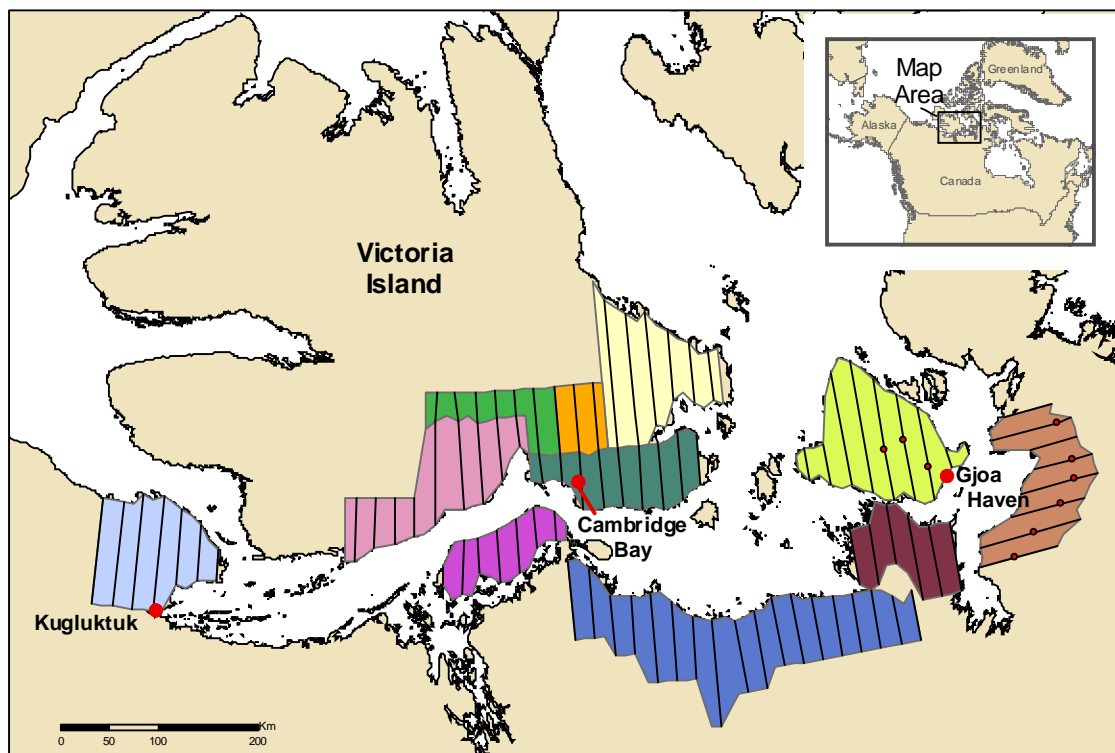


# MIGRATORY BIRD SURVEYS IN THE CANADIAN ARCTIC 2009



Deborah J. Groves  
Edward J. Mallek

U.S. Fish and Wildlife Service

March 2011

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**Deborah J. Groves**, *U.S. Fish and Wildlife Service, Migratory Bird Management, 3000 Vintage Blvd., Suite 240, Juneau, AK 99801, debbie\_groves@fws.gov*

**Edward J. Mallek**, *U.S. Fish and Wildlife Service, Migratory Bird Management, 1412 Airport Way, Fairbanks, AK 99701*

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**ABSTRACT:** We conducted a fixed-wing aerial survey of waterfowl and other migratory birds in Nunavut, Canada during 19 June-1 July 2009. The survey consisted of eleven areas of known or suspected high densities of waterfowl on southeastern Victoria Island, King William Island and the adjacent north coast 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 fifth 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, greater white-fronted goose, tundra swan, king eider, long-tailed duck, loons.

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## 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 2010) 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 migratory birds 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 migratory birds. 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 2005-2008, 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, Groves et al. 2009a, Groves et al. 2009b). In 2009 we resurveyed several of the areas flown in 2002-2007 and added one previously unsurveyed area. This report summarizes the results from our fixed-wing survey in 2009.

## STUDY AREA AND METHODS

### Survey Design

The survey in 2009 consisted of eleven 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. Three areas (Central Victoria Island, East Victoria Island, and Kugluktuk) were identified in 2005 or 2006 as areas that should be explored prior to designing a long-term monitoring survey for the region (Conant et al. 2006, Conant et al. 2007). We explored one additional area (Area C) in 2009 (Figure 1). The total survey area in 2009 was 113,391 km<sup>2</sup> (Table 1).

Transects established from previous surveys (Alisauskas 2003, Hines et al. 2003, Alisauskas 2005, Alisauskas 2006, Conant et al. 2006, Conant et al. 2007) were repeated in 2009, but at half the previous sampling intensity. The sampling intensity was reduced to enable us to cover all of the eleven 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 transects were not surveyed completely by Alisauskas in 2005 due to inclement weather (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 transects here as well.

## **Data Collection and Analyses**

We flew the 2009 survey on 19 June-1 July. The survey timing was intended to coincide with the mid-incubation period for geese, as well as the period when king eiders were paired (Cotter et al. 1997). We spent a total of 97.1 hours of flight time, including 61.0 hours surveying transects and flying to/from transects; 28.3 hours ferrying the survey airplane from and to our home base in Alaska; and 7.8 hours flying the aircraft to and from Yellowknife for maintenance. We based out of the communities of Kugluktuk, Cambridge Bay, and Gjoa Haven. 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 2009). Two observers participated in the survey, one left-seat pilot/observer and one right-seat observer (Ed Mallek and Debbie Groves, respectively).

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 feet) 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 respective 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 text data file. The transcribed text file was then used for data analyses.

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.  $2 * (\text{drakes} \leq 4 + \text{pairs}) + \text{grouped birds}$ ]. For Canada geese, white-fronted geese, and brant, 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 most duck species were adjusted for incomplete detection using visibility correction factors (VCFs) that were developed for this survey aircraft (N754) in 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 2009). 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**

### **Weather and Habitat Conditions**

Snow cover during the 2009 survey was 0-10% at lower elevations, increasing to 70-80% in a few areas at higher elevations and parts of King William Island. Spring phenology was approximately 2 weeks later than average.

### **Population Estimates**

Population indices are presented by species and area in Tables 2 and 3. Species for which VCF estimates exist are presented both with and without the VCF applied. 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 2-17. Common and scientific names of all species are listed in Appendix 1.

### **Canada Geese**

We differentiated Canada geese among two size classes: small Canada geese, which breed in the region, and large Canada geese, which are thought to use the area mainly or exclusively for molting (Latour et al. 2008). We also calculated separate estimates for small Canada geese west and east of the 100<sup>th</sup> meridian, a general boundary believed to separate the Short Grass Prairie (SGP) and Tall Grass Prairie (TGP) populations (Arctic Goose Joint Venture 2008).

