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Final Project Summary

Project Title

Annual cycle distribution and movements of Pacific scoters: addressing gaps in population delineation of surf, white-winged and black scoters.

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Project Description

The effective management and conservation of North American (NA) sea ducks necessitates the delineation of demographically or spatially independent population units. Population delineation requires an understanding of how seasonal aggregations of sea ducks are affiliated among major life-cycle stages (e.g., breeding, molting, and wintering areas); and thereby fundamentally defines the geographic scale at which monitoring, harvest management, and habitat conservation efforts may be implemented. It is, therefore, precursory to most other information needs and helps inform survey design, interpret population trends, identify critical habitats, and better understand population demographics. Despite numerous recent efforts using satellite telemetry, population delineation of many sea duck species still remains either incomplete or rudimentary.

In the Pacific flyway, several projects were conducted in the early 2000s to delineate scoter populations. Multiple agencies deployed satellite transmitters (PTTs) in surf scoters (*Melanitta perspicillata*; SUSC), white-winged scoter (*Melanitta fusca*; WWSC), and black scoter (*Melanitta nigra*; BLSC) throughout their winter range. However, for a number of reasons adequate effective (defined here as location data for adult females linking wintering, breeding, and molting areas) and representative (sample proportional to flyway abundance and distribution) sample sizes for SUSC and WWSC were achieved only in the southern portions of their winter range (e.g., from San Francisco to southern British Columbia [BC]), with the largest information gaps from the northern coast of BC to South-central Alaska. Similarly, for BLSCs effective sample sizes were insufficient throughout their primary winter range, most notably in western Alaska. Thus, data gaps from the north coast of BC to south-central and western AK need to be filled to better assess population delineation and potentially identify independent population units for each species.

We proposed to augment previous satellite telemetry projects of Pacific scoters by filling remaining geographic gaps and boosting effective PTT sample sizes for SUSC, WWSC, and BLSC. Specifically, we proposed a multi-year project to mark adult female scoters with PTTs during winter in major coastal regions; that includes marking SUSC and WWSC in the Southeast and Southcentral regions, and BLSC in the western region. Satellite data from past studies of Pacific scoters have indicated high return rates to specific winter locations suggesting a possible need to recognize multiple management units throughout the Pacific flyway.

Methods
We captured BLSCs, SUSCs, and WWSCs in April at Nelson Lagoon, Juneau, and Yakutat Bay, Alaska in 2015-2016, 2017, and 2019, respectively. Nelson Lagoon is located on the Bering Sea coast of the Alaska Peninsula in the western region of the state. Juneau is located in the southeast archipelago of Alaska adjacent to Admiralty Island and is characterized by bays and inlets that remain relatively ice-free during winter. Yakutat Bay is located between southcentral and southeast Alaska, near Prince William Sound extending southwest from Disenchantment Bay to the Gulf of Alaska.

We used floating mist nets and decoys (Kaiser et al., 1995; Brodeur et al., 2008) to capture flight-capable scoters over open water. Captured birds were immediately removed from mist nets, administered an intramuscular dose of midazolam, placed in small pet carriers, and transported to a surgical unit where birds were weighed (±1.0 g), banded with a U.S. Geological Survey metal leg band, and assigned to either a second year (SY) or after–second year (ASY) age class based on plumage characteristics (Palmer, 1976). An approximately 39 g satellite transmitter (hereinafter PTT; Microwave Telemetry Inc., Columbia MD) was surgically implanted into the coelomic cavity of captured birds, following protocols developed by Korschgen et al. (1996) with slight modifications for sea ducks (Mulcahy and Esler, 1999; Robert et al., 2000). Following surgery, birds were returned to pet carriers and allowed to recover from anesthesia before being released at or near their capture sites.

We programmed the PTTs with ON/OFF (duty) cycles that provided consistent data during sedentary periods and periods of seasonal movements. Specifically, we set duty cycles so that PTTs remained ON for three consecutive hours, during which time location data was transmitted, and OFF for 72 hours. Satellite telemetry data were acquired using Argos Data Collection and Location Systems and were filtered using the PC-SAS Argos-Filter Algorithm v.7.02 (D. Douglas, U.S. Geological Survey, Alaska Science Center, Anchorage, Alaska, USA) for accuracy (Harris et al., 1990), to remove implausible locations, and to retain the best location classes (i.e., lc 1,2,3 associated with lowest error). Filter criteria were based on travel distance, travel rate, and redundancy from previous or subsequent locations (Ely et al., 1997). We plotted filtered locations using ESRI ArcMap™ 10.2 (Environmental Systems Research Institute, Redlands, CA, USA).

