in each segment of the population was determined multiplying the portion of females in each age class by the total kill. The resulting values were then subtracted from the population vector (i.e., the number of individuals of each age class) prior to the population census.

For scenarios 3, 6, and 9, the number of individuals killed in each segment of the population portion of two-year old females by 0.26 to determine the portion of breeding two-year old females. The portion of breeding 2-year old females and the portion of three and older females affected was divided by their sum to determine the structure of the simulated kill. The number of birds killed in each class was determined by multiplying the total killed by the resulting portions. The resulting values were then subtracted from the population vector (i.e., the number of individuals of each age class) prior to the population census.

For scenarios 4-6, the survival rate of the population was lowered by 0.057, by implementing a 6.95% reduction in survival for 10 years following the simulated catastrophe. For scenarios 7-9, a sigmoid decay function:

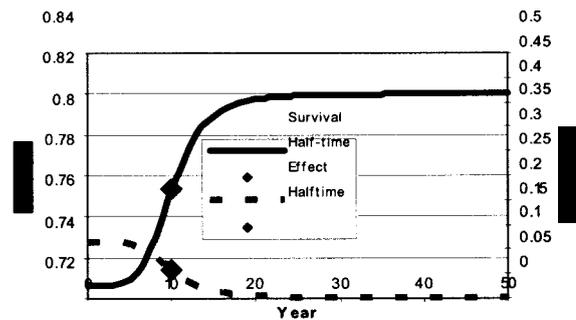


Figure 1. Simulated effect on annual survival that decays with an initial .0114 (13.90%) decrease in survival ($S_1 = 0.1292S_0$, where S_1 is the survival rate in the first year after the event and S_0 is the initial condition), half life of 10 years, and $b = 5$ (Equation 1.1).

$$f(t) = \frac{a}{1 + \left(\frac{t}{t_{50}}\right)^b} \tag{1.1}$$

was used to simulate an initial reduction in survival of 0.114 (α)(13.90%), that decayed based on Equation 1.1 such that by 10 years and 20 years post-catastrophe the survival rate was 0.057 and 0.003 lower than the base rate (i.e., half-life of $t_{50} = 10$ years, Figure 2)

Results

(see attached text files for complete model parameterization and output) As Figure 2 and the upper panels in Figures 3-5 illustrate at their current rate of growth the YKD, AR, and NS populations have no apparent probability of extinction, but the YKD and NS populations demonstrate some probability of falling below the recovery goal

As illustrated in Figures 3-5, the consequences of the catastrophic scenarios on population growth rates, quasi-extinction, and recovery are similar regardless of the structure of the loss.

Because these populations are assumed to be independent, closed, and not currently affected by density dependence, the effect of a catastrophe affecting only the NS population would likely have little effect on the global population. I did not cast a global model, but the results should be very similar to adding the stochastic results for the three extant populations considered above.