The total population index for small Canada geese was 305,758, of which 204,518 occurred west (SGP) and 101,240 occurred east (TGP) of the 100<sup>th</sup> meridian. We observed 13% as singles, 62% as paired, and 25% in flocks ( $\geq 3$  unpaired birds). Assuming single birds represented pairs with undetected mates on nests, indicated pairs comprised 78% of the total indicated birds observed.

The population index for large Canada geese was 113,230. Of the total observed, 98% were in flocks ( $\geq 3$  unpaired birds), and 92% were in the Queen Maud Gulf area west of 100° W (Figure 3).

### **White-fronted Geese**

The population index for greater white-fronted geese was 192,320. We observed 7% as singles, 44% as paired, and 49% in flocks ( $\geq 3$  unpaired birds). Assuming single birds represented pairs with undetected mates on nests, indicated pairs comprised 54% 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, 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 2009 is illustrated in Figure 5.

### **King Eiders**

The population index for king eiders was 64,838. We observed 15% as single drakes, 76% in pairs, 3% as flocked drakes, and 6% in mixed-sex groups of  $\geq 5$  birds. Assuming single drakes and flocked drakes in groups  $<5$  represented pairs with undetected mates on nests, indicated pairs comprised 94% of the total indicated birds observed.

### **Long-tailed Ducks**

The unadjusted population index for long-tailed ducks was 112,437, and the index adjusted with a VCF of 1.87 was 210,256.

### **Tundra Swans**

The population index for tundra swans was 39,241. The index for tundra swan nests was 4,037.

### **Northern Pintails**

The unadjusted population index for northern pintails was 78,569, and the index adjusted with a VCF of 3.05 was 239,636. The majority of pintails (93%) were on the mainland, with 68% found in Queen Maud Gulf (Figure 9). Indicated breeding pairs comprised 26% of the total number of indicated birds observed.

### **Sandhill Cranes**

The population index for sandhill cranes was 14,145.

### **Loons**

Pacific, red-throated, and yellow-billed loons were present in the survey area. Population indices in 2009 were 17,953 Pacific loons, 7,591 red-throated loons, and 2,408 yellow-billed loons.

## **RECOMMENDATIONS**

We experienced several days that we couldn't fly in 2009 due to inclement weather, as well as aircraft mechanical problems that required us to deviate to Yellowknife for 2.5 days. The combination made it a challenge to complete all of the survey areas within our allotted two-week survey window. Although this was the first time we encountered logistic difficulties since our fixed-wing surveys began in 2005, it highlighted the need to accommodate some number of potential non-flying days in the final survey design (by slightly reducing the expected number of flight hours per aircraft).

Overall, the terrain and flying-weather conditions we encountered in 2005-2009 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 pilots are highly experienced flying in remote and arctic environments. Single-engine fixed-wing aircraft surveying in this environment should be 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.

## **ACKNOWLEDGEMENTS**

Tim Moser (USFWS - Division of Migratory Bird Management), with help from Lynne Dickson (CWS), has led the efforts to develop the Canadian Arctic Migratory Bird Survey and has been largely responsible for obtaining needed support and funding. The survey in 2009 was accomplished with the support of the Gjoa Haven, Kugluktuk, and Ekaluktutiak Hunters and Trappers Associations, Nunavut Department of Environment, U.S. Fish and Wildlife Service, Canadian Wildlife Service, Arctic Goose Joint Venture, Sea Duck Joint Venture, Central Flyway Council, and Mississippi Flyway Council. We 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. The survey was conducted under Nunavut Wildlife Research Permit WL 2009-030.

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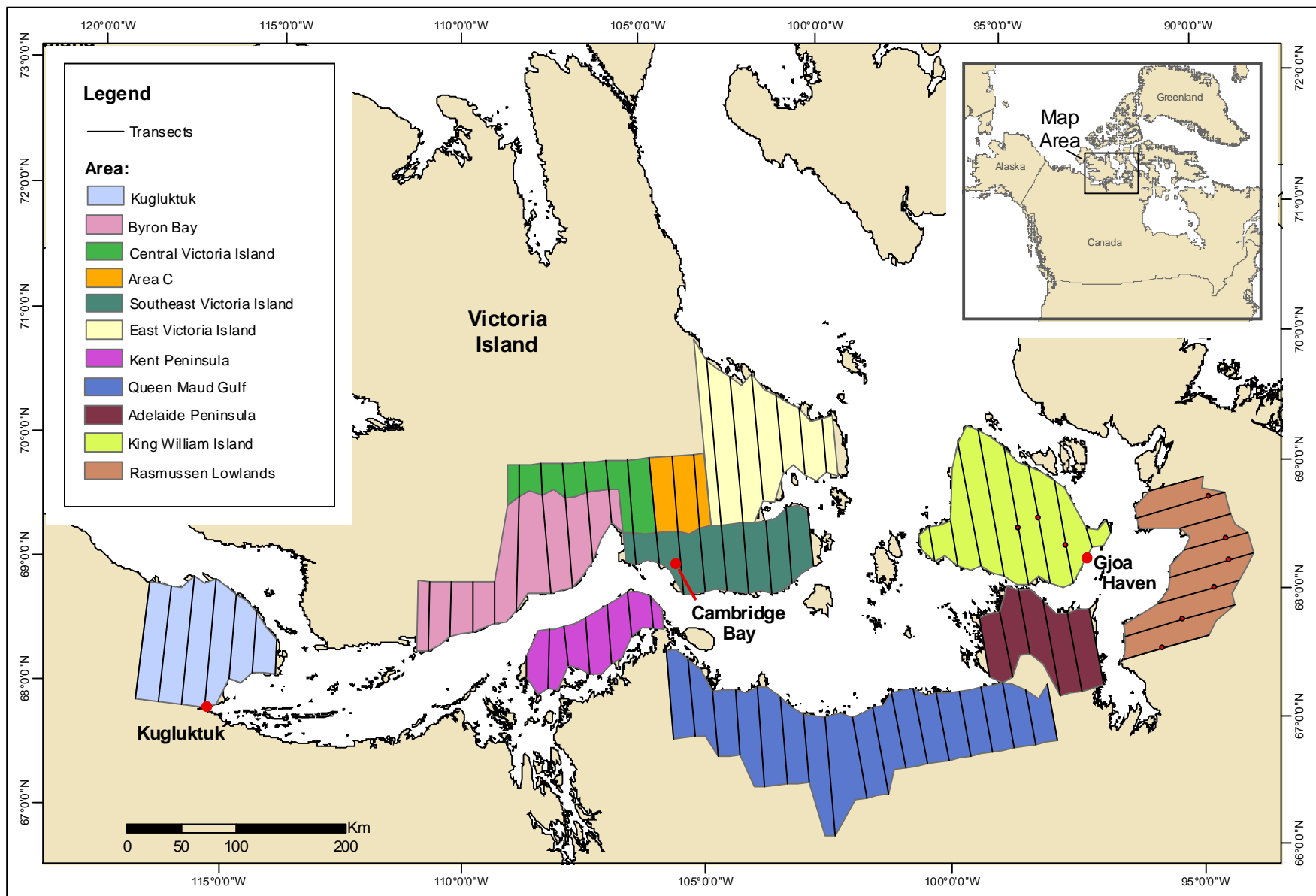


Figure 1. Transect lines within eleven areas surveyed for wildlife by fixed-wing aircraft in Nunavut, Canada, 19 June-1 July 2009. Red dots mark locations where transects were partitioned to facilitate comparability with previous surveys.

