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

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 % x 12,916 = 0.31 spectacled eiders killed by collisions/year/structure, and
0.0024% x 500 = 0.012 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 $\leq$ 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

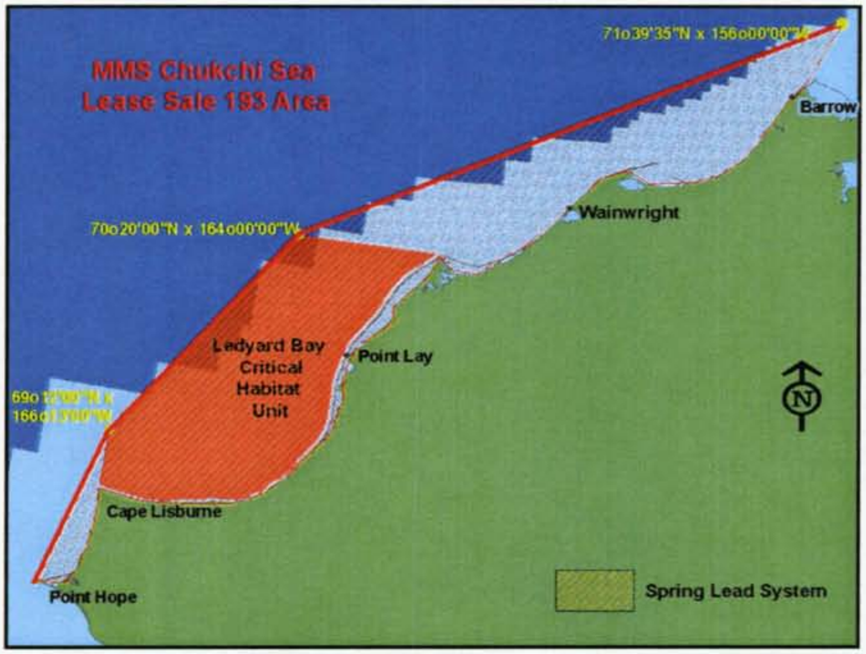

Figure 9.1 Spring Lead System for Information Needs and Terms and Conditions

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.

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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 - 3/12/07	Discussions between MMS and Service regarding proposed reasonable 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 Ledayrd 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 137,600km^2 (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.

<u>Aims of the Meeting</u>
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 =

Trend =

Y-K Delta
Population Size =

Trend =

Russian
Population Size =

Trend =

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 =

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.

Siesmic 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/km^2 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 km^2 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 km^2 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.

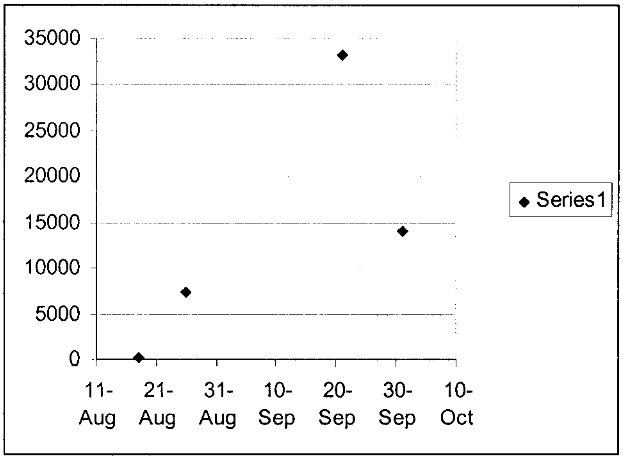
Bob Stehn: one way to look at it is to take the scenario in which, say, in the spring, all North Slope breeding birds and sub-adults (plus Steller's eiders) are in the spring leads.

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 bird 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.

