Exxon Valdez Oil Spill
Restoration Project Annual Report

Scoter Life History and Ecology: Linking Satellite Technology with Traditional Knowledge

Restoration Project 98273
Annual Report

This annual report has been prepared for peer review as part of *Exxon Valdez* Oil Spill Trustee Council restoration program for the purpose of assessing project progress. Peer review comments have been addressed in this annual report.

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December 1999

Scoter Life History and Ecology: Linking Satellite Technology with Traditional Knowledge

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Study History: Restoration Project 98273 was initiated in 1998 to monitor seasonal movements and distribution of surf scoters. Surf scoters, a sea duck, are an important subsistence resource. Their numbers, however, have reportedly declined for unknown reasons. This report describes results of the study's initial year.

Abstract: Little is known of surf scoter (*Melanitta perspicillata*) life history, migration routes, or distribution. Scoter numbers in Alaska are reportedly declining for unknown reasons. Scoters are an important subsistence resource to the native communities in Prince William Sound (PWS) and lower Cook Inlet (LCI). We conducted interviews to gather traditional ecological knowledge and surgically implanted satellite transmitters in 8 males and 2 females to monitor their movements to breeding, molting, and wintering areas. Scoters were captured in PWS during early spring in 1998. Three males and one female provided location data for areas outside of PWS. The three male surf scoters, all nonbreeders, traveled west and molted in Kuskokwim Bay. After the molt, males traveled to different wintering areas (PWS, Baranof Island, Shelikof Straits). As of June 1999, we continued to receive location data from the one male that wintered in PWS. It flew to the Mackenzie River drainage, NWT. The only female traveled northeast from PWS to Northwest Territories, 64 km from the Beaufort Sea. The 1,350km traveled from PWS suggests that the breeding range for surf scoters may be broadly distributed. Traditional knowledge indicates changes in food resources in PWS and LCI as a reason for declining populations.

Key Words: Capture, lower Cook Inlet, migration, Prince William Sound, satellite telemetry, sea ducks, surf scoter, traditional knowledge.

Project Data: *Description of data* – Location and sensor data was recorded for each satellite transmitter. *Format* – Location and sensor data are in Microsoft Excel and DBASE IV spread sheet format. GIS coverage of Alaska and Canada showing surf scoter locations are presented in ArcView format. *Custodian* - Archived at ADF&G regional headquarters in Anchorage. Contact Dan Rosenberg at ADF&G, 333 Raspberry Road, Anchorage, Alaska 99518 (907-267-2453) (dan_rosenberg@fishgame.state.ak.us) or Mike Petrula (907-267-2159) mike_petrula@fishgame.state.ak.us) for information. Project information can be viewed at http://www.state.ak.us/adfg/wildlife/waterfwl/scoter/surf.htm.

Citation:

Rosenberg, D.H., and M.J. Petrula. 1999. Scoter life history and ecology: Linking satellite technology with traditional knowledge, *Exxon Valdez* Oil Spill Restoration Project Annual Report (Restoration Project 98273), Alaska Department of Fish and Game, Division of Wildlife Conservation, Anchorage, Alaska.

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EXECUTIVE SUMMARY

Sea duck populations in Alaska have reportedly declined over the last few decades. A precipitous decline in several species has raised concern. The lack of information available to researchers and managers pertaining to sea duck ecology and inadequate methods of inventory and monitoring limits their ability to identify probable reasons for the decline. Identifying staging, nesting, molting and wintering areas is a crucial first step in understanding sea duck biology and population dynamics. By combining this information with traditional ecological knowledge we hope to begin to understand the reasons for population declines.

Scoters are sea ducks, some of which migrate through or spend the winter in Prince William Sound and lower Cook Inlet. Scoters are an important subsistence resource for communities in these areas and comprise a large proportion of their sea duck harvest. The decline in scoter numbers and their susceptibility to contaminants found in intertidal areas is a concern to managers and consumers.

We initiated a study that integrates traditional ecological knowledge, scientific methods and modern technology to begin to understand scoter ecology. We used satellite telemetry to track scoter movements throughout most of the year, and identify critical habitat areas. Of the 3 species of scoters (white-winged, black and surf), we chose to study surf scoters because of their relative abundance in Prince William Sound and their affiliation for nearshore areas.

We captured surf scoters in Prince William Sound, Alaska at the northern tip of Montague Island near Graveyard Point (60.362N.Lat.x147.218W.Long.) during the spring in 1998. We used floating mist nets and decoys to catch sea ducks. Ducks were captured when they flew or swam into the net. A captured bird was immediately removed from the net, placed in a small kennel and taken to a nearby vessel.

Once aboard the vessel, birds were weighed, morphological measurements were taken, blood was sampled, and a USFWS leg band was attached. The bird was anesthetized and prepared for surgery. A veterinarian (Dr. D. M. Mulcahy) implanted the satellite transmitter in the abdominal cavity of the bird. Respiration rate, body temperature and heart rate of the bird were monitored during surgery. No birds died during surgery. Each bird was held for approximately 5 hours after surgery and then released on the water.

Satellite transmitters weighed 36 grams and measured 10mm deep, 55mm long, and 35mm wide. Each satellite transmitter contained a sensor that recorded the bird's internal temperature and a sensor that recorded voltage of batteries powering the transmitter. Each transmitter was programmed to transmit for 6 hours every 78 hours for the first 56 cycles, then 8 hours every 128 hours until the transmitter failed. Five hundred hours of transmission was the expected transmitter life. Signals were analyzed using Argos Data Collection and Location Systems.

We captured and banded 59 sea ducks during 4 days of effort. Satellite transmitters were surgically implanted in 8 male and 2 female surf scoters. Five transmitters (2240, 2241, 2242, 2245, 2247) reported ambient temperature readings (indicating dead birds) within 19 days of release. We lost contact with one transmitter (2243) on 10 May, 11 days after release. We did

not receive data from this satellite until 7 January 1999 when we received ambient temperature readings but no location data. It is likely that we lost contact with the transmitter because the bird died.

A female (10928) moved northeast of the capture site to an area located between the Anderson and Horton rivers (Northwest Territories, Canada) approximately 64 km from the coast. She remained at that location from 2 to 27 June where we believe she initiated a nest. On 10 July (69 days after release) we received ambient temperature readings indicating that she died.

Three male surf scoters (2244, 2246, 10929) exhibited similar movements to molting areas. All males moved west from the capture site and molted in Kuskokwim Bay. We believe they were non-breeding males. Post-flightless males, however, traveled to different wintering areas. One male wintered in Shelikof Straits near Kodiak Island (2244), one in Prince William Sound (2246), and one near Baranof Island (10929) in southeast Alaska. The last locations received for 10929 and 2244 were 21 January 1999 and 13 March 1999, respectively. We received an ambient temperature reading for male (2244) on 23 June 1999. As of 9 June 1999, we continued to receive location data for male 2246. He departed PWS on 13 May 1999 and traveled to the Mackenzie River drainage in northern Canada, Northwest Territories arriving 4 June 1999. Unlike last year, we suspect that male (2246) traveled to a breeding area.

The extensive movements by surf scoters could have only been monitored through the use of satellite telemetry. A female and male traveling over 1350 km from the capture site indicates that the breeding range for surf scoters may be broadly distributed. Additionally, the wide dispersal of post-flightless males suggests that surf scoters, from wintering areas other than Prince William Sound, migrate to that area during early spring, perhaps in response to the abundant food source provided by spawning herring.

We are not certain why 60% of the surf scoters implanted with satellite transmitters died within two weeks of surgery. Mortality is not believed to be directly related to surgery (D. M. Mulcahy D.V.M. pers. comm.). We suspect, however, that the relatively high mortality of post-operative scoters may be indirectly related to surgery by increasing their vulnerability to the numerous predators inhabiting the marine environment, particularly bald eagles.

Traditional knowledge has identified changes in the PWS and LCI ecosystem that has altered the availability of prey. The 1964 Alaskan earthquake and the *Exxon Valdez* oil spill have reduced intertidal organisms. The 1993 herring crash has reduced the amount of herring spawn and altered the distribution of scoters. Scoters must also compete with the increasing sea otter population for clams and other benthic invertebrates.

Photographs of the capture, surgery, satellite transmitter, and color maps illustrating surf scoter movements can be viewed at http://www.state.ak.us/adfg/wildlife/waterfwl/scoter/surf.htm.

INTRODUCTION

The current population status for many of Alaska's 15 sea duck (Mergini) species is uncertain (U.S.Fish and Wildlife Service 1999). Populations of several species, however, appear to have declined in the last few decades and there is concern for many others (Kertell 1991, Stehn et al. 1993, Goudie et al. 1994, Hodges et al. 1996, U.S.Fish and Wildlife Service 1999). The uncertainty in the status of some populations of sea ducks is a result of the inherent difficulties associated with assessing population trends, and the lack of a standardized inventory and monitoring protocol designed specifically for sea ducks (U.S.Fish and Wildlife Service 1999). Further, little is known about the ecology and life history processes of sea ducks compared with those of dabbling (Anatini) and diving ducks (Aythyini). Sea ducks are widely dispersed throughout remote areas, conducting a winter study in the marine environment is difficult, and in some part, sea ducks have been neglected because of a lack of interest. This makes it extremely difficult to obtain and interpret information on population trends, productivity, survival, and harvest.

The best available evidence indicates that scoter (*Melanitta spp.*) populations have declined. Surf scoters (*M. perspicillata*), black scoters (*M. nigra*), and white-winged scoters (*M. fusca*) all occur in PWS and lower Cook Inlet with surf scoters being the most abundant (Isleib and Kessel 1973). Surf scoters occur as both a year-round residents and migrants. Nonbreeders are believed to remain in PWS during the summer. It has been estimated that scoters in Alaska have declined by as much as 40% since 1977 (Hodges et al. 1996). Between 1972-1973 and 1989, the estimated population of scoters wintering in PWS declined from 56,600 to 14,800 birds. Summer populations (July) declined from 13,000 to 5,400 birds during the same period (Klosiewski and Laing, 1994). An estimated 1,000 scoters died as a direct result of the *Exxon Valdez* oil spill (John Piatt, pers. comm.). The number of scoters in PWS has increased since the spill (Agler and Kendall 1977, Irons et al. in review) but remains below historic levels.