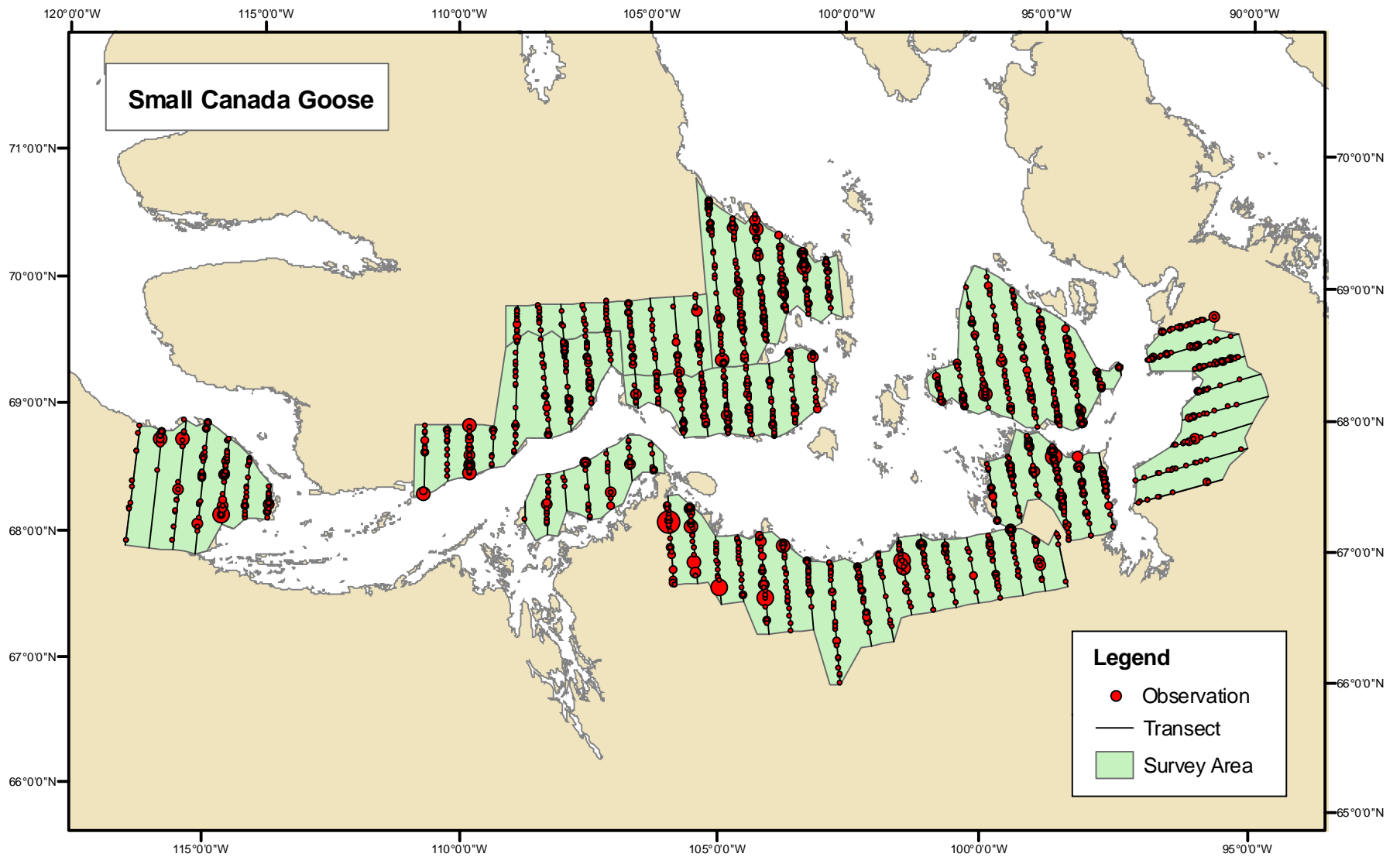


Figure 2. Locations of small Canada goose observations in 2009. Symbol size is proportional to the number of birds observed.