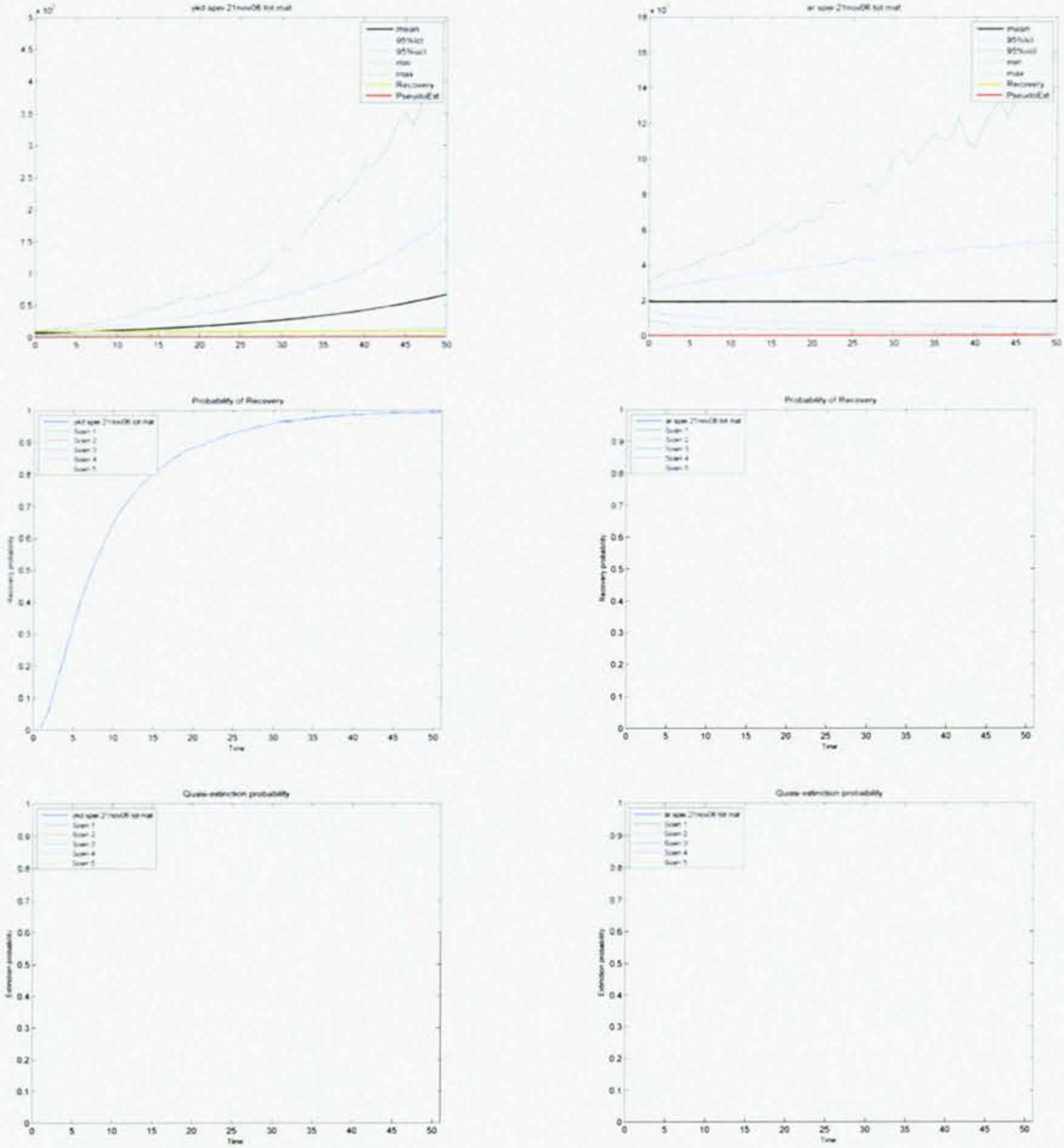
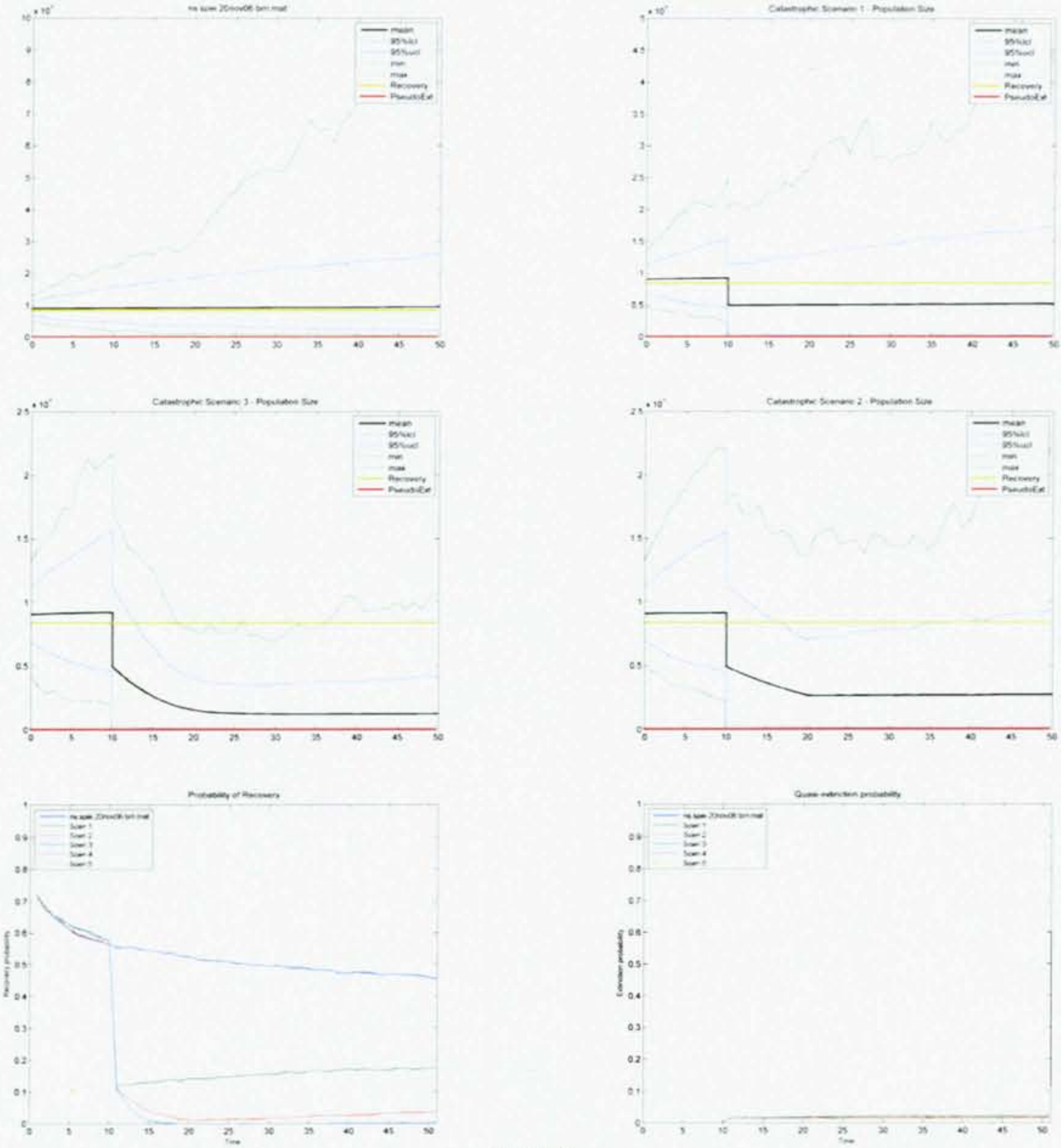


Figure 5. Results of 5000 trials of 50 year projections for Yukon-Kuskokwim Delta (left) and Arctic Russia (right) populations of Spectacled Eiders. Upper-left panel is the 50-year stochastic projection of the population. The lower panels depict the portion of trials (probability) in which the population 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).



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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).

