Long-tailed Duck, *Clangula hyemalis*, Eider, *Somateria* spp., and Scoter, *Melanitta* spp., Distributions in Central Alaska Beaufort Sea Lagoons, 1999–2002

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During July and August 1999–2002, distributions of Long-tailed Ducks (*Clangula hyemalis*), eiders (*Somateria* spp.) and scoters (*Melanitta* spp.) were documented in three barrier island-lagoon systems in the central Alaska Beaufort Sea. Concentration areas for each species were determined during 16 aerial surveys. Kernel density procedures were used to delineate 75% and 50% "activity" or concentration areas for all three species. Long-tailed Ducks were 13 times more numerous than eiders and 38 times more numerous than scoters. The Long-tailed Duck 75% activity area encompassed all three lagoon systems and was three times as large as the eider activity area and one-third larger than the scoter activity area. Eider activity areas were located only in the eastern lagoon, and scoter activity areas were located only in the western lagoon. Density contours showed patterns of repeated habitat use for sea ducks over the four years of sampling and improve our understanding of sea duck habitat use within Beaufort Sea barrier island-lagoon habitats.

Key Words: *Clangula hyemalis*, *Melanitta*, *Somateria,* molt, normal kernel density, Arctic, barrier island, Alaska.

Up to 30 000 molting waterfowl aggregate during mid-July through early September along the mainland and barrier island shorelines in the central Beaufort Sea, Alaska (Figure 1; Johnson et al. 2005). Since 1990, Long-tailed Ducks (*Clangula hyemalis*), the predominant waterfowl species in the central Alaska Beaufort Sea lagoon systems (Johnson and Gazey 1992), have shown a declining trend in total numbers during the male molt period in these lagoons (i.e., mid July to late August) (Fischer et al. 2002; Johnson et al. 2005). During 1999–2002, distributions of waterfowl in the barrier island-lagoon systems between Spy Island and Flaxman Island, Alaska, were documented (Figure 1). Normal kernel density contours, a smoothed density estimation function (Powell 2000), for the combined distributions are presented to delineate "activity" or concentration areas for Long-tailed Ducks, eiders and scoters within these lagoons.

Methods

Aerial Surveys

During each survey, the western lagoon, Stefansson Sound, and eastern lagoon subdivisions of the study area were surveyed on the same day (Figure 1; Johnson 1990; Johnson and Gazey 1992). Lagoon systems were surveyed in varying orders, but all transects within a lagoon system were surveyed before moving to the next lagoon system, and the entire survey area was flown within a 5-hour period. A total of 16 surveys totaling 59 hours was conducted over four years. Four surveys each were flown during 30 July to 26 August 1999 and 1 to 24 August 2000, three surveys were flown during 23 July to 11 August in 2001, and five surveys were flown during 20 July to 14 August 2002.

Aerial surveys were conducted in a single-engine fixed high-wing aircraft (Cessna 206) on floats. The survey crew consisted of a pilot and two observers. One observer sat in the right front seat and the other in the left rear seat. Survey altitude was approximately 45 m above ground level and ground speed was approximately 180 km/h. Transect width was 400 m total, 200 m on each side of the aircraft.

The surveys were during the peak of the male Long-tailed Duck molt (flightless) period from 15 July to 21 August (Johnson and Richardson 1981; Johnson 1985; Johnson and Gazey 1992). Because Long-tailed Ducks are known to concentrate along the barrier islands in the late afternoon and evening (Johnson and Richardson 1981; Johnson 1982, 1985), surveys were scheduled as late in the day as practical, generally from 14:00 to 19:00. Surveys on days with high winds (>35 km/h) were postponed until winds, wave height, and chop diminished, thereby improving the observers' ability to see birds on the water (Johnson 1990; Johnson and Gazey 1992).

