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Molting, Staging, and Wintering Locations of Common Eiders Breeding in the Gyrfalcon Archipelago, Ungava Bay

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ABSTRACT. The northern common eider (*Somateria mollissima borealis*) has become a source of concern because of recent declines and possible overharvest. Birds that breed in the Canadian mid-Arctic winter in both Greenland and Canada, but the wintering grounds of birds that breed farther south are unknown. Our objectives were thus to identify the molting and wintering areas of birds breeding in Ungava Bay and to compare their home-range sizes during the pre-molt, molt, post-molt, and winter periods. Using satellite telemetry, we determined that common eiders breeding in the lower Arctic winter in Greenland (67%) and Canada (33%). These proportions are consistent with the split established for common eiders that breed farther north. Females spent their pre-molt period close to their breeding islands and had the smallest home ranges during the molt period. Winter home ranges were larger in Canada than in Greenland, probably because they contained more ice. Once settled, birds wintered in a relatively small area and did not undertake long movements. Distance between molt and winter sites ranged between 1054 and 2173 km. Duration of migration to or from wintering areas varied among individuals from rapid movement in a few days to slow progress over a month. Fall migration occurred in late October or early November, and spring migration, in early to mid-May. This study highlights the importance of Ungava Bay for northern common eiders and the need for international collaboration to ensure sustainable use of the resource.

Key words: common eider, home range, molting area, migration, satellite telemetry, *Somateria mollissima borealis*, wintering area

RÉSUMÉ. L'eider à duvet du nord (*Somateria mollissima borealis*) représente une source de préoccupation en raison de déclins récents et de récoltes susceptibles d'être excessives. Les oiseaux nichant dans la zone arctique moyenne canadienne hivernent au Groenland et au Canada, mais l'aire d'hivernage des oiseaux nichant plus au sud n'est pas connue. Nos objectifs consistaient donc à identifier les aires de mue et d'hivernage des oiseaux nichant dans la baie d'Ungava et de comparer leur aire d'activité lors des périodes de pré-mue, de mue, d'après-mue et d'hiver. Au moyen de la télémétrie satellitaire, nous avons déterminé que l'eider à duvet nichant dans la zone arctique inférieure hiverne au Groenland (67 %) et au Canada (33 %). Ces proportions sont similaires à celles trouvées dans les colonies d'eider à duvet plus nordiques. Les femelles passent la période de la pré-mue près de leurs îles de nidification et sont les plus restreintes en termes d'aire utilisée lors de la période de mue. Les aires d'activité hivernale étaient plus grandes au Canada qu'au Groenland, probablement en raison de la plus grande présence de glaces au Canada. Une fois sur leur site d'hivernage, les oiseaux évoluaient dans une aire relativement petite et n'entreprenaient pas de longs déplacements. La distance entre les sites de mue et d'hivernage variait entre 1 054 et 2 173 kilomètres. La durée de la migration variait d'un individu à l'autre, allant de déplacements rapides sur quelques jours à des déplacements plus lents sur près d'un mois. La migration automnale a débuté à la fin octobre, début novembre et celle du printemps vers le début et la mi-mai. Cette étude met en évidence la grande importance de la baie d'Ungava pour l'eider à duvet du nord de même que le besoin de collaboration internationale pour assurer l'utilisation soutenue de cette ressource.

Mots clés : eider à duvet, aire d'activité, aire de mue, migration, télémétrie satellitaire, *Somateria mollissima borealis*, aire d'hivernage

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INTRODUCTION

The northern common eider (*Somateria mollissima borealis*) is known to breed primarily in the eastern Canadian Arctic and migrate to southwestern Greenland and eastern Canada to winter (Gillespie and Learning, 1974; Reed and Erskine, 1986; Mosbech et al., 2006a; Gilliland and Robertson, 2009). However, migration patterns, locations of important molting and staging sites, and affiliations between breeding and wintering areas remained poorly understood.

The status of northern common eiders is a concern because of recent declines reported in their Arctic breeding areas (Cooch, 1965, 1986; Reed, 1986a; Robertson and Gilchrist, 1998), and past overexploitation in Greenland has led to a massive decline in the breeding eider population there (Hansen, 2002; Merkel, 2004a). Northern common eiders are still heavily hunted (Gilliland et al., 2009) by aboriginal groups (Inuit of Nunavut, Nunavik, Nunatsiavut, and Greenland and Innu and Métis of the Gulf of St. Lawrence), and recreational hunters in Quebec, Newfoundland and Labrador, Greenland, and Saint-Pierre and Miquelon Islands (France) also compete for that resource (Wendt and Silieff, 1986; Blanchard, 2004; Gilliland et al., 2009). This intense exploitation jeopardizes the emergence of a lucrative and environmentally sustainable eider down industry in Nunavik and Nunavut (Nakashima, 1986; Reed, 1986b; Nakashima and Murray, 1988; Bédard et al., 2008). Also, in the face of climate change, northern common eiders may encounter new threats as the Arctic becomes more accessible and environmental conditions become more favorable for epizootic disease events (Descamps et al., 2009) and predator pressure increases (Smith et al., 2010). Eiders form large, dense concentrations on their breeding, molting, and wintering areas (Lehoux and Bordage, 1999; Goudie et al., 2000), which makes them sensitive to disturbance, highly vulnerable to oil spills and overharvest, and vulnerable to disease transmission.