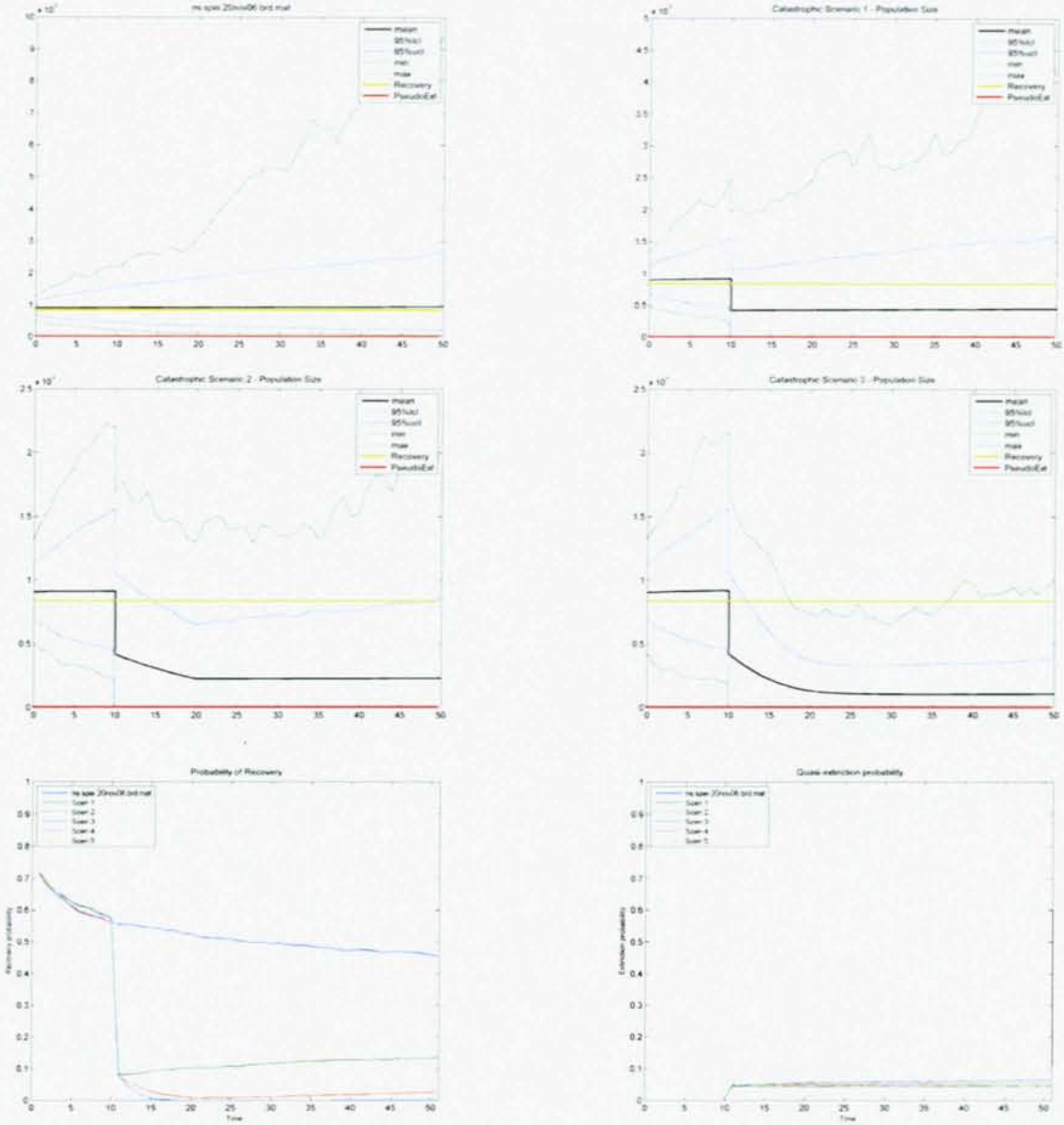


Figure 4. Results of 5000 trials for catastrophic losses of 5000 breeding females and offspring in year 10 of 50-year projection for North Slope Populations of Spectacled Eiders. (Breeding females includes 26% of two-year olds and all >3-year olds and male and female offspring in proportion to population 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).

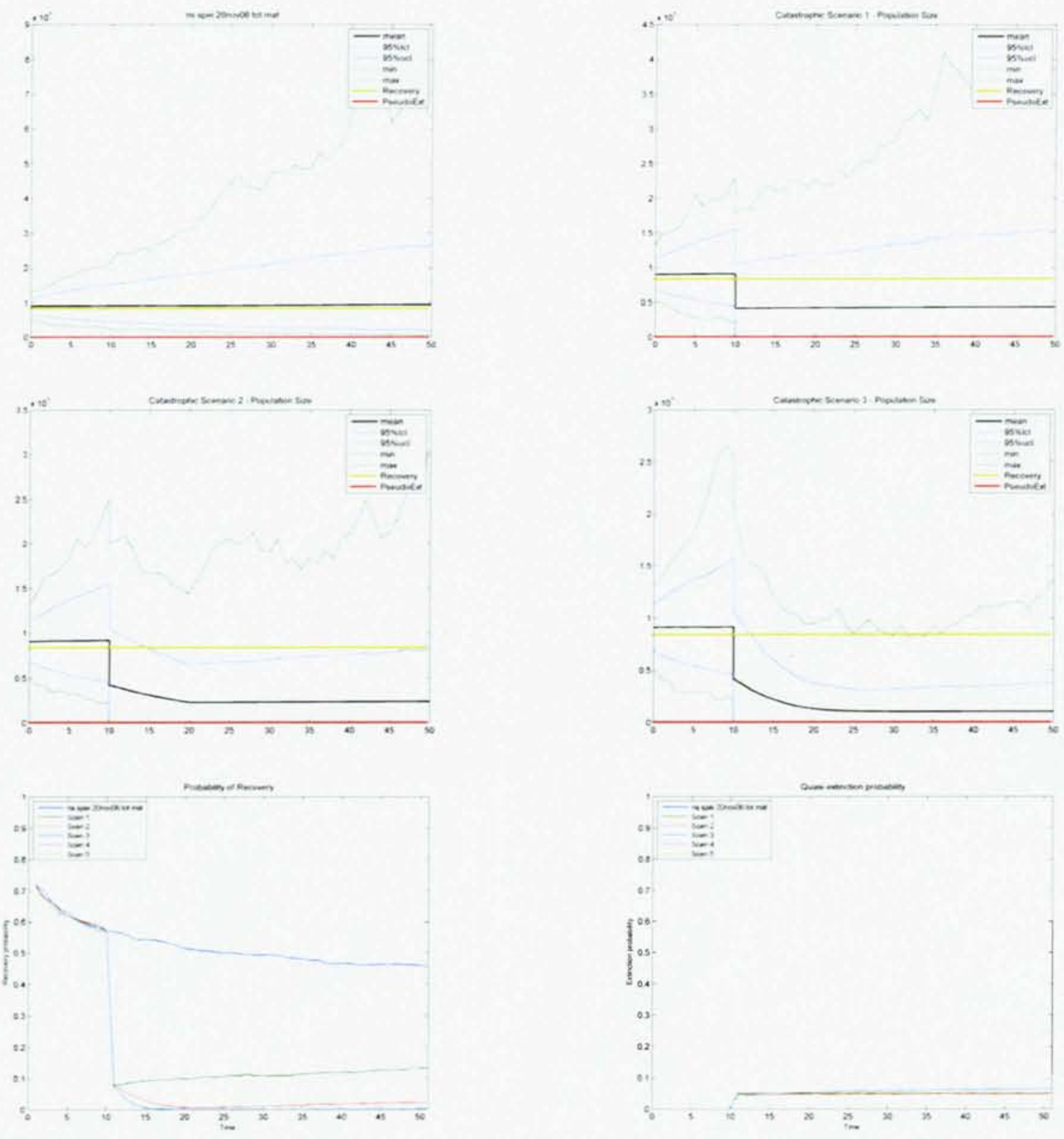


Figure 5. Results of 5000 trials for catastrophic losses of 5000 females in year 10 of 50-year projection for North Slope Populations of Spectacled Eiders. (Losses include females of all ages in proportion to population structure just prior to census time.) Projections (top 4 panels are for **total** 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_f 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.

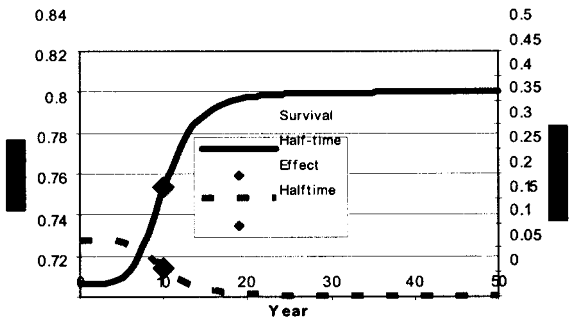


Figure 1. Simulated effect on annual survival that decays with an initial .0114 (13.90%) decrease in survival ($S_1 = 0.1292 S_0$, where S_1 is the survival rate in the first year after the event and S_0 is the initial condition), half life of 10 years, and $b = 5$ (Equation 1.1).

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 populatio 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:

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

was used to simulate an initial reduction in survival of 0.114 (a)(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 affect 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.

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 - 3/12/07	Discussions between MMS and Service regarding proposed reasonable 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 Ledayrd 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 137,600km^2 (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.