Survey Data

Tape recorders were used to record all bird observations. Continuous audio-tape recordings included information on transects, observations, survey weather

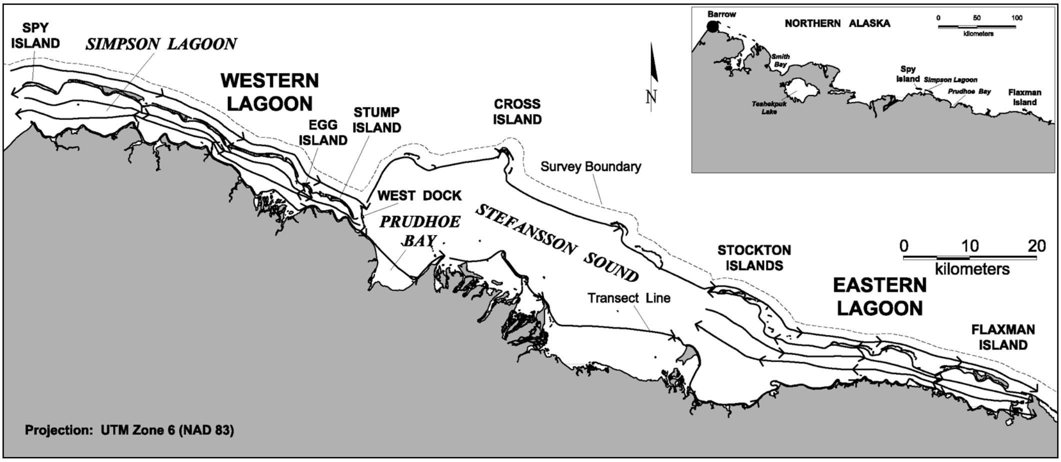

FIGURE 1. Location of aerial survey transects used to record Long-tailed Duck, eider and scoter distribution and abundance in the barrier island-lagoon systems between Spy Island and Flaxman Island, Alaska, July and August 1999–2002.

conditions, and 30-second intervals (time periods) marked by a timer. A notebook computer with mapping software linked to a Global Positioning System (GPS) receiver recorded the flight line at one-second intervals during surveys. Observers synchronized their watches with GPS satellite time, and these times (recorded for transects and time periods) were used to geo-reference survey data.

Normal Kernel Density Contours

Density contours were computed and mapped using the ArcView® (ESRI, 1996, Redlands, California) Animal Movement software extension (Hooge and Eichenlaub 1997*; Silverman 1986; Worton 1989; Seaman and Powell 1991∗). "Activity" or concentration areas were represented by density contours delineating 75% and 50% of birds (Powell 2000). Computations were based on the total number of on-transect individuals summarized for each 30-second time-period over the entire survey area.

Density contours were calculated for Long-tailed Ducks, all eiders and all scoters. Most eiders (99% of eiders identified to species) were Common Eiders (*Somateria mollissima v-nigrum*) with very small numbers of King Eiders (*Somateria spectabilis*). Most scoters (98% of scoters identified to species) were Surf Scoters (*Melanitta perspicillata*) with small numbers of Black Scoters (*Melanitta nigra*) and White-winged Scoters (*Melanitta fusca*).

Results

Long-tailed Ducks were 13 times more numerous than eiders and 38 times more numerous than scoters (Table 1). The 75% activity area for Long-tailed Ducks included parts of survey areas in all three lagoon systems and was three times as large as the eider activity area and one-third larger than the scoter activity area (Figure 2, Table 1). The only eider activity area was in the eastern lagoon, and the only scoter activity area was in the western lagoon (Figure 2). The 50% contour area was about one-third to three-quarters of the size of the 75% contour area depending on the species (Figure 2, Table 1).

The eider activity area was used mainly by large flocks of molting males, and smaller groups (<10 birds) of resting females and females with broods aggregated along barrier-island or mainland shorelines. Scoters occurred in scattered mixed feeding flocks with Long-tailed Ducks in mid-lagoon habitats in the western lagoon. Eider and scoter activity areas did not overlap (Figure 2).