An aerial survey conducted in 1978 combined with ground censuses in 1980 produced an estimate of 48 700 pairs of northern common eiders breeding in Ungava Bay and along the Québec coast of Hudson Strait (Chapdelaine et al., 1986), making this area the most important known breeding concentration of northern common eiders in the Canadian Arctic. Recent satellite telemetry studies have indicated that birds from some northern colonies winter either in Greenland or in the Gulf of St. Lawrence and along the coast of Newfoundland (Mosbech et al., 2006a). However, it is unknown whether this winter segregation applies to birds breeding throughout the range.

Management of the use of northern common eiders is complex and requires cooperation among international resource agencies, as well as between recreational and aboriginal users. A key component of management and habitat protection plans is an understanding of migration patterns, the locations of important molting and staging sites, and the affiliations between breeding and wintering areas. Knowledge about the home ranges that birds use at different periods of their annual cycle and the movements they make within and between these areas can help us understand the strategies used by the birds to cope with different environmental conditions (Merkel et al., 2006). However, no such information is available for northern common eiders breeding in the southern part of their range.

Our objectives were to determine 1) some of the molting areas used by eiders breeding in the Gyrfalcon Archipelago, Ungava Bay; 2) their wintering areas; 3) their home ranges during pre-molt, molt, post-molt, and winter; and 4) the chronology of their spring and fall migrations.

METHODS

Study Area

All birds were captured in 2006 in the Gyrfalcon Archipelago on the western coast of Ungava Bay, just north of the mouth of the Leaf River (59˚ 06′ 31.75″ N, 68˚ 56′ 51.42″ W). The Gyrfalcon is the largest archipelago of Ungava Bay, with some 200 clustered islands (see Chapdelaine et al., 1986 for island locations). The bare and rocky shores of the islands are the result of exposure to wind and ice carried by currents. Tidal amplitude reaches maxima of 14 to 16 m at the mouth of the Leaf River (Dunbar, 1966) and causes strong tidal currents between islands. Ice starts to break up around 7 June in this region, but this date can vary by several weeks from year to year (Canadian Ice Service, Environment Canada). Eiders were captured on the nest between 22 and 28 June 2006, using dip nets or mist nets strung across the colony. Birds were flown back to Kuujjuaq by helicopter (45 min. trip) and implanted with satellite transmitters. Transmitters were programmed to transmit for five hours every three days (5 h on and 70 h off). To minimize stress, all birds were returned to their capture site and released on the same day they were captured.

Surgical Procedure

Birds were anesthetized with insoflurane through a mask and maintained with an endotracheal intubation and assisted ventilation. Prior to the surgery, birds were locally anesthetized with an injection of lidocaine at a mean dose of 2.7 mg/kg at the incision site. A 4 cm incision was cut between the sternum and the pubis on the median line to expose the coelomic cavity. A second incision of 0.5 cm was done at the right of the distal vertebral column. The transmitter was inserted in the right caudal air sac and the antenna was simultaneously inserted through a dorsal incision with pliers. The transmitter was fixed on the right lateral wall of the coelomic cavity to stabilize it. The ventral incision was closed in three planes of suture (one suture for the muscle wall; one for the subcutaneous fat; and one for the skin) and the dorsal incision was closed in a circular fashion around the antenna. After the operation, the birds also received intramuscular injections of a systemic analgesic (butorphanol: 1 mg/kg) and the antibiotic enrofloxacin (Baytril: 15 mg/kg).

Home Range Analysis

Satellite location data were classified according to their accuracy. We retained location quality codes of classes 3, 2, and 1 with estimated accuracy of more than 150 m, 150–350 m, and 350–1000 m, respectively. We excluded other, less precise quality codes (0, A, or B; > 1000 m). To delineate home ranges used by each individual, we used Calhome software (Kie et al., 1994) to calculate harmonic means (Dixon and Chapman, 1980) and estimate the 50% (core area) and 95% home range confidence areas (White and Garrott, 1990). Home ranges are sometimes overestimated by Calhome because land areas on islands and shore are included in the calculations. We corrected our home range estimates by intersecting the Calhome home ranges with 1:50 000 topographic maps in a GIS (MapInfo, 2005) and removing the dry land from the home range before estimating the area. Total home range areas were plotted against the number of locations to determine the number necessary to achieve stable estimates (Kenward, 1987; Harris et al., 1990). The mean number of locations needed to reach an asymptote was 21 (SE = 4).

We calculated home ranges for the pre-molt, molt, and post-molt periods, determining those periods by a visual analysis of movement rates (km/h) between consecutive locations. The identification of these periods depended greatly on bird movements, the timing of which varied greatly among females. The pre-molt period corresponded to the time prior to reaching the molting site. For a few females that molted in the same area used for pre-molt, we could not separate these periods. Similarly, the post-molt period corresponded to the time between a female's first significant movement away from her molting location and her first migration movement. Because females arrived at their molting location before becoming flightless and remained there long after regaining flight capabilities, this period does not correspond to the flightless period and is quite variable between females.