Scoters are an important subsistence resource to the people living in the communities of PWS and LCI (James Fall, ADF&G, pers. comm., Gary Kompkoff, Tatitlek IRA, pers. comm.). Native inhabitants of PWS have used scoters (locally known as black ducks) as a subsistence resource for centuries. Bones from surf scoters, black scoters, and white-winged scoters are the most abundant avifaunal remains found at archeological sites in PWS over a 2,000 year period (Linda Yarborough, USFS, pers. comm.). Currently, scoters comprise the majority of the sea duck harvest in the communities of Tatitlek, Chenega Bay, Port Graham, and Nanwalek (Scott et al. 1996). Residents of the communities affected by the *Exxon Valdez* Oil Spill remain concerned about the abundance of their traditional food resources and maintaining their cultural ties to traditional use of fish and wildlife (*Exxon Valdez* Oil Spill Trustee Council, 1999).

The large decline in scoter numbers in PWS between 1972-1973 and 1989 may be a result of long-term oscillations in ocean temperatures in the Gulf of Alaska (Piatt and Anderson 1996) or effects from exposure to contaminants. Scoters are among the species most vulnerable to oil spills (Piatt et al. 1990); several studies have shown scoters and other sea ducks to bioaccumulate trace metals and organochlorines from their environment (Vermeer and Peakall 1979, Henny et al. 1991, Olendorf et al. 1991, Henny et al. 1995). Among the three scoter species, surf scoters are most associated with intertidal areas in PWS (Patten et al. 1998). They feed primarily on bivalves, especially mussels (Crow 1978, Vermeer 1981), but in spring they may switch to a diet composed primarily of herring roe (Vermeer 1981, Goudie et al. 1994, Bishop et al. 1995). Mussels and intertidal sediments in PWS showed increases in petroleum hydrocarbon concentrations directly attributable to *Exxon Valdez* oil (Short and Babcock 1996), and oil in mussel beds in PWS and the Kenai Peninsula persisted for several years after the spill (Babcock et al. 1996). A white-winged scoter die-off occurred in the Cape Yakataga area in southeast Alaska during 1990-1992 (Henny et al. 1995). Although no definitive cause could be identified, elevated levels of cadmium were detected in the birds, but no source of contamination could be identified.

PWS herring stocks suffered a dramatic decline in 1993 and stocks have remained depressed (Morstad et al. 1997). Increasing sea otter populations since the mid-1900's may have led to increased competition for food between scoters and otters (Stratton 1981, Appendix A). Quite likely, any decline results from a combination of factors such as food and habitat changes, contaminants, or climate change. Climate and ecosystem changes or human activities, such as hydroelectric development (Savard and Lamothe 1991) or introductions of exotic species (Bordage and Savard 1995) on breeding or molting areas can also have profound affects on abundance or distribution of a population.

Scoters are among the least studied of North American waterfowl (Godfrey 1986, Savard and Lamothe 1991, Henny et al. 1995, Savard et al. 1998). Little is known about the ecology, breeding areas, molting areas, and migration routes of these species anywhere in North America (Bellrose 1976, Herter et al. 1989, Goudie et al. 1994, Savard et al. 1998). Although scoters are known to breed throughout much of Alaska and Canada (Gabrielson and Lincoln 1959, Godfrey 1986), nothing is known about specific populations and the affiliations between winter, breeding, and molting areas. The few studies that have identified molting sites have not made the link between these and winter and breeding areas (Johnson and Richardson 1982, Dau 1987). Exposure of migratory waterfowl to contaminants or other mortality factors may occur anywhere in a bird's annual cycle. The difficulty of detecting causes of population declines in a migratory species, especially one with a broad range, is confounded by a lack of specific information on affiliations between breeding, molting, and wintering areas (Henny et al. 1991).

Not until we begin to understand the basics of sea duck biology will we be able to understand the factors that influence their numbers. Identifying important staging, nesting, molting and wintering areas and understanding the links between these areas would allow us to direct sampling and monitoring efforts at specific population segments. Traditional marking of birds with metal leg bands has little success with sea ducks because so few birds are killed in the harvest. The potentially vast geographic range of these birds makes conventional telemetry impractical and costly. Satellite telemetry studies offer the best method for identifying migration routes, staging areas, and breeding, molting, and wintering sites. Satellite transmitters have been used effectively in other studies designed to monitor movements of sea ducks (Petersen et al. 1995, Dickson et al. 1998, Robert et al. 1999, Savard et al. 1999).

In summary, little is known about the ecology, breeding areas, molting areas, and migration routes of scoters anywhere in North America. Population trends in scoters are uncertain, but appear to be declining in most regions. Affiliations between breeding and wintering areas are unknown, compounding meaningful integration of survey data. The susceptibility of seaducks to contaminants is a concern to resource managers and subsistence consumers. Determining distribution is the first step in assessing breeding, wintering, and molting ecology. Potential breeding and molting sites range throughout Alaska and western Canada. We initiated a study that integrates traditional ecological knowledge, scientific methods, and modern technology to begin to understand scoter ecology. We used satellite telemetry to track scoter movements throughout most of the year, and identify critical habitat areas. Of the 3 species of scoters (white-winged, black and surf), we chose to study surf scoters because of their relative abundance in Prince William Sound and their affiliation with nearshore environments.

STUDY AREA AND METHODS

An aerial reconnaissance survey was conducted on April 24, 1998 to locate flocks of scoters. The survey included the following areas: Shoup Bay (Valdez Arm), Busby and Bligh islands, Tatitlek Narrows, Boulder Bay; Fish Bay, Two Moon Bay, and Snug Corner Cove in Port Fidalgo; Porcupine Point to St. Matthews Bay, Olsen Bay (Port Gravina), Gravina Point, and Rocky Bay to Graveyard Point on Montague Island.

We captured surf scoters in Prince William Sound, Alaska at the northern tip of Montague Island near Graveyard Point (60.362N X 147.218W) (Fig. 1). Capture efforts were scheduled for April 25 to May 3, 1998. We selected this time and location to take advantage of the large numbers of sea ducks concentrated on herring spawn (M. A. Bishop pers. comm.). High winds and rough seas, however, limited our trapping effort to only 4 days (31 April – 3 May).

We used floating mist nets and hand-made decoys to catch sea ducks. Two mist nets (3m by 18m) were hung between three masts (3.05m by 1.9cm dia.) made of aluminum conduit. Each mast was attached to a hub consisting of four aluminum poles (1.8m by 1.9cm dia.) connected at one end forming a + pattern. Attached at the distal end of each pole was a closed-cell, foam float painted to resemble a surf scoter. The trap was erected on the beach and towed into place by skiff, and placed up to 100m from shore. Additional lines, the length of the net, connected each hub so that tension was not placed on the net when towed. One end of the trap was secured to the shore with a line and the other end was anchored to the sea floor. We placed silhouette style decoys near the nets to lure ducks. Ducks were captured when they flew or swam into the net. An observer on-shore, and another off-shore (in a skiff), monitored the nets at all times. A captured bird was immediately removed from the net, placed in a small kennel and taken to a nearby vessel.

Once aboard the vessel, the bird was weighed, morphological measurements were taken, blood was sampled, and a USFWS metal leg band was attached. The bird was anesthetized and prepared for surgery. A veterinarian (D. M. Mulcahy, D.V.M.) implanted the satellite transmitter in the abdominal cavity of the bird (Korschgen et al. 1996). The 21.6cm stainless steel antenna exited the bird near the base of the tail. Respiration rate, body temperature and heart rate of the bird were monitored during surgery. No birds died during surgery. Each bird was held for approximately 5 hours after surgery and then released on the water.

Transmitters, manufactured by Microwave Telemetry, Inc., weighed 36 grams, and measured 10mm deep, 55mm long, and 35mm wide. Each satellite transmitter was equipped with a sensor to record the bird's internal temperature, and a sensor to record voltage of batteries powering the transmitter. Each satellite transmitter was programmed to transmit for 6 hours every 78 hours for the first 56 cycles, then 8 hours every 128 hours until the transmitter failed. Five hundred hours of transmission was the expected transmitter life (P. Howey, Microwave Telemetry, pers. comm.). Signals were analyzed using Argos Data Collection and Location Systems. Polar-orbiting satellites received the transmitted signal and the bird's location was calculated from Doppler shifts of the signal frequency (Fancy et al. 1988). We used Agros "standard and auxiliary" location data processing services. The accuracy of "standard locations" (class codes 1, 2, and 3) is generally <1000m and requires that the satellite receives at least 4 transmissions during a pass over the transmitter. Accuracy for "standard locations" with "class code" 0, however, is >1000m with no maximum limit. The accuracy of "auxiliary locations" (class codes A and B) can not be calculated because the normal system specifications are relaxed so that locations can be calculated from 2 or 3 messages. The lack of an "auxiliary location's" estimate of accuracy, however, does not mean that "auxiliary locations" are less accurate. We accepted or rejected "auxiliary locations" and "class code" 0 locations based on past and subsequent locations.

Standard locations for a transmission period were averaged (except "class code" 0) to generate a daily location. If no "standard locations" were available for a transmission period we used "auxiliary locations". We only used one "auxiliary location" per transmission period. Auxiliary locations were rejected if not confirmed by "standard locations" in previous or subsequent days.

Photographs of the capture, surgery, and satellite transmitter, can be viewed at http://www.state.ak.us/adfg/wildlife/waterfwl/scoter/surf.htm.

