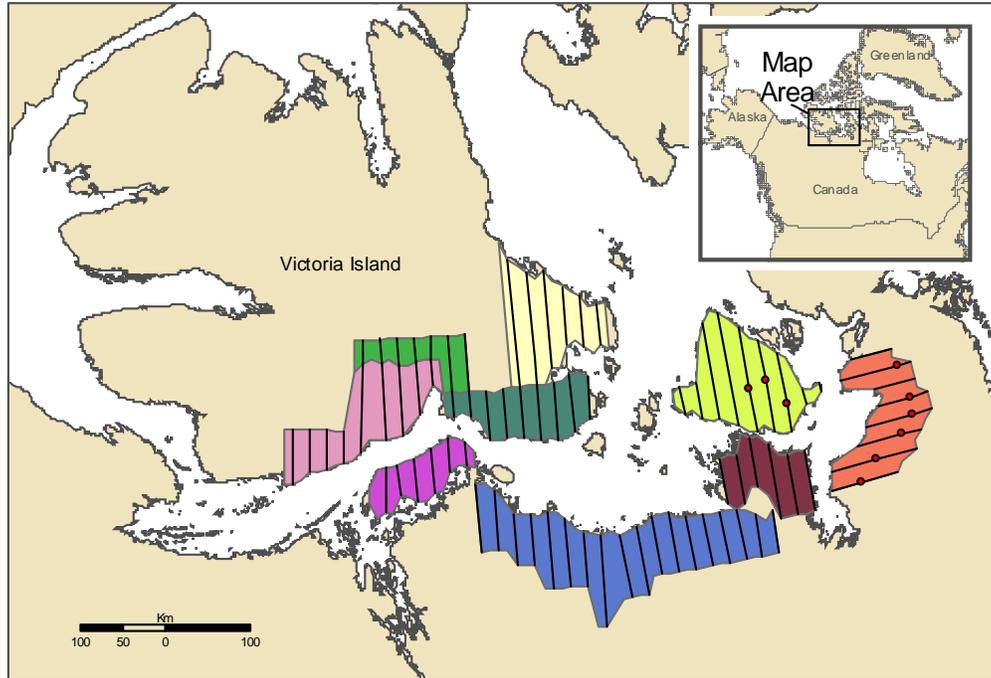


MIGRATORY BIRD SURVEYS IN THE CANADIAN ARCTIC 2007



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April 2009

ABSTRACT: We conducted a fixed-wing aerial survey of waterfowl and other migratory birds in Nunavut, Canada during 19-26 July 2007. The survey consisted of nine areas of known or suspected high densities of waterfowl on southeastern Victoria Island, King William Island and the adjacent north-coastal mainland. The sample design consisted of 400-m-wide transects spaced systematically at 20-km intervals (approximately 2% sample). Most of the area boundaries and transects had been established previously for helicopter surveys conducted by the Canadian Wildlife Service. The results from this survey are presented by area. This year marks our third year conducting fixed-wing waterfowl surveys in Canada's central Arctic. We believe that fixed-wing aircraft offer a safe and cost-efficient alternative to the use of helicopters for conducting these surveys. We recommend the establishment of a long-term annual survey to monitor the status and trends of migratory birds nesting in the region.

Key words: aerial survey, Canadian Arctic, waterfowl, migratory birds, Canada goose, cackling goose, greater white-fronted goose, tundra swan, king eider, long-tailed duck, detection probability.

INTRODUCTION

Many important nesting areas of North American waterfowl lie outside the range of the existing Waterfowl Breeding Population and Habitat Survey (U.S. Fish and Wildlife Service 2007) and other cooperative waterfowl survey efforts. For example, portions of the central and western Canadian Arctic are recognized as important nesting areas of waterfowl and other waterbirds but due to their remoteness have been surveyed only periodically or not at all. Cooperating agencies of the Arctic Goose Joint Venture and Sea Duck Joint Venture recently initiated efforts to assess bird abundance and distribution in these areas to improve status information and harvest management for several species of sea ducks, geese, swans, and other waterbirds. As part of these efforts, the Canadian Wildlife Service (CWS) conducted systematic transect surveys by helicopter in 2002-2006 (Alisauskas 2003, Alisauskas 2005, Alisauskas 2006, Raven and Dickson 2006, Alisauskas unpubl. data). Also in 2005-2006, the Waterfowl Management Branch of the U.S. Fish and Wildlife Service (USFWS) flew transect surveys using a single-engine, turbine-powered, fixed-wing aircraft to gather additional data and to explore the logistic feasibility of using this more cost-effective survey aircraft for regular surveys in the region (Conant et al. 2006, Conant et al. 2007). The 2005 and 2006 fixed-wing surveys were successful, so in 2007 we resurveyed all areas flown in 2005 and 2006 (at a lower sampling effort) to collect additional data. This report summarizes the results from our fixed-wing survey in 2007.

STUDY AREA AND METHODS

Survey Design

The survey in 2007 consisted of nine areas on Victoria Island, King William Island, and the north coast mainland in Nunavut, Canada (Figure 1, Table 1). Seven of these areas were delineated for previous surveys by Alisauskas (2003, 2005, 2006) and Hines et al. (2003), based on known or suspected high densities of waterfowl. The other two areas (Central and East Victoria Island) were identified in 2005 as areas that should be explored prior to designing a long-term monitoring survey for the region (Conant et al. 2006). The total survey area in 2007 was 98,864 km² (Table 1).

We also surveyed the Tuktoyaktuk Peninsula in 2007 in conjunction with ongoing helicopter surveys. Because this area was disjunct from the bulk of our survey in 2007, results will be presented in a separate report.

Transects established from previous surveys (Alisauskas 2003, Hines et al. 2003, Alisauskas 2005, Alisauskas 2006, Conant et al. 2006) were repeated in 2007, but at half the previous sampling intensity. The sampling intensity was reduced to enable us to cover all of the nine areas within our approximate two-week survey window. The variable-length transects were spaced systematically, 20 km apart, and oriented generally perpendicular to the coastline (Figure 1, Table 1). The width of each transect strip was 400 m. Approximately 2% of the total survey area was sampled.

On King William Island, some of the transects in the design were not surveyed completely by Alisauskas in 2005 due to poor weather conditions (Alisauskas 2006). To facilitate comparison with that survey, we incorporated Alisauskas' 2005 actual transect endpoints (the points where he stopped surveying) into our design and partitioned each transect into two separate ones. Also, in the Rasmussen Lowlands we extended several transects further to the east than were flown by Hines in 1994-1995, thus we partitioned our transects here as well.

Data Collection and Analysis

The 2007 survey was flown on 19-26 June. The survey timing was intended to coincide with the mid-incubation period for geese, as well as the period when the peak number of paired male king eiders was present (Cotter et al. 1997). A total of 78 hours of flight time was expended, including 54 hours spent on survey (surveying transects and flying to/from transects) plus 24 hours spent flying the survey airplane from and to our home base in Alaska. We used the specially modified de Havilland Turbine Beaver (N754) as our fixed-wing survey platform. This aircraft has been used for waterfowl surveys in Alaska since 1977 (Mallek and Groves 2007). Four observers participated in the survey this year: two pilots alternating as pilot and right-seat observer, and two individuals as right-seat observers only.

Survey procedures followed established USFWS and CWS protocol for aerial waterfowl breeding population surveys (USFWS and CWS 1987). The centerline of each transect strip was flown at a height of 30-45 m (100-150 ft) above ground level and at a ground speed of 145-170

km/hr (90-105 miles/hr). Aircraft navigation to transect “start” and “end” waypoints and along the transect centerline was maintained using the aircraft Global Positioning System (GPS). The pilot and right-seat observer each recorded observations by species (or species group) within 200 m of the flight path on their side of the aircraft. Marks on the windows and wing struts were used to delineate the outer edges of transects. All birds (except shorebirds and small passerines) and large mammals observed within the transect strip were recorded. Each observation was recorded vocally to a sound file (.wav format), linked with simultaneous GPS coordinates, and saved to separate on-board computers for each observer, via custom software developed by John I. Hodges (USFWS, Migratory Bird Management, Juneau, AK). After the flight, a transcription program, also developed by John Hodges, was used to replay the sound files and combine the transcribed observation data with the geographic coordinates to produce a final text data file. The final text file was then used for data analysis.

Observations of waterfowl were recorded and summarized according to established survey protocol (USFWS and CWS 1987). For duck species, observations were recorded by the following categories: lone drakes, pairs, flocked drakes, and mixed-sex groups of five or more birds. Observations of one hen and two drakes were recorded as a pair and a lone drake. A hen and three drakes were recorded as a pair and two drakes. Observations of one to four hens were not recorded. Geese, swans, loons, and cranes were recorded as singles, pairs, or groups (flocks). The remaining bird and mammal species were recorded by number, and we differentiated between adults and calves for caribou and muskoxen.

The number of total indicated ducks was calculated for each species or species group by multiplying two times the sum of the number of lone drakes, drakes in flocks of two to four, and pairs, and adding this to the total number of grouped birds [i.e. $2 * (\text{drakes} \leq 4 + \text{pairs}) + \text{grouped birds}$]. Scaup were an exception in that all lone and flocked drakes were treated as grouped birds, because their sex ratio is strongly skewed toward males. For geese, the number of total indicated birds was calculated by multiplying the number of singles and pairs by two and adding the number of grouped birds. For the remaining bird species, the number of total indicated birds was simply the number of birds observed. Using the number of total indicated birds for each species or species group, densities, population indices, and variances were estimated with the ratio method (Cochran 1977, Smith 1995).

Population indices of northern pintail, long-tailed duck, red-breasted merganser, green-winged teal, and scaup were adjusted for incomplete detection using visibility correction factors (VCFs) that were developed for tundra habitats, derived from a 3-year helicopter/fixed-wing study on the Yukon-Kuskokwim Delta, Alaska in 1989-1991 (Conant et al. 1991, Smith 1995). These VCFs have been used in Alaska as constant adjustments to annually-obtained breeding population indices (Mallek and Groves 2007). King and common eider indices were not adjusted for incomplete detection because we do not have reliable VCFs for these species. The remaining bird and mammal indices were also not adjusted for incomplete detection.

RESULTS AND DISCUSSION

Population indices (adjusted by standard Alaska VCFs for a few species only) are presented by species and area in Tables 2 and 3. Population densities of total indicated birds (not adjusted for

incomplete detection) are presented in Tables 4 and 5. Distributions of selected species within the survey area, displayed as locations of observations along the survey transects, are illustrated in Figures 2-6 and 8-17.

Canada/Cackling Goose

Canada/cackling geese breeding in the survey area are defined as belonging to two populations: Short Grass Prairie (SGPP) and Tall Grass Prairie (TGPP). Results of banding studies suggest that the 100th meridian is a general boundary separating the two populations, with SGPP nesting to the west and TGPP breeding to the east (Arctic Goose Joint Venture 2008). Both SGPP and TGPP are composed of unknown proportions of lesser Canada geese (*Branta canadensis parvipes*) and Richardson's cackling geese (*B. hutchinsii hutchinsii*). *B. c. parvipes* and *B. h. hutchinsii* were formerly considered subspecies of the Canada Goose (*B. canadensis*), but in 2004 the American Ornithologists' Union split the Canada goose into two separate species (Banks et al. 2004). The majority of these geese breeding in our survey area are likely *B. h. hutchinsii*.

In addition to breeding populations of the small Canada and cackling geese, a number of large Canada geese (*B. c. maxima* and *B. c. moffitti*) use the survey area for molting. These large Canada geese are generally concentrated along rivers in the western Queen Maud Gulf area (Latour et al. 2008). We attempted to differentiate between the two size classes, and results are reported separately in Tables 2 and 4. However, because some observers felt uncertain about their ability to distinguish the small and large geese, we have also presented our results with both size classes combined (Tables 2 and 4).

Canada/cackling geese were widely distributed throughout the survey area and were the second most abundant bird species after snow/Ross's geese (Figures 2 and 3, Table 2). The population index for small Canada/cackling geese was 343,668 (Table 2). Separating data at the 100th meridian resulted in estimates of 230,604 SGPP geese and 113,064 TGPP geese. Of these geese observed, 11% were singles, 51% were paired, and 38% were in flocks (≥ 3 unpaired birds). Assuming a single bird represented a pair with an undetected mate on a nest, indicated pairs comprised 66% of the total indicated birds observed.

The population index of geese classified as large Canadas was 44,672 (Table 2), 94% of which were observed west of the 100th meridian. Of the total large Canada geese observed, 86% were in flocks (≥ 3 unpaired birds).

White-fronted Goose

The population index for greater white-fronted geese (*Anser albifrons*) was 149,160 (Table 2). Densities were highest in the Rasmussen Lowlands (2.80/km²), Queen Maud Gulf (2.12/km²), and Kent Peninsula (2.06/km²) (Figure 4, Table 4). Of the total number of white-fronted geese observed, 7% were singles, 51% were paired, and 42% were in flocks (≥ 3 unpaired birds). Assuming a single bird represented a pair with an undetected mate on a nest, indicated pairs comprised 60% of the total indicated birds observed.