RESULTS

Capture and Sampling

We implanted 1 adult male eider and 14 adult female eiders with satellite transmitters. Birds originated from three islands. We captured three females on island No. 203 in the Gyrfalcon Archipelago (colony size ~ 300 nests) on 23 June 2006, six females on island No. 62 (~ 200 nests; Chapdelaine et al., 1986; Falardeau et al., 2003) on 24 June, and five females and one male on an unnamed island (58° 55′ 20.80″ N – 68° 58′ 01.39″ W; ~1500 nests) located at the mouth of the Leaf River, just east of the Gyrfalcon Archipelago on 25 June (Fig. 1). All birds implanted were in average to good condition, and transmitter weight (45 g) ranged between 2.2% and 2.8% of body weight.

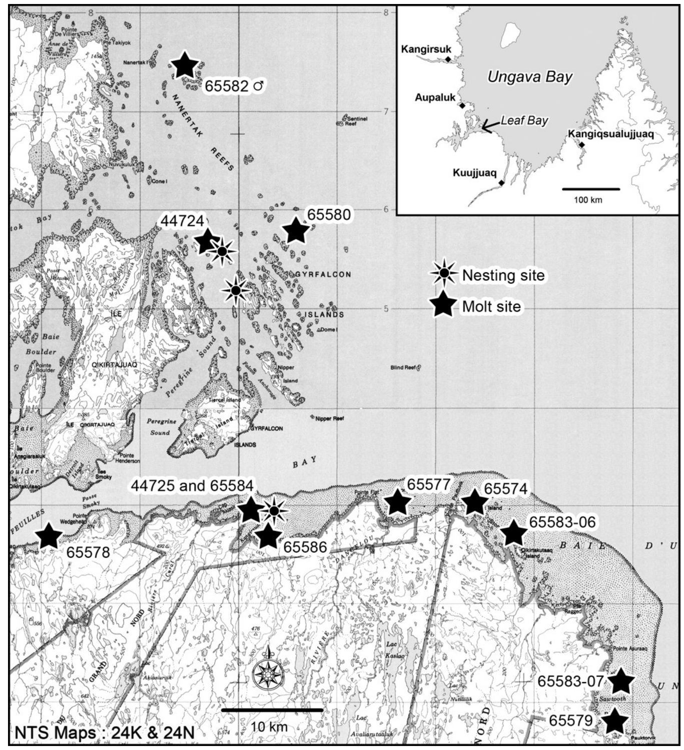

FIG. 1. Location of molting sites of common eiders breeding in and near the Gyrfalcon Archipelago in Leaf Bay. Insert shows location of Leaf Bay in Ungava Bay.

Pre-Molt Locations

The pre-molt areas used by females were near their nesting islands. All females captured on islands number 203 and 62 in the Gyrfalcon Archipelago (Chapdelaine et al., 1986) stayed within the archipelago during pre-molt, whereas females captured on the island in Leaf Bay stayed along the mainland south of Leaf Bay. During the pre-molt period, home range core areas averaged 1004 ha (n = 10; range: 111–3010 ha), and total home ranges averaged 14 598 ha (range: 1322–36 471 ha; Table 1). Birds moved between successive transmitter locations at an average speed of 3.0 ± 5.9 (SD) km/h. The average duration of the pre-molt period was 37.1 days (n = 10; Table 2). Movements of common eiders from pre-molting to molting areas occurred mostly in early August (Table 2).

Molting Locations

We located the molting areas of five females and one male from Leaf Bay Island and seven females from the Gyrfalcon Archipelago (Fig. 1). All 13 birds whose transmitters lasted into the molting period molted in Ungava Bay within a radius of 50 km of their breeding colony. All five Leaf Bay females molted along the mainland. Three of them

TABLE 1. Home range (ha) of common eiders during pre-molt, molt, post-molt, and wintering periods based on the harmonic means method (Dixon and Chapman, 1980).

	50% of observations				95% of observations			
Eider ♀	Pre-molt	Molt	Post-molt	Winter	Pre-molt	Molt	Post-molt	Winter
65580	378	75	848	–	3205	4814	17798	–
44718	111	–	–	–	1322	–	–	–
65577	1708	–	–	693Gr[1]	21727	–	–	55790
65574	3010	322	705	10970Gu	11145	1919	6071	119657
65578	1055	335	8542	–	17509	3853	267240	–
65575	–	–	171	–	–	–	2462	–
65579	138	355	2073	473Gr	8155	2133	23692	11247
65583	1481	1305	7252	1361Gr	36471	10278	76014	25490
65583b	414	978	–	–	6837	7738	–	–
65584	287	577	1039	4749Ne	25543	3057	28674	103843
44725	1454	–	–	139Gr	14061	2794	–	13410
Mean	1004	564	3410	3064	14598	4573	69915	54906
CV	96	76	104	138	77	65	142	86
n	10	7	6	6	10	8	6	6
Eider ♂								
65582	997	2122	2190	893Ne	9693	9186	18851	6937

[1] Wintering areas: Gr = Greenland; Gu = Gulf of St. Lawrence; Ne = Newfoundland.