RESULTS

We captured and banded 59 sea ducks during 4 days of effort (Table 1). Satellite transmitters were surgically implanted in 8 male and 2 female surf scoters. We received our first location data for each bird on the day of release indicating that the satellite transmitters were functioning properly. Five transmitters (2240, 2241, 2242, 2245, 2247), however, reported ambient temperature readings (indicating dead birds) within 19 days of release (Table 2). We lost contact with one transmitter (2243) on 10 May, 11 days after releasing the bird. We received no data from this transmitter until 7 January 1999 (Table 2) when we received ambient temperature readings but no location data. We believe we lost contact with the transmitter because the bird died.

A female (10928) provided substantial location data (Table 3) enabling us to track her movements to the Northwest Territories, Canada (Fig. 1). After release, she traveled ca. 95km (straight-line distance) north to Shoup Bay in Valdez Arm and then 300km to Tetlin Lake, in Tetlin National Wildlife Refuge, near Tok, Alaska (Table 3, Fig. 1). From that location, she traveled 1010km in 3 days to northern Canada, east of Inuvik, Northwest Territories (Table 3, Fig. 1). She then moved slightly northwest to a location between the Anderson and Horton rivers, approximately 64 km from the coast. She remained at that location from 2 to 27 June where we believe she initiated a nest. On 10 July (69 days after release) we received ambient temperature readings indicating that the bird had died (Table 2). Before she died, we received location data for each duty cycle (n=19) (Table 2).

Three male surf scoters (2244, 2246, 10929) exhibited similar movements to molting areas. We believe they did not breed in 1998 because they were not paired at capture and they stayed, for the most part, on the coast.

After being released, male (2244) traveled to the southeast side of Montague Island where he remained for approximately 3 weeks (Table 4, Fig. 2). His last location in PWS was recorded on 25 May on the west side of Montague Island. After leaving PWS, 2244 traveled to Kamishak Bay on the west side of lower Cook Inlet (LCI) where he remained from 28 May to 9 June (Table 4, Fig. 2). He then traveled west ca. 264km to Nushagak Bay, south of Dillingham, Alaska, where he remained from 12 to 15 June (Table 4, Fig. 2). Three days later (18 June) he was located on the west side of Kuskokwim Bay, 350km west of his previous location (Table 4, Fig. 2). He remained in Kuskokwim Bay until 18 August where we believe he molted. After molt, he moved north near the mouth of the Kolavinarak River at the southern tip of Nelson Island where he remained from 21 to 31 August (Fig. 2). Our next location was three days later (3 September) when he traveled ca. 628km to Kashvik Bay, in Shelikof Straits, near the southern boundary of Katmai National Park (Table 4, Fig.2). He remained in this general area until the transmitter batteries expired. Our last location was received on 13 March 1999. We received ambient temperature readings for male (2244) on 23 June 1999.

Male (10929) traveled to Orca Inlet on the east side of PWS near Cordova, Alaska ca. 79km from the release site (Table 5, Fig. 3). He remained in eastern PWS until 16 May. His last location in PWS (23 May), however, was on the west side of PWS, in Passage Canal, near Whittier, Alaska (Fig. 3). After leaving PWS, 10929 traveled to Kachemak Bay, on the east side of LCI, and remained there from 26 to 29 May (Fig. 3). He traveled ca. 144km to Rocky Cove on the west side of LCI, in Kamishak Bay, where he remained from 1 to 4 June (Table 5, Fig. 3). On 8 June he was located in the Wood River Lakes area north of Dillingham, Alaska (Fig. 3). From 11 to 14 June, 10929 was located in Kuskokwim Bay. He then moved north near to the southern end of Nelson Island where he remained from 17 to 30 June. He moved back to Kuskokwim Bay and remained there to molt from 3 July to 3 September (Fig. 3). Nine days later (12 September), he was located on the east side of the state, near Baranof Island, in southeast Alaska, ca. 1610km from his previous location (Table 5, Fig. 3). He remained in this general area until the transmitter batteries expired. Our last location was received on 21 January 1999.

Male (2246) traveled extensively throughout PWS after being released (Table 6, Fig. 4). Our last location in PWS was recorded on 15 June on the southwest side of Hinchinbrook Island. We did not receive another location until 25 June when it was located in Kuskokwim Bay (Fig. 4). Our last location in Kuskokwim Bay was recorded on 18 July; however, our next location was not received until 5 October, near the southern tip of Montague Island, in Prince William Sound. We are not certain how long 2246 remained in Kuskokwim Bay, but based on the movement patterns of males 2244 and 10929, we believe he also molted in Kuskokwim Bay. After returning to PWS, 2246 remained near the southern half of Montague Island until 26 March 1999

(Fig. 4). From 8-13 May 1999, 2246 was located in Rocky Bay, northern Montague Island, near the capture site. He moved ca. 386km north to Tetlin Lake where he remained from 19-29 May 1999 (Fig. 4). He continued north and was located on the Mackenzie River drainage on 4 June 1999, 644km form his previous location (Fig. 4). Unlike the 1998 season, we suspect that he is paired and traveling to a breeding area.

We estimated that 2-4,000 scoters were present in the vicinity of our capture site on Montague Island. These were primarily surf and white-winged scoters. An equal number of surf and white-winged scoters were present in Orca Inlet, near Cordova on April 28, 1998. We flew a reconnaissance survey on April 24, 1998 to locate scoter flocks. In addition to the birds located on Montague Island (Graveyard Point) we also saw flocks of 200 to 400 scoters in Shoup Bay (Valdez Arm), Fish Bay (Port Fidalgo), and at Gravina Point.

Results of the traditional ecological knowledge component of this project are presented in Appendix A.

DISCUSSION

Several thousand sea ducks, mostly surf and white-winged scoters, were in the immediate vicinity of our capture site on Montague Island where they were feeding on herring spawn. Sex ratios for surf scoters were skewed towards males, as many females were accompanied by several males in "courting parties" (McKinney 1992). Only 2 of the 25 surf scoters captured were females. In contrast, 15 of the 30 white-winged scoters captured were females. We are not sure why female surf scoters were less vulnerable to our trap than males, and female white-winged scoters. We suspect that the constant competition among male surf scoters for the establishment of pair-bonds with females, and their continuous displays may have made female surf scoters less eager to join (decoy) flocks of conspecifics.

Movements by Surf Scoters

After being released, scoters moved to other areas in PWS. Areas of frequent use were Orca Inlet, Shoup Bay, and the southern end of Montague Island (Patton Bay, Macleod Harbor, Jeannie Cove). Other areas within PWS were visited less frequently by scoters during the study. We obtained limited location data for surf scoters that died before leaving PWS. Four of these birds traveled to locations a significant distance from the capture site (Fig. 5).

The only female to depart PWS after being implanted with a satellite transmitter was located in northern Canada 28 days after being captured (Fig. 1). Because she did not move from this location for 25 days and the site is located in an area where surf scoters are reported to nest (Lynne Dickson, CWS, pers. comm.), we believe she initiated a nest during this period rather than molt. The extensive movements by this female could have been monitored only through the successful use of satellite radio telemetry. That she traveled over 1350 km from the capture site indicates that the breeding range for surf scoters may be broadly distributed over a large geographic area.

Male surf scoters exhibited similar movements after being captured and released in Prince William Sound. All males that departed Prince William Sound traveled west to Kuskokwim Bay and remained there during the flightless period (molt). Dau (1987) identified this area as an important molting area for scoters but lacked information to associate it with wintering or nesting areas. On route to Kuskokwim Bay, two birds stopped in Kamishak Bay, perhaps in response to the availability of herring roe. The timing of herring spawning activity occurs sequentially later from PWS to Kamishak Bay, Bristol Bay, and the Yukon-Kuskokwim Delta (Ted Otis, ADF&G, pers. comm.). The timing of migration, and important stopover areas may be timed to coincide with this spawning activity. Because these males were not observed with a female when captured, and they did not travel inland, we believe they were surplus males that did not pair in 1998. We do not know, however, whether the effect of the implanted transmitter will preclude them from subsequently breeding.

The similarity in movements by radioed males ended after molt when they departed Kuskokwim Bay for different wintering areas. One male (2244) traveled to Shelikof Straits (Fig. 2), another (10929) to southeast Alaska (Fig. 3), and another (2246) back to Prince William Sound (Fig. 4). Various population estimates exist for these wintering areas. In July, Bailey and Faust (1984) reported approximately 2,500 surf and white-winged scoters in bays in the vicinity of the wintering area of bird number 2244. Conant (1996) estimated 139,000 surf scoters wintered in southeast Alaska. While only seen occasionally in August near Sitka, Willett (1914) describes surf scoters as abundant in the region by the middle of September. In 1998, the USFWS estimated a wintering population of 30,000 surf scoters in PWS (B. Lance, USFWS, pers. comm.). This greatly exceeded previous estimates of 5,000-10,000 surf scoters from 1990-1996 (Agler and Kendall 1997). The wide dispersal of post-flightless males suggests that surf scoters, from wintering areas other than Prince William Sound, migrate to that area during early spring, perhaps in response to the food source (roe) provided by spawning herring.

Travel Routes

We do not know the exact route surf scoters traveled to reach molting, wintering and breeding areas because the transmission cycle spanned a 3-5 day period, location data was not received on all cycles, and locations can not be calculated for moving birds from a Doppler shift in signal strength. We believe, however, that male 10929 departed PWS en route to LCI via Portage Pass because he was located near Whittier, Alaska 3 days prior to being located in Kachemak Bay (Fig. 3). The route to LCI taken by males 2244 and 2246 may have been along the coast of the Kenai Peninsula, as these males were centrally located in PWS prior to their departure. Once in LCI, 2 of 3 males (2244, 10929) staged in Kamishak Bay (LCI) prior to being located on the west side of the Alaska Peninsula. We suspect male (2246) staged there as well. We do not know, however, which drainages were used for this overland movement. Once on the west side of the Alaska Peninsula, our location data indicates that a coastal route was primarily used by males moving to molting areas in Kuskokwim Bay, and also during their return to respective wintering areas.