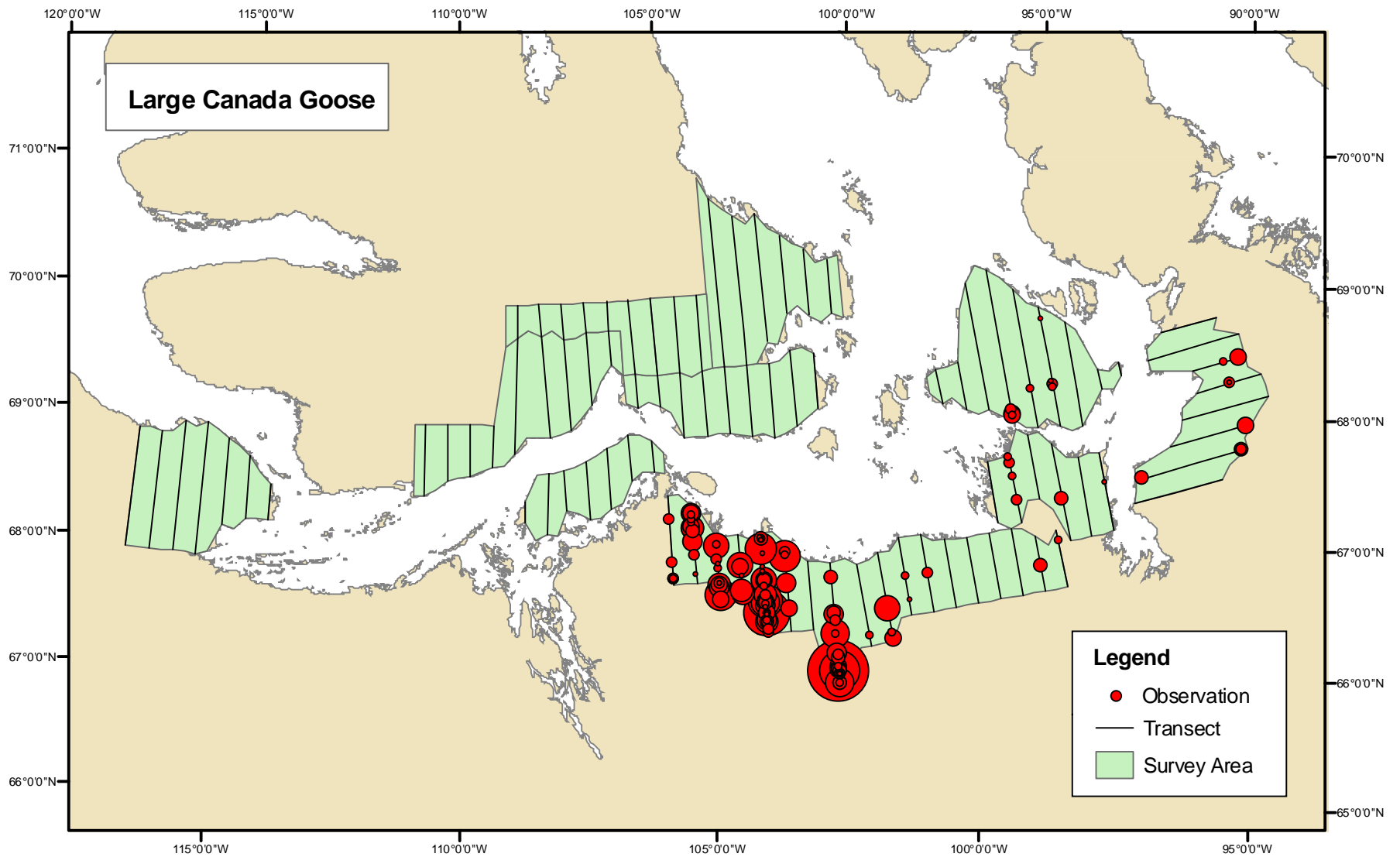


Figure 3. Locations of large Canada goose observations in 2009. Symbol size is proportional to the number of birds observed.

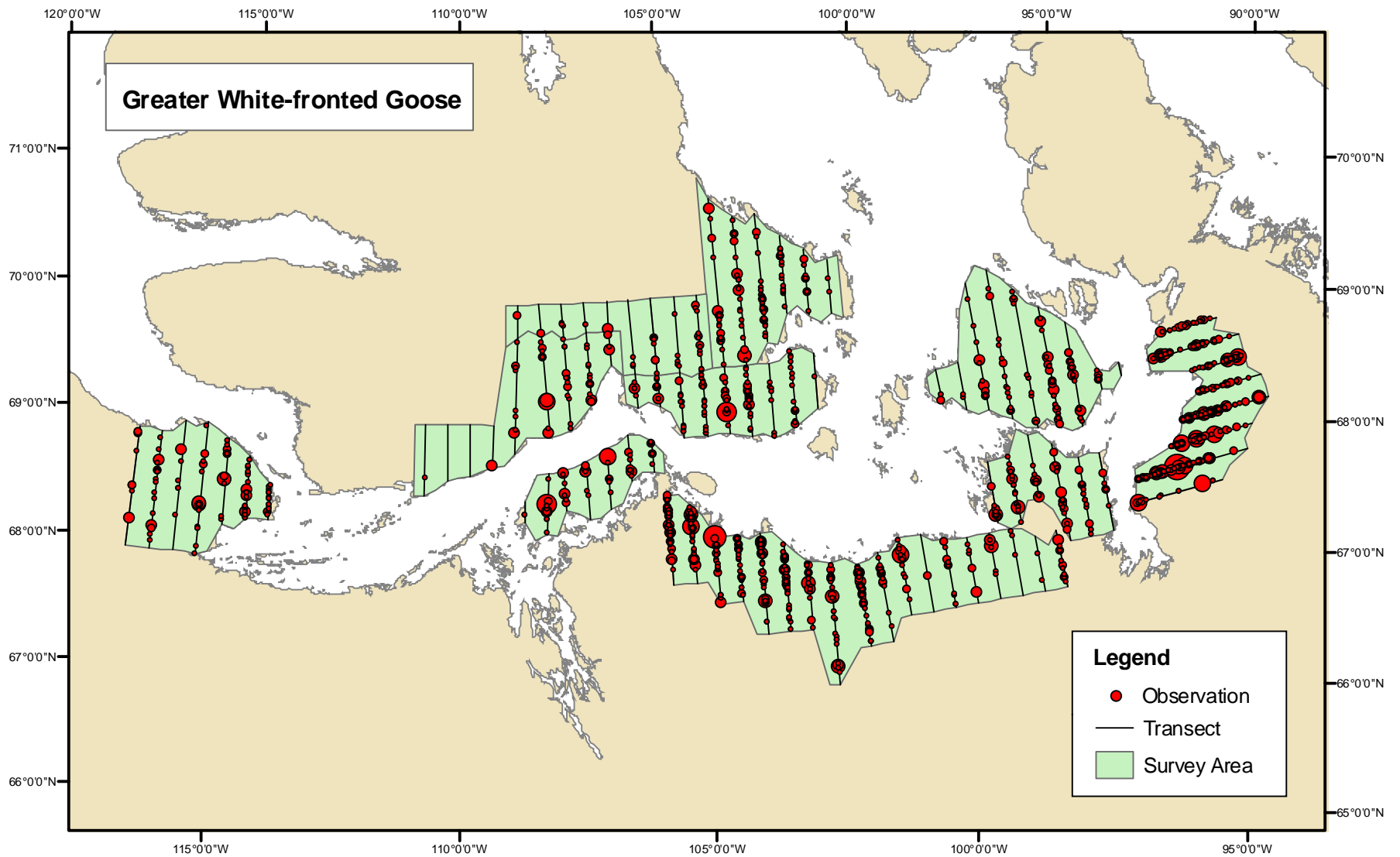


Figure 4. Locations of white-fronted goose observations in 2009. Symbol size is proportional to the number of birds observed.