Snow and Ross's Geese

This survey was not expected to provide an accurate population estimate of snow and Ross's geese (*Chen caerulescens*, *C. rossii*), due to their clumped distribution. However, we recorded these species when encountered, because the data may be useful for documenting changes in the distribution of colonies. The distribution of our observations of snow and Ross's geese in 2007 is illustrated in Figure 5.

King Eider

The population index for king eiders (*Somateria spectabilis*) was 71,064 (Table 2). Densities were highest in Southeast Victoria Island (1.28/km²), Central Victoria Island (1.10/km²), and East Victoria Island (0.92/km²) (Figure 6, Table 4). Of the total number of king eiders observed, 13% were single drakes, 80% were paired, 1% were flocked drakes, and 5% were in mixed-sex groups of ≥ 5 birds. The overall ratio of lone drakes (drakes not associated with females) to total drakes (lone and paired drakes) was 0.27; the daily ratio fluctuated between 0.17 and 0.43 (Figure 7).

Long-tailed Duck

The unadjusted population index for long-tailed ducks (*Clangula hyemalis*) was 86,535, and the index adjusted with the standard Alaska VCF of 1.87 was 161,821 (Table 2). The highest densities were found in Queen Maud Gulf (1.51/km²) and Adelaide Peninsula (1.43/km²) (Figure 8, Table 4).

Tundra Swan

The population index for tundra swans (*Cygnus columbianus*) was 37,804 (Table 2). Densities were highest on the Adelaide Peninsula (0.53/km²) and King William Island (0.51/km²) (Figure 9, Table 4). King William Island also had one of the highest densities of swan nests (0.07/km²), second only to Rasmussen Lowlands (0.08/km²). In contrast, while the Adelaide Peninsula had the highest swan density, it had the third lowest nest density (0.01/km²) of all the areas.

Northern Pintail

The unadjusted population index for northern pintails (*Anas acuta*) was 40,837, and the index adjusted with the standard Alaska VCF of 3.05 was 124,552 (Table 2). The majority of pintails (90%) was on the mainland, with 73% of the total found in Queen Maud Gulf (Figure 10). The highest observed densities were 1.22/km² in Queen Maud Gulf, 0.61/km² on the Kent Peninsula, and 0.44/km² on the Adelaide Peninsula (Table 4). Indicated breeding pairs comprised 40% of the total number of indicated birds observed.

Sandhill Crane

The population index for sandhill cranes (*Grus canadensis*) was 11,971 (Table 3). Densities

were highest in Queen Maud Gulf (0.27/km²), followed by Kent Peninsula (0.18/km²) and Adelaide Peninsula (0.17/km²) (Figure 11, Table 5).

Loons

Pacific (*Gavia pacifica*), red-throated (*G. stellata*), and yellow-billed (*G. adamsii*) loons were present in the survey area. Of the total loons observed, all but 2 (0.3%) were identified to species. Population indices from the species-specific data were 16,569 Pacific loons, 9,637 red-throated loons, and 2,367 yellow-billed loons (Table 3). Densities of Pacific loons were highest on Central Victoria Island (0.30/km²) and Kent Peninsula (0.29/km²), while the highest densities of red-throated loons were found in Byron Bay (0.17/km²) and Queen Maud Gulf (0.15/km²) (Figures 12 and 13, Table 5). The highest density of yellow-billed loons was 0.16/km² on the Kent Peninsula (Figure 14, Table 5).

Gulls/Terns/Jaegers

Gull species that breed regularly in the survey area include the glaucous gull (*Larus hyperboreus*), Sabine's gull (*Xema sabini*), herring gull (*L. argentatus*), and Thayer's gull (*L. thayeri*). We were not able to distinguish herring from Thayer's gulls during the survey. Population indices were 34,009 glaucous gulls, 10,435 Sabine's gulls, and 1,831 herring/Thayer's gulls (Table 3). The highest densities of glaucous gulls were on King William Island (0.58/km²) and Queen Maud Gulf (0.57/km²) (Figure 15, Table 5). The highest densities of Sabine's gulls were found on Southeast Victoria Island (0.31/km²) and East Victoria Island (0.27/km²) (Figure 16, Table 5). Herring/Thayer's gulls were not observed on Southeast Victoria Island, East Victoria Island, or the Adelaide Peninsula, and were observed in low densities in the remaining 5 areas (Table 5).

The population index for arctic terns (*Sterna paradisaea*) was 12,016 (Table 3). The highest density was in Queen Maud Gulf (0.21/km²), due in part to a couple of large groups that were observed (Figure 17, Table 5).

Jaegers (*Stercorarius* spp.) were not identified to species to avoid diverting our focus from higher priority species. The population index for combined jaegers was 4,640 (Table 3). Densities were low throughout the survey area, ranging from 0.01/km² in the Rasmussen Lowlands to 0.07/km² in Byron Bay and King William Island (Table 5).

Ptarmigan

The population index for ptarmigan (*Lagopus* spp.) was 13,558 (Table 3). Ptarmigan were present in all of the survey areas, with the highest densities on East Victoria Island (0.23/km²) and Queen Maud Gulf (0.21/km²) (Table 5).

Raptors/Common Raven

Although this survey was not designed to estimate raptor or common raven (*Corvus corax*) abundance, we documented their occurrence (Table 3). We observed rough-legged hawks

(*Buteo lagopus*), golden eagles (*Aquila chrysaetos*), gyrfalcons (*Falco rusticolus*), short-eared owls (*Asio flammeus*), and snowy owls (*Nyctea scandiaca*) on transects. We also observed common ravens in low densities in several of the survey areas (Table 3).

Caribou/Muskox

The population indices for muskoxen (*Ovibos moschatus*) were 20,479 adults and 2,213 calves (Table 3). The majority of adults (89%) and all calves were observed on Victoria Island. The highest densities were on Central Victoria Island and Byron Bay (Table 5).

Caribou (*Rangifer tarandus*) indices were 147,510 adults and 50,999 calves (Table 3). The majority of adults (81%) and calves (81%) were observed in Queen Maud Gulf, with substantial numbers and densities of adults and calves also observed on the Adelaide Peninsula and Rasmussen Lowlands (Tables 3 and 5).

Miscellaneous

We had 7 observations of arctic foxes (*Vulpes lagopus*) and 3 observations of wolves (*Canis lupus*) during the survey (Table 3). We also had 2 observations of grizzly bears (*Ursus arctos*): 1) a sow with 2 cubs in the Byron Bay area, and 2) a sow with 3 cubs in Queen Maud Gulf.

RECOMMENDATIONS

The results obtained from this third consecutive year of conducting fixed-wing aerial surveys in the central Canadian Arctic are encouraging. The terrain and flying-weather conditions we encountered in all three years were manageable. The remoteness and high latitude of the region did provide certain logistic challenges, including:

- 1) Extreme distances between airports
- 2) Lack of suitable off-airport landing surfaces (i.e., lakes that were large and deep enough to land on and take off from with a float-equipped aircraft were almost entirely ice-covered during the survey period)
- 3) Extremely sparse weather reporting and forecasting for the survey area

Given these characteristics of the region, we strongly recommend that single-engine fixed-wing aircraft surveying in this environment are turbine powered, equipped with amphibious floats, have an automated flight following (AFF) system on board, and have an installed aircraft satellite phone. The turbine engine delivers a significant increase in engine reliability over a piston engine, and the amphibious floats deliver increased safety (to the aircraft and occupants) in the unlikely event of a forced landing due to mechanical problems or weather. The AFF system allows real-time tracking of the aircraft (via a satellite phone data system), providing the aircraft's geographic location at all times. The aircraft satellite phone enables the pilot to call flight service in remote areas, allowing the pilot to get updated weather and forecasts and to update (shorten, extend, and close) flight plans.

Monitoring the status and trends of small Canada/cackling geese in the SGPP and TGPP is an important objective of this survey. Combining small and large Canada/cackling goose observations would confound results and should be avoided in future surveys if possible. Observers should continue to differentiate the small and large size classes and work on improving their ability to do so.

ACKNOWLEDGEMENTS

This work was accomplished with the support of the Gjoa Haven and Ekaluktutiak Hunters and Trappers Committees, Nunavut Department of Environment, U.S. Fish and Wildlife Service, Canadian Wildlife Service, Central Flyway Council, Arctic Goose Joint Venture, and Sea Duck Joint Venture. The work was done under Nunavut Wildlife Research Permit WL000894. We especially thank Lynne Dickson for her major role in developing the survey and her help in obtaining support and funding. We also thank Qikiqtak Co-op Ltd. in Gjoa Haven, Kitnuna Corporation and Ikaluktutiak Co-op Ltd. in Cambridge Bay, and Kugluktuk Co-op Ltd. in Kugluktuk for providing fuel and/or accommodation services.

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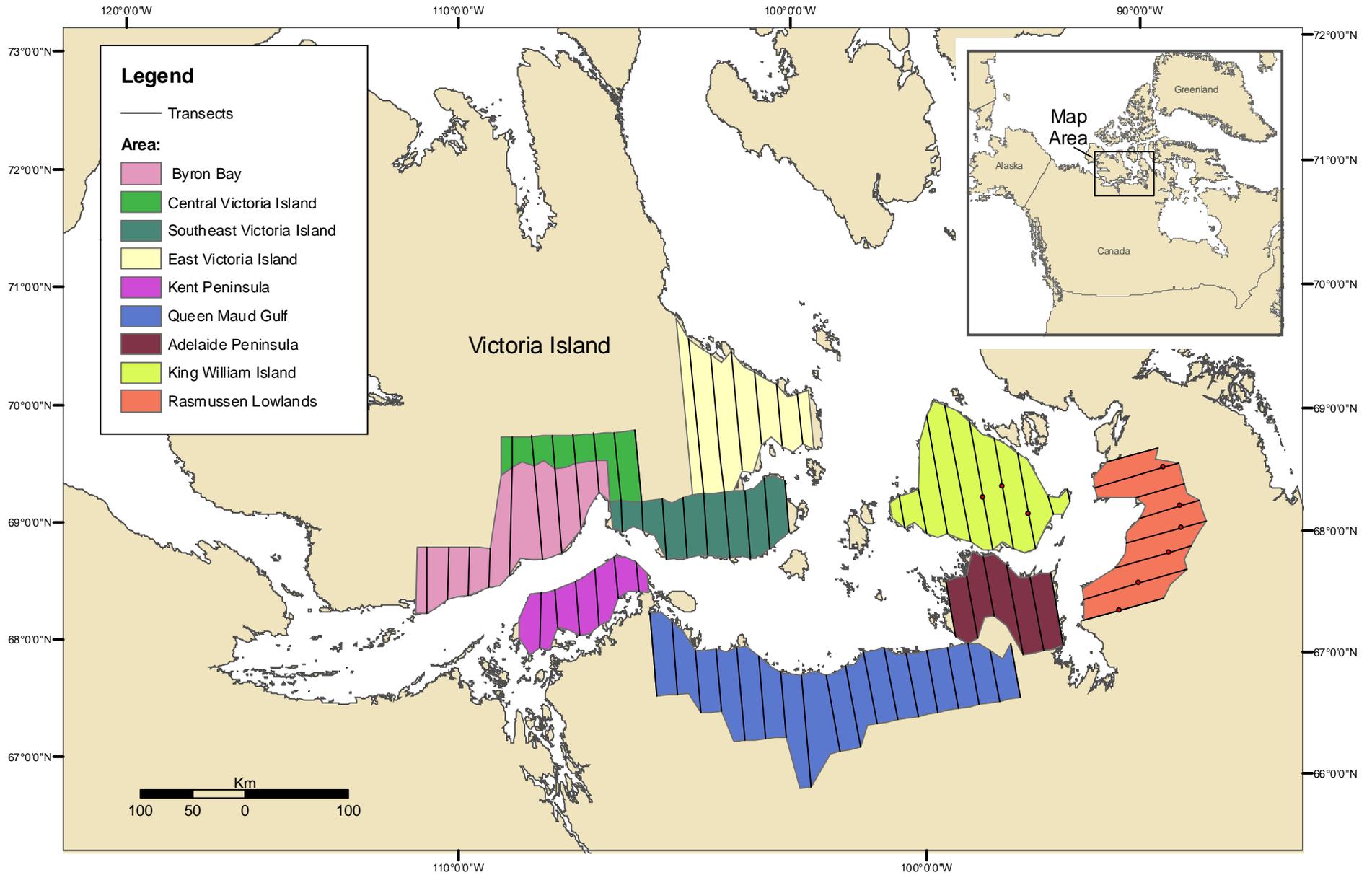


Figure 1. Transect lines within nine areas surveyed for wildlife by fixed-wing aircraft in Nunavut, Canada, 19-26 June 2007. Red dots mark locations where transects were partitioned to facilitate comparability with previous surveys.