Herter et al. (1989) estimated a minimum number of 8,200 surf scoters, primarily adult males, migrating west past Cape Pierce (south side of Kuskokwim Bay). Their migration watches began on 21 June, by which time two of our birds would have already reached Kuskokwim Bay, assuming similar migration chronology between years. In daylight hours it appeared that most birds migrated around Cape Pierce although some flocks were observed inland, cutting across the peninsula. The authors assumed these birds were migrating from nesting areas in interior Alaska to molting sites in the Bering Sea.

Female 10928 traveled inland to reach breeding areas in northern Canada (Fig. 1). If we assume scoters travel primarily over water then this bird could have used one of several drainage systems to travel from Shoup Bay in Valdez Arm to Tetlin NWR. The route from Tetlin NWR to northern Canada was somewhat direct, taking only 3 days. We can only speculate on which drainage systems were used to reach this destination. We plan to shorten the period between transmission cycles in the future to obtain more location data during expected periods of peak movement.

Mortality

We are not certain why 60% of the surf scoters implanted with satellite transmitters died soon after being released. Surf scoters were less stressed and responded better than 3 other species of diving ducks to identical surgical procedures (Dr. D. M. Mulcahy pers. comm.). Thus, mortality is not believed to be a direct consequence of surgery. Dr. Mulcahy indicated that initial mortality observed in this study was much higher than other studies he has conducted with similar surgical procedures. We suspect that the relatively high mortality of post-operative scoters is indirectly related to surgery by increasing their vulnerability to the many predators that inhabit the marine environment, particularly bald eagles. Bald eagles were frequently observed near the trap site disturbing flocks of sea ducks with their overflights. Post-operative birds may be less likely or slower to flush from an avian threat, making them more conspicuous and vulnerable to potential predators. Poor weather before, during, and after our capture efforts may have also contributed to the high mortality rate. We regret the death of our study birds and the loss of valuable equipment. However, the invaluable information gained by this study can not be acquired by other means. In the future we will attempt to decrease the immediate vulnerability of post-operative birds to depredation, and to investigate methods of retrieving transmitters in the field in the event of mortality.

A discussion of the traditional ecological knowledge component of this project is presented in Appendix A.

ACKNOWLEDGEMENTS

We are greatly indebted to the many people who have contributed their time, energy, skills, and knowledge to the many aspects of this project. All have contributed to its success. Dr. Dan Mulcahy's skills, experience, and dedication were invaluable in the care, handling, and surgical implantation of satellite transmitters in our scoters. Celia Hall provided an equally invaluable service to our project with her skills and patience as an anesthetist. The skills, dedication, and personalities of Dave Crowley, Doug Hill, Tim Bowman, and Joshua Hall made the capture efforts go smoothly, safely, and enjoyably. Patrick Endress graciously assisted with the capture but also used his skills as a professional photographer to provide us with a photographic record of the project, often under the most challenging of weather conditions. We are very grateful to Captain Dean Rand and the crew of the MV Discovery, including Ken Hadzima and Heather and Hanna Rand for their patience and hospitality as well as being ready, willing, and able to accommodate any needs that arose. We thank Bill Larned for his aerial support.

We would like to thank Gary Kompkoff and the village of Tatitlek for their hospitality, insight, and willingness to share their knowledge of PWS and its wildlife. We would also like to thank all the other Community Facilitators and residents who generously gave their time to facilitate our visits to their villages and share their knowledge, including: Walter Meganack Jr., of Port Graham, Nancy Yeaton of Nanwalek, Pete Kompoff Jr. of Chenega Bay, and Lillian Elvsaas of Seldovia. Special thanks to Henry Huntington (Huntington Consulting), and Hugh Short of the Exxon Valdez Oil Spill Restoration Office for their guidance and support in collecting Traditional Ecological Knowledge. We greatly appreciate the valuable assistance and insight of Rita Miraglia, Bill Simeone, and Jim Fall of ADF&G, Division of Subsistence. We also thank Patty Brown-Schwalenberg of the Chugach Regional Resources Commission for her many contributions.

We thank Joshua Hall and Rick Schrieber of the Chugach School District for their encouragement and support in initiating the Youth Area Watch component of this project. Marianne Bishop, Copper River Delta Institute, kindly offered us information on PWS scoter observations during the spring herring spawn. Thanks to Celia Rozen, ADF&G librarian, for her literature searches and acquisitions and many other library skills, and to Tom Rothe, Joe Sullivan, Bill Hauser, Melanie Bosch, Cathy Kane, and Pat Oldford, who all provided much additional support to our project for which we are grateful.

And finally, we greatly appreciate the support and encouragement of the Exxon Valdez Oil Spill Restoration Office. We thank the Restoration Office and the Exxon Valdex Oil Spill Trustee Council for funding this project.

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Table 1. Number and composition of sea ducks captured with floating mist nets in Prince William Sound, Alaska during early spring 1998.

Species	Male	Female	Total
Surf scoter *(Melanitta perspicillata)*	23	2	25
White-winged scoter *(Melanitta fusca)*	16	15	31
Black scoter *(Melanitta nigra)*	1	0	1
Harlequin duck *(Histrionicus histrionicus)*	2	0	2
Oldsquaw (*Clangula hyemalis*)	1	1	2
Total	43	18	61

Table 2. Summary of location and sensor data (as of 30 January 1999)[a] for surf scoters captured in Prince William Sound, Alaska in early spring 1998 and surgically implanted with satellite transmitters.

	Date				Actual number of days with location data and the number of possible transmission days while the bird was known to be alive.				
PTT number[b]	captured	first location	last location[c]	ambient temperature[d]	<1000m accuracy[e]	>1000m accuracy[f]	no estimate of accuracy[g]	actual total	possible total
2240	3 May	3 May	3 May	12 May	1	0	0	1	1
2241	30 April	30 April	30 April	13 May	1	0	0	1	1
2242[h]	1 May	1 May	14 May	20 May	4	0	1	5	6
2243	30 April	30 April	10 May	7 Jan 99	2	2	0	4	4
2244	30 April	30 April	13 March 99	23 June 99	23	27	12	62	77
2245	1 May	1 May	1 May	4 May	1	0	0	1	1
2246	3 May	3 May	active	active	18	3	15	36	76
2247	1 May	1 May	4 May	21 May	2	0	0	2	2
10928[h]	2 May	2 May	27 June	10 July	17	1	1	19	19
10929	30 April	30 April	21 Jan 99	not recorded	23	6	26	55	76

[a] Location data after this time was received infrequently.
[b] Satellite transmitter (platform transmitter terminal) identification number.
[c] Last location prior to ambient temperature readings.
[d] Ambient temperature sensor readings indicates the bird had died.
[e] Location class codes 1, 2 and 3.
[f] Location class code 0.
[g] Location class codes A and B.
[h] Female surf scoters.

Table 3. Locations of female surf scoter (10928) obtained from satellite telemetry in 1998.

Dates	Latitude[a]	Longitude[a]	Location	Location accuracy	Site description	Straight-line distance traveled[b]
2 May 1998	60.362	147.218	Graveyard Point, Montague Island, Prince William Sound, AK	<1000m	spring migration/ staging	0 km
5-24 May 1998	61.102	146.633	Shoup Bay, Valdez Arm, Prince William Sound, AK	<1000m	spring migration/ staging	95 km
27 May 1998	63.124	142.695	Tetlin Lake, Tetlin NWR near Tok, AK	<1000m	spring migration/ staging	300 km
30 May 1998	68.687	125.101	Horton River drainage, east of Inuvik, Northwest Territories	<1000m	breeding area	1010 km
2-27 June 1998	68.823	126.347	between Horton and Anderson river drainages, Northwest Territories	<1000m	breeding area	55 km

[a] decimal degrees
[b] approximate distance from previous location

Table 4. Locations of male surf scoter (2244) obtained from satellite telemetry in 1998 and 1999.

Dates	Latitude[a]	Longitude[a]	Location	Location accuracy	Site description	Straight-line distance traveled[b]
30 April 1998	60.362	147.218	Graveyard Point, Montague Island, Prince William Sound, AK	<1000m	spring migration/ staging	0 km
3 May 1998	59.764	147.884	Cape Cleare, Montague Island, Prince William Sound, AK	<1000m	spring migration/ staging	79 km
9 May 1998	59.825	147.586	Jeanie Cove, Montague Island, Prince William Sound, AK	<1000m	spring migration/ staging	18 km
12-21 May 1998	59.951	147.400	Patton Bay, Montague Island, Prince William Sound, AK	<1000m	spring migration/ staging	16 km
25 May 1998	60.144	147.424	western shore of Montague Island, Prince William Sound, AK	<1000m	spring migration/ staging	27 km
28 May - 9 June 1998	59.341	153.950	Contact Point, Kamishak Bay, Lower Cook Inlet, AK	<1000m	spring migration/ staging	377 km

Table 4. (cont.)

12-15 June 1998	58.575	158.306	Nushagak Bay, Bristol Bay, south of Dillingham, AK	<1000m	spring migration/ staging	264 km
18 June - 18 Aug. 1998	59.710	163.867	western shore of Kuskokwim Bay, near Anogok, AK	<1000m	molting area	350 km
21-31 Aug. 1998	60.161	164.620	mouth of Kolavinarak River, Nelson Island, near Chefornak, AK	<1000m	fall staging area	58 km
3 Sept. 1998 - 31 March 1999	57.984	155.012	Kashvik/Katmai Bay, Shelikof Strait, Katmai National Park, AK	<1000m	wintering area	628 km

[a] decimal degrees
[b] approximate distance from previous location

Table 5. Locations of male surf scoter (10929) obtained from satellite telemetry in 1998 and 1999.