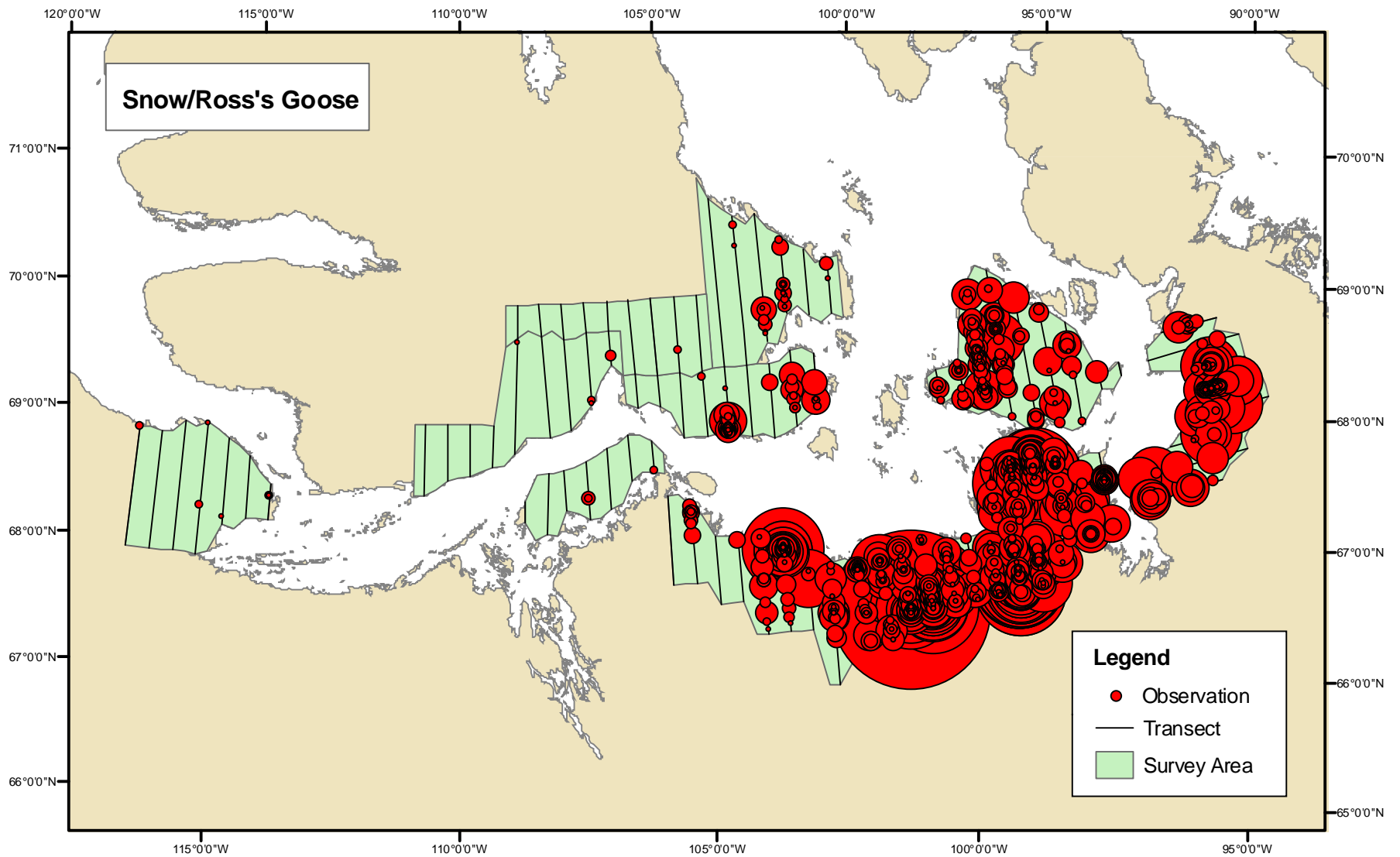


Figure 5. Locations of snow/Ross's goose observations in 2009. Symbol size is proportional to the number of birds observed.

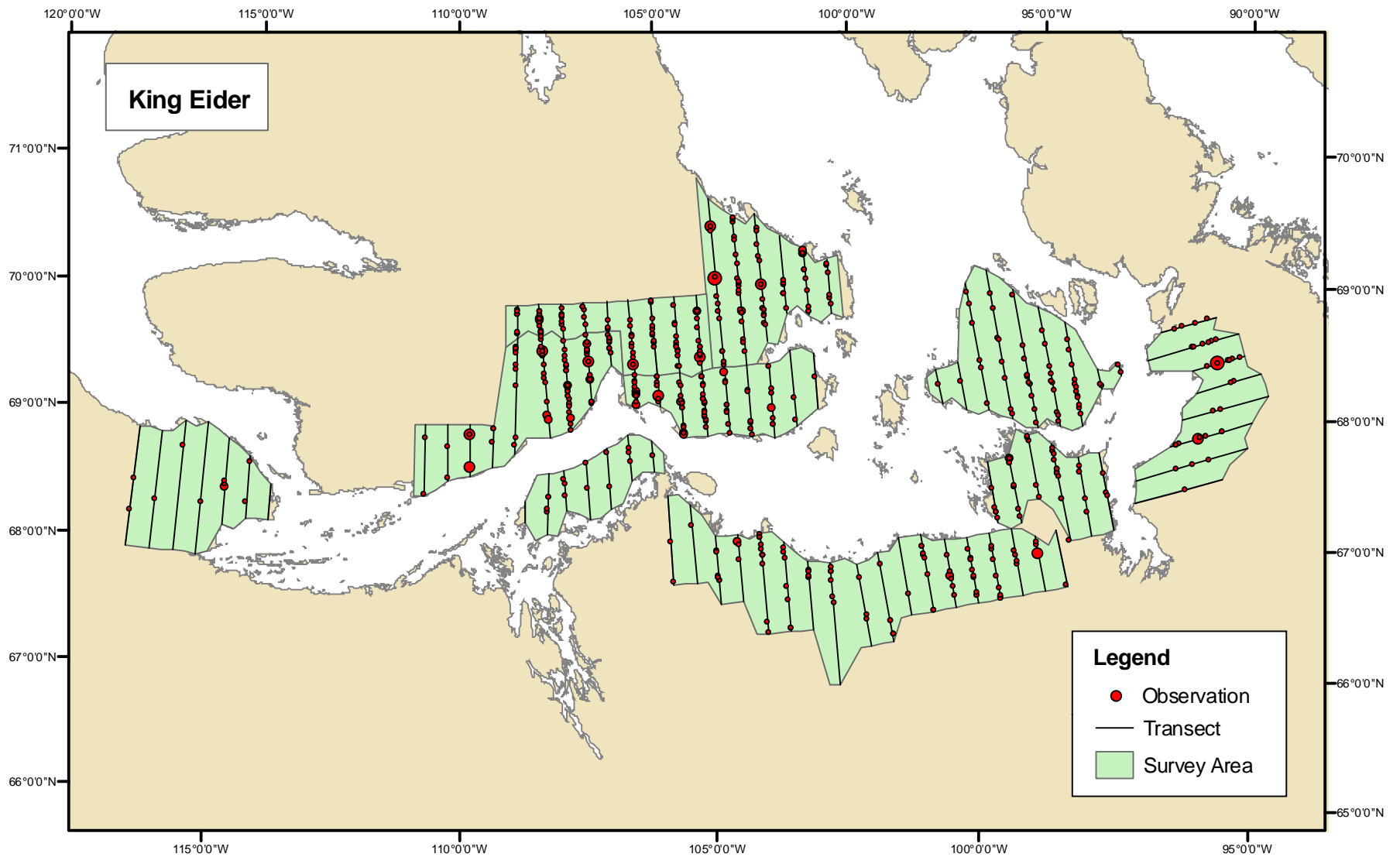


Figure 6. Locations of king eider observations in 2009. Symbol size is proportional to the number of birds observed.