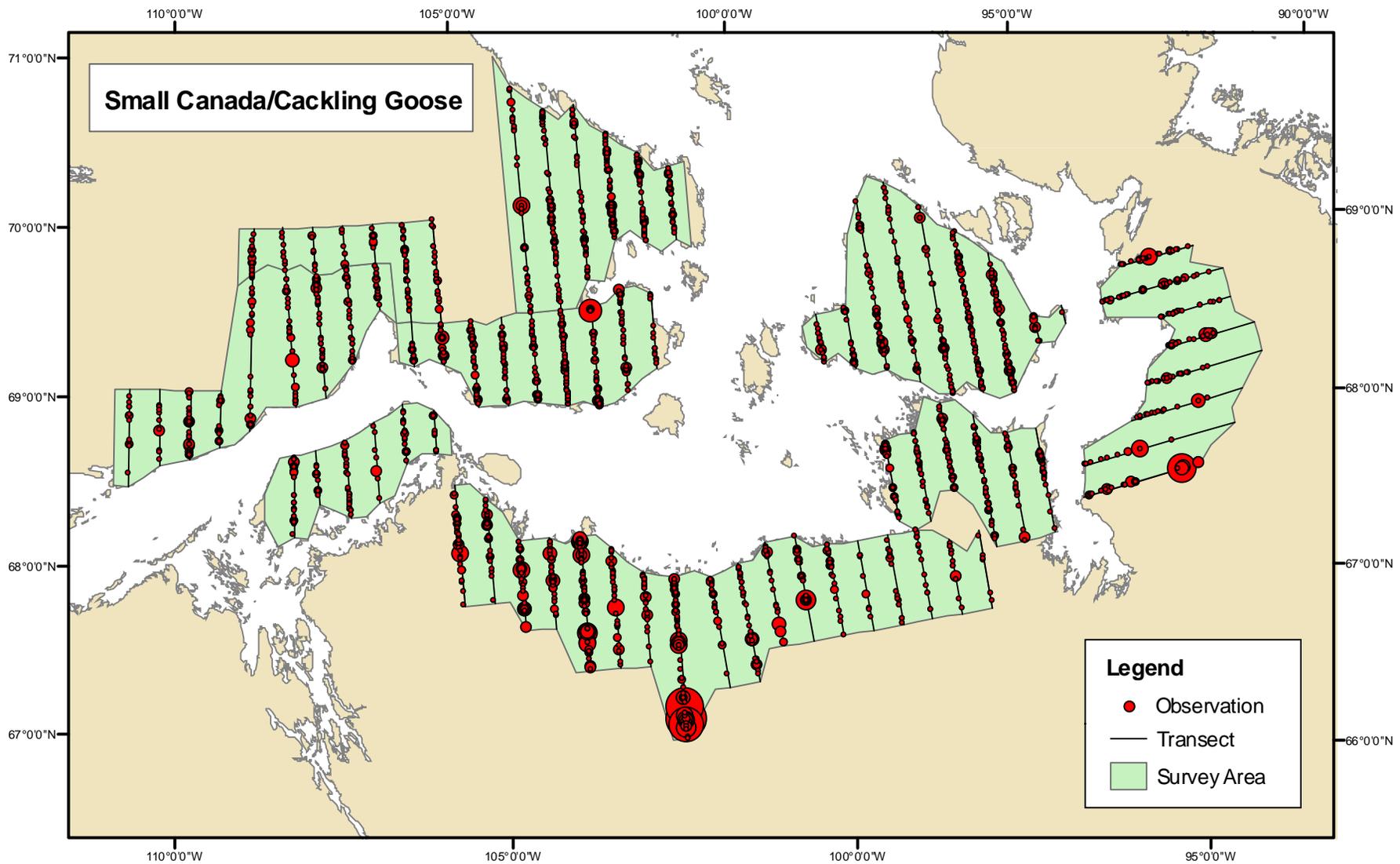


Figure 2. Locations of small Canada/cackling goose observations in 2007. Symbol size is proportional to the number of birds observed.

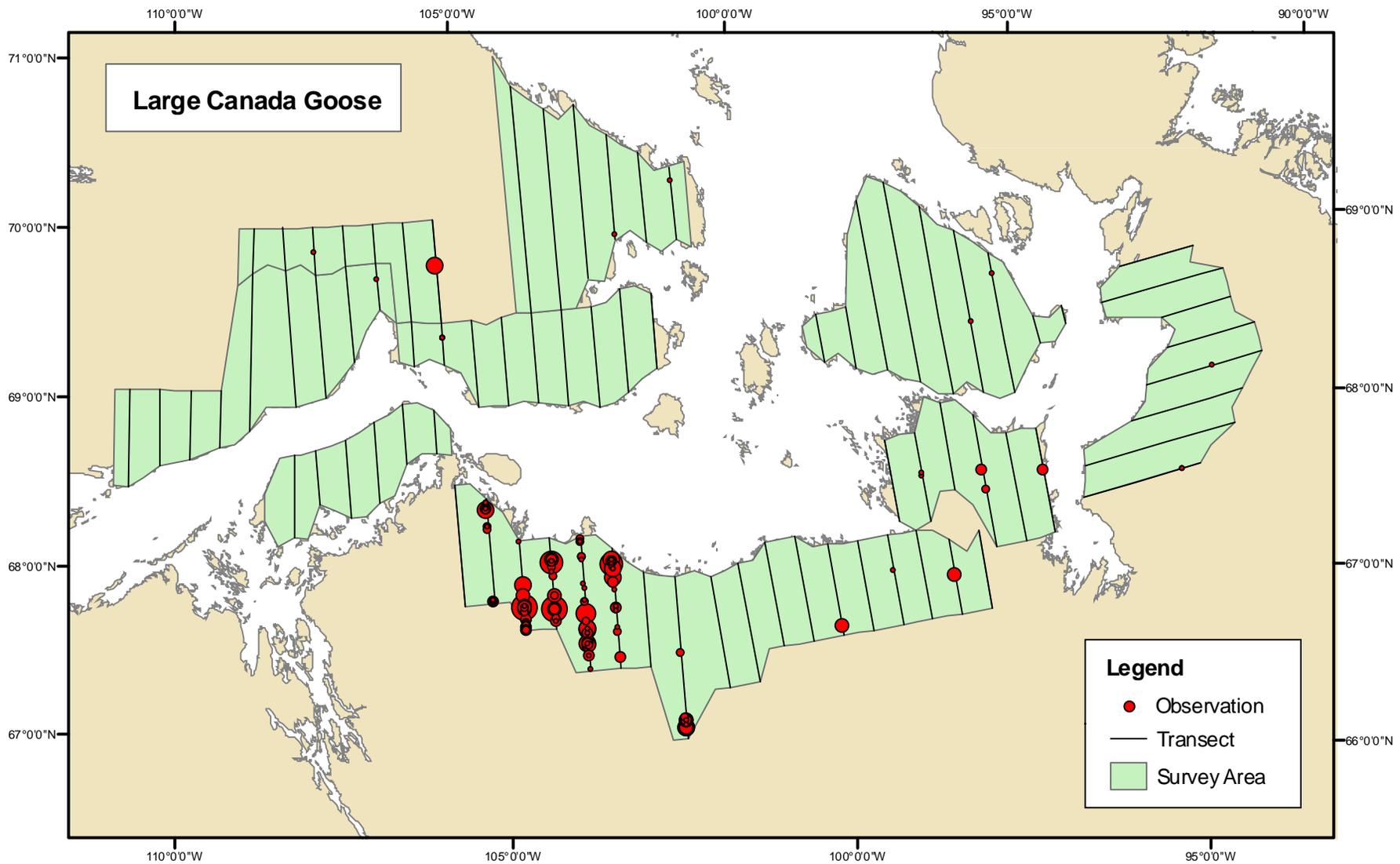


Figure 3. Locations of large Canada goose observations in 2007. Symbol size is proportional to the number of birds observed.

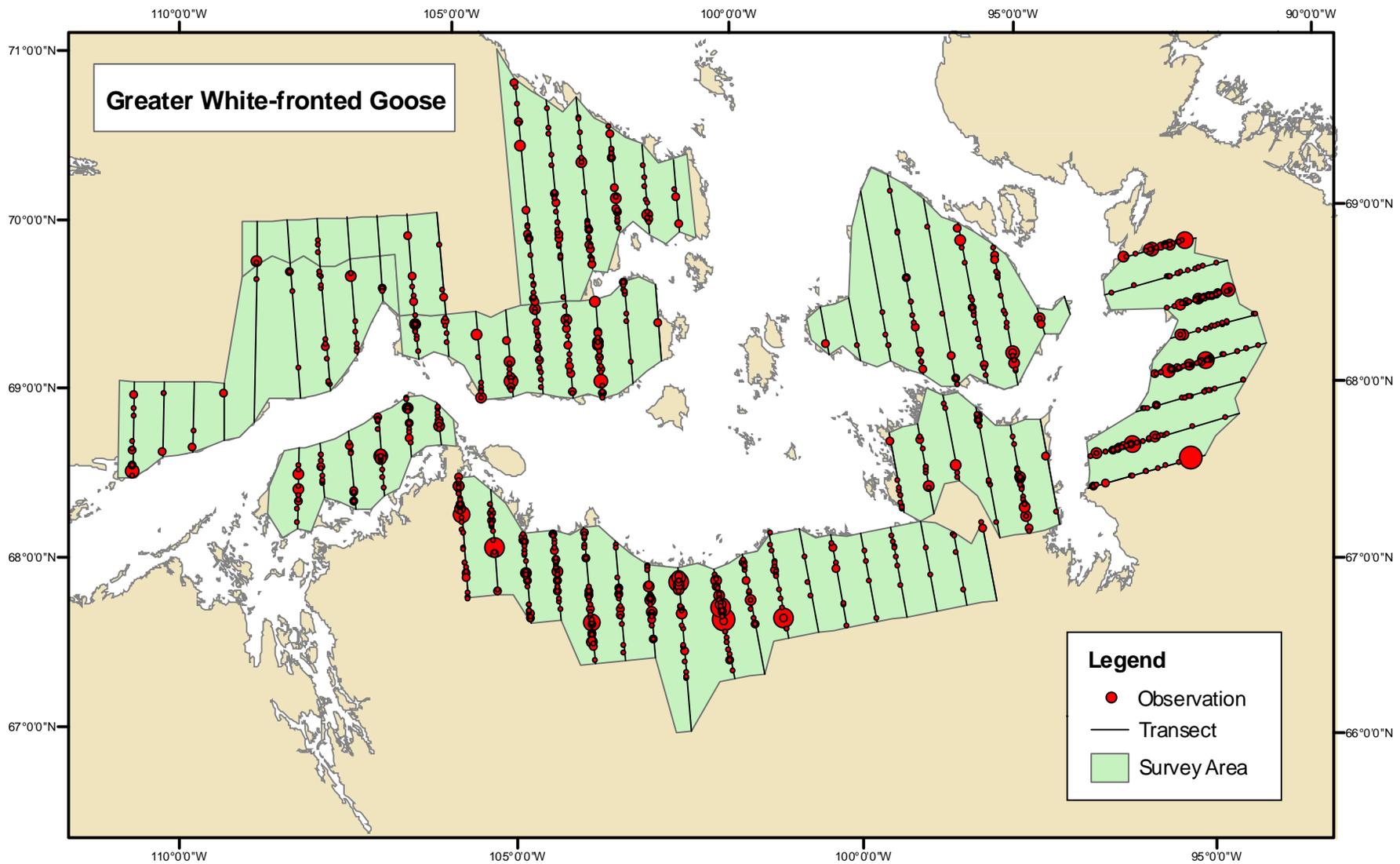


Figure 4. Locations of white-fronted goose observations in 2007. Symbol size is proportional to the number of birds observed.