<u>Aims of the Meeting</u>
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 =

Trend =

Y-K Delta
Population Size =

Trend =

Russian
Population Size =

Trend =

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 =

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.

Siesmic 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/km^2 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 km^2 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 km^2 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.

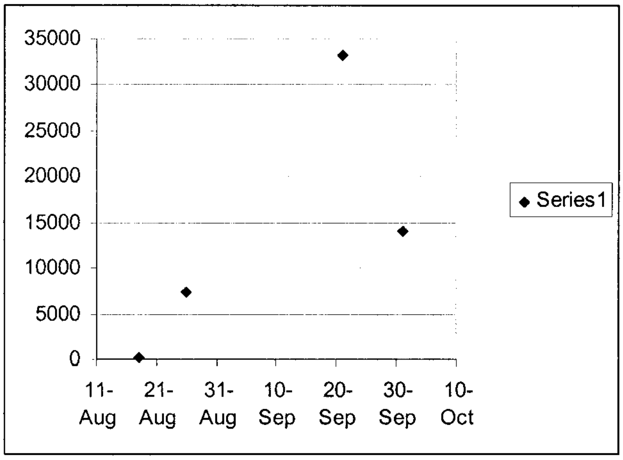
Bob Stehn: one way to look at it is to take the scenario in which, say, in the spring, all North Slope breeding birds and sub-adults (plus Steller's eiders) are in the spring leads.

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 bird 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.

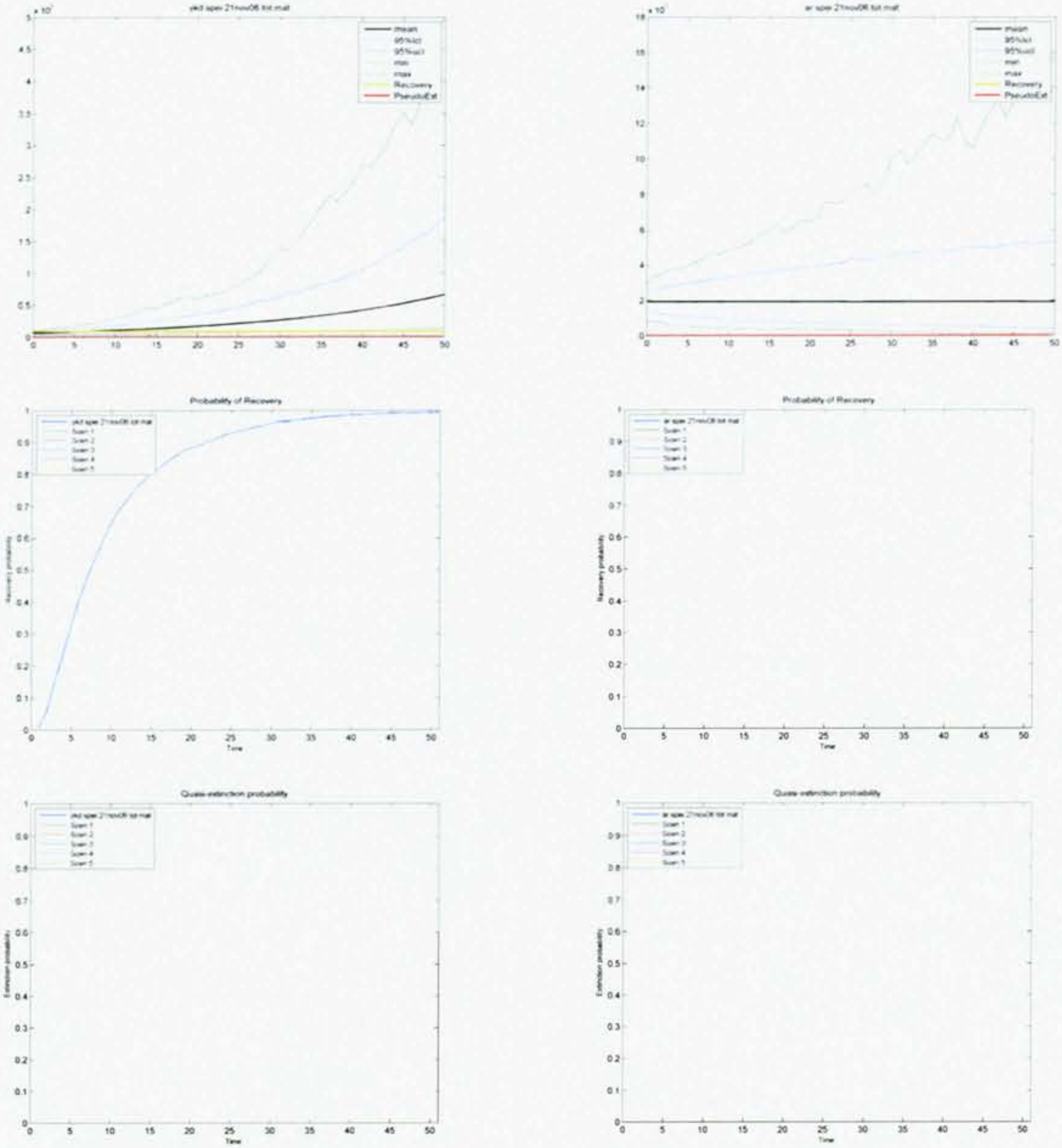
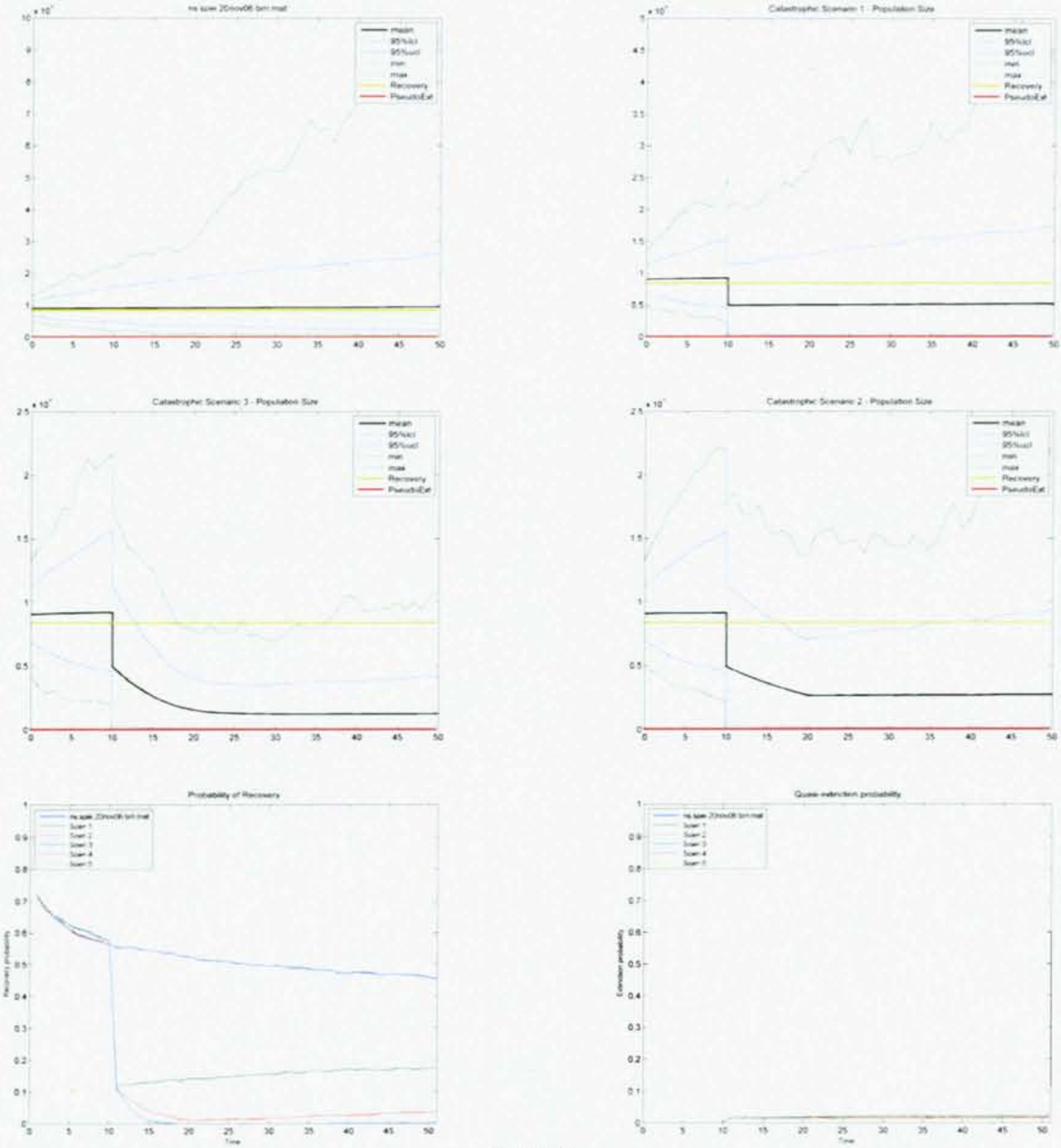