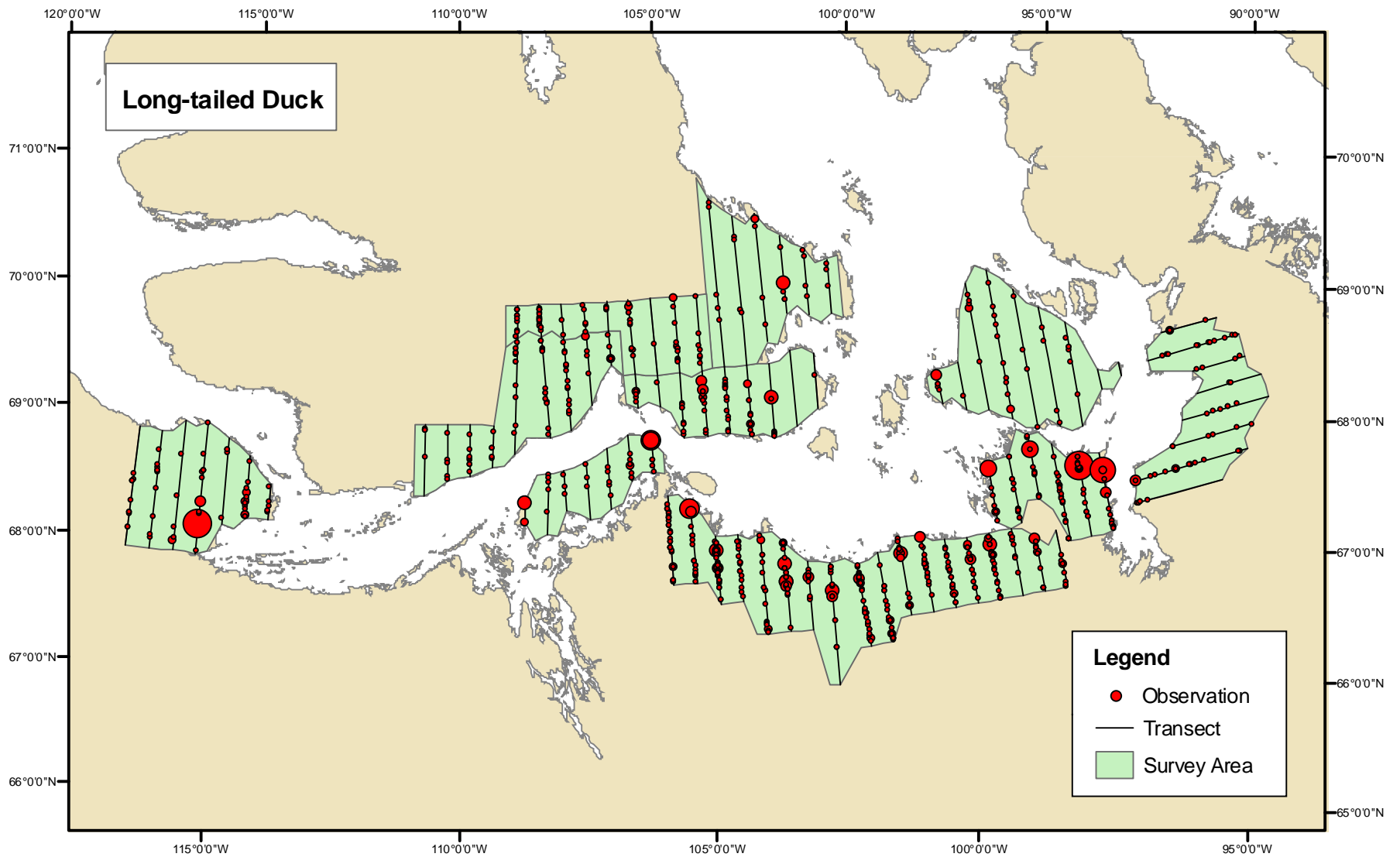


Figure 7. Locations of long-tailed duck observations in 2009. Symbol size is proportional to the number of birds observed.