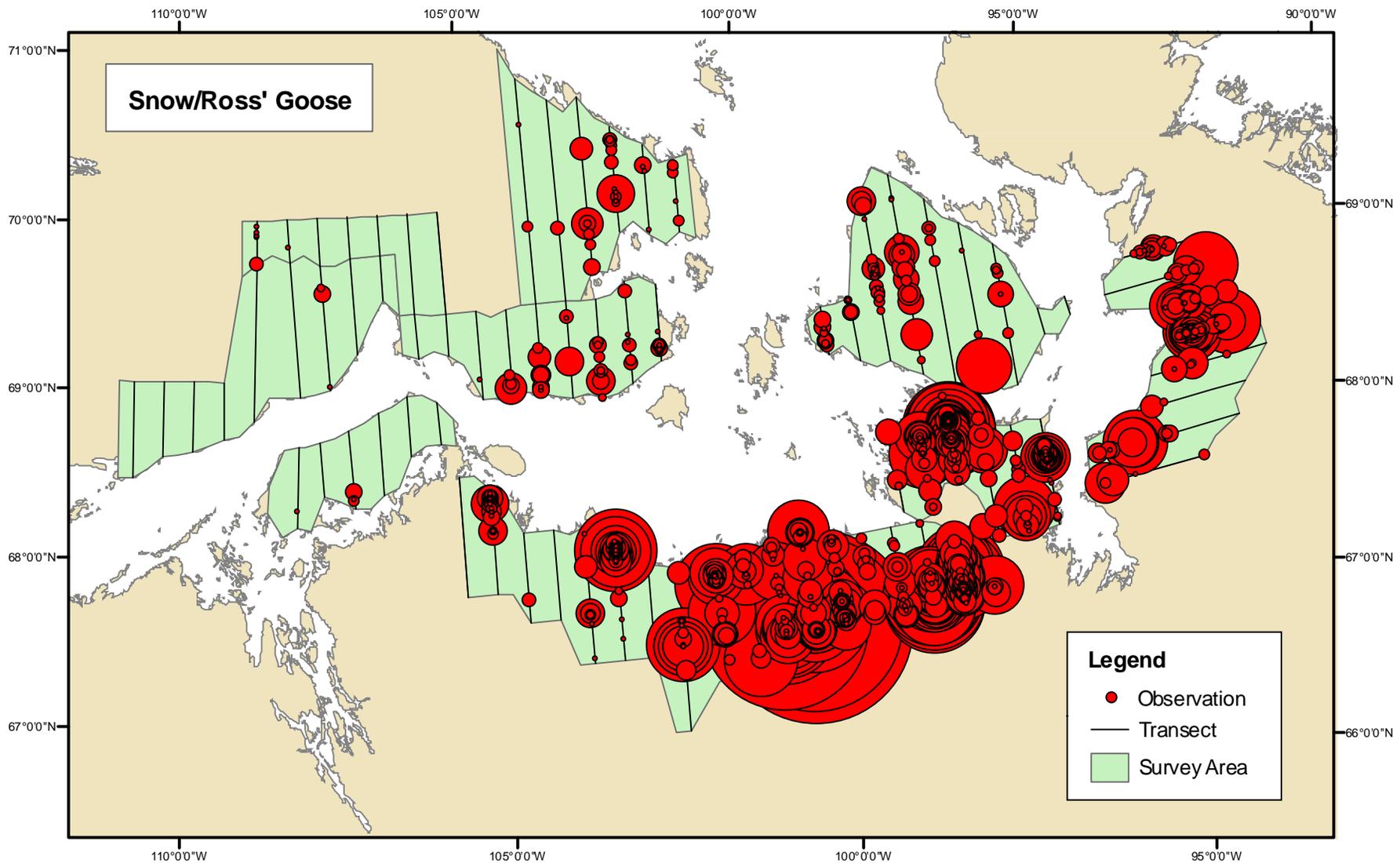


Figure 5. Locations of snow/Ross' goose observations in 2007. Symbol size is proportional to the number of birds observed.

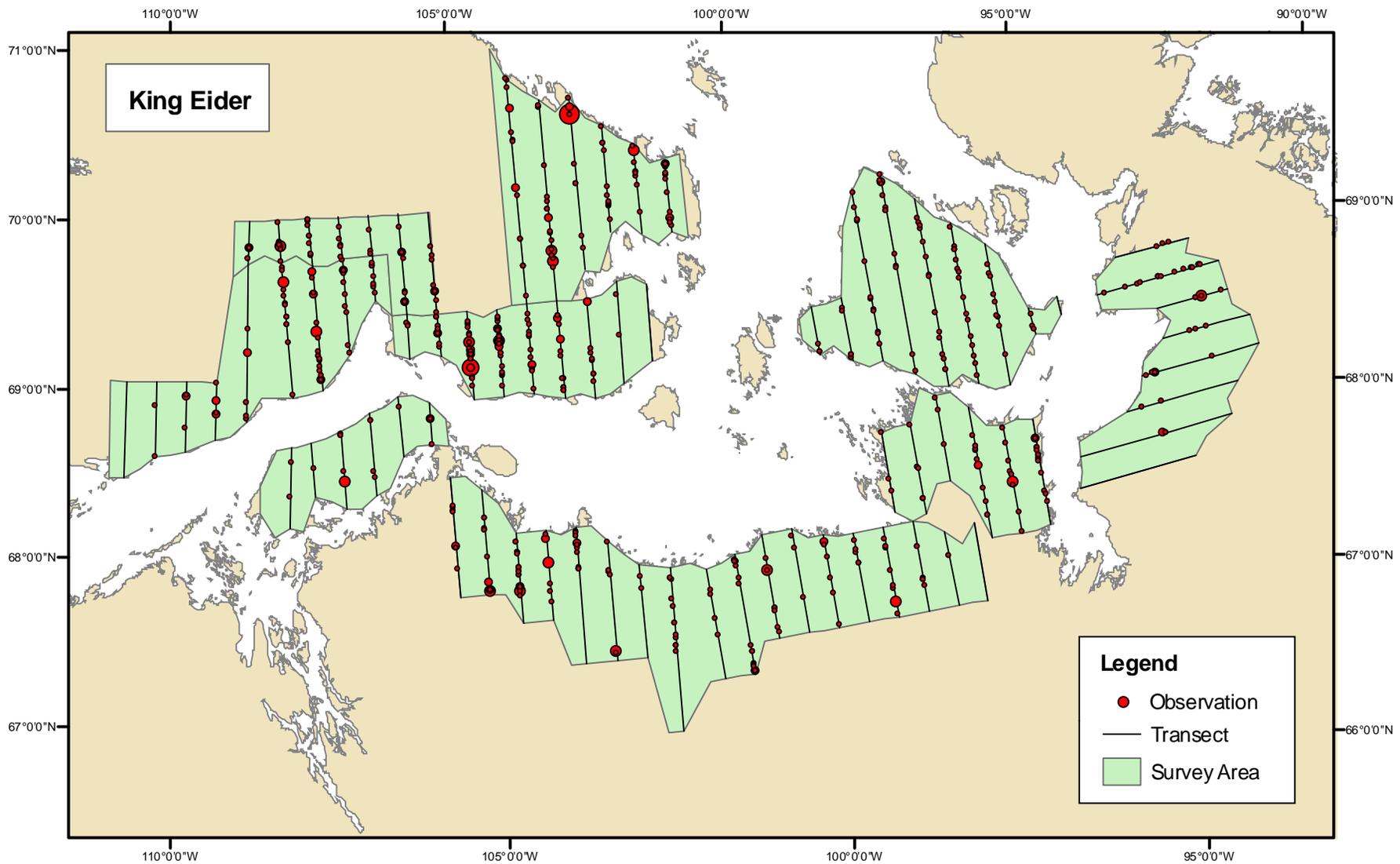


Figure 6. Locations of king eider observations in 2007. Symbol size is proportional to the number of birds observed.

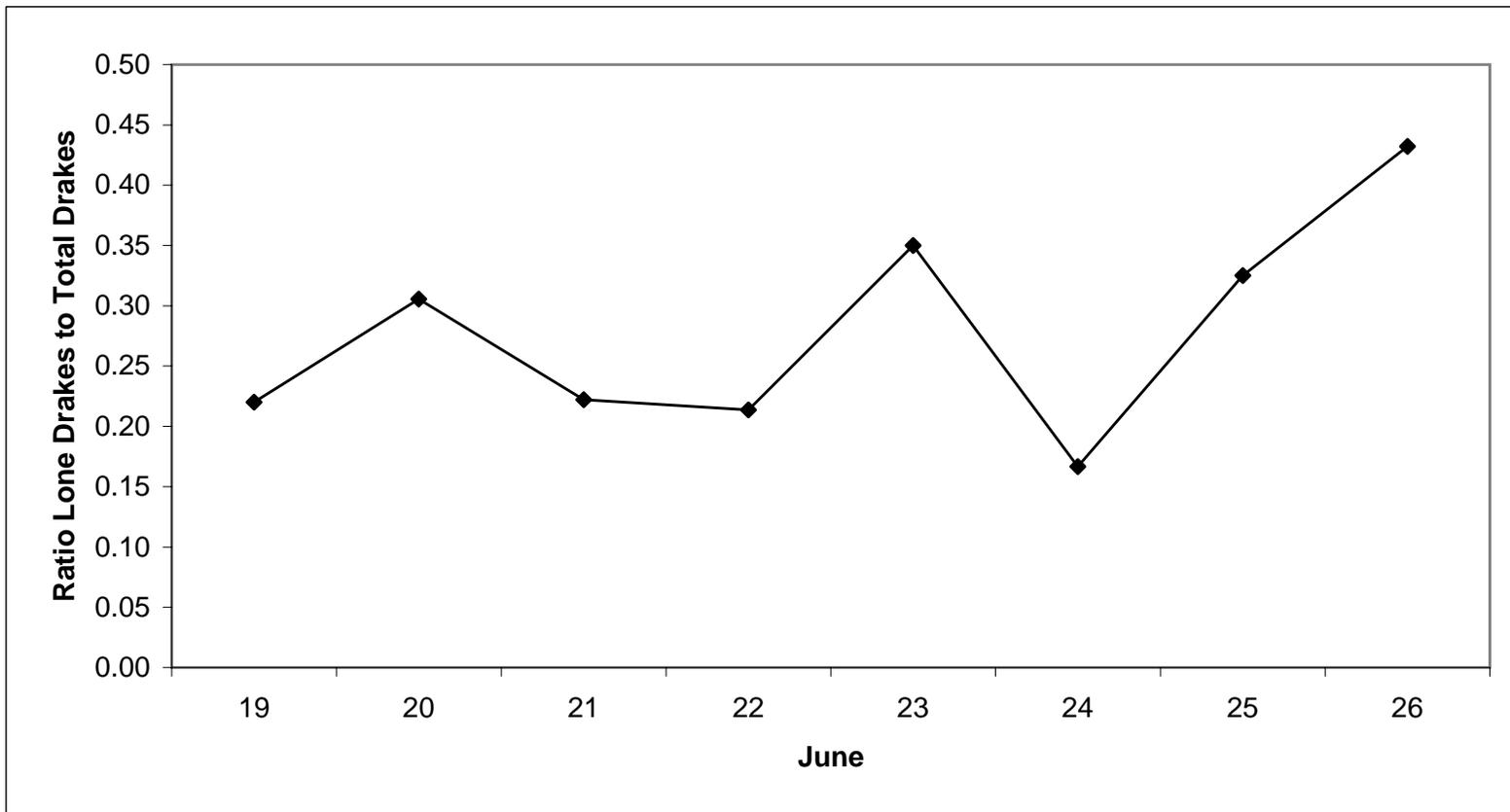


Figure 7. Daily ratios of lone drakes (drakes not associated with females) to total drakes for king eiders observed during the fixed-wing survey in Nunavut, Canada in June 2007.

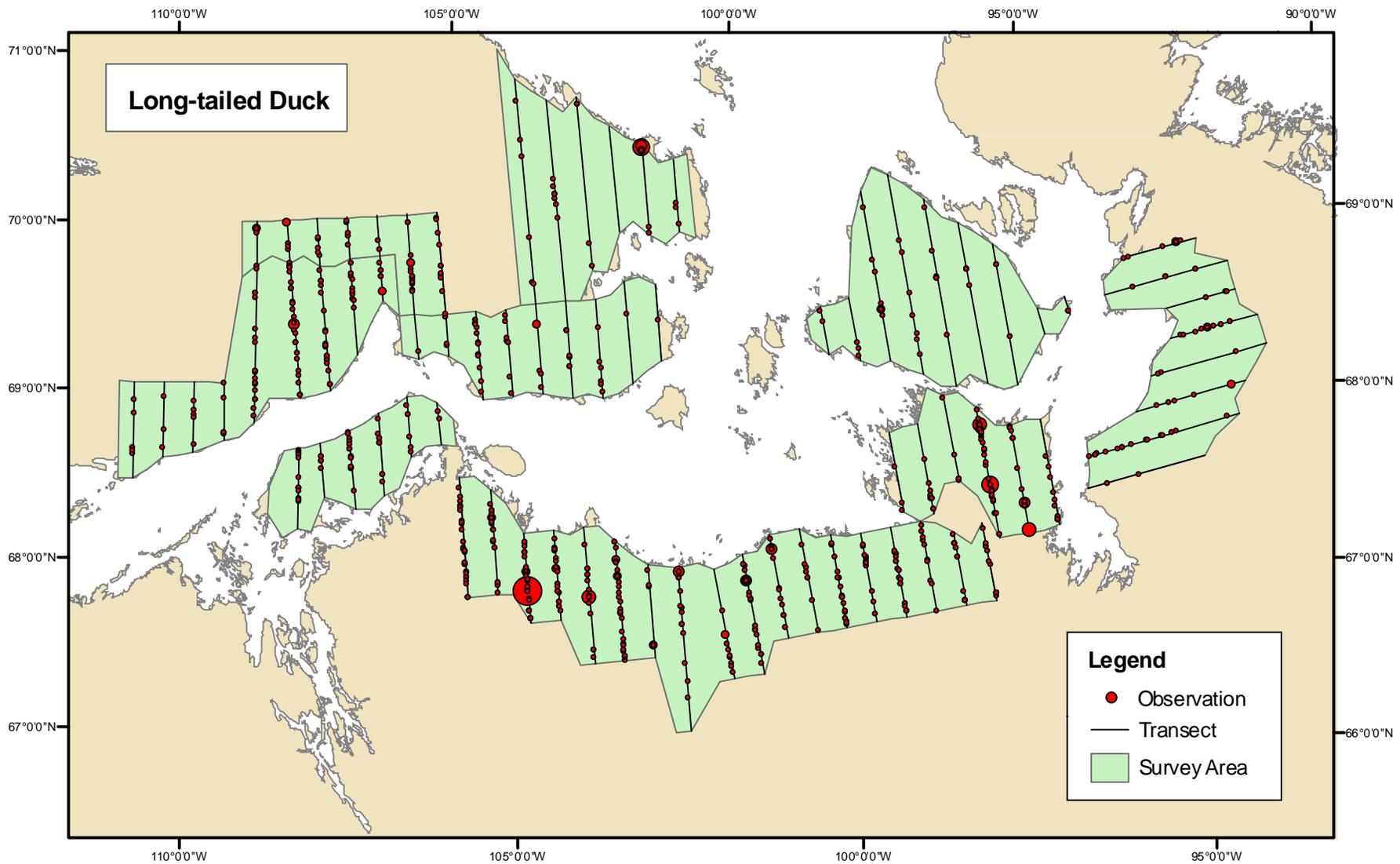


Figure 8. Locations of long-tailed duck observations in 2007. Symbol size is proportional to the number of birds observed.