Dates	Latitude[a]	Longitude[a]	Location	Location accuracy	Site description	Straight-line distance traveled[b]
30 April 1998	60.362	147.218	Graveyard Point, Montague Island, Prince William Sound, AK	<1000m	spring migration/ staging	0 km
4 May 1998	60.374	145.646	near Egg Island, Orca Bay, south of Cordova, AK	<1000m	spring migration/ staging	85 km
7-10 May 1998	60.528	145.826	Orca Inlet, Prince William Sound, near Cordova, AK	<1000m	spring migration/ staging	21 km
13 May 1998	60.385	146.743	Deer Cove, Hinchinbrook Island, Prince William Sound, AK	<1000m	spring migration/ staging	53 km
16 May 1998	60.570	145.795	Orca Inlet, Prince William Sound, near Cordova, AK	<1000m	spring migration/ staging	53 km
23 May 1998	60.784	148.703	Passage Canal, Prince William Sound, near Whittier, AK	<1000m	spring migration/ staging	160 km
26-29 May 1998	59.756	151.145	Kachemak Bay, Lower Cook Inlet, near Homer, AK	<1000m	spring migration/ staging	177 km

Table 5. (cont.)

1-4 June 1998	59.469	153.687	Rocky Cove, Kamishak Bay, Lower Cook Inlet, AK	<1000m	spring migration/ staging	144 km
8 June 1998	59.281	158.695	Lake Aleknagik, north of Dillingham, AK	<1000m	spring migration/ staging	285 km
11-14 June 1998	59.762	162.591	mouth of Kuskokwim River, Kuskokwim Bay, near Kulvagavik, AK	<1000m	spring migration/ staging	225 km
17-30 June 1998	60.331	165.117	south Nelson Island, Etolin Strait, near Toksook Bay, AK	<1000m	spring staging area	153 km
3 July - 8 Aug. 1998	59.743	163.640	western shore of Kuskokwim Bay, near Anogok, AK	<1000m	molting area	106 km
27 Aug. - 3 Sept. 1998	59.847	162.735	mouth of Kuskokwim River, Kuskokwim Bay, near Kulvagavik, AK	no estimate of accuracy	fall staging area	48 km
12 Sept. 1998- 21 Jan. 1999	57.163	135.446	Sitka Sound, Baranof Island, near Sitka, Ak	<1000m	wintering area	1610 km

[a] decimal degrees
[b] approximate distance from previous location

Table 6. Locations of male surf scoter (2246) obtained from satellite telemetry in 1998 and 1999.

Dates	Latitude[a]	Longitude[a]	Location	Location accuracy	Site description	Straight-line distance traveled[b]
3 May 1998	60.362	147.218	Graveyard Point, Montague Island, Prince William Sound, AK	<1000m	spring migration/ staging	0 km
7 May 1998	59.893	147.804	Macleod Harbor, Montague Island, Prince William Sound, AK	<1000m	spring migration/ staging	59 km
10-13 May 1998	59.991	148.335	Procession Rocks, Bainbridge Island, Prince William Sound, AK	<1000m	spring migration/ staging	27 km
26 May - 2 June 1998	60.518	145.878	Orca Inlet, Prince William Sound, near Cordova, AK	<1000m	spring migration/ staging	148 km
5 June 1998	60.331	147.662	Marsha Bay, Knight Island, Prince William Sound, Ak	<1000m	spring migration/ staging	102 km
9-15 June 1998	60.365	145.922	shoals south of Orca Inlet, Prince William Sound, AK	<1000m	spring migration/ staging	95 km
25 June - 18 July 1998	59.740	163.840	western shore of Kuskowkim Bay, near Anogok, AK	>1000m	molting area	1013 km

Table 6. (cont.)

5 Oct. 1998- 26 March 1999	59.940	147.836	southern half of Montague Island, Prince William Sound, AK	<1000m	wintering area	901 km
8-13 May 1999	60.377	147.088	Rocky Bay, Montague Island, Prince William Sound, AK	>1000m	spring migration/ staging	68 km
19-29 May 1999	63.136	142.416	Tetlin Lake, Tetlin NWR, near Tok, AK	no estimate of accuracy	spring migration/ staging	386 km
4 June 1999	67.777	134.731	MacKenzie River drainage, Northwest Territories, Canada	no estimate of accuracy	breeding area	644 km

[a] decimal degrees
[b] approximate distance from previous location

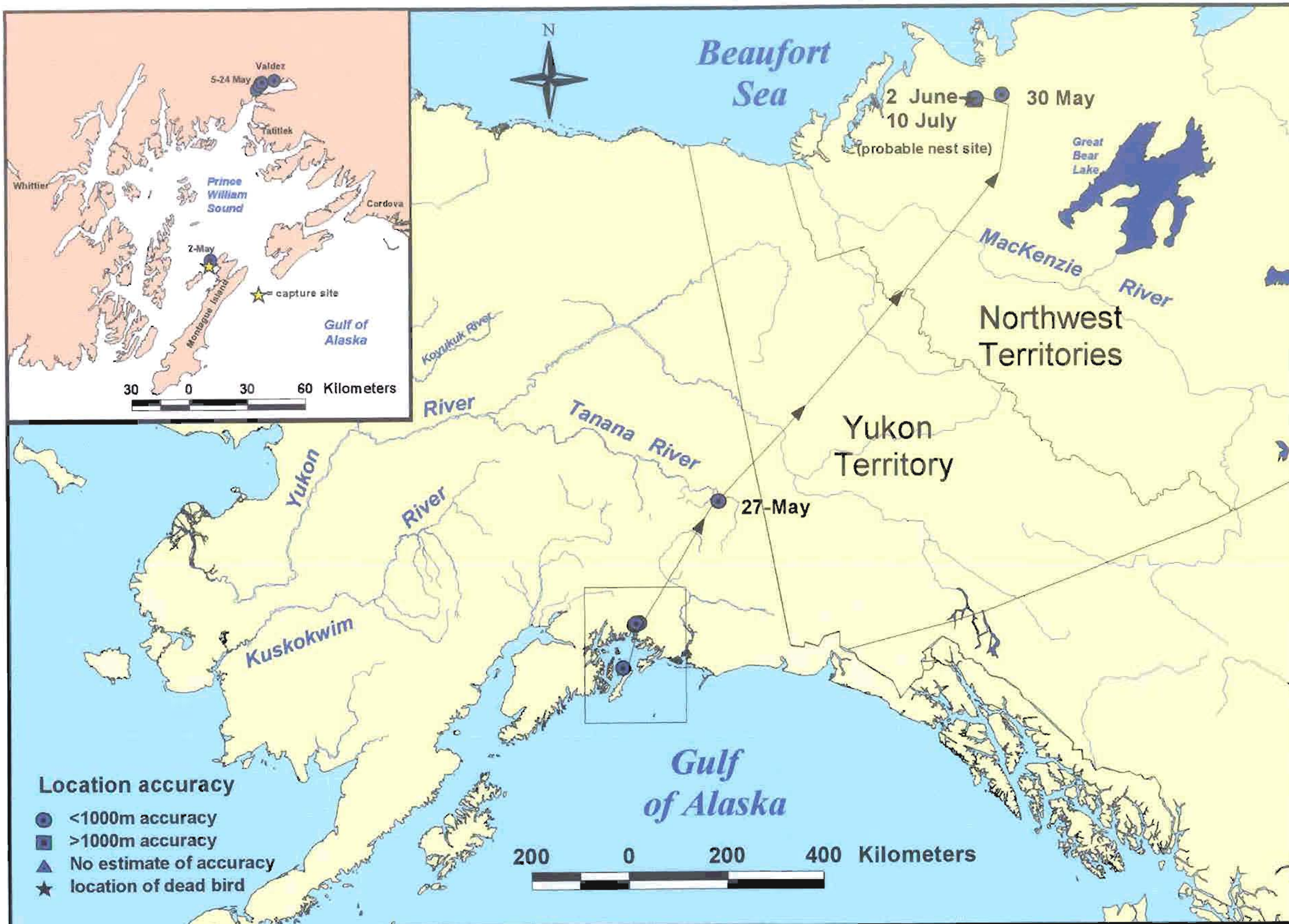

Fig. 1. Movements of female surf scoter (10928) obtained from satellite telemetry. Locations are plotted for movements near the capture site in Prince William Sound, Alaska (inset) and for movements outside of Prince William Sound. Scoters were captured during early spring in 1998. Lines depict direction of movement, not actual travel route.