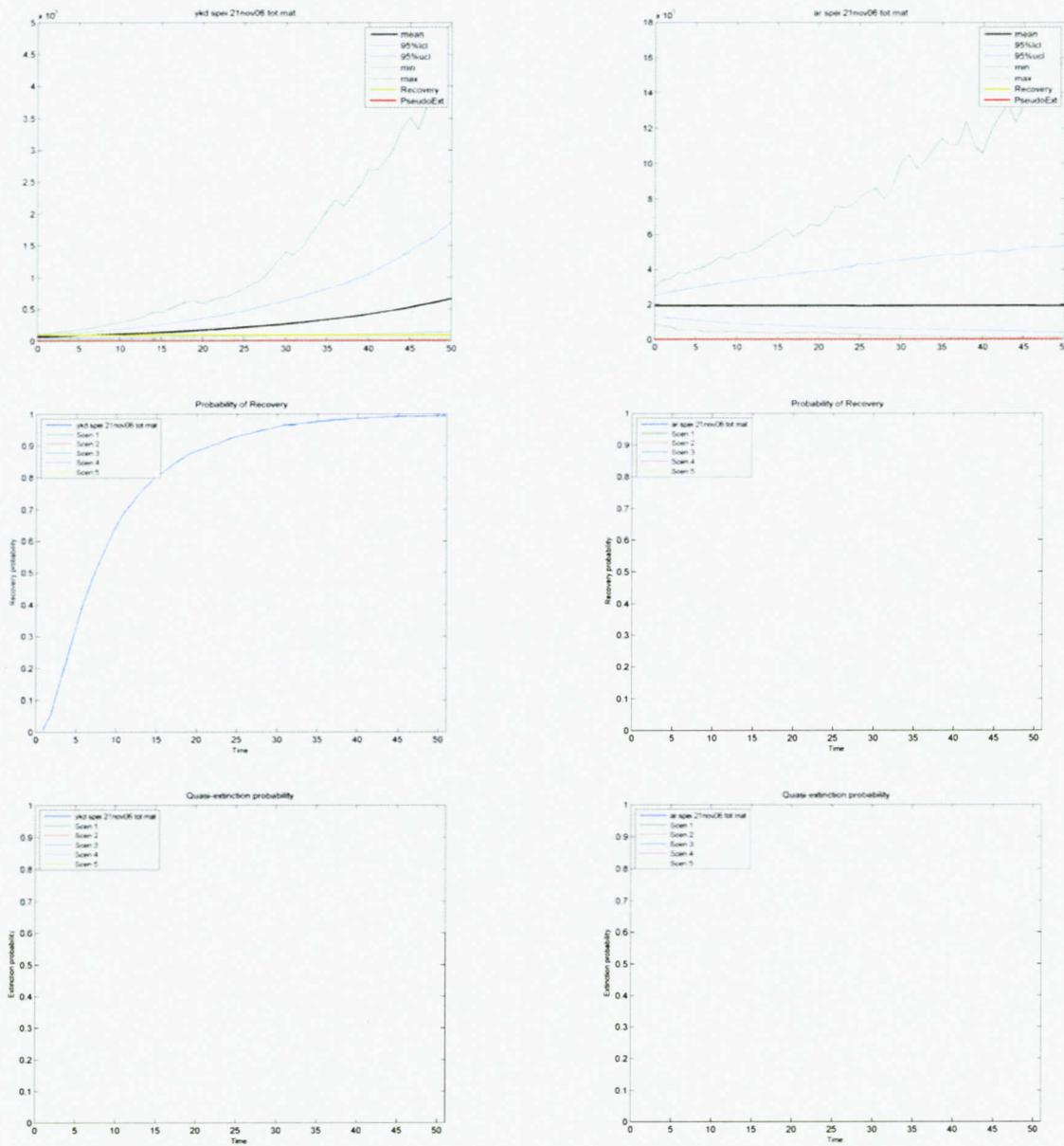