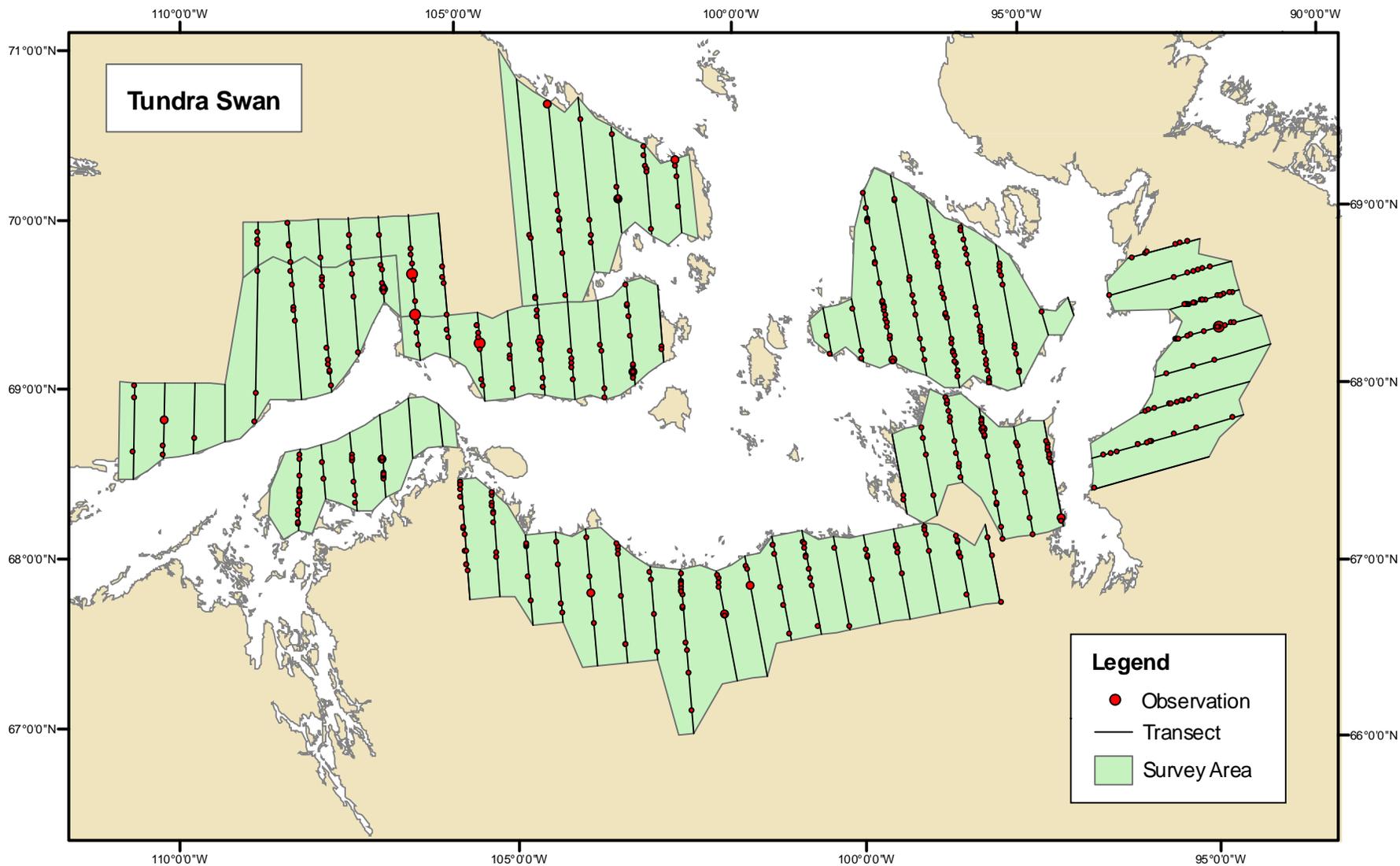


Figure 9. Locations of tundra swan observations in 2007. Symbol size is proportional to the number of birds observed.

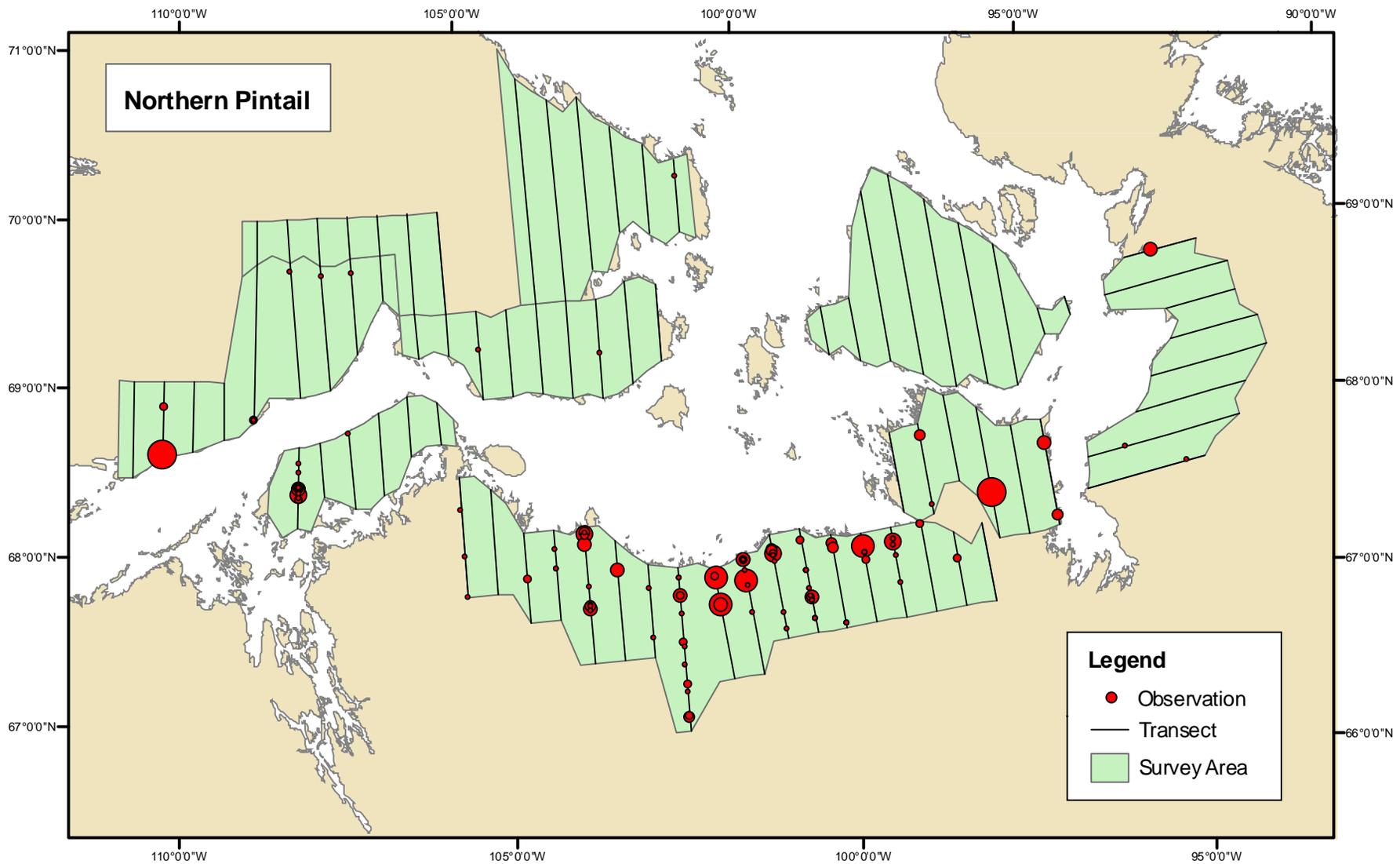


Figure 10. Locations of northern pintail observations in 2007. Symbol size is proportional to the number of birds observed.

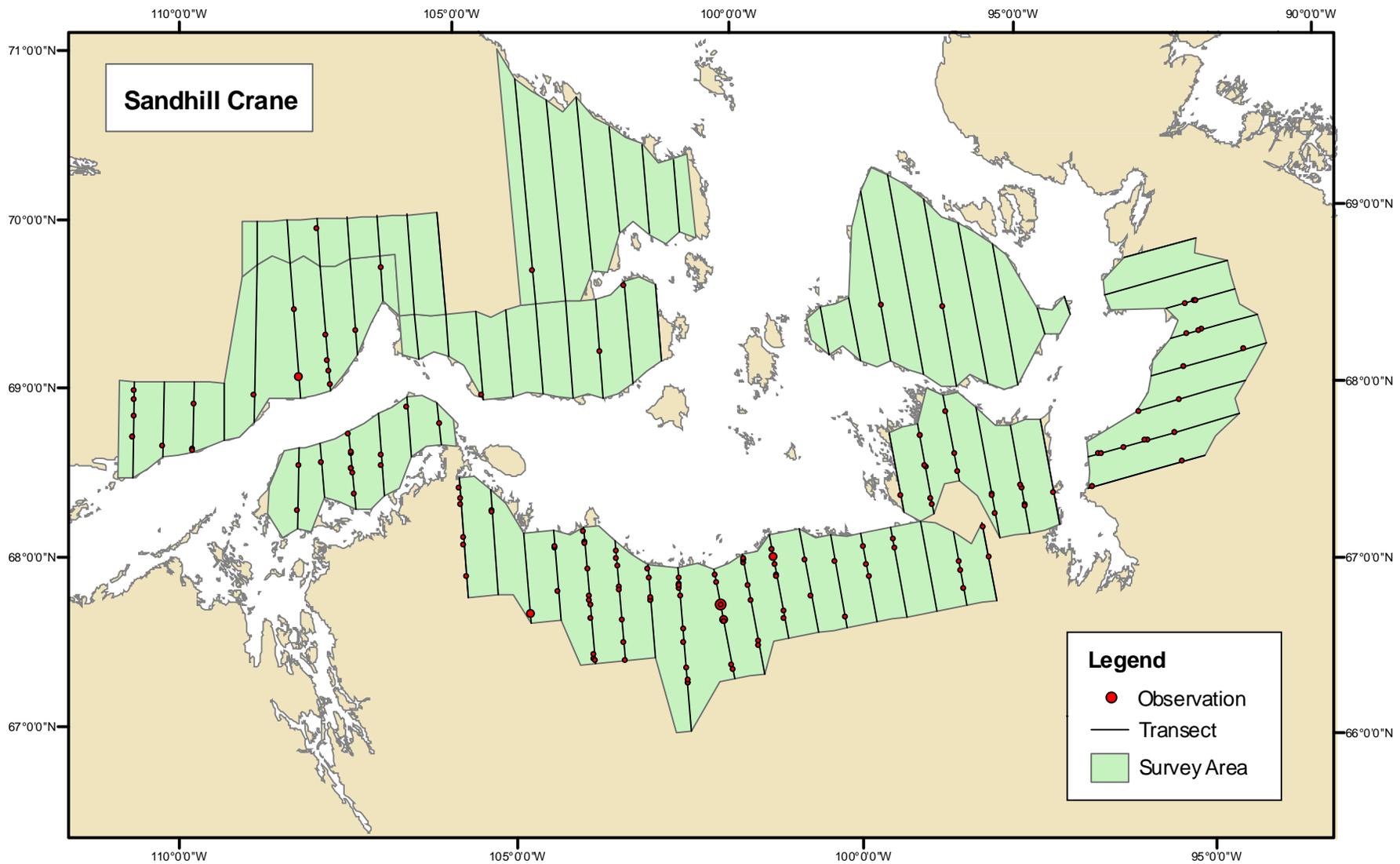


Figure 11. Locations of sandhill crane observations in 2007. Symbol size is proportional to the number of birds observed.