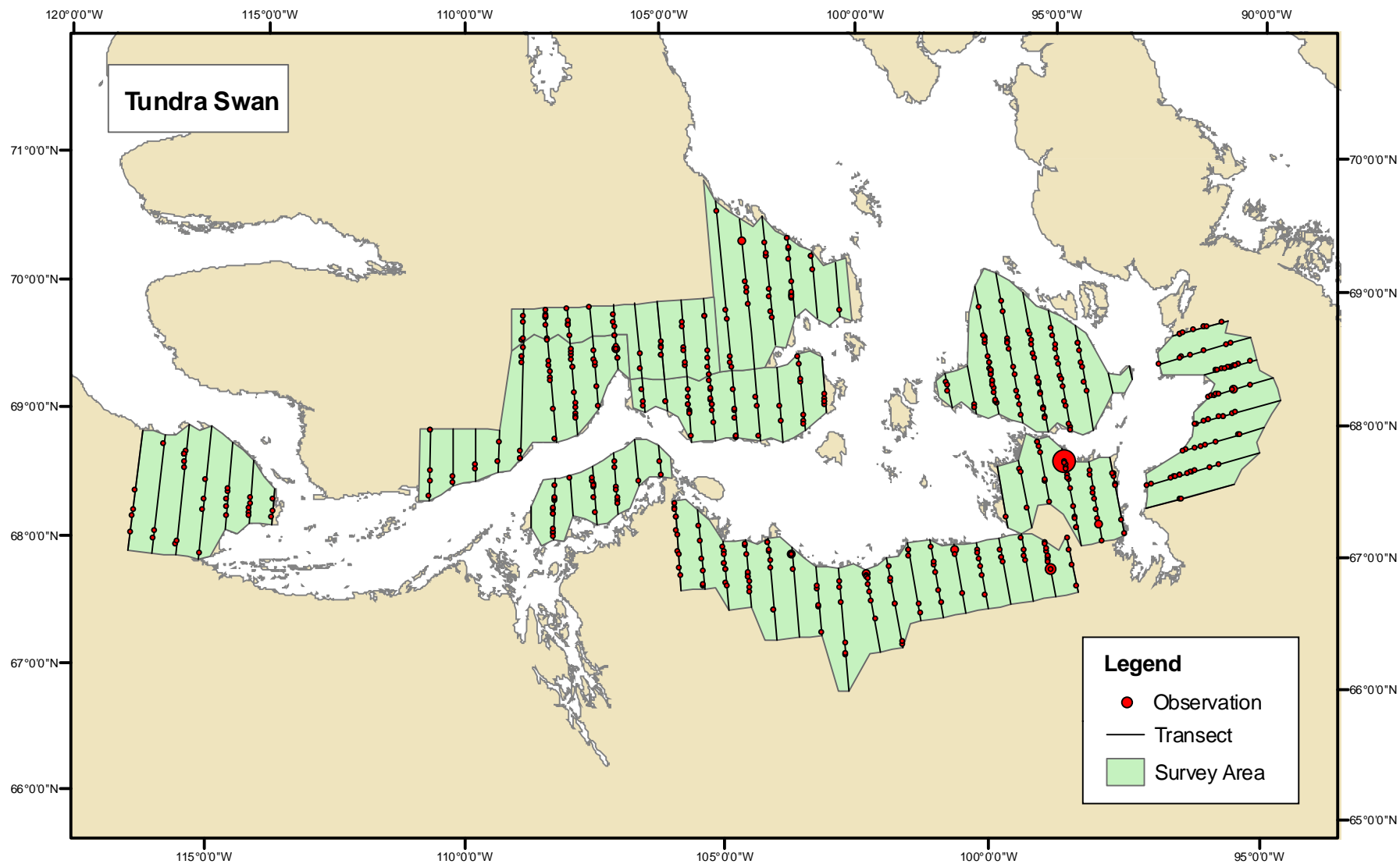


Figure 8. Locations of tundra swan observations in 2009. Symbol size is proportional to the number of birds observed.



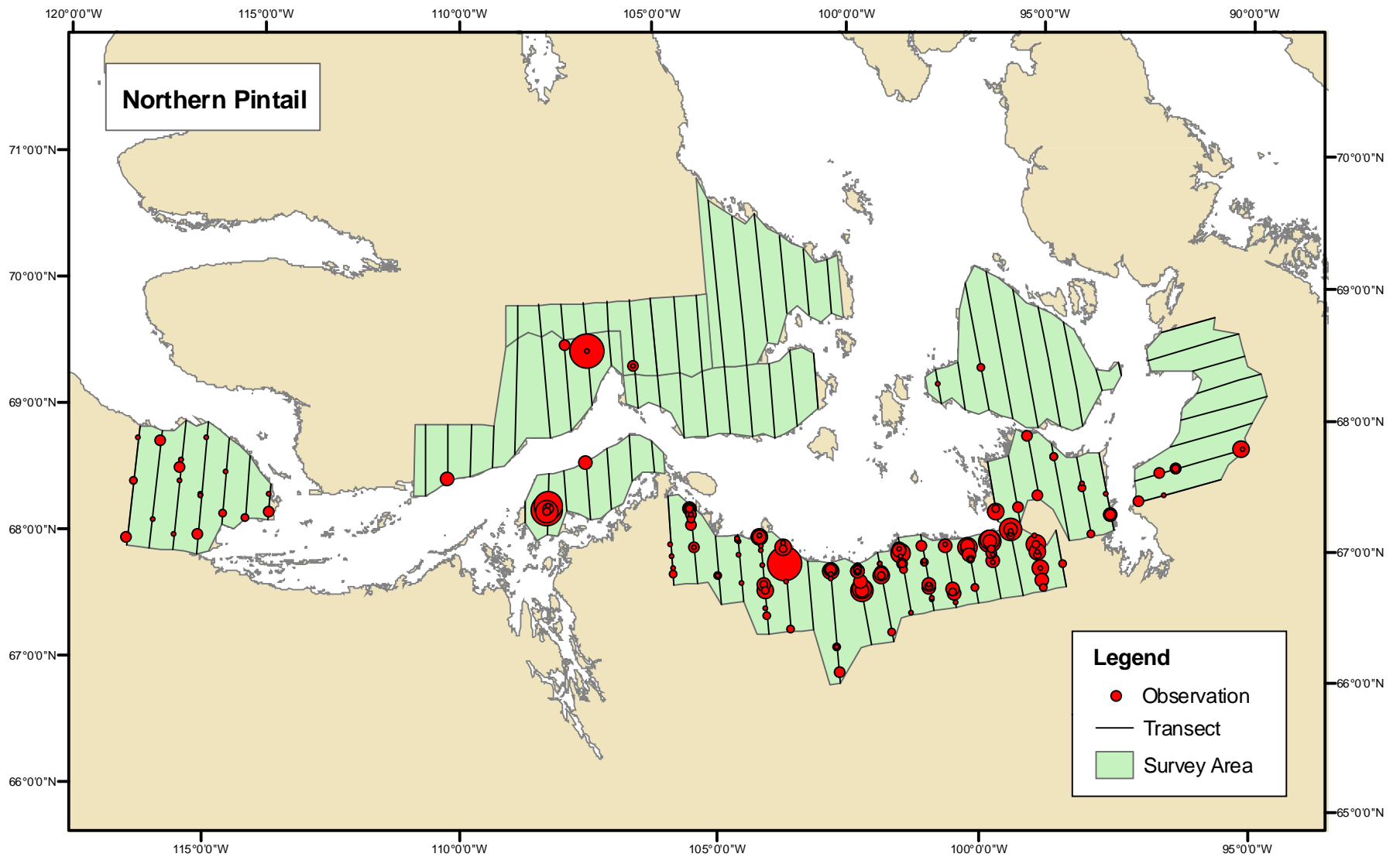


Figure 9. Locations of northern pintail observations in 2009. Symbol size is proportional to the number of birds observed.