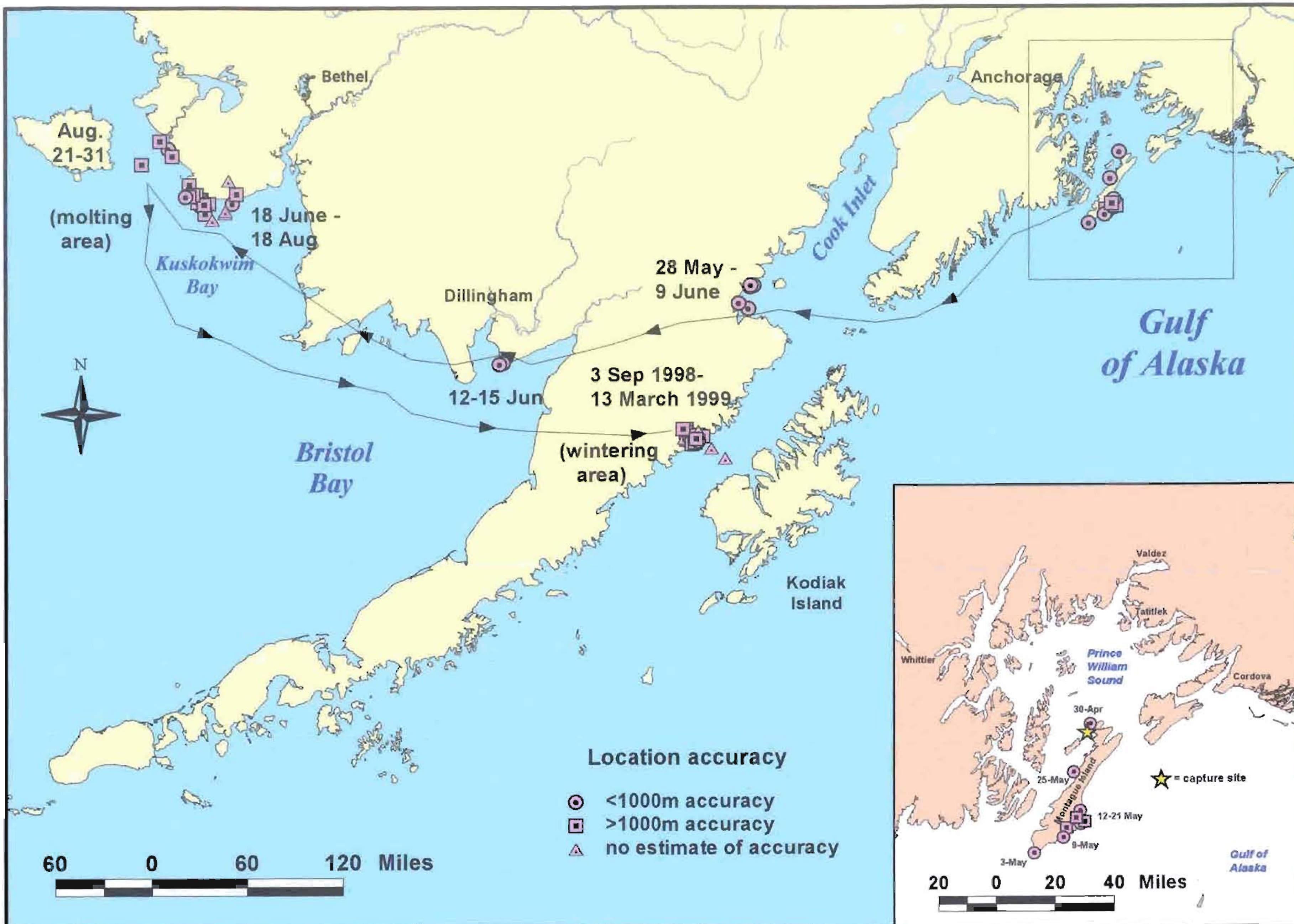

Fig. 2. Movements of male surf scoter (2244) obtained from satellite telemetry. Locations are plotted for movements near the capture site in Prince William Sound, Alaska (inset) and for movements outside of Prince William Sound. Scoters were captured during early spring in 1998. Lines depict direction of movement, not actual travel route.

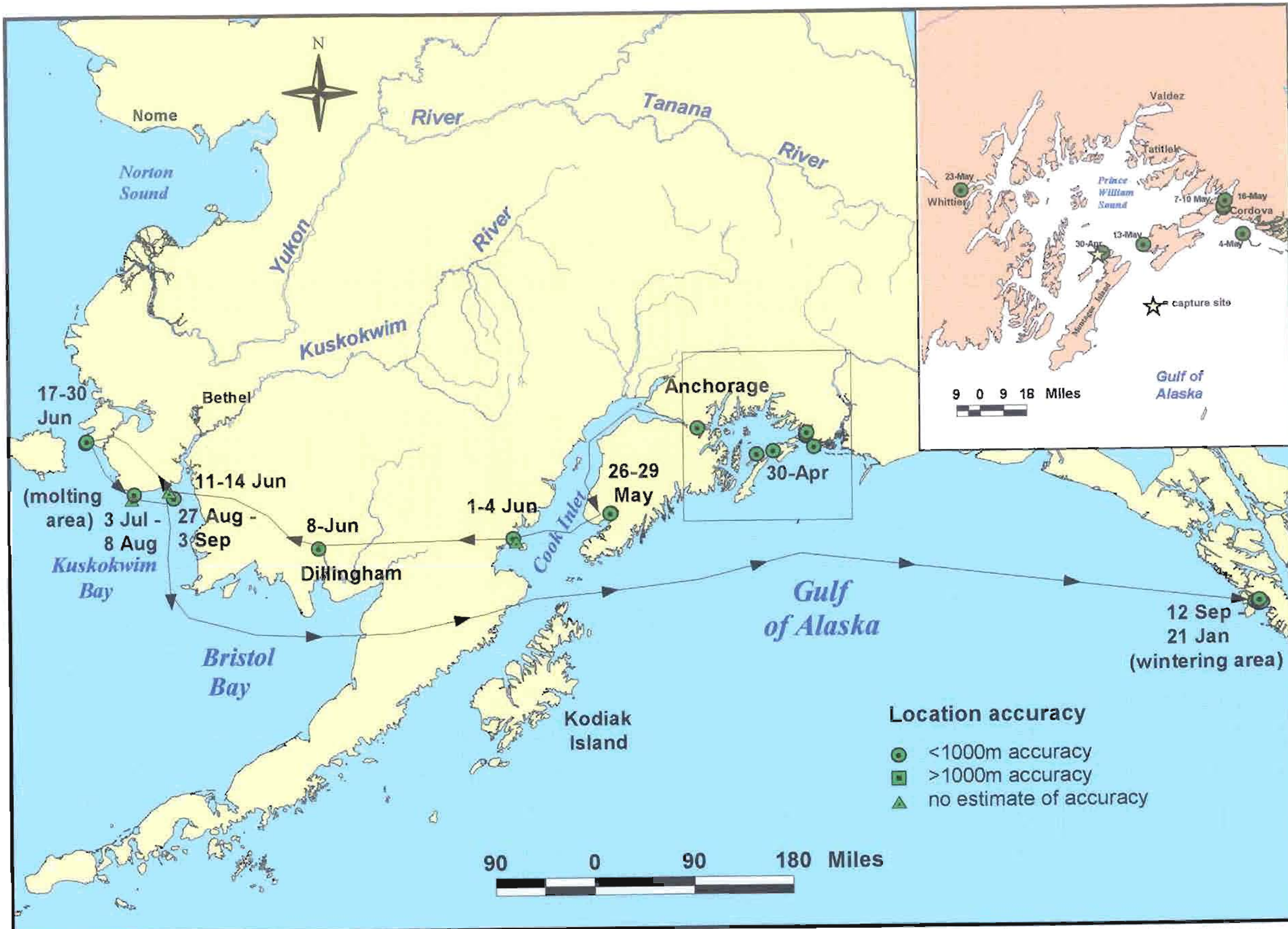

Fig. 3. Movements of male surf scoter (10929) obtained from satellite telemetry. Locations are plotted for movements near the capture site in Prince William Sound, Alaska (inset) and for movements outside Prince William Sound. Scoters were captured during early spring in 1998. Lines depict direction of movement, not actual travel route.

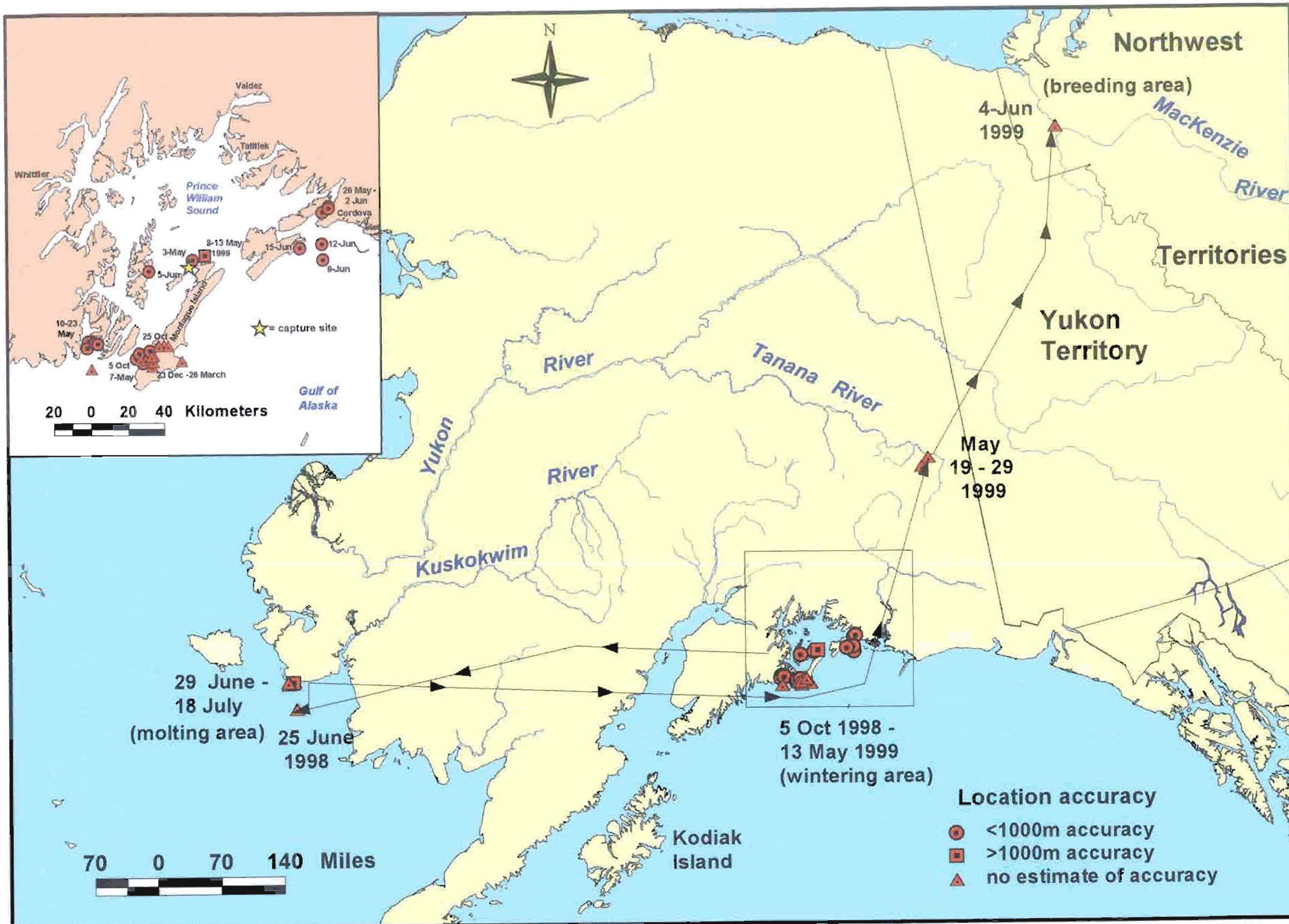

Fig. 4. Movements of male surf scoter (2246) obtained from satellite telemetry. Locations are plotted for movements near the capture site in Prince William Sound, Alaska (inset) and for movements outside of Prince William Sound. Scoters were captured during early spring in 1998. Lines depict direction of movement, not actual travel route.