Figure 5. Results of 5000 trials of 50 year projections for Yukon-Kuskokwim Delta (left) and Arctic Russia (right) populations of Spectacled Eiders. Upper-left panel is the 50-year stochastic projection of the population. The lower panels depict the portion of trials (probability) in which the population 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).



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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).

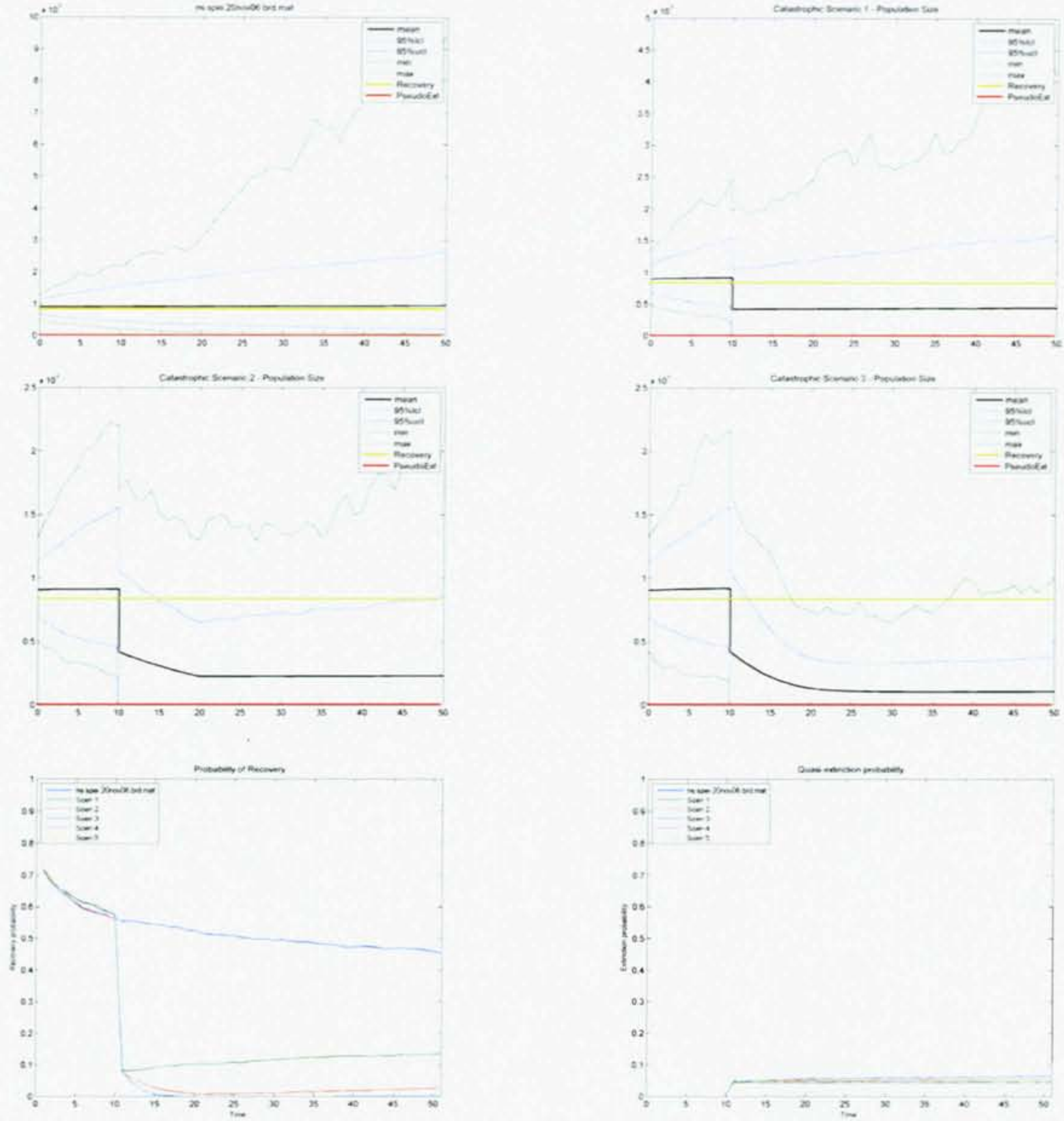


Figure 4. Results of 5000 trials for catastrophic losses of 5000 breeding females and offspring in year 10 of 50-year projection for North Slope Populations of Spectacled Eiders. (Breeding females includes 26% of two-year olds and all >3-year olds and male and female offspring in proportion to population 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).