(ID 65586, 65584, and 44725) molted just across the breeding island (within 3–4 km of the breeding site); one (ID 65583) molted 27 km away in 2006 and 50 km away in 2007 (23 km south of the 2006 site); and one (ID 65579) molted 47 km away. The single captured male chose a site different from those chosen by the females, molting north of the Gyrfalcon Archipelago in the Natertak Reefs area, 25 km south east of Aupaluk (Fig. 1). The site was 54 km north of Leaf Bay Island, where the male was captured. The molting sites of five females captured in the Gyrfalcon Archipelago were also determined. Two (ID 44724 and 65580) molted within 1 km of their nesting island, one (ID 65578) 44 km away, and the other two (ID 65577 and 65574) about 30 km away in the same general area as birds from Leaf Bay Island. Females reached their molting location around 9 August (range: 28 July–16 August). Duration of stay at the molting location averaged 53 days (range: 40–63, n = 7; Table 2). The first movement away from the molting area occurred around 7 October (range: 28 September–5 November).

Home ranges were smallest and least variable on the molting areas with an average core area of 564 ha (n = 7; range: 75–1305 ha) and an average total home range (95%) of 4827 ha (range: 1919–10 278; Table 1). Birds moved between successive transmitter locations at an average speed of 1.7 ± 1.8 (SD) km/h. The average duration of the molt period was 52.6 ± 8.0 days (n = 7; Table 2).

Post-Molt Locations

After dispersal from their molting areas, birds stayed in the general area used during pre-molt and spent an average of 29.6 days (n = 7) in Ungava Bay before migrating (Table 2). Birds were most mobile during the post-molt period, with core areas averaging 2947 ha (n = 7; range: 171–8542 ha) and total home ranges averaging 60 279 ha (range: 2462–267 240 ha; Table 1). During this period, birds moved between successive transmitter locations at an average speed of 2.7 ± 3.8 (SD) km/h.

Wintering Locations

Five females wintered in Greenland, and one most likely died during her migration to Greenland. One female wintered in the Gulf of St. Lawrence, and one female and the male wintered in Newfoundland (Fig. 2). Wintering locations were not associated with breeding on a given island (Table 2). The wintering area of five of the six females wintering in Greenland could be determined. They all wintered south of Nuuk along the southwest coast of Greenland. The largest coastal distance between two wintering females in Greenland was 515 km. Two females wintered at the southern tip of Greenland about 60 km apart (ID 65577 and 65575). Two females wintered near Arsuk (ID 44725 and 65583), 48 km apart and one (ID 65579) wintered just north of Ugarsiorfik, 275 km from Arsuk. In addition to the male eider, two females wintered in Canada: one (ID 65574) in the Gulf of St. Lawrence, near the Magdalen Islands, and the other (ID 65584) along the east coast of Newfoundland, just 90 km south of the wintering location of the male (ID 65582; Fig. 2). The female that wintered in Newfoundland was subsequently shot by a hunter on 6 January 2007.

Core winter areas of females averaged 3064 ha (range: 139–10 970, n = 6) and total home ranges averaged 54 906 ha (range: 11 247–119 657). Once settled, birds remained in a relatively small area and did not undertake long movements. One female (ID 65577) wintering in Greenland spent most of the winter around a small archipelago of islands on the open coast, but around 14 March she moved 47 km away to an inlet near Tasiussaq, where she stayed until her spring migration on 11 May. On average, core home ranges of females in Canada were 11 times as large (mean = 7860 ha; n = 2; range: 4749–10 970) as

TABLE 2. Duration and timing of pre-molt, molt, and post-molt periods and location of wintering areas of common eiders implanted in 2006 in the Gyrfalcon Archipelago.

ID	Sex	Nesting island	Pre-molt (days)	Molt (days)	Molt start (date)	Molt end (date)	Post-molt days	Winter days	Departure fall migration	Departure spring migration	Molt to winter (km)	Nesting island to molt area (km)	Wintering location
65580	F	203	33	63	28 July	28 September	22	–	–	–	–	0	unknown
44718	F	203	46	–	11 August	–	–	–	–	–	–	–	unknown
65577	F	62	26		1 August	5 November		180	5 November	11 May	1370	24	Greenland
44724	F	62	–	–	–	–	–	–	–	–	–	6	
65574	F	62	50	47	16 August	1 October	34	167	7 November	4 May	2173	30	St. Lawrence
65578	F	62	26	49	11 August	28 September	33	–	9 November	–	–	32	Greenland
65575	F	62	–	–	–	6 October	24	11	4 November		1306	1	Greenland
65579	F	Leaf Bay	37	40	16 August	30 September	30	190	1 November	13 May	1054	47	Greenland
65586	F	Leaf Bay	–	–	–	–	–	–	–	–	–	4	unknown
65583[1]	F	Leaf Bay	30	58	12 August	8 October	37	165	16 November	8 May	1133	27	Greenland
65583[2]	F	Leaf Bay?	43	59	6 August	3 October						50	unknown
65584	F	Leaf Bay	39	52	12 August	2 October	27	56	31 October		1609	3	Newfoundland
44725	F	Leaf Bay	41		12 August	21 October		41	21 October		1171	3	Greenland
Mean			37.1	52.6	9 August	7 October	29.6	115.7	4 November	9 May	1402	18.9	
CV (%)			22	15	3	4	19	66	2	3	28	97	
n			10	7	10	10	7	7	8	4	7	12	
65582	M	Leaf Bay	37	38	11 August	17 September	25	81	14 October		1352	54	Newfoundland

[1] 2006.
[2] 2007.