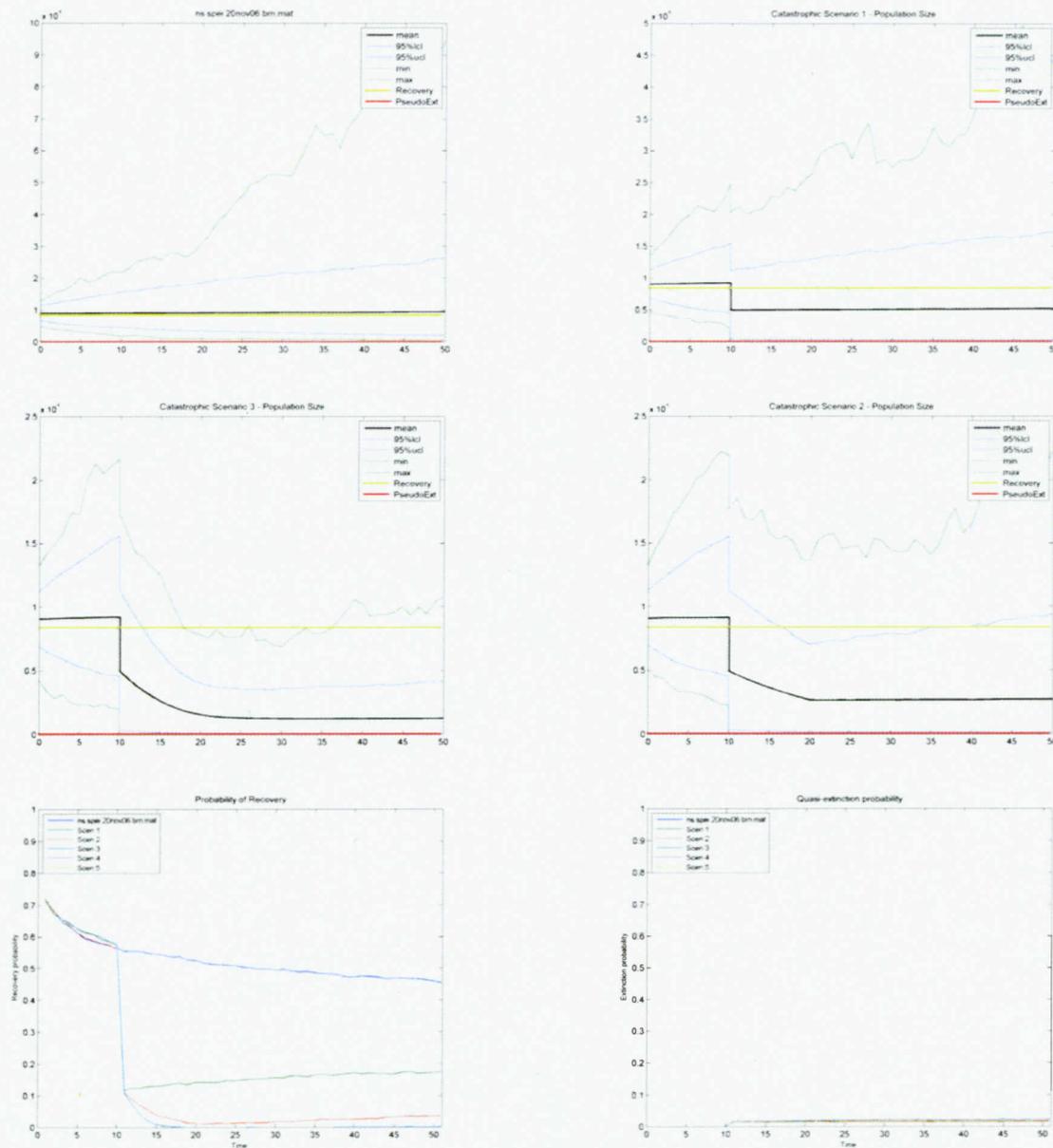