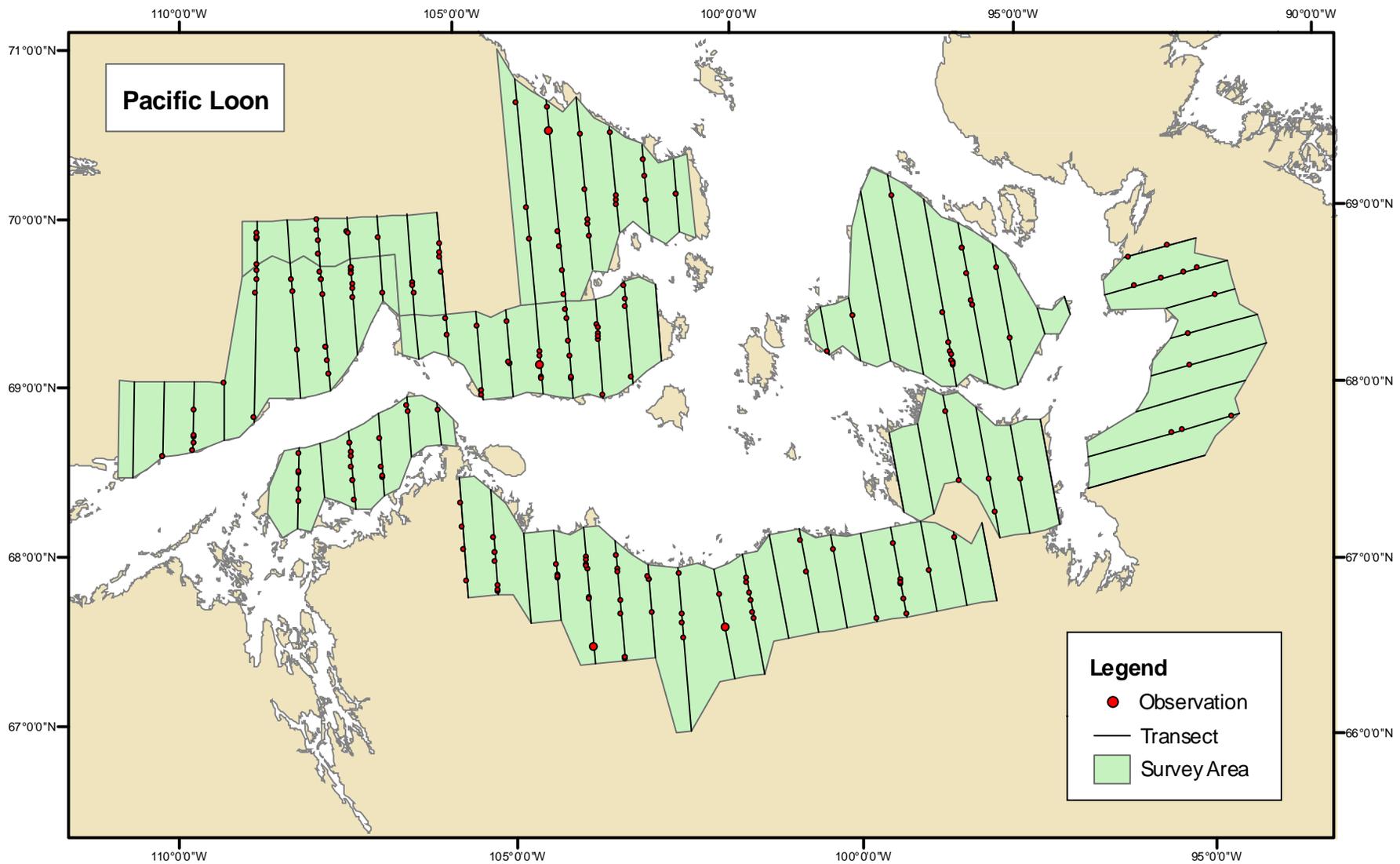


Figure 12. Locations of Pacific loon observations in 2007. Symbol size is proportional to the number of birds observed.

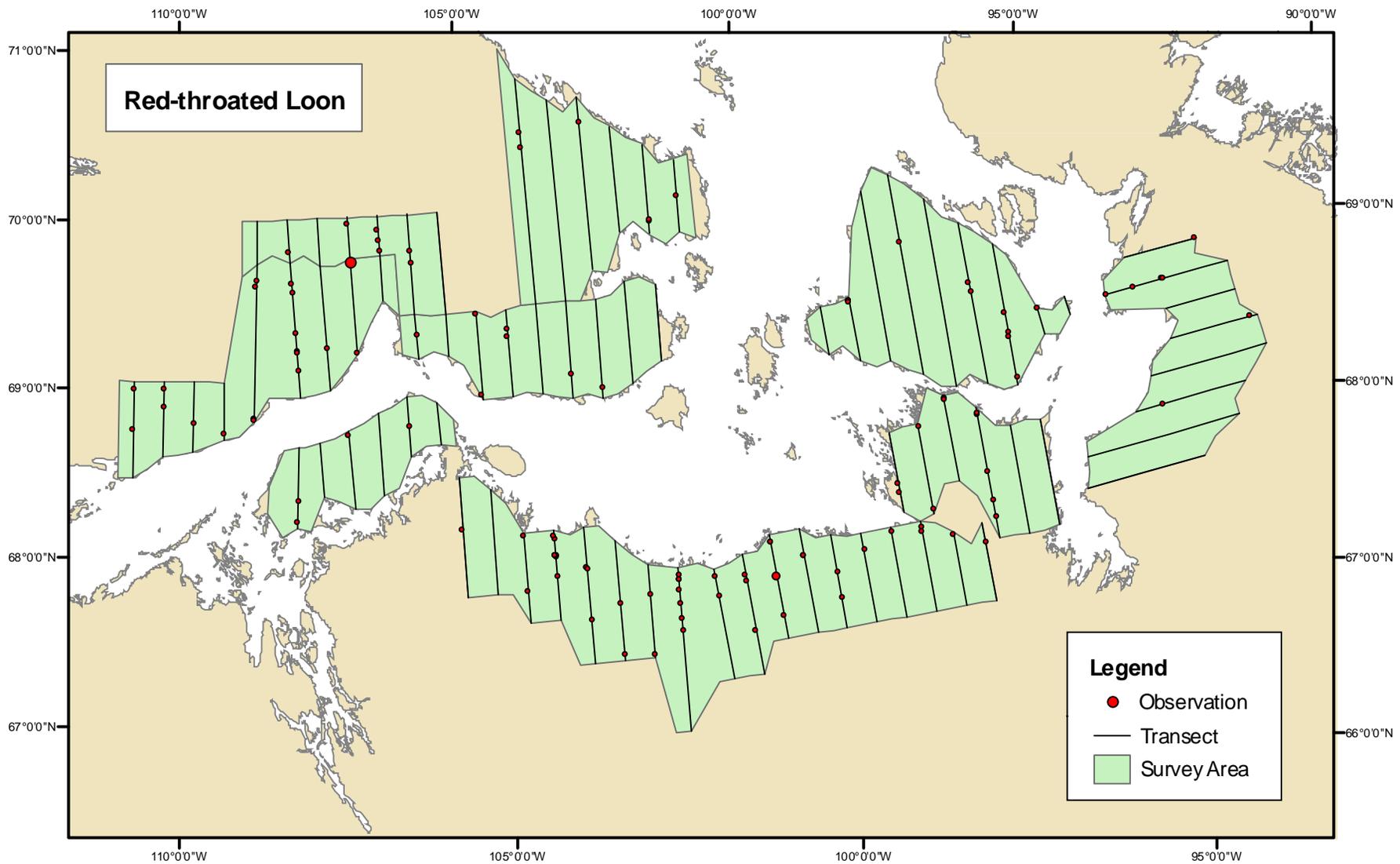


Figure 13. Locations of red-throated loon observations in 2007. Symbol size is proportional to the number of birds observed.

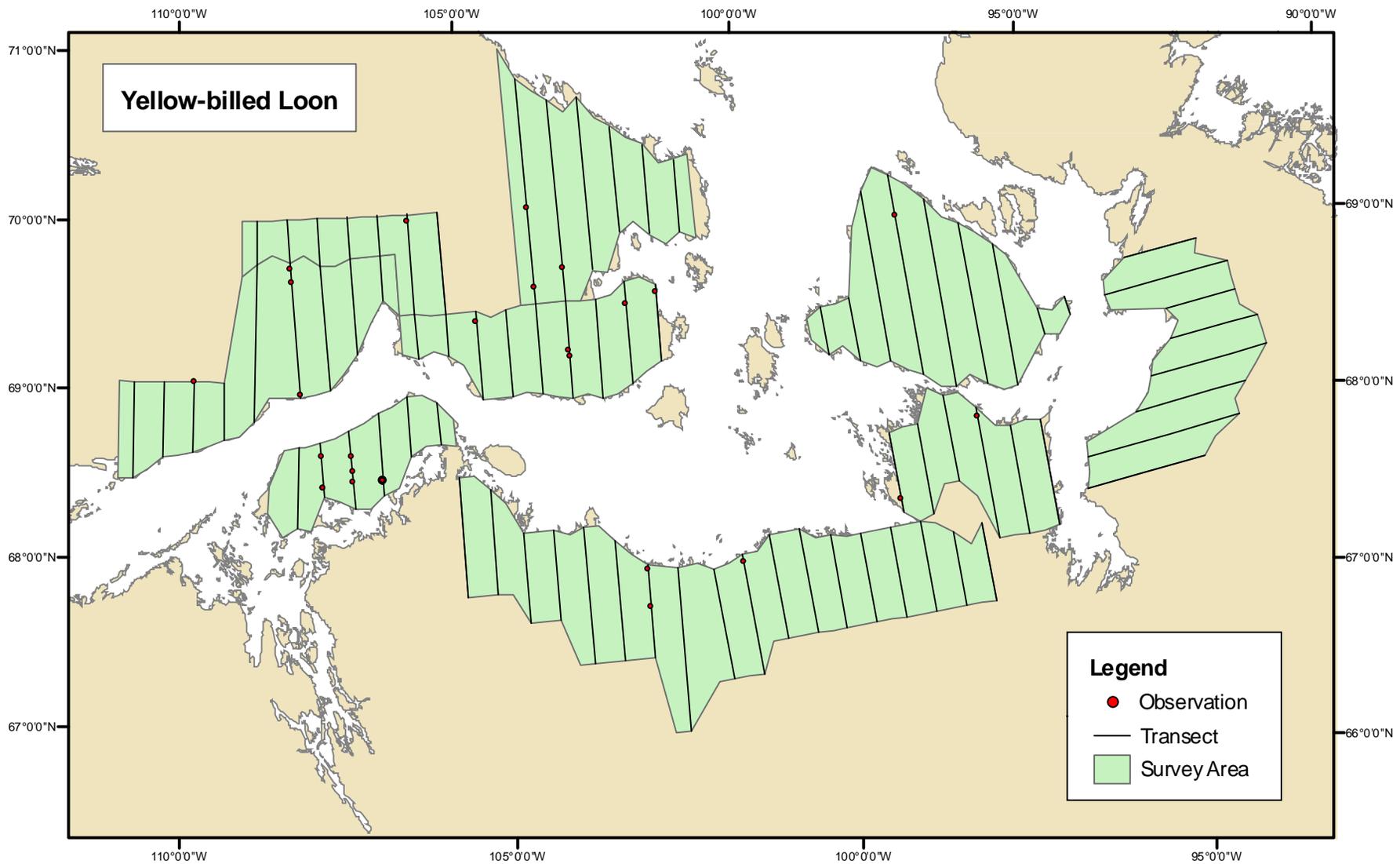


Figure 14. Locations of yellow-billed loon observations in 2007. Symbol size is proportional to the number of birds observed.

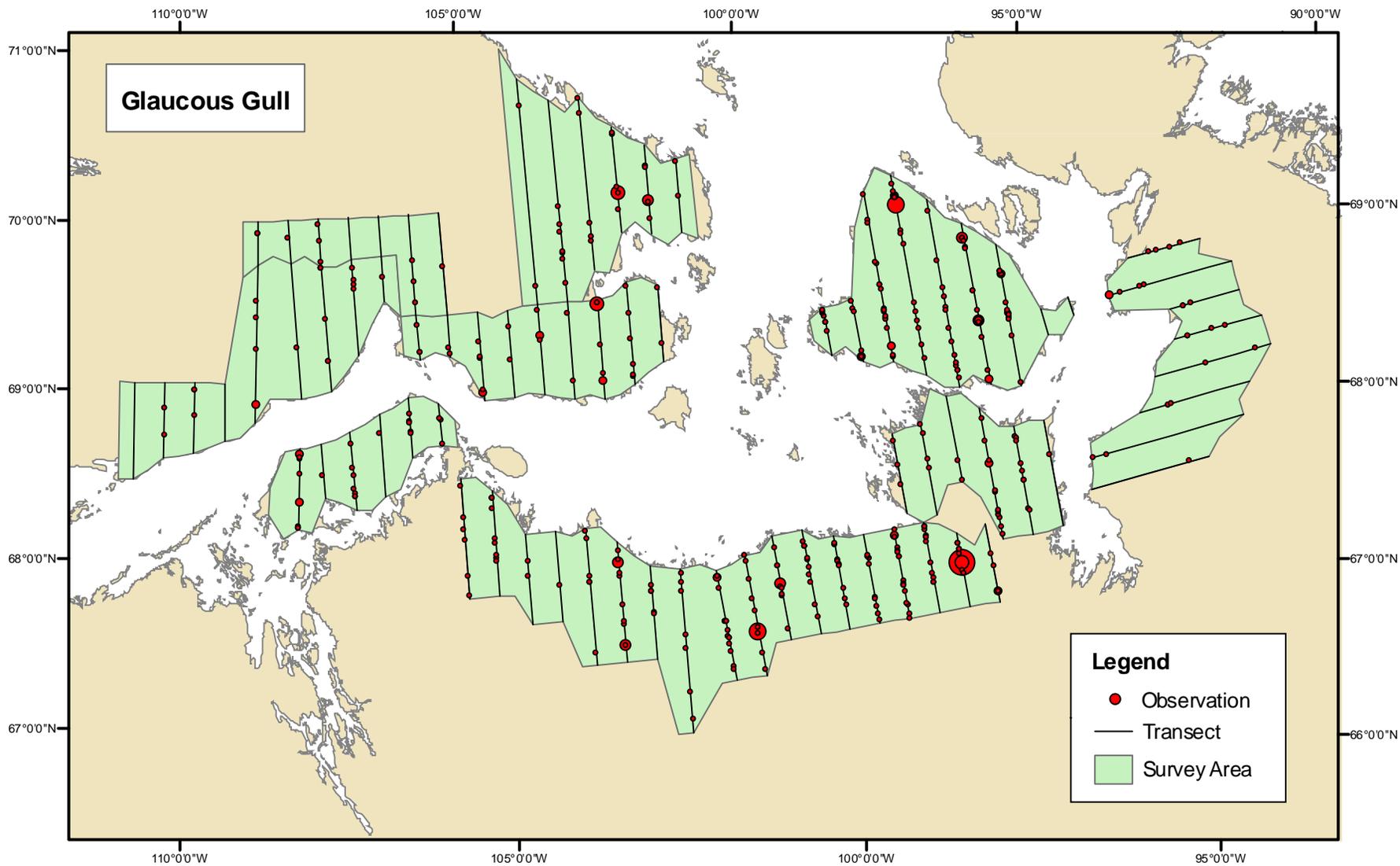


Figure 15. Locations of glaucous gull observations in 2007. Symbol size is proportional to the number of birds observed.