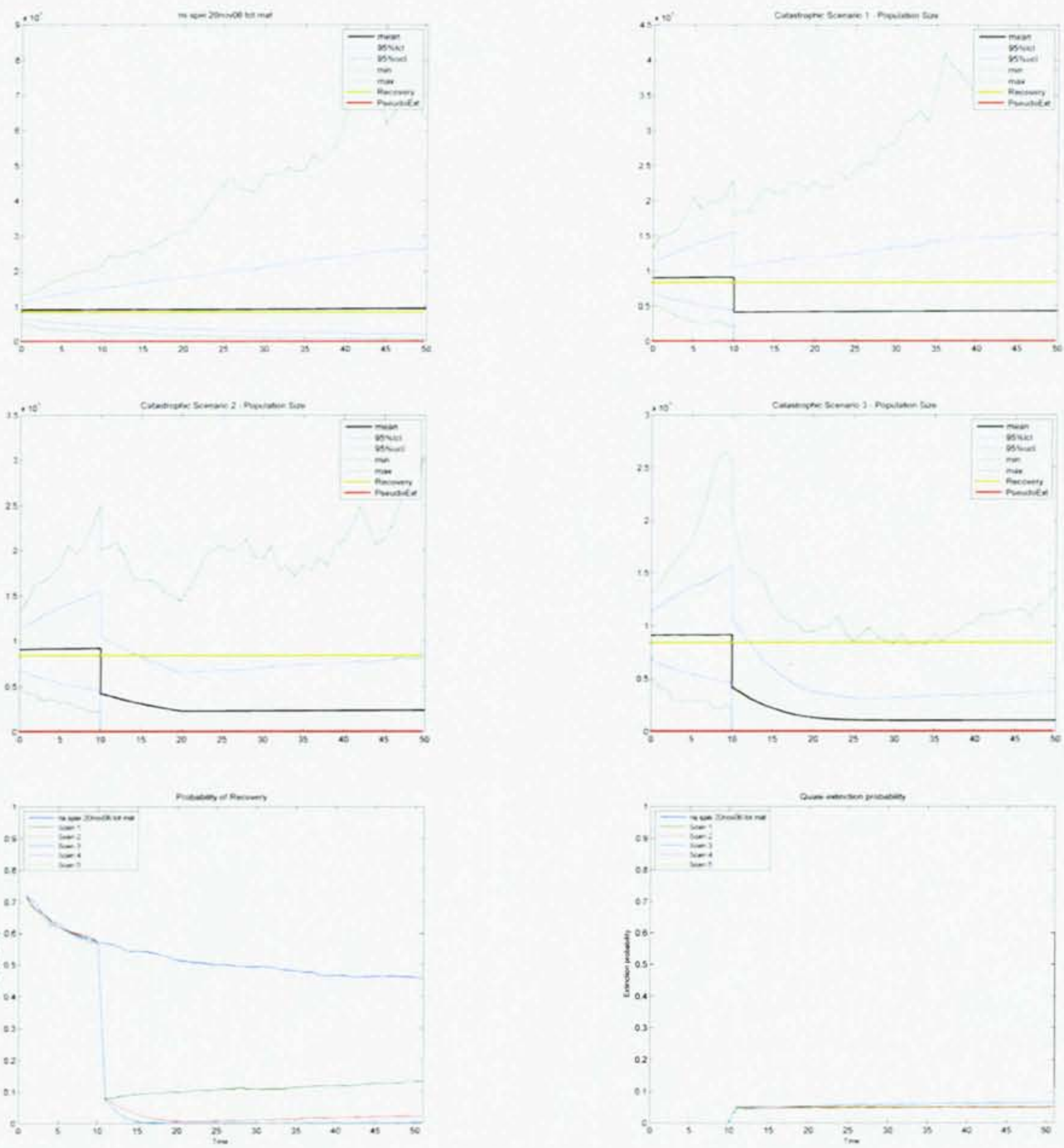


Figure 5. Results of 5000 trials for catastrophic losses of 5000 females in year 10 of 50-year projection for North Slope Populations of Spectacled Eiders. (Losses include females of all ages in proportion to population structure just prior to census time.) Projections (top 4 panels are for **total** 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_f 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.

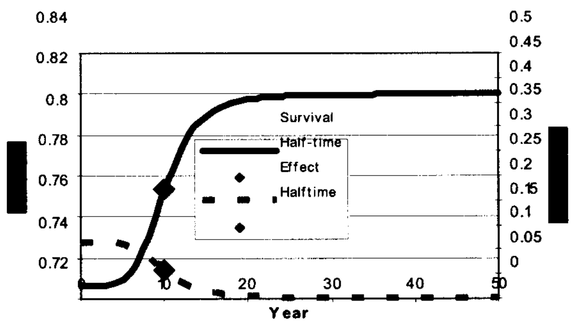


Figure 1. Simulated effect on annual survival that decays with an initial .0114 (13.90%) decrease in survival ($S_1 = 0.1292S_0$, where S_1 is the survival rate in the first year after the event and S_0 is the initial condition), half life of 10 years, and $b = 5$ (Equation 1.1).

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 populatio 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:

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

was used to simulate an initial reduction in survival of 0.114 (a)(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 affect 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.