Figure 5. Results of 5000 trials of 50 year projections for Yukon-Kuskokwim Delta (left) and Arctic Russia (right) populations of Spectacled Eiders. Upper-left panel is the 50-year stochastic projection of the population. The lower panels depict the portion of trials (probability) in which the population recovers, i.e. exceeds the population goal of 6000 breeding females each year (middle) or becomes quasi-extinct, i.e. <50 total females remaining (bottom).



es of 50

projection for North Slope Populations of Spectacled Eiders. (Brown bird losses include females and <1-yr old males in proportion to population structure just prior to census time.) Projections (top 4 panels are for **total** females (y-axis, including nonbreeders) over 50 years (x-axis). Upper-left panel is the 50-year stochastic projection without catastrophic loss. Scenario 1 includes the single catastrophic event (i.e., removal of the birds (Note that fewer than 5000 females are lost). Scenario 2 depicts removal and the reduction of survival by 6.46% for 10 years following removal. Scenario 3 depicts removal and an initial reduction of survival by 13.90% which decays to 6.95% by 10 years post-removal. The lower panels depict the portion of trials (probability) in which the population recovers (exceeds the population goal of 6000 breeding females each year) or becomes quasi-extinct (<50 total females remaining).

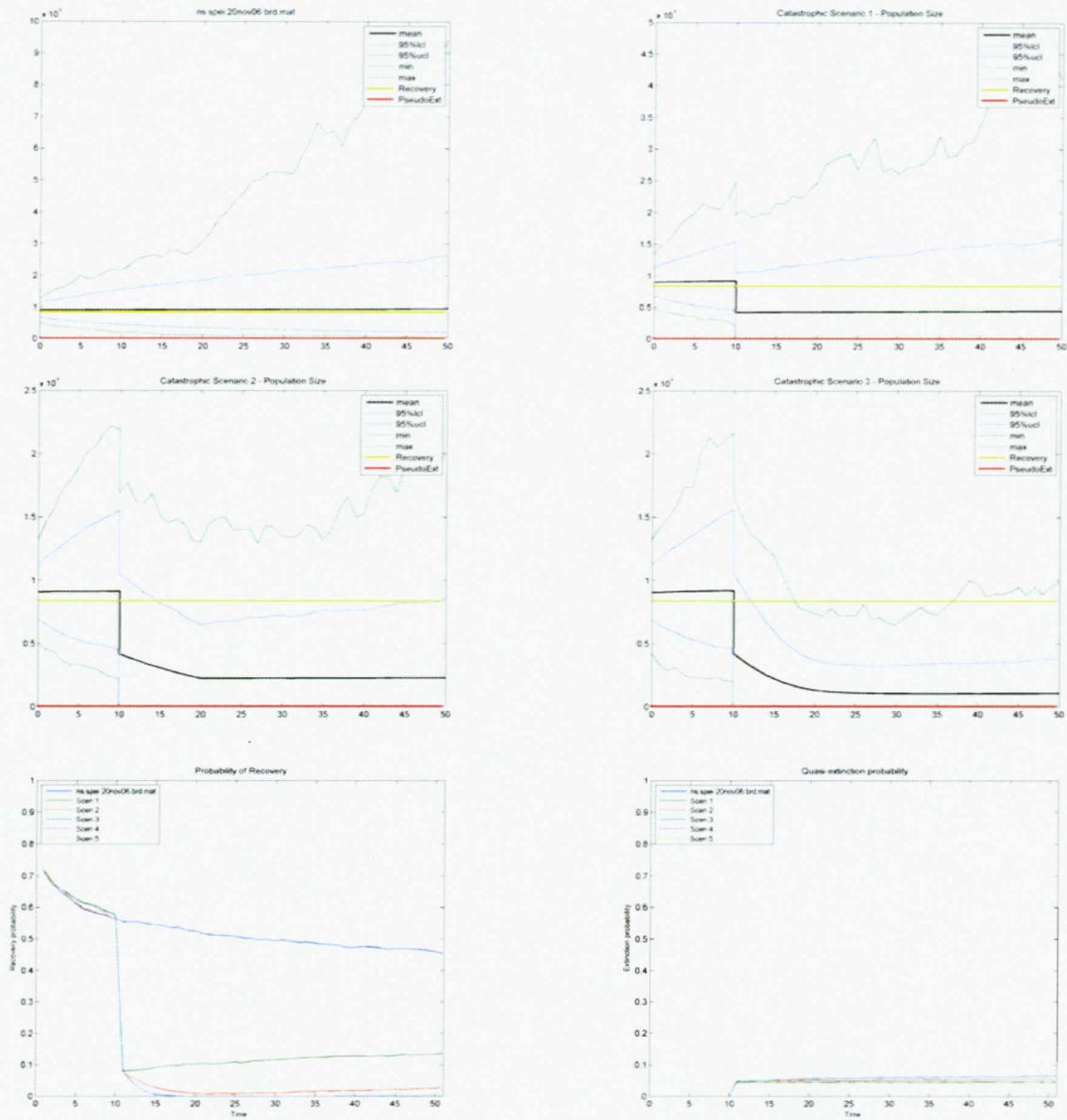


Figure 4. Results of 5000 trials for catastrophic losses of 5000 breeding females and offspring in year 10 of 50-year projection for North Slope Populations of Spectacled Eiders. (Breeding females includes 26% of two-year olds and all >3-year olds and male and female offspring in proportion to population structure just prior to census time.) Projections (top 4 panels are for **total** females (y-axis, including nonbreeders) over 50 years (x-axis). Upper-left panel is the 50-year stochastic projection without catastrophic loss. Scenario 1 includes the single catastrophic event (i.e., removal of the birds (Note that fewer than 5000 females are lost). Scenario 2 depicts removal and the reduction of survival by 6.46% for 10 years following removal. Scenario 3 depicts removal and an initial reduction of survival by 13.90% which decays to 6.95% by 10 years post-removal. The lower panels depict the portion of trials (probability) in which the population recovers (exceeds the population goal of 6000 breeding females each year) or becomes quasi-extinct (<50 total females remaining).