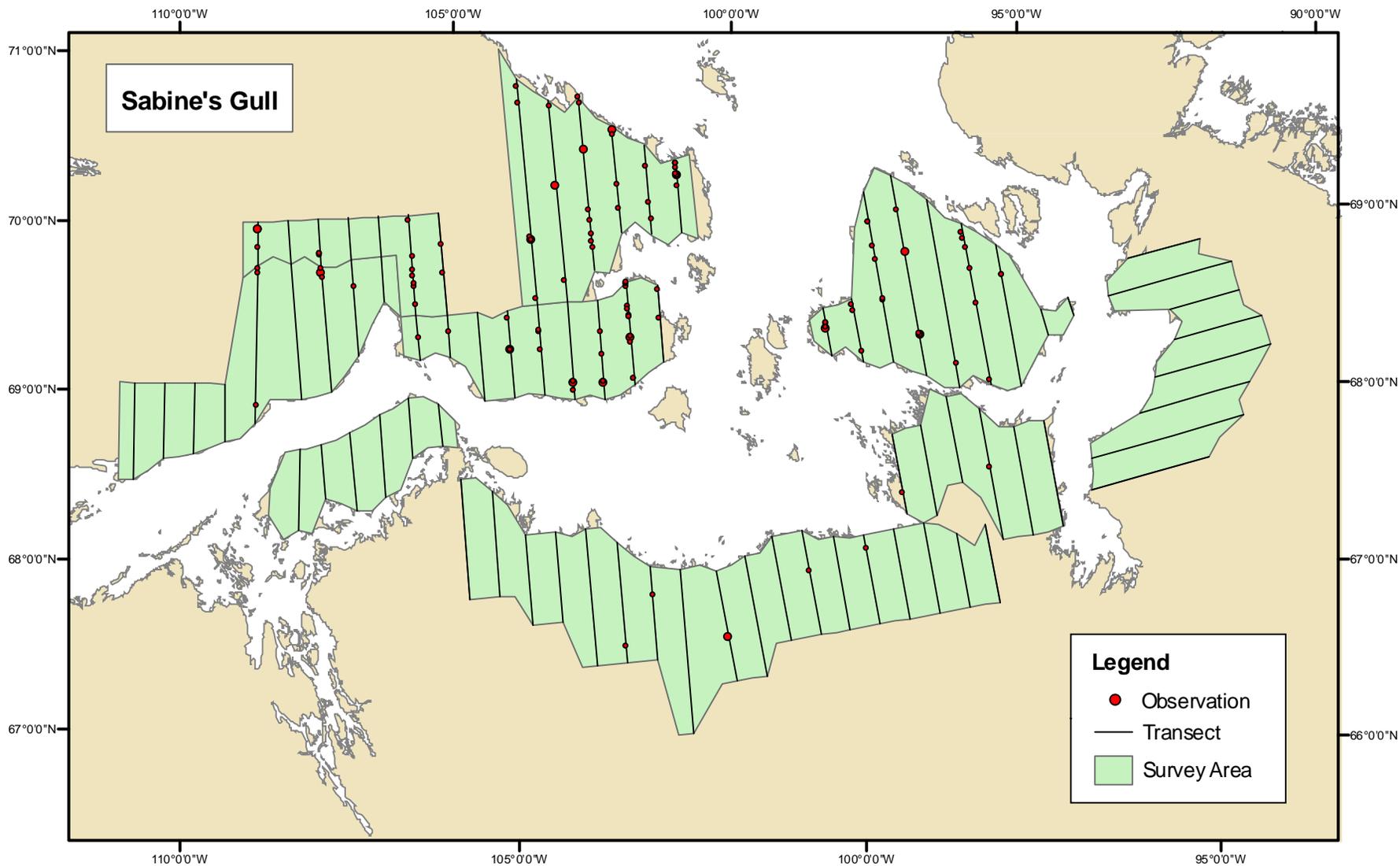


Figure 16. Locations of Sabine's gull observations in 2007. Symbol size is proportional to the number of birds observed.

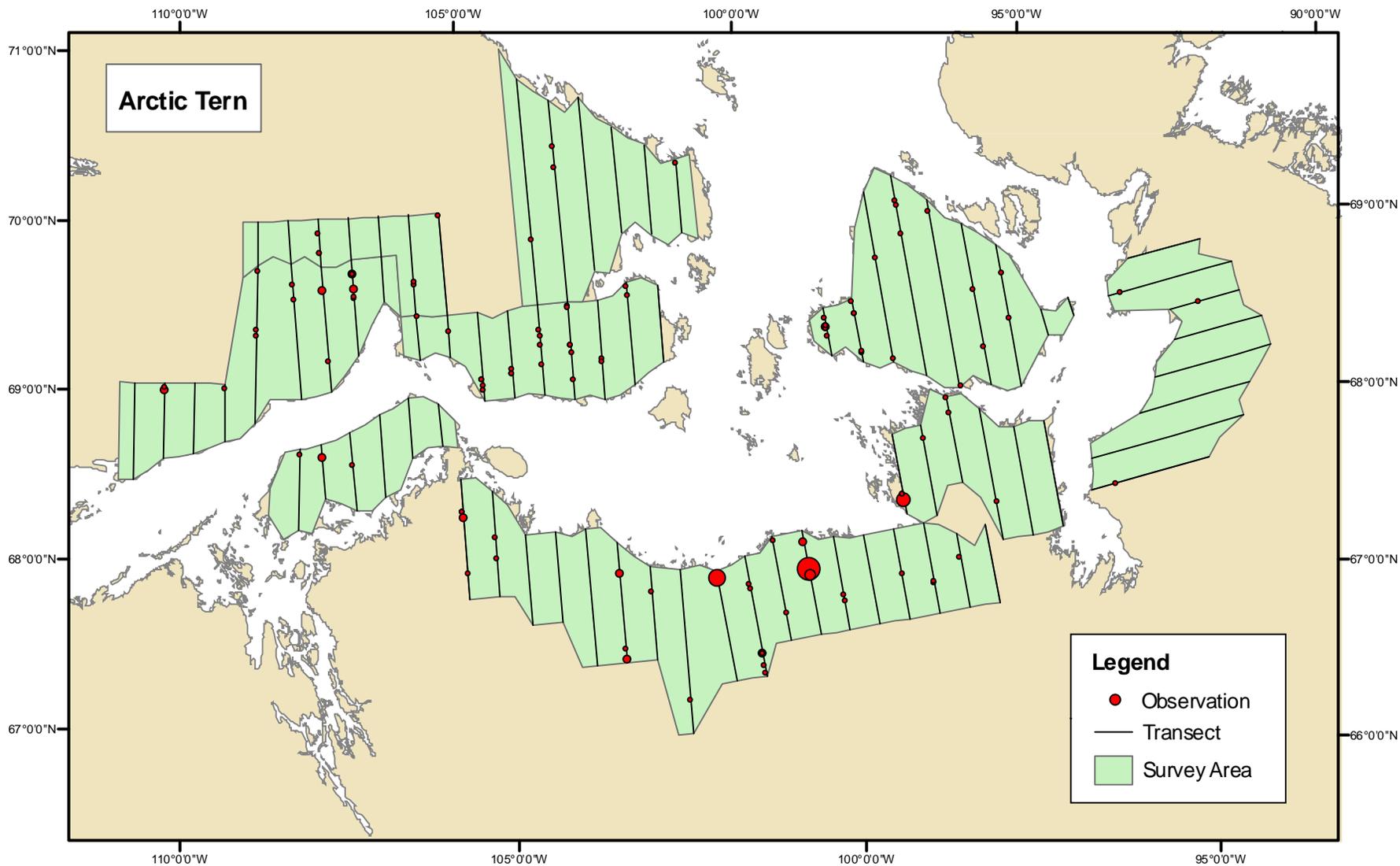


Figure 17. Locations of arctic tern observations in 2007. Symbol size is proportional to the number of birds observed.

Table 1. Survey design used for fixed-wing aerial surveys in Nunavut, Canada in June 2007.

	Byron Bay	Central Victoria Island	Southeast Victoria Island	East Victoria Island	Kent Peninsula	Queen Maud Gulf	Adelaide Peninsula	King William Island	Rasmussen Lowlands	All Areas
Survey Area (km ²)	12,346	4,792	8,926	11,692	5,624	24,385	6,865	13,801	10,433	98,864
No. Transects	9	7	9	6	6	18	6	12	14	87
Total Transect Length (km)	568.6	278.2	482.5	575.5	264.2	1,248.0	402.1	650.7	581.8	5,051.6
Transect Coverage (km ²)	227.4	111.3	193.0	230.2	105.7	499.2	160.9	272.3	232.7	2,032.7
% Coverage of Survey Area	1.8	2.3	2.2	2.0	1.9	2.0	2.3	2.0	2.2	2.1

Table 2. Population indices, by area, of waterfowl from the fixed-wing survey in Nunavut, Canada in June 2007. Single birds (except scaup and tundra swans) were doubled when calculating estimates. Indices of selected species are presented both with and without visibility correction factors (VCFs) applied to adjust for incomplete detection. VCFs are from 1989-1991 fixed-wing vs. helicopter comparison surveys in Alaska tundra habitats.

Species	VCF	Byron Bay		Central Victoria Island		Southeast Victoria Island		East Victoria Island		Kent Peninsula		Queen Maud Gulf		Adelaide Peninsula		King William Island		Rasmussen Lowlands		Total	
			SE		SE		SE		SE		SE		SE		SE		SE		SE		SE
Small Canada/Cackling Goose	---	29,965	4,336	11,067	1,663	38,153	3,982	44,086	8,651	15,008	3,133	101,459	24,290	26,971	1,731	50,735	7,491	26,224	4,241	343,668	28,092
Large Canada Goose	---	109	116	818	637	555	589	203	156	0	0	41,619	13,672	896	392	203	140	269	192	44,672	13,709
Total Canada/Cackling Goose	---	30,074	4,364	11,885	1,367	38,708	4,167	44,289	8,748	15,008	3,133	143,078	33,194	27,867	1,747	50,938	7,581	26,493	4,333	388,340	36,135
White-fronted Goose	---	6,840	1,946	1,938	582	14,475	2,706	16,304	2,175	11,602	1,340	51,780	8,880	7,212	2,616	9,782	2,399	29,227	6,390	149,160	12,258
Brant	---	163	164	0	0	92	98	0	0	0	0	1,172	1,173	0	0	0	0	0	0	1,428	1,189
Snow/Ross' Goose	---	2,063	1,391	431	372	23,401	5,426	19,961	10,521	1,331	1,160	1,677,418	603,011	434,561	296,621	52,661	14,188	193,654	85,666	2,405,480	677,709
Am. Green-winged Teal	---	0	0	0	0	0	0	0	0	0	0	195	133	0	0	0	0	0	0	195	133
Am. Green-winged Teal	8.36	0	0	0	0	0	0	0	0	0	0	1,634	1,127	0	0	0	0	0	0	1,634	1,127
Northern Pintail	---	3,746	2,753	0	0	185	118	102	113	3,406	3,008	29,651	6,192	3,030	1,662	0	0	717	528	40,837	7,618
Northern Pintail	3.05	11,424	8,418	0	0	564	361	310	344	10,389	9,183	90,436	20,018	9,241	5,102	0	0	2,188	1,614	124,552	24,182
Scaup	---	651	447	0	0	0	0	0	0	0	0	586	205	341	355	0	0	0	0	1,578	607
Scaup	1.93	1,257	868	0	0	0	0	0	0	0	0	1,131	411	659	686	0	0	0	0	3,047	1,180
Common Eider	---	1,194	906	0	0	370	194	305	225	319	225	537	538	0	0	0	0	0	0	2,726	1,118
King Eider	---	8,848	2,109	5,254	951	11,469	3,793	10,768	1,506	2,022	573	15,485	2,495	4,524	1,049	8,211	581	4,483	1,239	71,064	5,615
Long-tailed Duck	---	12,051	2,127	4,479	587	4,162	1,011	4,012	1,867	5,535	899	36,832	5,169	9,815	3,343	4,359	867	5,290	1,305	86,535	7,109
Long-tailed Duck	1.87	22,536	5,122	8,375	1,631	7,783	2,186	7,503	3,622	10,350	2,243	68,876	13,850	18,355	6,737	8,151	1,995	9,892	2,810	161,821	17,347
Red-breasted Merganser	---	0	0	0	0	0	0	0	0	0	0	391	302	0	0	0	0	0	0	391	302
Red-breasted Merganser	1.27	0	0	0	0	0	0	0	0	0	0	496	302	0	0	0	0	0	0	496	302
Tundra Swan	---	3,094	746	1,550	348	4,162	895	2,793	704	2,608	836	8,255	788	3,627	760	7,096	1,983	4,617	1,463	37,804	3,154
Tundra Swan Nest	---	0	0	86	91	277	128	102	91	106	102	391	179	85	87	1,014	233	807	440	2,868	575

Table 3. Population indices, by area, of additional bird and mammal species from the fixed-wing survey in Nunavut, Canada in June 2007. Indices were not adjusted to account for incomplete detection.