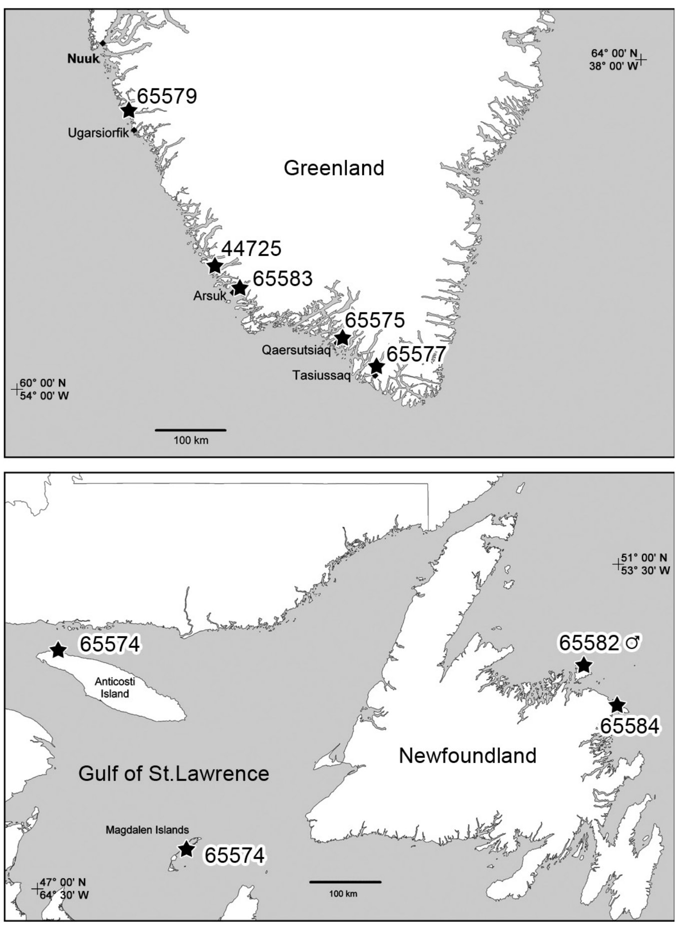

FIG. 2. Location of wintering areas of common eiders breeding in and near the Gyrfalcon Archipelago in Ungava Bay.

those in Greenland (mean = 667 ha; n = 4; range: 139–1361), and total home ranges in Canada (mean = 111 750 ha; range: 103 843–119 657) were four times as large as those in Greenland (mean = 26 484 ha; range: 11 247–55 790).

Migrations

Fall departure from Ungava Bay varied among females. Five of the six females that wintered in Greenland left Ungava Bay in early November (on 1, 4, 5, 9, and 16 November, respectively) and the other female left on 21 October (Table 2). The first signals from Greenland for the five females that reached their wintering area were received on 5, 10, 11, and 25 November and 31 October, respectively, indicating a quick migration (Fig. 3). The female that wintered in the Gulf of St. Lawrence (ID 65574) near the Magdalen Islands left Ungava Bay on 7 November and had reached Anticosti Island on 14 November, which also suggests a quick, direct migration with no significant staging along the way (Fig. 4). She stayed at the western end of Anticosti Island from 14 November to 14 December before moving to the Magdalen Islands. However, the female that wintered on the Newfoundland coast (ID 65584) left Ungava Bay on 31 October, spent about a month (3 November–5 December) on the northern Labrador coast, and moved directly from there to her wintering location in Newfoundland, where she arrived on 11 December. The only male captured (ID 65582) left Ungava Bay on 14 October. Like female 65584, the male spent a few days (17 October–6 November) on the northern Labrador coast before undertaking a slow, southward migration along that coast towards Newfoundland, reaching the wintering location only on 9 January.

Females followed the eastern shore of Ungava Bay, but it is not clear whether they went around the northeastern Labrador Peninsula or cut across it somewhere (Figs. 3 and 4).