The PTTs were equipped with body temperature and battery-voltage sensors that allowed us to infer fate of the birds or transmitters (Murray, 2006). For example, ambient body temperature readings indicated that a bird had died; and battery failure was determined by a rapid drop (or sequential drop) in the battery voltage sensor prior to the final signal of a transmitter.

Because sample sizes were small for each species, we were not able to quantify the variation in our data (see Lindberg and Walker, 2007); thus, we offered a qualitative assessment of the timing and patterns of movements of scoters. Timing of movements are presented as medians with a minimum-maximum range. In instances where there was only a single bird, we report actual values.

Results

Nelson Lagoon 2015 - We spent 10 days in Nelson Lagoon, Alaska with the intent of deploying 8 PTTs in adult female BLSCs. However, we were able to work successfully for only 1 of those days because of adverse weather conditions (30-40 knot winds, fog, snow, and rain) that weren't conducive to boating and trapping. The result was the instrumentation of one adult female BLSC. We terminated our stay after 10 days because the extended forecast was for similar weather conditions.

The marked female departed Nelson Lagoon in early May, traveled to a stopover site at Egegik Bay and resided there for ~12 days. The female departed Egegik Bay on 21 May, stopped briefly at Kuskokwim Bay and then at the mouth of the Black River enroute to the Seward Peninsula, which is one of three major BLSC breeding areas. The female arrived inland on the Seward Peninsula at the end of May and resided for the breeding period (30 May – 7 August). After departure from the Seward Peninsula, the female stopped at the mouth of the Black River for a few days and then traveled to Kvichak Bay for the molt period. Kvichak Bay is a major spring staging and molting area for BLSCs. The female departed Kvichak Bay at the end of October and flew to the Alaska Peninsula, stopping briefly near Nelson Lagoon and Izembek Lagoon before continuing on to the near-Aleutian Islands. The last signal transmitted in December 2015 indicated the bird was located at Umnak Island near Nikolski Bay, likely the terminal winter location (Figure 1).

Nelson Lagoon 2016 - We captured a total of 59 BLSCs and instrumented 10 females (3 ASY and 7 SY) with PTTs. A single female apparently died within 5 days following post-surgery release, as indicated by a rapid drop in the temperature sensor. Another female seemingly died in early August, also indicated by the temperature sensor. A third female's PTT failed to transmit data after 9 August.

The median departure date of females from Nelson Lagoon was 25 April (range=15 April–10 May). Most females stopped at one to three spring staging areas in the Bristol Bay or Kuskokwim Bay regions. Eight of 9 females spent the summer period at an inland location; one female spent the summer offshore in Jack Smith Bay near the Kuskokwim River. Five females spent the summer at locations on the Yukon-Kuskokwim Delta; one female was located in the Bristol Bay region; one female was located on the Seward Peninsula, and one female spent the summer ~180 km inland from the coast near the village of Ambler at the base of the Brooks Range. The median arrival date and departure date to / from summer areas was 24 May (range=11 May–8 June) and 24 July (range=9 July–13 August), respectively. After summer, all females migrated to the Kuskokwim Shoals area (suggesting this is an important molt or fall staging site) and resided for a median 69 days (range=59–97 days). Most females then migrated to other various staging areas for short stays in Bristol Bay and the Alaska Peninsula before settling at winter locations along the Alaska Peninsula and near Aleutian Islands, which included Izembek Lagoon, Seal Islands, and Unalaska Island (Figure 1). The median arrival date to winter locations was 27 November (range=17 October–9 December).

Juneau 2017 - We conducted captures over the span of two weeks with the objective to deploy 9 and 16 PTTs in adult female WWSC and SUSC, respectively. A total of 30 WWSC and 92 SUSCs were captured. We obtained an additional 9 "leftover" PTTs from another project (the SDJV funded study of LTDU at Lake Michigan), and deployed PTTs in 12 and 22 adult female WWSC and SUSC, respectively.

Within the first two weeks following surgery and release, there was a high incidence of transmitter failure or mortality (based on internal body temperature sensor), particularly for SUSC. A total of 7 transmitters failed and 16 PTTs signaled low body temperature indicating mortality. The source of mortality was unknown, but likely related to a high predator population of bald eagles (*Haliaeetus leucocephalus*). We retrieved or located 6 PTTs from dead scoters, and all had evidence of either predation or scavenging by eagles (e.g., in or under nest, bill drag marks obvious on surface of PTT). The surviving marked females, two SUSCs and 9 WWSCs, migrated from Juneau to summer locations in Canada.