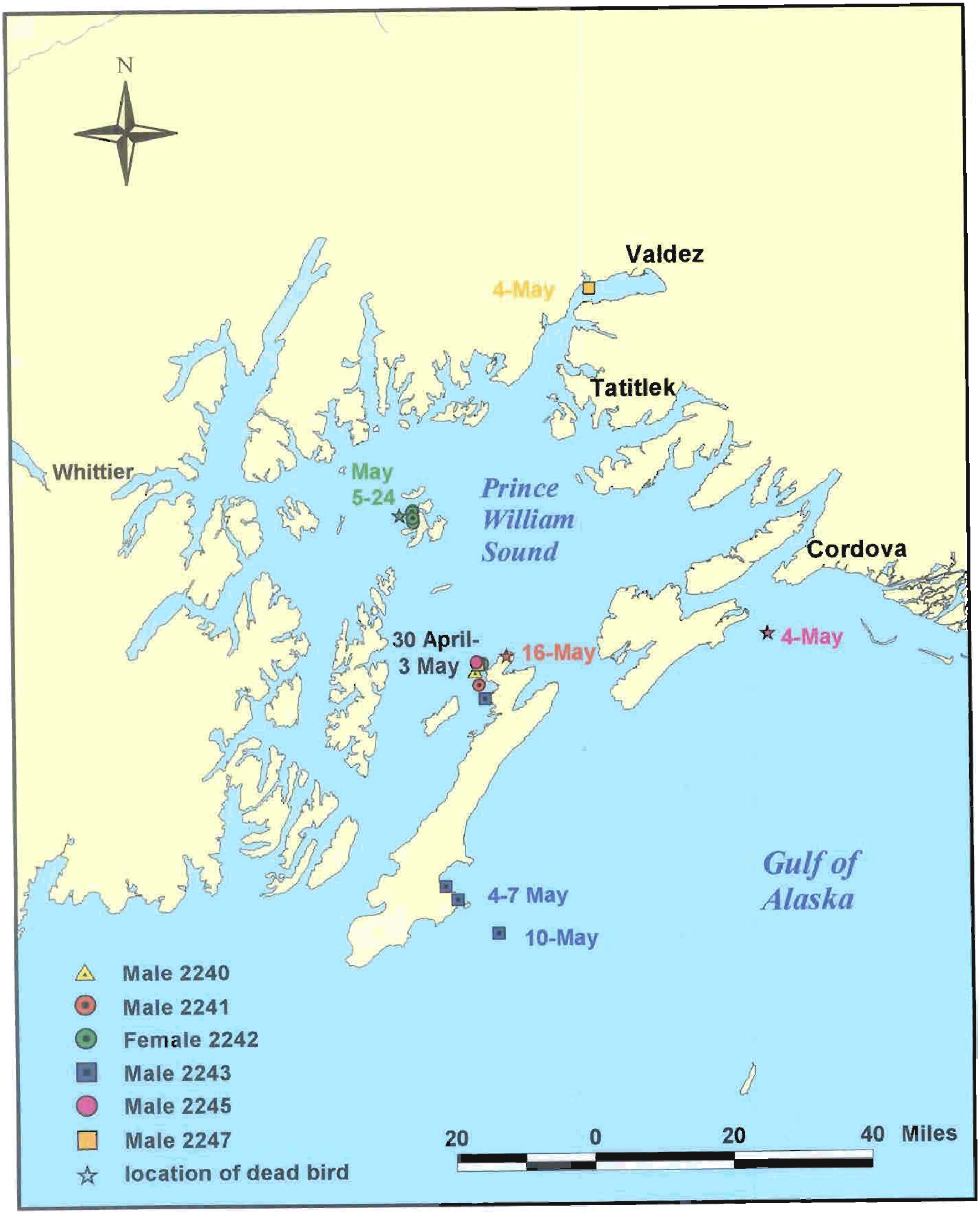

Fig. 5. Movements of surf scoters surgically implanted with satellite transmitters in 1998 that died before leaving Prince William Sound, Alaska.

APPENDIX A. Traditional Ecological Knowledge

Note: The following information is based on interviews and discussions with members of native communities in PWS and lower Cook Inlet. Participants or other representatives of these communities have not been given the opportunity to review this section. Further discussions, interviews, and reviews in 1999 and 2000 may result in changes. Please consider this as a draft and do not release it as a public document at this time.

The Scoter's Guts

There was a black scoter(?). A land otter went to the sea looking for food. There he saw five scoters sitting on the water, and dived. He came up under them and seized one of them and swam ashore. When he got to his hole he took the scoter in and ate it, but he did not touch the guts. The other scoters missed their partner. They were aware that something had taken him and started to sing:

cajaha•, cajaha•	
*i*nim-pik$_v$m	Under that mountain
manuan*i*	right here
qil$_{vRL}$uanka pakma	my guts up there.
*i*nim-pik$_v$m	Under that mountain
manuan*i*	right here

The four scoters went after the guts, took them and turned them into a scoter again. They never went back to the same place anymore (story told by Chief Makari Feodorovich Chimovitski as recorded in Birket-Smith 1953).

INTRODUCTION

Traditional Ecological Knowledge (TEK), a system of understanding one's environment, is built over generations, as people depend on the land and sea for their food, materials, and culture (Huntington and Mymrin 1996). TEK is based on observations and experience, evaluated in light of what one has learned from one's elders. Historically, the survival of communities depended upon the reliability of this detailed knowledge.

We can improve our understanding of the environment and ecological processes by integrating the findings of western science and traditional knowledge into one complementary process. One goal of gathering traditional ecological knowledge is to use traditional knowledge in resource management (Ferguson and Messier 1997). Another goal is to understand TEK as its own system, supporting a unique culture. Traditional ecological knowledge can provide a long-term perspective often lacking in western scientific studies by contributing information on long-term changes in distribution and abundance of wildlife populations and the ecological factors that influenced those changes. Regarding the oil spill, this process is aimed at understanding the injury and recovery of the resources affected by the spill.

The importance of a particular species, be it for food, clothing, or ceremonial purposes, to the inhabitants of a region, greatly influences the amount of traditional knowledge associated with that species. The Chugach settlement pattern reflects a subsistence lifestyle based on the efficient exploitation of a variety of resources (Hassen 1978). However, by the time Birket-Smith (1953) and de Laguna (1956) conducted their research in the early 1930's, Chugach society and culture had already experienced almost 200 years of contact with European and American cultures. This "outside" contact often forced lifestyle changes and introduced imported goods, including foods, all of which ultimately reduced dependence on the local environment. Consequently, many of the details involving life during the pre-contact period have been forgotten (Hassen 1978).

Historically, scoters (*Melanitta* spp.) have been hunted for centuries in PWS. Scoters were the most abundant species found in avifaunal remains at the Palugvik archeological site on Hawkins Island in PWS. Archeological evidence indicates that scoters have been hunted for at least the past 2,250 years (Linda Yarborough, USDA-Forest Service, unpubl. data). Scoters, particularly surf scoters, were also the most abundant avifaunal remains found at archeological sites in Kachemak Bay (Lobdell 1980). These sites have been occupied intermittently since ca. 1500 BC. In the early 1900's sea ducks, including scoters were an important food resource for the people of Chenega (Birket-Smith 1953).

Today, scoters comprise a significant portion of the waterfowl subsistence harvest in both coastal and interior Alaska and were the most important species in the subsistence waterfowl harvest in PWS and LCI (Wolfe et al. 1990). Scoters are an important subsistence resource to the people living in the communities of PWS and LCI (James Fall, ADF&G, pers. comm., Gary Kompkoff, Tatitlek IRA, pers. comm.) These species of seaducks comprise the large majority of the waterfowl harvest in the communities of Tatitlek, Chenega Bay, Port Graham, and Nanwalek (Wolfe et al. 1990, Scott et al. 1996).). Scoters are also harvested in PWS by residents of Eyak and Valdez (Stratton 1981).

Generally, the subsistence waterfowl harvest appears to be declining. From 1987-1989, between 74 and 81 percent of Tatitlek households reported using scoters (Stratton 1990). In 1979, 25-49% of Port Graham and Nanwalek households reported harvesting scoters (Stratton 1981). While not species specific, over 90 percent of Chenega households harvested ducks in the early 1960's (Stratton and Chisum 1986). In 1993, only 55% of the households in Tatitlek reported using scoters harvested for subsistence purposes, as did 40% of the households in Nanwalek and less than 12% of Port Graham households (Scott et al. 1996). Only 63 percent of Chenega households reported harvesting ducks in 1985-1986 (Stratton and Chisum 1986). Only in Nanwalek have scoter harvests remained fairly constant, at least when comparing 1979-1980 data with 1993.

STUDY AREA AND METHODS

We use a broad definition of TEK, defining it as a composite of indigenous, local, and experiential knowledge (Miraglia, 1997). TEK is reinforced, revised, and accumulated by each generation through the addition of local and experiential knowledge. As TEK is rarely written down, we interviewed residents of Prince William Sound (PWS) and lower Cook Inlet (LCI) to record their knowledge of scoters. Our methods were modeled after those of Huntington and Mymrin (1996). Community elders and hunters were interviewed either individually or in groups. When possible, this information was compared with past studies or historical accounts. Information on traditional and current use of scoters for food and clothing is also presented to indicate the significance of this resource to the Alaska native communities in PWS and LCI.