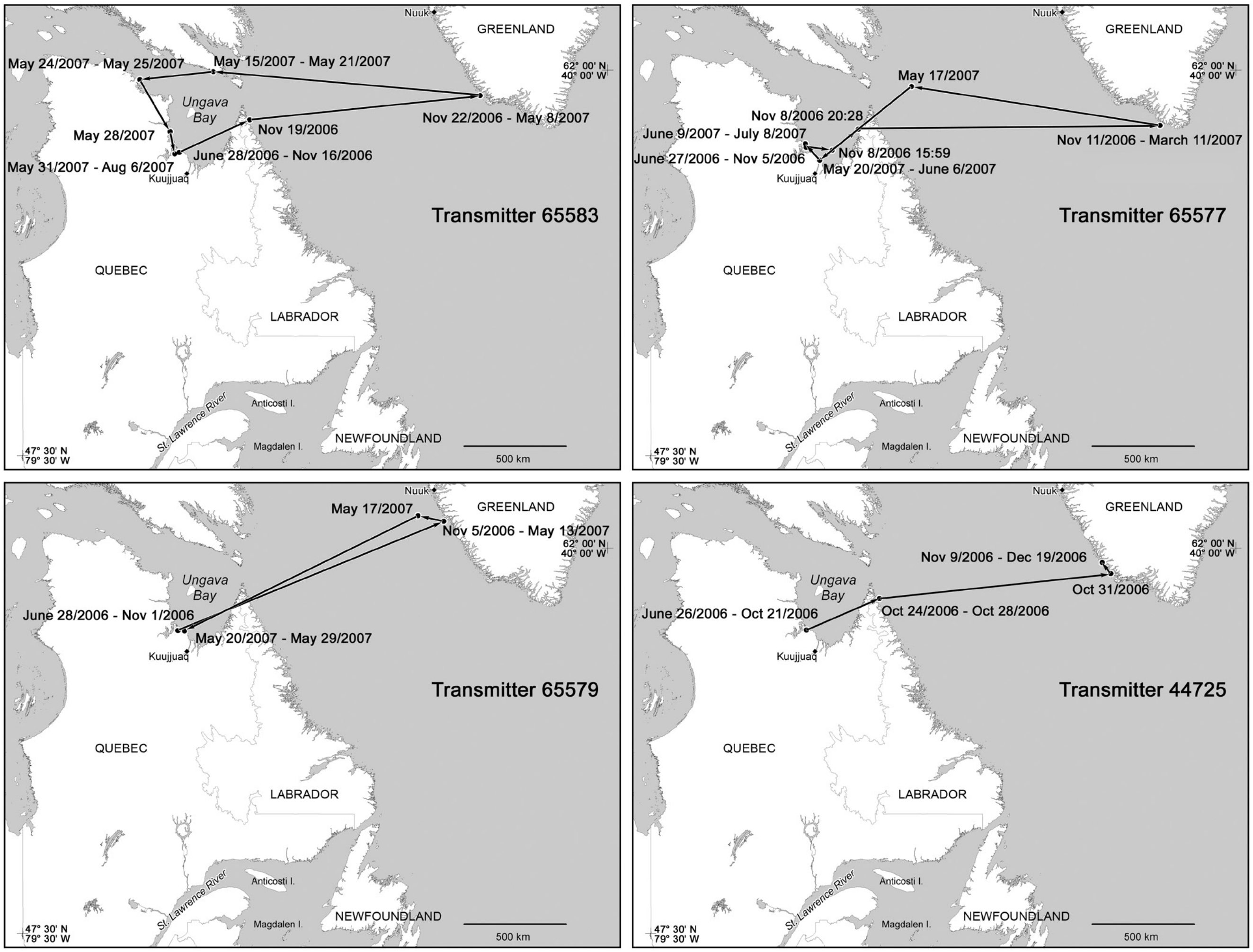

FIG. 3. Migration route of common eiders wintering in Greenland.

Most migrating eiders stopped along the northern Labrador coast but did not spend much time there, with the exception of female 65584 and male 65582 (Figs. 3 and 4).

Because all eiders molted relatively close to their breeding areas, we measured the distance between molting and wintering areas. For the five females wintering in Greenland, the distance between molt and winter sites averaged 1200 km (range: 1054–1370). The male and the female wintering in Newfoundland averaged 1481 km from their molting location to their wintering site, and the female wintering in the Gulf of St. Lawrence, 2173 km (Table 2).

We were able to follow the 2007 spring migrations of three of the five females that wintered in Greenland and of one female that wintered near the Magdalen Islands in the Gulf of St. Lawrence. Female 65577 wintered in southern Greenland and was still there on 11 May. She was next detected close to Baffin Island on 17 May, and she was back in Ungava Bay about 72 km south of her breeding island on 20 May. She remained there until 5 June and was back in the Gyrfalcon Archipelago on 9 June (Fig. 3). Female 65583 last signaled from Greenland on 8 May, and her first signal from Canada, at the southeast end of Baffin Island, was received on 15 May. She staged there until 21 May. On 24 May she was located near Doctor Island, Nunavik (western side of Ungava Bay), and then started moving south along the coast towards the Gyrfalcon Archipelago arriving there on 31 May (Fig. 3). Female 65579 last signaled from her wintering area on 17 May, and the next signal from the Gyrfalcon Archipelago was on 20 May, suggesting that she flew nearly directly there from Greenland (Fig. 3). Female 65574 was still near the Magdalen Islands on 4 May; she was next located along the southern Labrador coast on 10 May, along the southeastern coast on 13 May, and on the northeast coast of Labrador on 30 May. She was first located in southern Ungava Bay on 2 June, 133 km southeast of her nesting island. She remained there until 9 June and finally reached the Gyrfalcon Archipelago on 12 June (Fig. 4).