The surviving 11 marked females departed Juneau in early to late May (median=21 May; range=26 April–24 May). Most females migrated directly inland, stopping briefly at a few inland locations in transit to their final summer location. However, two birds stopped at coastal areas before traveling inland. A single female SUSC spent the summer at the McKenzie River Delta. All remaining birds, except one, spent the summer at locations in the Northwest Territories of Canada, primarily near Great Bear Lake with half above the Arctic Circle and half below; a single female SUSC never settled at a summer location but spent the summer moving among various locations near Great Bear Lake. A single WWSC spent the summer above the Arctic Circle in the Yukon Territory. Females arrived at terminal summer locations in late May to early June and stayed through the summer period. The median arrival date to summer locations was 2 June (range=30 May–6 June). Departure dates from summer areas were variable, ranging from late July to late September, although a single female was still in the Northwest Territories as of 15 October. The median departure date from summer locations was 14 September (range=3 July–5 October). Two females departed summer locations in early July and traveled to large lakes nearby and stayed until mid-September; a third female departed in early August and traveled to a coastal location in Yakutat Bay. Most females returned to the Juneau area or within 125 km near Admiralty Island or upper Lynn Canal for winter. The median arrival date to winter locations was 9 October (range=13 September–3 November). Four WWSC had transmitters that lasted into the next summer. Departure dates from winter locations and arrival dates to summer locations were similar to the previous year. All four birds spent the summer at locations near the previous summer locations in the Northwest Territories (Figure 1).

Yakutat 2019 - We conducted captures over the span of two weeks in Yakutat, Alaska with the objective to deploy 9 PTTs each in adult female WWSC and SUSC, respectively. A total of 29 WWSC, 126 SUSCs and 26 BLSCs were captured.

Within the first two weeks following surgery and release one SUSC died. All other PTT-instrumented birds migrated from Yakutat Bay in early to late May to breeding areas in Canada and Alaska. The median departure date from Yakutat Bay was 10 May (range=5 May–17 May). Most birds migrated directly inland, stopping briefly at a few locations in transit to their final summer location. The majority of birds (5 SUSC and 9 WWSC) spent the summer at locations in the Northwest Territories in Canada, primarily near Great Slave Lake and Great Bear Lake. Two SUSCs migrated to Alaska for the summer. Median arrival date to summer locations was 24 May (range=15 May–9 June), and most birds stayed through the summer period. However, one SUSC and two WWSCs signaled ambient temperature, indicating mortality. In addition, sensors from one SUSC and one WWSC indicated their transmitters failed. Departure dates from summer areas were variable, ranging from late July to late September (median=12 August; range=7 July–

4 October). Most birds that were still signaling returned to Yakutat for winter (5 SUSC and 3 WWSC), but one SUSC wintered in Glacier Bay and three WWSC wintered off the coast of Baranof Island or Chichagof Island. Median arrival date to winter locations was 18 October (range=6 September–9 November). Of the 18 PTT-instrumented birds, one SUSC and six WWSCs provided location data for a second summer. All birds returned to the same area as the previous summer. Four WWSCs provided location data for a second winter; all returned to the site used the previous winter: Yakutat, Baranof Island, and Chichagof Island (Figure 1).

Discussion

The data gathered in this study from PTT-marked scoters expands on past studies to examine their annual movements in Alaska, the northern extent of their wintering range along the Pacific coast. The pattern and timing of movements of PTT-marked birds in this study generally coincided with those described in the previous studies; thus, we suggest that inference drawn from our data may be relevant to a large portion of the scoter populations in Alaska. Nonetheless, the sample sizes in this study were small (Lindberg and Walker 2007) and we cannot exclude the possibility that surgical procedures and/or internal transmitters influenced the behavior of PTT-marked birds (Wilson and McMahon 2006, Oppel et al. 2008); thus, we suggest caution when interpreting our results or comparing them to other migratory bird populations. Further, we were unable to quantify much of the apparent variability in our data; thus, we offered a qualitative assessment of timing and patterns of movement.

In general, individually marked birds in our study migrated between marking locations (i.e, Nelson Lagoon, Juneau, and Yakutat Bay) to summer locations in western Alaska (BLSC), interior Alaska (SUSC from Yakutat Bay), and northern Canada (SUSC and WWSC). Scoters in Alaska appear to be relatively short-distance migrants; however, the pattern of spring and fall migration and distances traveled were highly variable depending on where individuals settled in summer. Birds completed spring and fall migration in a series of rapid movements often punctuated by frequent stopovers at coastal locations, similar to the migration pattern found in other Pacific coast sea duck populations (Petersen et al. 2009, Phillips et al. 2006, De la Cruz et al. 2009). In general, BLSCs primarily followed the Bering Sea coastline; SUSCs and WWSCs used direct inland routes but a few birds also stopped at coastal locations.