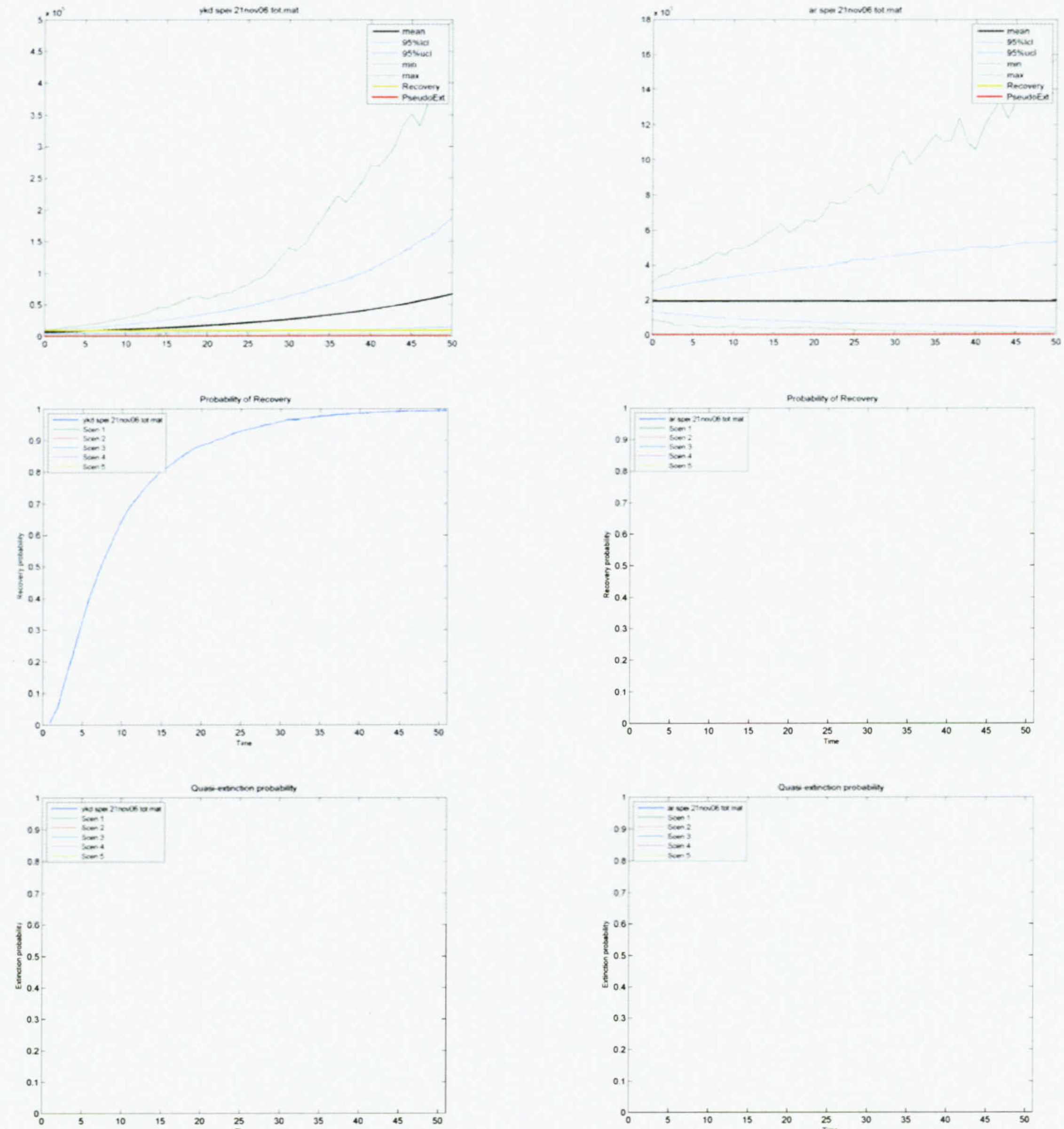
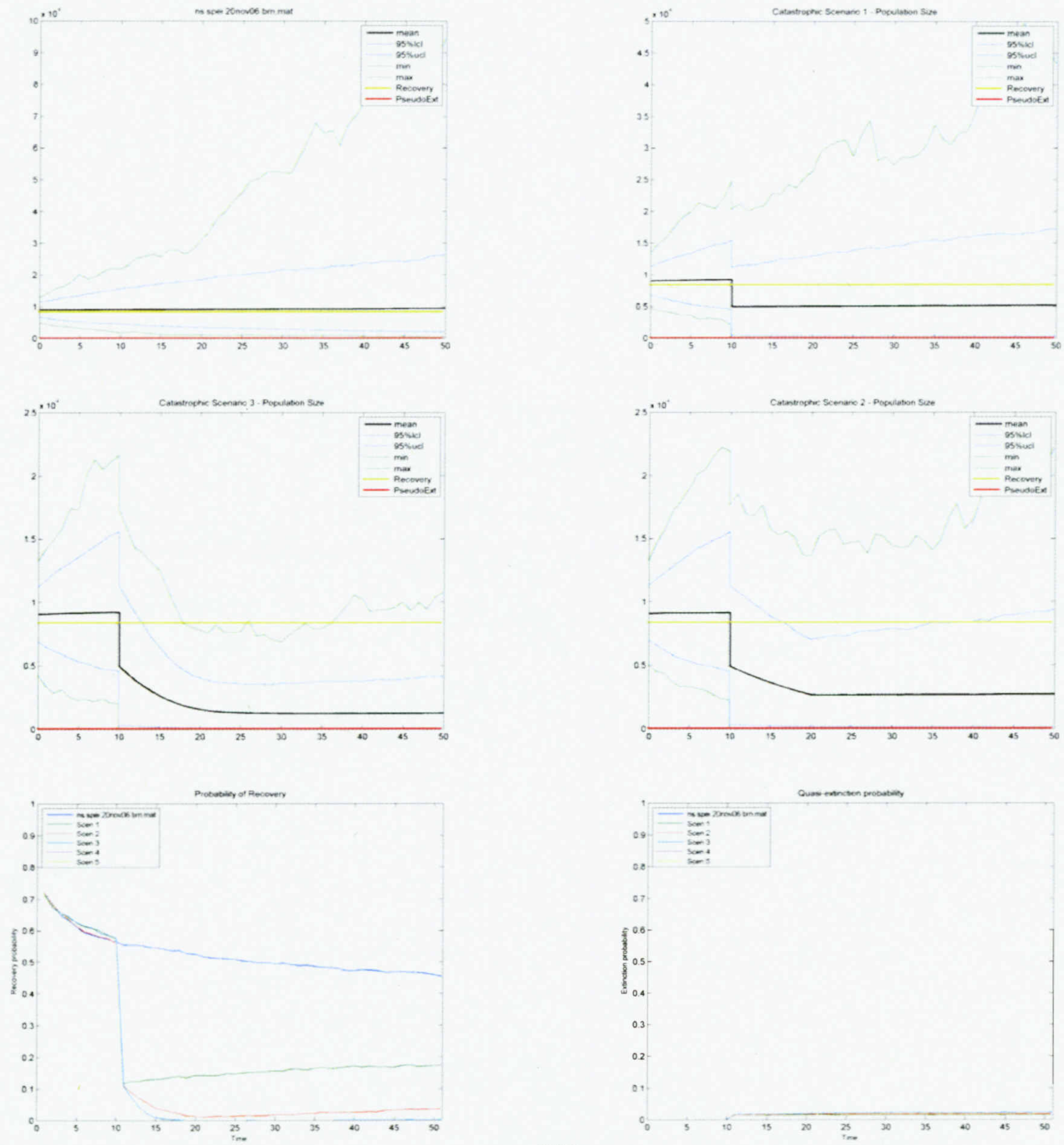


Figure 5. Results of 5000 trials of 50 year projections for Yukon-Kuskokwim Delta (left) and Arctic Russia (right) populations of Spectacled Eiders. Upper-left panel is the 50-year stochastic projection of the population. The lower panels depict the portion of trials (probability) in which the population 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).