DISCUSSION

Pre-Molt, Molt, and Post-Molt

Adult female northern common eiders spent their pre-molt period close to their breeding islands but, as expected, had a larger home range than during the molting period,

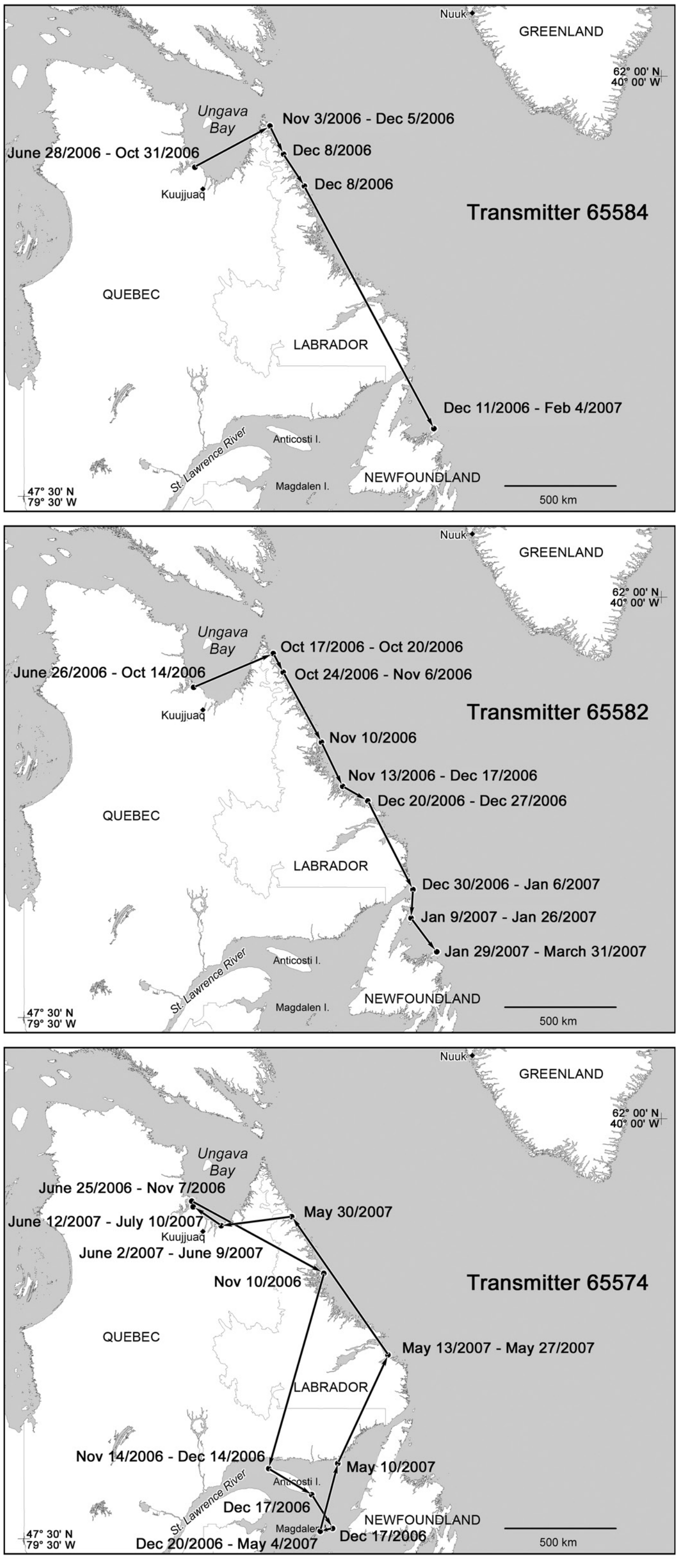

FIG. 4. Migration route of common eiders wintering in Canada.

when they were mostly flightless. Most females may have abandoned their nesting attempts following the surgery and may have ranged more widely than if they had bred successfully. The male and all female eiders molted within 50 km of their breeding area. However, Mosbech et al. (2006a) reported that some eider females molted locally, whereas others undertook extensive movements. Results might have differed if more males had been implanted, as male sea ducks often molt several hundred kilometres from their breeding sites (Salomonsen, 1968; Brodeur et al., 2002; Robert et al., 2002). Factors leading to the selection of a molting site by sea ducks remain to be determined, but distance between the breeding area and the molt site does not appear to be an important factor: some birds may travel hundreds of kilometres between these sites, bypassing known molt sites along the way (Robert et al., 2002, 2008). Little data exists on home range sizes in molting areas. Mosbech et al. (2006b) reported core areas of 5000 ha for a female king eider (*Somateria spectabilis*) and O'Connor (2008) reported average core areas of 317 ha for flightless surf scoters (*Melanitta perspicillata*), which is comparable to our average of 587 ha. The home ranges cited above were not limited to the flightless period. Birds stayed at their molting site well after regaining flight capacity, which seems to be a common pattern among sea ducks (Brodeur et al., 2002; Robert et al., 2002, 2008; O'Connor 2008). Thus, birds complete most of their body molt at their wing molt site.

Wintering

Merkel et al. (2006) reported winter home ranges with a mean core area of 800 ha and total home ranges of 6800 ha for northern common eider. In our study, the four birds that wintered in Greenland had comparable core areas (average = 667 ha) and somewhat larger total home ranges (average = 26 484 ha). Differences in total home range sizes are likely the result of the period chosen for calculation. We included all data after the arrival of the birds in Greenland, whereas Merkel et al. (2006) were more restrictive. The winter home ranges found in Canada were larger than those in Greenland, probably because the presence of more ice (see Robert et al., 2003) forced birds to travel longer distances to find food. In general, birds did not move much during winter, and as found by Merkel et al. (2006), most movements were local, likely made in response to feeding conditions or food availability.