Species	Byron Bay		Central Victoria Island		Southeast Victoria Island		East Victoria Island		Kent Peninsula		Queen Maud Gulf		Adelaide Peninsula		King William Island		Rasmussen Lowlands		Total	
		SE		SE		SE		SE		SE		SE		SE		SE		SE		SE
Sandhill Crane	1,574	429	86	90	185	93	51	46	1,011	410	6,546	972	1,195	433	203	123	1,121	305	11,971	1,270
Pacific Loon	2,769	693	1,421	358	2,220	401	1,828	236	1,650	449	4,348	821	299	134	1,318	697	717	277	16,569	1,510
Red-throated Loon	2,117	496	474	217	370	144	508	222	319	154	3,615	744	683	285	1,014	404	538	339	9,637	1,140
Yellow-billed Loon	380	269	86	77	370	181	203	124	905	435	244	200	128	89	51	45	0	0	2,367	605
Unidentified Loon sp.	0	0	0	0	0	0	102	50	0	0	0	0	0	0	0	0	0	0	102	50
Glaucon Gull	1,357	337	560	196	2,451	626	2,438	981	2,182	713	13,873	3,315	1,750	539	8,008	1,009	1,390	369	34,009	3,801
Sabine's Gull	651	339	861	311	2,775	991	3,149	814	0	0	488	228	128	82	2,382	625	0	0	10,435	1,518
Herring/Thayer's Gull	217	174	86	77	0	0	0	0	213	96	1,124	353	0	0	101	107	90	89	1,831	435
Arctic Tern	1,574	606	301	167	1,480	351	305	126	373	214	5,227	2,334	854	691	1,723	615	179	99	12,016	2,625
Jaeger spp.	869	249	172	69	555	160	609	274	160	87	879	219	299	96	963	193	134	71	4,640	524
Ptarmigan spp.	2,063	932	732	231	509	226	2,743	506	852	236	5,031	1,071	640	155	405	254	583	284	13,558	1,613
Common Raven	109	112	0	0	92	92	0	0	0	0	98	95	43	44	0	0	224	100	566	205
Rough-legged Hawk	54	57	0	0	46	46	0	0	53	51	0	0	0	0	0	0	0	0	154	89
Unidentified Hawk spp.	163	119	0	0	46	46	0	0	0	0	98	65	0	0	0	0	45	45	352	150
Golden Eagle	163	119	0	0	0	0	0	0	0	0	49	48	0	0	0	0	0	0	212	128
Gyrfalcon	0	0	0	0	0	0	0	0	0	0	49	48	0	0	0	0	0	0	49	48
Short-eared Owl	0	0	43	46	46	46	0	0	160	106	147	102	0	0	0	0	0	0	396	161
Snowy Owl	54	53	0	0	0	0	102	57	160	166	195	118	43	42	558	219	179	77	1,290	321
Muskox Adult	7,817	2,055	4,436	1,546	2,590	494	3,403	1,293	1,543	793	195	155	0	0	405	374	90	62	20,479	3,054
Muskox Calf	706	283	431	174	416	152	660	227	0	0	0	0	0	0	0	0	0	0	2,213	429
Caribou Adult	2,389	437	904	406	277	187	2,387	754	373	257	119,289	38,349	11,480	6,009	101	63	10,310	2,027	147,510	38,883
Caribou Calf	109	100	129	135	0	0	762	178	0	0	41,473	18,698	6,145	3,399	51	51	2,331	656	50,999	19,017
Arctic Fox	54	55	86	63	92	91	51	50	0	0	0	0	128	90	152	62	0	0	564	173
Wolf	0	0	43	39	0	0	0	0	0	0	49	49	0	0	0	0	45	45	137	77

Table 4. Population densities (number per km²), by area, of waterfowl (total indicated birds) from the fixed-wing survey in Nunavut, Canada in June 2007. Densities were not adjusted to account for incomplete detection.

Species	Byron Bay		Central Victoria Island		Southeast Victoria Island		East Victoria Island		Kent Peninsula		Queen Maud Gulf		Adelaide Peninsula		King William Island		Rasmussen Lowlands	
	Bay	SE	Island	SE	Island	SE	Island	SE	Peninsula	SE	Gulf	SE	Peninsula	SE	Island	SE	Lowlands	SE
Small Canada/Cackling Goose	2.427	0.351	2.310	0.347	4.274	0.446	3.770	0.740	2.668	0.557	4.161	0.996	3.929	0.252	3.676	0.543	2.514	0.407
Large Canada Goose	0.009	0.009	0.171	0.133	0.062	0.066	0.017	0.013	0.000	0.000	1.707	0.561	0.131	0.057	0.015	0.010	0.026	0.018
Total Canada/Cackling Goose	2.436	0.354	2.480	0.285	4.337	0.467	3.788	0.748	2.668	0.557	5.867	1.361	4.060	0.254	3.691	0.549	2.539	0.415
White-fronted Goose	0.554	0.158	0.404	0.121	1.622	0.303	1.394	0.186	2.063	0.238	2.123	0.364	1.051	0.381	0.709	0.174	2.802	0.612
Brant	0.013	0.013	0.000	0.000	0.010	0.011	0.000	0.000	0.000	0.000	0.048	0.048	0.000	0.000	0.000	0.000	0.000	0.000
Snow/Ross' Goose	0.167	0.113	0.090	0.078	2.622	0.608	1.707	0.900	0.237	0.206	68.788	24.728	63.305	43.211	3.816	1.028	18.562	8.211
Am. Green-winged Teal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.005	0.000	0.000	0.000	0.000	0.000	0.000
Northern Pintail	0.303	0.223	0.000	0.000	0.021	0.013	0.009	0.010	0.606	0.535	1.216	0.254	0.441	0.242	0.000	0.000	0.069	0.051
Scaup	0.053	0.036	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.024	0.008	0.050	0.052	0.000	0.000	0.000	0.000
Common Eider	0.097	0.073	0.000	0.000	0.041	0.022	0.026	0.019	0.057	0.040	0.022	0.022	0.000	0.000	0.000	0.000	0.000	0.000
King Eider	0.717	0.171	1.096	0.198	1.285	0.425	0.921	0.129	0.360	0.102	0.635	0.102	0.659	0.153	0.595	0.042	0.430	0.119
Long-tailed Duck	0.976	0.172	0.935	0.122	0.466	0.113	0.343	0.160	0.984	0.160	1.510	0.212	1.430	0.487	0.316	0.063	0.507	0.125
Red-breasted Merganser	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.009	0.000	0.000	0.000	0.000	0.000	0.000
Tundra Swan	0.251	0.060	0.324	0.073	0.466	0.100	0.239	0.060	0.464	0.149	0.339	0.032	0.528	0.111	0.514	0.144	0.443	0.140
Tundra Swan Nest	0.000	0.000	0.018	0.019	0.031	0.014	0.009	0.008	0.019	0.018	0.016	0.007	0.012	0.013	0.073	0.017	0.077	0.042

Table 5. Population densities (number per km²), by area, of additional birds (total indicated birds) and mammals from the fixed-wing survey in Nunavut, Canada in June 2007. Densities were not adjusted to account for incomplete detection.

Species	Byron Bay		Central Victoria Island		Southeast Victoria Island		East Victoria Island		Kent Peninsula		Queen Maud Gulf		Adelaide Peninsula		King William Island		Rasmussen Lowlands	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Sandhill Crane	0.128	0.035	0.018	0.019	0.021	0.010	0.004	0.004	0.180	0.073	0.268	0.040	0.174	0.063	0.015	0.009	0.107	0.029
Pacific Loon	0.224	0.056	0.297	0.075	0.249	0.045	0.156	0.020	0.293	0.080	0.178	0.034	0.044	0.019	0.095	0.050	0.069	0.027
Red-throated Loon	0.171	0.040	0.099	0.045	0.041	0.016	0.043	0.019	0.057	0.027	0.148	0.031	0.099	0.041	0.073	0.029	0.052	0.032
Yellow-billed Loon	0.031	0.022	0.018	0.016	0.041	0.020	0.017	0.011	0.161	0.077	0.010	0.008	0.019	0.013	0.004	0.003	0.000	0.000
Unidentified Loon sp.	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Glaucon Gull	0.110	0.027	0.117	0.041	0.275	0.070	0.209	0.084	0.388	0.127	0.569	0.136	0.255	0.079	0.580	0.073	0.133	0.035
Sabine's Gull	0.053	0.027	0.180	0.065	0.311	0.111	0.269	0.070	0.000	0.000	0.020	0.009	0.019	0.012	0.173	0.045	0.000	0.000
Herring/Thayer's Gull	0.018	0.014	0.018	0.016	0.000	0.000	0.000	0.000	0.038	0.017	0.046	0.014	0.000	0.000	0.007	0.008	0.009	0.009
Arctic Tern	0.128	0.049	0.063	0.035	0.166	0.039	0.026	0.011	0.066	0.038	0.214	0.096	0.124	0.101	0.125	0.045	0.017	0.010
Jaeger spp.	0.070	0.020	0.036	0.014	0.062	0.018	0.052	0.023	0.028	0.015	0.036	0.009	0.044	0.014	0.070	0.014	0.013	0.007
Ptarmigan spp.	0.167	0.076	0.153	0.048	0.057	0.025	0.235	0.043	0.151	0.042	0.206	0.044	0.093	0.023	0.029	0.018	0.056	0.027
Common Raven	0.009	0.009	0.000	0.000	0.010	0.010	0.000	0.000	0.000	0.000	0.004	0.004	0.006	0.006	0.000	0.000	0.021	0.010
Rough-legged Hawk	0.004	0.005	0.000	0.000	0.005	0.005	0.000	0.000	0.009	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Unidentified Hawk sp.	0.013	0.010	0.000	0.000	0.005	0.005	0.000	0.000	0.000	0.000	0.004	0.003	0.000	0.000	0.000	0.000	0.004	0.004
Golden Eagle	0.013	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000
Gyrfalcon	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000
Short-eared Owl	0.000	0.000	0.009	0.010	0.005	0.005	0.000	0.000	0.028	0.019	0.006	0.004	0.000	0.000	0.000	0.000	0.000	0.000
Snowy Owl	0.004	0.004	0.000	0.000	0.000	0.000	0.009	0.005	0.028	0.030	0.008	0.005	0.006	0.006	0.040	0.016	0.017	0.007
Muskox Adult	0.633	0.166	0.926	0.323	0.290	0.055	0.291	0.111	0.274	0.141	0.008	0.006	0.000	0.000	0.029	0.027	0.009	0.006
Muskox Calf	0.057	0.023	0.090	0.036	0.047	0.017	0.056	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Caribou Adult	0.193	0.035	0.189	0.085	0.031	0.021	0.204	0.064	0.066	0.046	4.892	1.573	1.672	0.875	0.007	0.005	0.988	0.194
Caribou Calf	0.009	0.008	0.027	0.028	0.000	0.000	0.065	0.015	0.000	0.000	1.701	0.767	0.895	0.495	0.004	0.004	0.223	0.063
Arctic Fox	0.004	0.004	0.018	0.013	0.010	0.010	0.004	0.004	0.000	0.000	0.000	0.000	0.019	0.013	0.011	0.005	0.000	0.000
Wolf	0.000	0.000	0.009	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.000	0.000	0.000	0.004	0.004