TABLE 1. Activity area size (km^2), total bird density (number per km^2) and total number of Long-tailed Ducks, eiders, and scoters during July and August 1999–2002 in the barrier island-lagoon systems between Spy Island and Flaxman Island, Alaska.

	Total birds 16 surveys	75% activity area km^2	Density Number per km^2	50% activity area km^2	Density Number per km^2
Long-tailed Ducks	181224	642	243	238	388
Eiders	13708	225	38	97	54
Scoters	4762	423	10	318	13

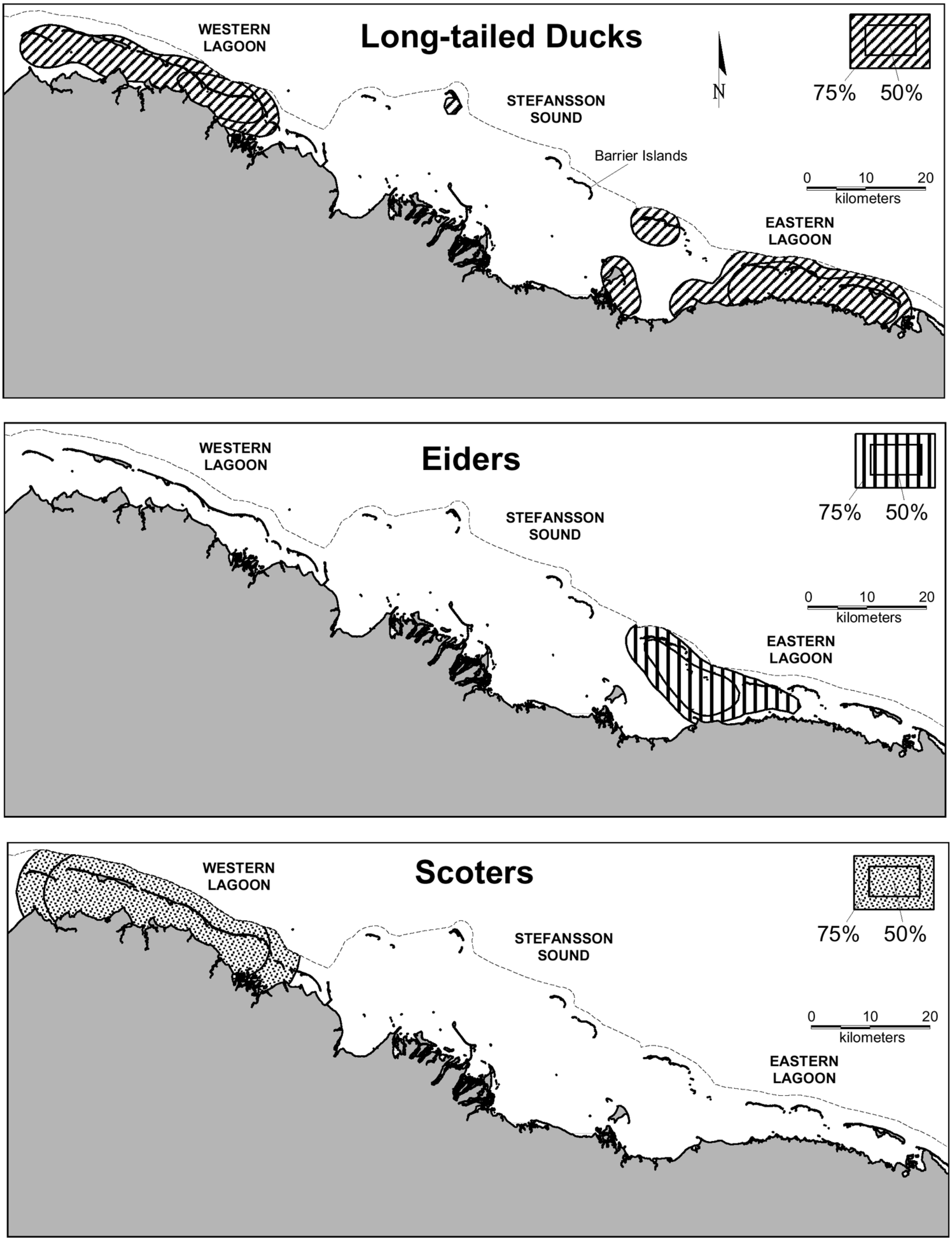

FIGURE 2. Long-tailed Duck, eider and scoter activity areas for 75% and 50% of total birds during July and August 1999–2002 in the barrier island-lagoon systems between Spy Island and Flaxman Island, Alaska.

Discussion

Long-tailed Duck distributions in barrier island-lagoon systems reflected proximity to both lagoon foraging habitats and resting habitats along the barrier island and mainland shorelines (Johnson 1990; Johnson and Gazey 1992; Johnson et al. 2005). Eiders and scoters both were more limited in their distributions than Long-tailed Ducks (Figure 2). Eider activity area was limited to the eastern lagoon, while scoter activity area was within the western lagoon (Figure 2). Eider distributions reflected foraging, nesting and resting habitat use, but scoter distributions reflected only foraging and resting habitat use. Only the Long-tailed Duck 75% activity area included the Stefansson Sound subdivision of the study area.

Long-tailed Ducks are less specific in their prey selection than are either eiders or scoters (Nilsson 1972; Stott and Olson 1973, Sanger and Jones 1984). Long-tailed Duck prey may be either nektonic or benthic (Johnson 1984; Stott and Olson 1973). In the Simpson Lagoon area, preferred prey are crustaceans and bivalves in 2–3 m water depths, where prey densities are highest (Johnson 1984). Given the less specific nature in their foraging, and observations of mixed-species foraging flocks of Surf Scoters and Long-tailed Ducks in the western lagoon, competition and mutual exclusion between Long-tailed Ducks and scoters is unlikely.