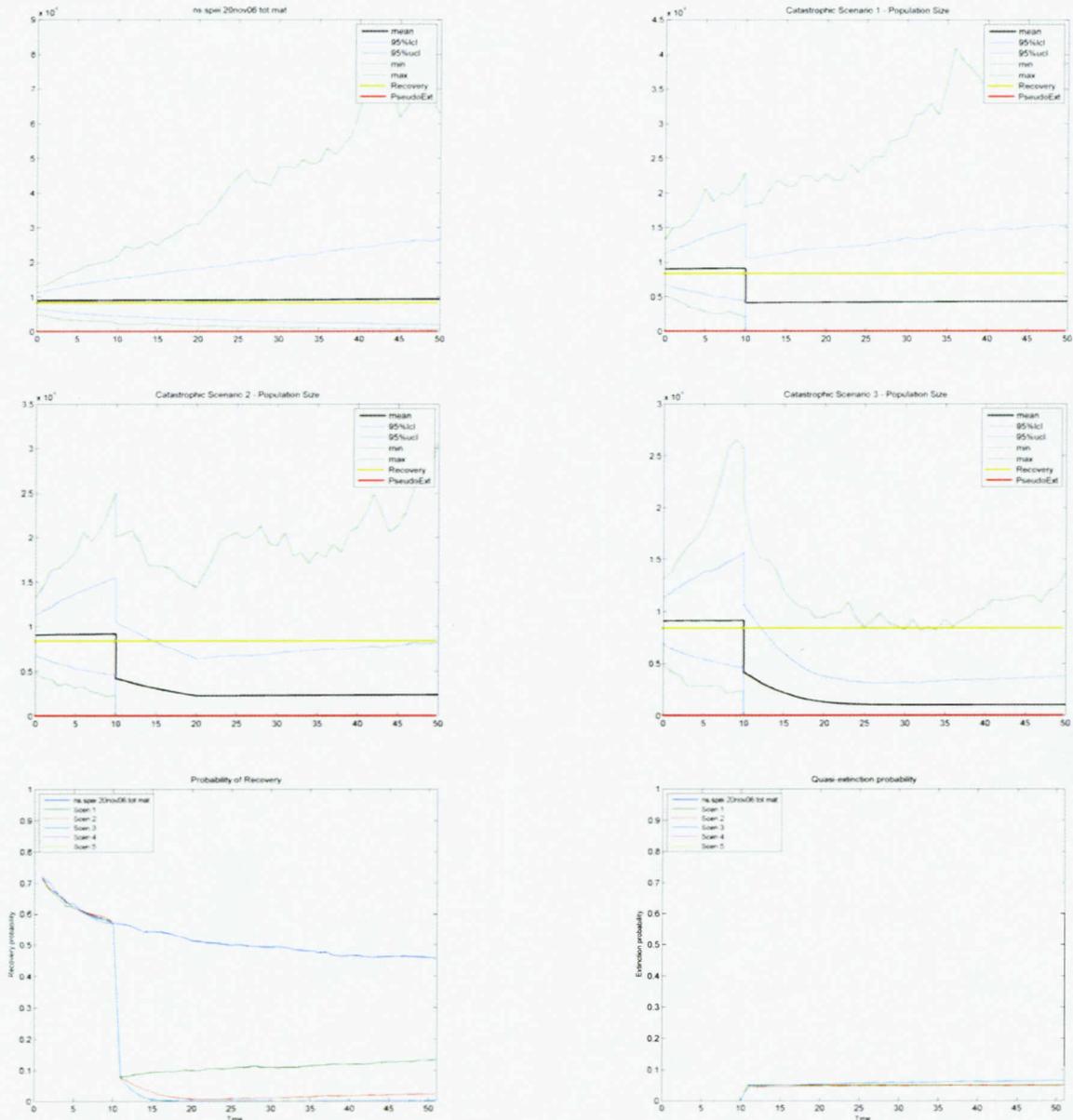


Figure 5. Results of 5000 trials for catastrophic losses of 5000 females in year 10 of 50-year projection for North Slope Populations of Spectacled Eiders. (Losses include females of all ages in proportion to population structure just prior to census time.) Projections (top 4 panels are for **total** females (y-axis, including nonbreeders) over 50 years (x-axis). Upper-left panel is the 50-year stochastic projection without catastrophic loss. Scenario 1 includes the single catastrophic event (i.e., removal of the birds (Note that fewer than 5000 females are lost). Scenario 2 depicts removal and the reduction of survival by 6.95% for 10 years following removal. Scenario 3 depicts removal and an initial reduction of survival by 13.90% which decays to 6.95% by 10 years post-removal. The lower panels depict the portion of trials (probability) in which the population recovers (exceeds the population goal of 6000 breeding females each year) or becomes quasi-extinct (<50 total females remaining).