Common eiders breeding in the lower Arctic wintered in Greenland (67%) and Canada (33%). These proportions are consistent with the split established for more northern breeding common eiders (Mosbech et al., 2006a), suggesting that this dual wintering division may be common to most colonies of the mid and southern Arctic. However, it is still unknown whether this pattern is the same for more northern colonies. Such a split in the direction of wintering areas suggests that re-colonization of breeding islands following the last glaciations may have involved birds from both the Greenland and Newfoundland glacial refugia (Ploeger, 1968). The fact that birds breeding in the same colony winter in different areas has important management implications. Eiders face different hunting pressures in Newfoundland, the Gulf of St. Lawrence, and Greenland (Wendt and Silieff, 1986; Merkel, 2004b; Gilliland et al., 2009). This fact implies that females of a given breeding colony likely have different migration and winter survival as they use different migration routes and winter in different areas. Winter conditions differ between Greenland and Canada, with ice being an important ecological constraint in Canada, but not in southwestern Greenland. Common eiders wintering in Greenland cross Davis Strait, while those wintering in the Gulf of St. Lawrence travel along the coast of Labrador (Mosbech et al., 2006a); these are two very different environments.

Migration

The duration of migration to or from wintering areas varied among individuals, from quick movement in a few days to slow progress over a month. Mosbech et al. (2006a) reported similar individual variation. Sample sizes are too small to determine factors affecting those movements, but the presence and movements of sea ice may be important factors during spring migration. Migrations followed coastlines except when crossing Davis Strait. During fall migration, birds followed the inner coastline of Ungava Bay or, for those wintering in Canada, the east coast of Labrador. However, some birds may have followed an overland route from Ungava Bay to the northeastern Labrador coast as has been described by local Inuit of Nunavik (Nakashima, 1986).

Departure for molting sites occurred mostly in early August, which is similar to the timing found by Mosbech et al. (2006a) for eiders breeding along the western edge of their breeding range. Fall departures for wintering areas were also similar, occurring in late October and early November (Mosbech et al., 2006a). Spring departures for breeding areas were more synchronized (early to mid-May) than those that Mosbech et al. (2006a) observed (21 April to 29 May), which likely reflects our smaller sample size. Ranges in departure dates for the molt, fall, and spring migrations suggest that each bird follows its own schedule, but even so, most departures occurred over a relatively short period. Factors affecting departure dates could be related to bird condition, individual flock behavior, pairing status, or a combination. Pairing status likely has a major impact on the timing of spring migration, especially for males. Robert et al. (2002) reported that an unpaired adult Barrow's goldeneye (*Bucephala islandica*) male left his wintering areas much later than paired birds and flew directly to his molting site. In most sea ducks, adult males are more numerous than females, so it is unlikely that adult females were unpaired (Goudie et al., 2000). Even so, departure dates for the spring migration of females varied considerably (Mosbech et al., 2006a; this study), indicating that other factors affect these dates. These staggered spring movements seems typical of most sea ducks (Bond et al., 2007).

Conservation Implications

This study shows that movements of adult female eiders are limited during molt and at their wintering locations and that eiders use only a small area during these periods. Their limited movements over very long periods of time provide an opportunity to monitor these populations. The study also highlights the great importance for northern common eiders of Ungava Bay, which not only has the highest proportion of the breeding population (Chapdelaine et al., 1986; Falardeau et al., 2003), but also supports eiders from mid-May to mid-November. The flightless period in waterfowl is one of the key life-cycle events, and molting locations for northern common eiders remain largely unknown. Other sea ducks are also known to molt in Ungava Bay (Robert et al., 2002; J.-P.L. Savard and S.G. Gilliland, unpubl. data), but to date there has been no survey designed to locate important molting sites and evaluate the abundance of molting birds there. Such a survey is urgently needed in view of the ongoing development of the North and the expected increase in marine traffic linked to climate change. Climate change is also expected to moderate environmental conditions in the Arctic, resulting in more favorable conditions for incubation of diseases. Such conditions may already have occurred, as the first recorded outbreaks of avian cholera were documented in this population in 2005 and have had profound effects on population dynamics at local colonies (Descamps et al., 2009).

The fact that eiders breeding in Ungava Bay are affiliated with all the major wintering areas in Greenland and Canada confirms the complexity of managing this species. The breeding populations of eiders are exploited for eiderdown. They also face new stressors, such as diseases and anthropogenic disturbance, and more importantly, are still heavily hunted by both aboriginal and non-aboriginal hunters in Greenland, Labrador, Newfoundland, Saint-Pierre and Miquelon (France), and Quebec. International coordination is thus essential to ensure the sustainable use of this eider resource (Gilliland et al., 2009). Precise estimates of the size of the Canadian breeding population and of the proportion wintering in Greenland are necessary for proper modeling and management of northern common eiders.

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