At a finer spatial scale, the apparent pattern and chronology of migratory movements of birds were individually variable as evidenced by protracted timing of movements and multiple migration pathways. In particular, individuals varied in their selection of stopover sites but the few birds that we tracked in a subsequent year appeared to alter their migration route little across years. Among the multiple stopover sites used by birds in our study, we identified the Kuskokwim Shoals as an important site for BLSCs, and Juneau and Yakutat Bay for SUSCs and WWSCs that did not winter in these locations.

The timing of spring and fall migration appeared to vary among individuals; although, we were unable to quantify this variability. Most BLSCs departed Nelson Lagoon in late April to early May; but the range between first and last departures was 30 days from mid-April to near mid-May. SUSCs and WWSCs departed in either early May (Yakutat Bay) or late-May (Juneau) depending on marking location, but departure was more protracted for birds from Juneau (29 days) than those from Yakutat Bay (12 days). Protracted spring departures appeared to result in asynchronous movements throughout spring migration which included variation in timing of stopovers. Median departure dates from summer locations that initiated fall migration appeared on a latitudinal gradient of marking location. BLSCs departed summer locations in Alaska in late July which varied across 35 days. SUSCs and WWSCs departed summer locations in mid-August (Yakutat Bay) and mid-September but had a more protracted departure period than BLSCs: varied across 58 and 63 days, respectively.

In general, birds arrived at summer areas at fairly similar dates across species, 24 May – 2 June, despite the high variability in timing and pattern of spring migration. During summer, BLSCs traveled to locations in the three primary breeding areas in Alaska: the Alaska Peninsula, Yukon-Kuskokwim Delta, and the Seward Peninsula. SUSCs and WWSCs traveled to summer locations in the Yukon and Northwest Territories in Canada. Although we lacked data to suggest that birds nested, it is likely reasonable to assume that birds were capable of nesting since some evidence from captive sea ducks indicates that females can lay a clutch of eggs following transmitter implantation. Also, scoters visited known breeding areas in our study during the summer period and most stayed for a period indicative of breeding behavior.

High fidelity to winter location appears to be a life-history attribute found in many species of sea ducks (Robertson and Cooke 1999); and our data support a relatively higher degree of fidelity to marking region. All birds in our study returned to either the marking location or nearby locations within a marking region. A high level of winter-site fidelity may allow mate-pairs to reunite during winter to maintain fitness benefits of a long-term pair bond or may confer selective advantages associated with site familiarity such as knowledge of food resources and predators that may increase over-winter survival (Robertson et al. 2000). Nonetheless, a high degree of fidelity to discrete regions of Alaska may indicate the potential for demographic independence among birds using these areas, and therefore, a possible need to consider their management accordingly.

Summary

Conservation and management of scoters require an understanding of their annual movements and habitat use. However, because scoters are dispersed widely in remote areas throughout the annual cycle, particularly during the non-breeding season when they are at sea, little still is known about connectivity among life-history stages. This study adds to PTT data collected in the early 2000s to describe the annual movements of scoters in Alaska. Results indicated that scoters migrate between discrete winter regions and inland summer areas along predictable pathways with some individual variability in timing and movement patterns along the routes. The timing of spring and fall movements is consistent with previous studies and that reported for other sea ducks. Seeming higher fidelity to winter regions may suggest the possibility of demographic independence among these regions and for Alaska scoters relative to those wintering at lower latitudes. However, further study is needed to support this hypothesis.

Managers may consider that many coastal habitats important to sea ducks have been or have potential to be impacted by factors such as mineral extraction, urban development (Dickson and Gilchrist 2002), or climate-related changes (Grebmeier et al. 2006). Continued or future alteration of marine habitats could translate to demographic responses in scoters at various life stages because they tend to favor and return to coastal near-shore areas during non-breeding periods. Direct (e.g., reduced survival) or indirect responses (e.g., seasonal carryover effects) have potential to influence demographic attributes at different life stages or scales. Our study provides supplemental information, including timing and patterns of movements throughout the annual cycle and affiliations among seasonal locations. Such information is an important step toward understanding population-limiting factors and helping managers predict and mitigate possible future impacts of habitat changes on the Alaska populations of scoters; perhaps with a goal of developing specific action plans to help protect important regional habitats and the birds using those areas.

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Figure 1. Annual movements of black scoters (red dots), surf scoters (blue dots) and white-winged scoters (yellow dots) marked with satellite transmitters at Nelson Lagoon, Juneau, and Yakutat, Alaska in April 2015-2016, 2017, and 2019, respectively. Numbered locations are: 1. Nelson Lagoon-Alaska Peninsula, 2. Egegik Bay-Bristol Bay, 3. Kuskokwim Shoals, 4. Yukon-Kuskokwim Delta, 5. Seward Peninsula; 6. Yakutat Bay, 7. Juneau, 8. Great Bear Lake, 9. McKenzie River Delta.