Eiders are primarily benthic feeders and, although they may be more specific in their food habits than Long-tailed Ducks, they are more general than scoters (McGilvrey 1967; Stott and Olson 1973; Cantin et al. 1974; Vermeer 1981). The eider activity area in the eastern lagoon encompassed the deeper waters (up to 6 m), with crustacean and bivalve prey (Woodward-Clyde Consultants 1996*) known to be preferred by this species (Nilsson 1972).

Aggregations of eiders are often associated with breeding habitats (Savard et al. 1999). Common Eider nesting activities in our study area are concentrated on the Stockton Islands in the eastern lagoon system and on Egg and Stump islands in the western lagoon system (Figure 1; Johnson 2000). The 50% eider activity contour in our study included the Stockton Island group; however, the center of this activity area was directly associated with the larger foraging flocks of eiders, not with known nesting areas (Figure 2).

There was no overlap in activity areas for eiders and scoters (Figure 2). Although some of the same foods are preferred by these two species, different foraging habitats were selected. The lack of overlap between eider and scoter activity areas may reflect differential habitat use similar to that described elsewhere (Savard et al. 1999). Scoter distributions are known to be associated with foraging habitats rich in bivalves (Nilsson 1972; Vermeer 1981). Although bivalves are known to occur throughout the barrier island-lagoon systems in the Alaska Beaufort Sea, fine-scale prey sampling across all known feeding habitats has not yet occurred.

Direct links between sea duck distribution and prey availability in Beaufort Sea barrier island-lagoon habitats have only been documented in a few studies (Johnson and Richardson 1981; Johnson 1984). Nevertheless, this study and others (Johnson et al. 2005) show strong patterns of repeated use of discrete lagoon habitats by sea ducks. These patterns are likely linked to food availability during the mid-summer molt period. This information will be helpful when designing sea duck mitigation and monitoring programs as development occurs in barrier island-lagoon habitats in the Alaska Beaufort Sea.

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