The first series of interviews and meetings were conducted between October 27, 1997 and January 22, 1998. Interviews were conducted in Tatitlek, Chenega Bay, and Port Graham. Additional interviews were conducted at the Elders-Youth Subsistence conference in Cordova, AK, August 19-23, 1998. In addition, Tatitlek high school students, as part of this project, conducted interviews with two elders in the community. Interviews are part of an on-going process that will continue in FY99 and FY00.

RESULTS

All three species of scoters, surf (*M. perspicillata*), white-winged (*M. fusca*), and black (*M. nigra*) are commonly referred to as "black ducks" by residents of PWS and LCI. However, black scoters are often differentiated from the other two species as they are called "whistlers". Chugach Alutiiq names can be found in Stanek (1985). Some people also refer to hunting "gray ducks", possibly referring to female black scoters. Scoters, as well as other waterfowl are not a dietary staple used throughout the year. Rather, they are a seasonal resource, primarily hunted in spring and late-fall. The number of hunters and the total time spent hunting has been declining.

Historically (living memory), of the three species of scoters, surf and white-winged have been the most abundant in both PWS and LCI. However, while the decline in scoter numbers has been spread among all species in PWS, the decline in LCI has been most noticeable among black scoters. Black scoters are now described as rare in LCI. While surf and white-winged scoters are often found in mixed flocks, black scoters tend to remain segregated.

In PWS, the preferred time to hunt scoters is in spring, about a week after pacific herring (Clupea pallasi) begin to spawn. At this time, the scoters have increased their weight and fat reserves and this improves the flavor and desirability of the ducks. In PWS ducks have been described as being thin and tough prior to fattening up on herring spawn. In LCI, ducks were described as being fatter in winter than spring. Males, because of their larger size, are preferred. Because herring spawn generally occurs earlier in eastern than western PWS, scoter hunting was a more important component of the Tatitlek culture than the Chenega culture. Scoters were less likely to concentrate on herring spawn in western PWS. "Gray ducks" have a softer meat making them less desirable to some. Black and white-winged scoters are now the preferred species in LCI.

In spring, the distribution of scoters is associated with the deposition of herring spawn. It is estimated that upwards of ten thousand scoters would congregate in the Tatitlek Narrows to feed on herring spawn prior to *Exxon Valdez* oil spill. Residents have described the sky "as black with scoters." In living memory, herring spawned annually in the Tatitlek Narrows. In the 1940's, herring (and cod) could be found in Tatitlek Narrows in all months. The herring decline at least in the vicinity of Tatitlek began shortly after World War II. A further and more dramatic decline occurred in the years following the oil spill. Since this most recent decline in the PWS herring population, very few scoters have been observed in the Tatitlek Narrows. In recent years, most scoter activity now occurs on the north shore of Montague Island. However, in the past scoters were more abundant between St. Matthews Bay and the Tatitlek Narrows than at Montague Island. This change in the late-winter and early-spring distribution of scoters appears associated with these recent changes in herring spawning distribution and abundance.

Prince of Whales and Bainbridge passages were important wintering areas for scoters in southwestern PWS. Columbia and Heather bays and Port Gravina were important wintering areas in northeastern PWS. Scoters would remain in the vicinity of Columbia and Heather bays until the spring herring spawn. The west side of Bligh Island was also an area traditionally used by scoters in spring. Large concentrations of scoters were also observed in Port Wells, near the mouth of the Avery River, Port Fidalgo, and Galena and Boulder bays in northern and eastern PWS. After the 1964 earthquake the numbers of scoters declined. Port Wells was an important area for scoters in late-June and July. Thousands of ducks would be observed there during the seining season. The number of scoters in Port Wells has declined and very few have been seen there in the late-1980's and 1990's. In November, scoters can generally be found between Porcupine Point and Knowles Head. Prior to the 1964 earthquake scoters could be found in large numbers during late-fall between northern Green Island and Graveyard Point, Montague Island and within a several mile radius of Little Green Island.

In the lower Kenai Peninsula scoters are found in the various bays and off prominent points of land from China Poot Bay to Dogfish Bay (Koyuktolik Bay). Large flocks are generally found from one-half to one mile offshore. In general, numbers are declining, with the greatest decline among black scoters. The decline in scoters has coincided with an increase in sea otters (*Enhydra lutris*) that began in the late 1970's. Many scoters were found washed up on beaches either dead or near death as a result of an oil spill that occurred in Cook Inlet in the late-1960's.

Scoters are known to eat a variety of foods primarily mollusks. Most food habit observations result from analyzing the gizzard contents of harvested ducks. Mussels, clams, chitons, barnacles, snails, scallops, and herring spawn were the foods most often observed. The clams eaten by scoters are of the same species eaten by sea otters. PWS residents have not observed any evidence of scoters feeding on fish. However, in the lower Kenai Peninsula scoters have been observed feeding on "candlefish" (assumed to be pacific sandlance, *Ammodytes hexapterus*). Scoters feed on candlefish in spring as the fish emerge from the substrate in nearshore reefs. Crab eggs may also be eaten by scoters. In LCI, no change in diet has been observed over the past 30 years.

Several of the foods commonly eaten by scoters have undergone changes in abundance over the past 35 years. The first change coincided with the 1964 earthquake. The earthquake resulted in an immediate decline in the number of clams as intertidal areas subsided or uplifted. Clams briefly rebounded and then underwent another decline, as they were and still are an important prey species for the increasing sea otter population. Clam populations were further reduced by the oil spill. Herring spawn became less abundant and with the decline also came a change in the distribution. This decline occurred gradually since World War II and then was exacerbated with the oil spill. Commercial fishing was cited as a reason for the decline in herring. As one village elder reported, if you disturb herring the fish will vacate an area. In the lower Kenai Peninsula, sandlance numbers have declined. The increase in sea otters and the decline in herring have affected scoters throughout PWS and the lower Kenai Peninsula, not just the oil spill area. Crabs have also declined.

The timing of scoter migration from PWS to nesting and molting areas coincides with the start of gull nesting. Scoter nests have never been observed in PWS and no broods have been observed on salt water in PWS or the lower Kenai Peninsula. Scoters return in September and October.

Other changes in the climate and ecosystems of PWS and LCI were mentioned that may have had or are having an affect on scoter populations or result from similar underlying causes. Tatitlek is experiencing milder winters with less snow. The direction of the prevailing winter winds has also changed. Thinner ice in the Nanwalek Lagoon is thought to be a result of milder winters. Other species such as harbor seals have been declining in both PWS and LCI. In LCI puffins, mallards, and most recently sea otters are beginning to decline. However, the extent of kelp beds (*Nereocystis sp.*) near Nanwalek and Port Graham are increasing. Increased competition with hatchery released pink salmon (*Onchorynchus gorbuscha*) was mentioned as a possible contributor to changes in species abundance. Wild pink salmon stocks all spawned by August. Since the advent of hatcheries pink salmon remain in salt water until October and early November. The increase in numbers and time spent foraging in nearshore environments has some LCI residents concerned that pink salmon are reducing food resources for other species.

DISCUSSION

This information is not intended to be conclusive but represents the first steps in gathering TEK. Further discussions, interviews, and reviews by community members in 1999 and 2000 may result in modifications to some of the preliminary results.

All three species of scoters are thought to have declined in PWS. The lack of scoters in the Tatitlek Narrows is most noticeable. Black scoter populations have exhibited the greatest decline in LCI. Some of the decline may be a result of changes in distribution and not solely in abundance.

Native residents of PWS believe the decline in herring stocks has had the greatest negative effect on sea duck populations in general, which includes scoters. Scoters appear to feed almost exclusively on herring spawn, during a 4-6 week period in spring, prior to migration. Herring populations began a noticeable decline around the time of World War II. However, the first year in living memory that herring did not spawn in Tatitlek Narrows was in 1993, four years after the oil spill. Traditional knowledge reports that ducks throughout PWS have been affected by the herring decline, which was worsened after the oil spill. The magnitude of this effect on scoters is thought be significant. At the least, major changes in distribution have occurred in PWS. Since the 1993 herring crash scoters no longer concentrate in the Tatitlek Narrows and numbers have declined along the northeast shore of PWS. A change in herring populations was not cited as a reason for changes in scoter populations in LCI.

The decline in clams after the 1964 Alaskan earthquake, the re-populating of sea otters in PWS and LCI, and the oil spill's deleterious effect on intertidal organisms are believed to have contributed to declining scoter populations. No specific values can be assigned to these parameters. Intertidal organisms are an important food source of scoters. Intertidal habitats and their organisms have been altered in several ways. Intertidal areas were uplifted during the 1964 Alaskan earthquake. Nearshore areas were heavily oiled in various locations throughout WPWS and some parts of LCI as a result of the *Exxon Valdez* oil spill. This caused a decline in intertidal organisms. Thus, with reduced food supplies, intertidal areas could support fewer ducks. Weathered and relatively unweathered crude oil can still be found on some beaches in WPWS where it may still be affecting ducks.

Native experts also believe that the distribution and abundance of sea ducks has changed with the re-populating of PWS by sea otters. An overabundance of sea otters was a concern of Nanwalek residents in 1979 (Stratton, 1981). As sea otter populations increased, they altered the intertidal environments in ways that reduced the types or amounts of foods available to scoters. Scoters eat a variety of intertidal invertebrates especially blue mussels (*Mytilius sp.*), and clams (*Tellina* sp., *Astarte* sp, *Nuculana* sp., and *Macoma* sp.) (Patten et al. 1998). This food reduction may result from direct competition for prey or by sea otter feeding habits causing ecological changes that ultimately reduce the prey populations of scoters.

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