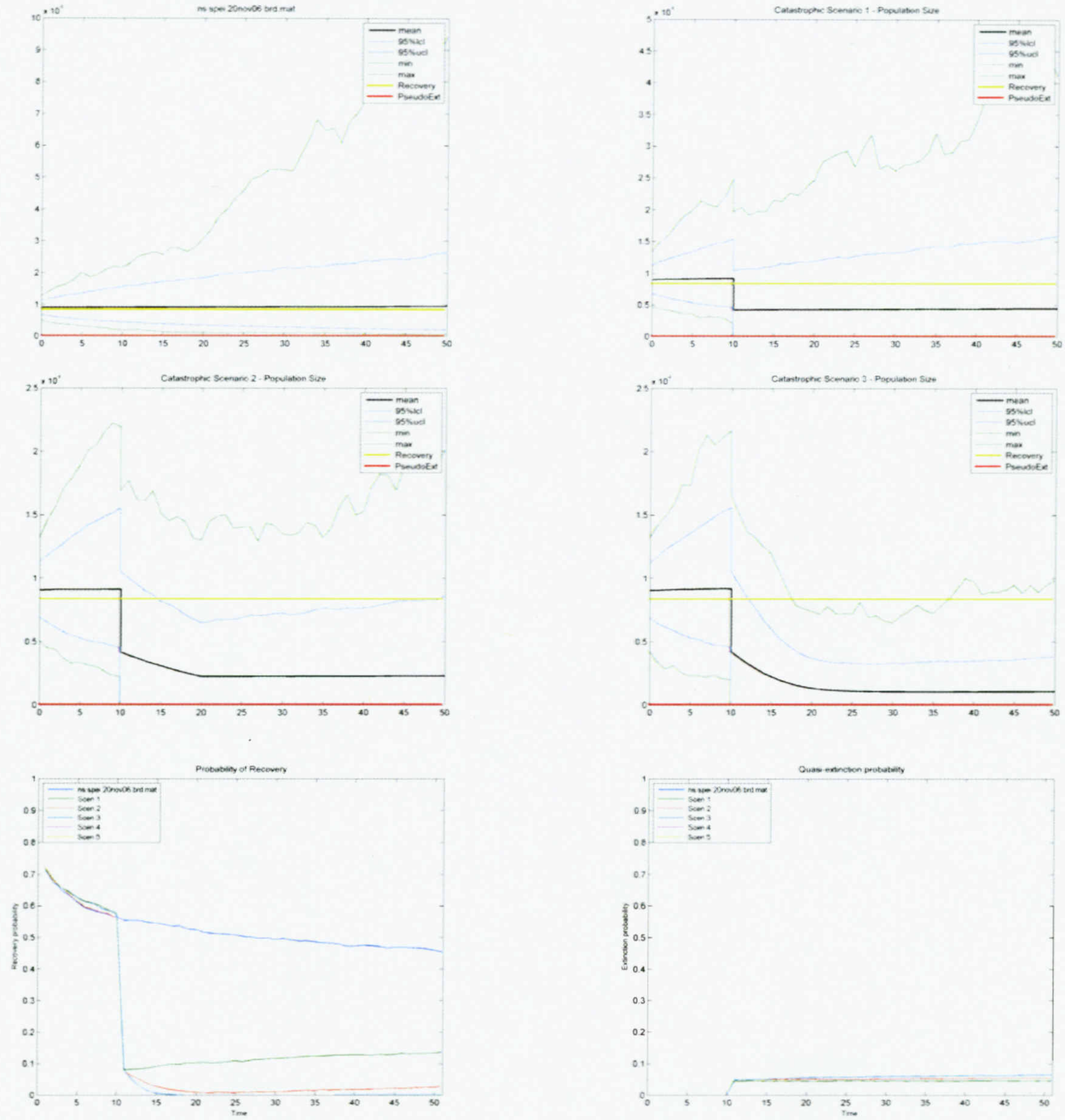


Figure 4. Results of 5000 trials for catastrophic losses of 5000 breeding females and offspring in year 10 of 50-year projection for North Slope Populations of Spectacled Eiders. (Breeding females includes 26% of two-year olds and all >3-year olds and male and female offspring in proportion to population 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).

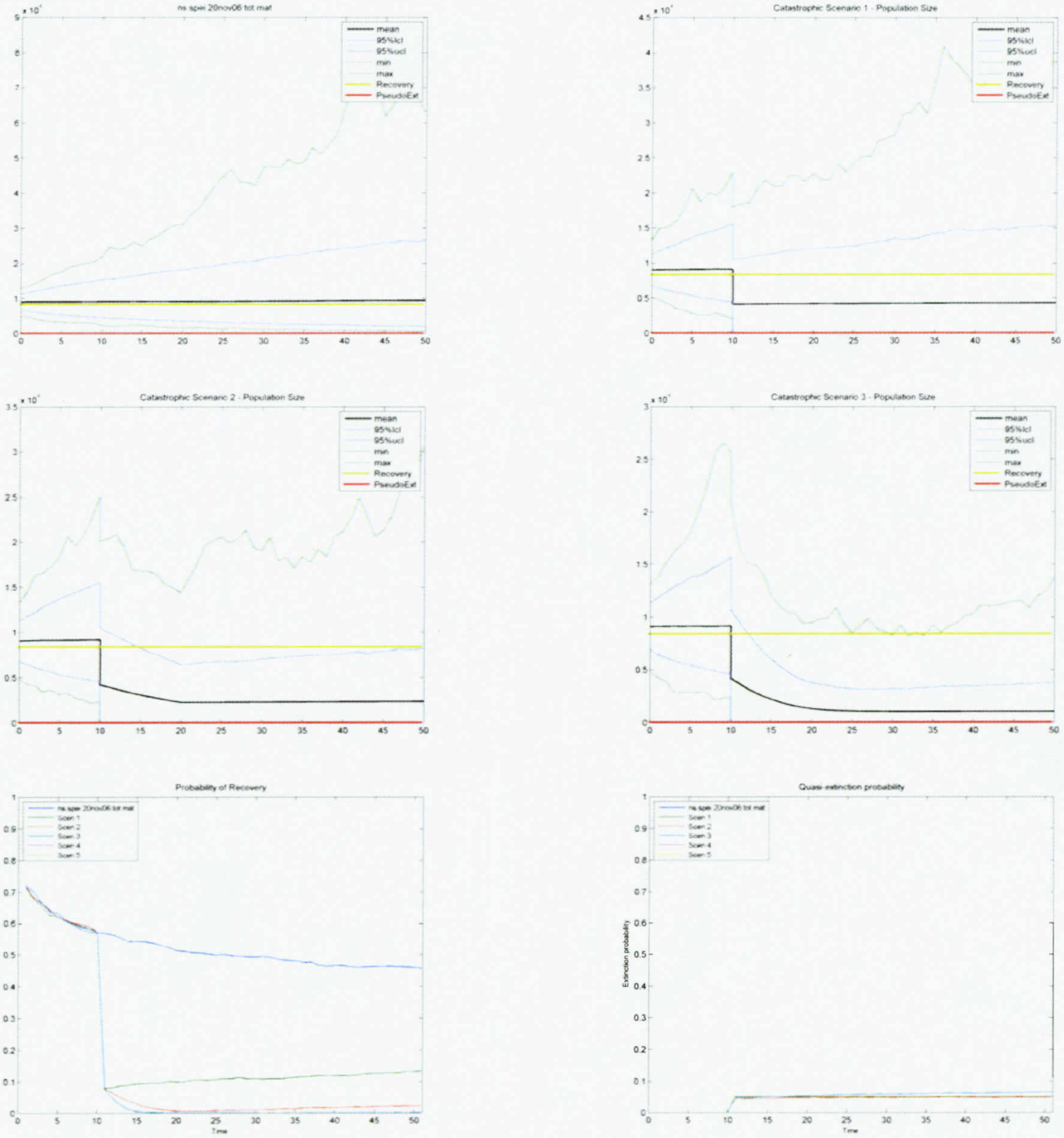


Figure 5. Results of 5000 trials for catastrophic losses of 5000 females in year 10 of 50-year projection for North Slope Populations of Spectacled Eiders. (Losses include females of all ages in proportion to population structure just prior to census time.) Projections (top 4 panels are for **total** 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).