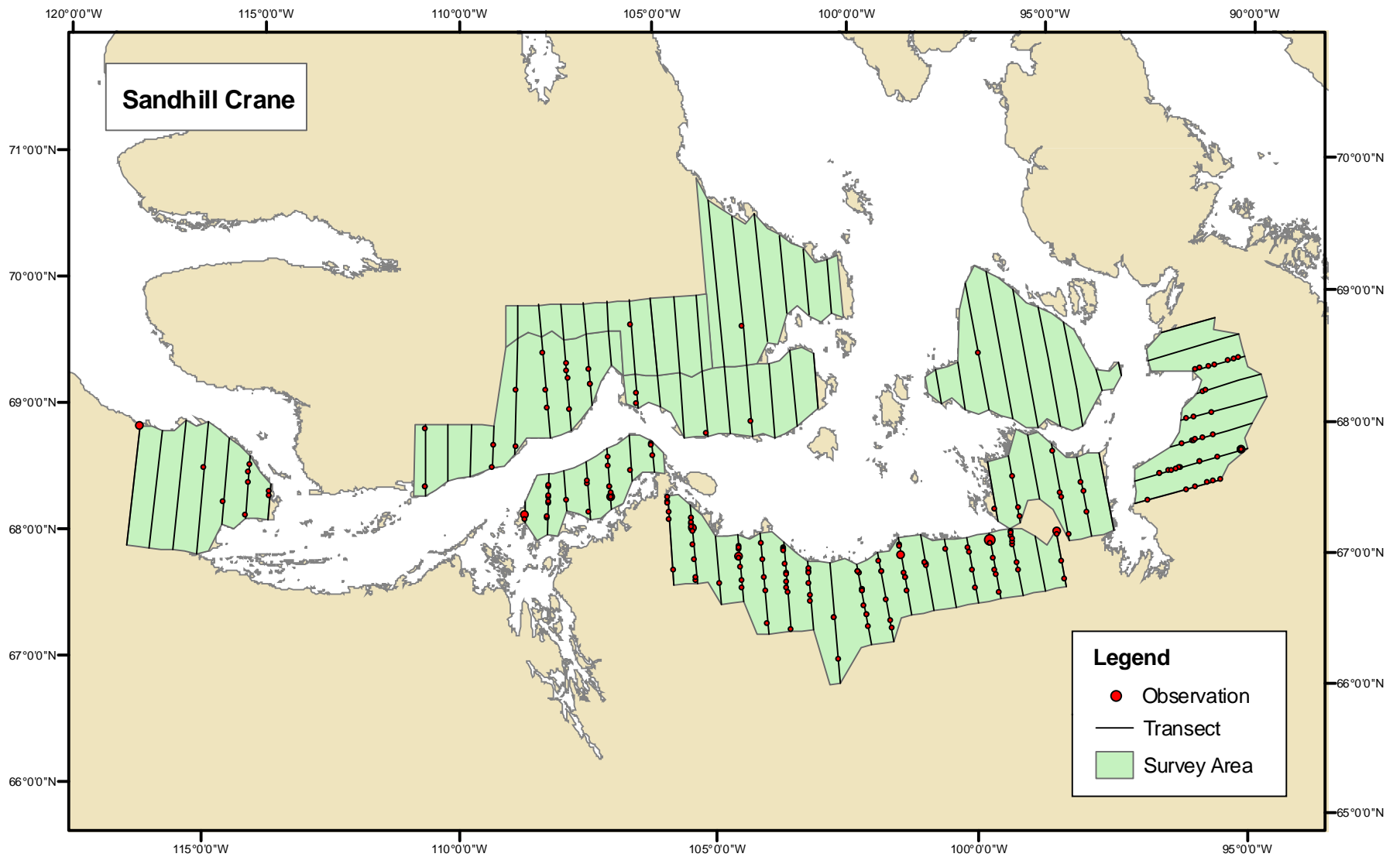


Figure 10. Locations of sandhill crane observations in 2009. Symbol size is proportional to the number of birds observed.

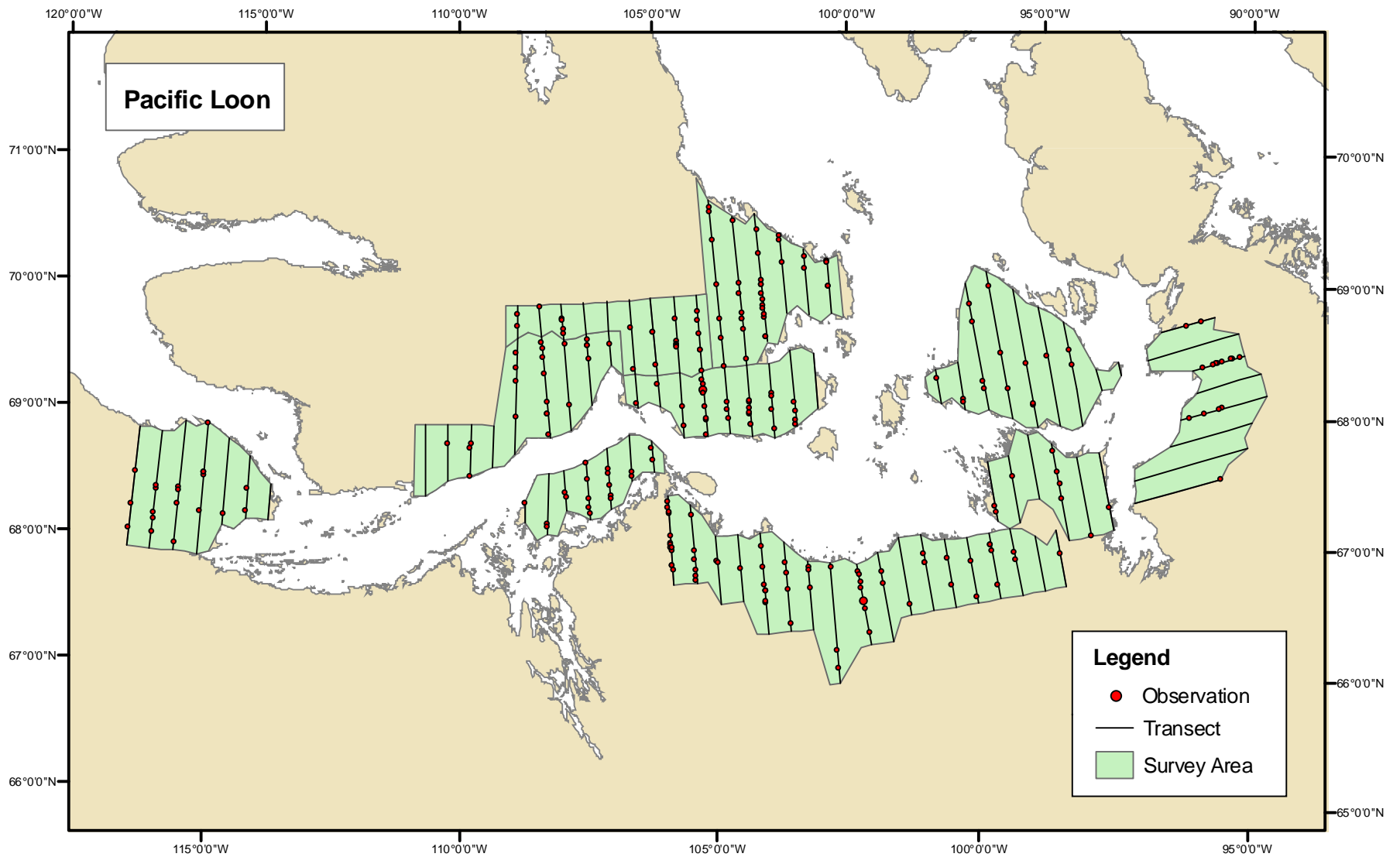


Figure 11. Locations of Pacific loon observations in 2009. Symbol size is proportional to the number of birds observed.

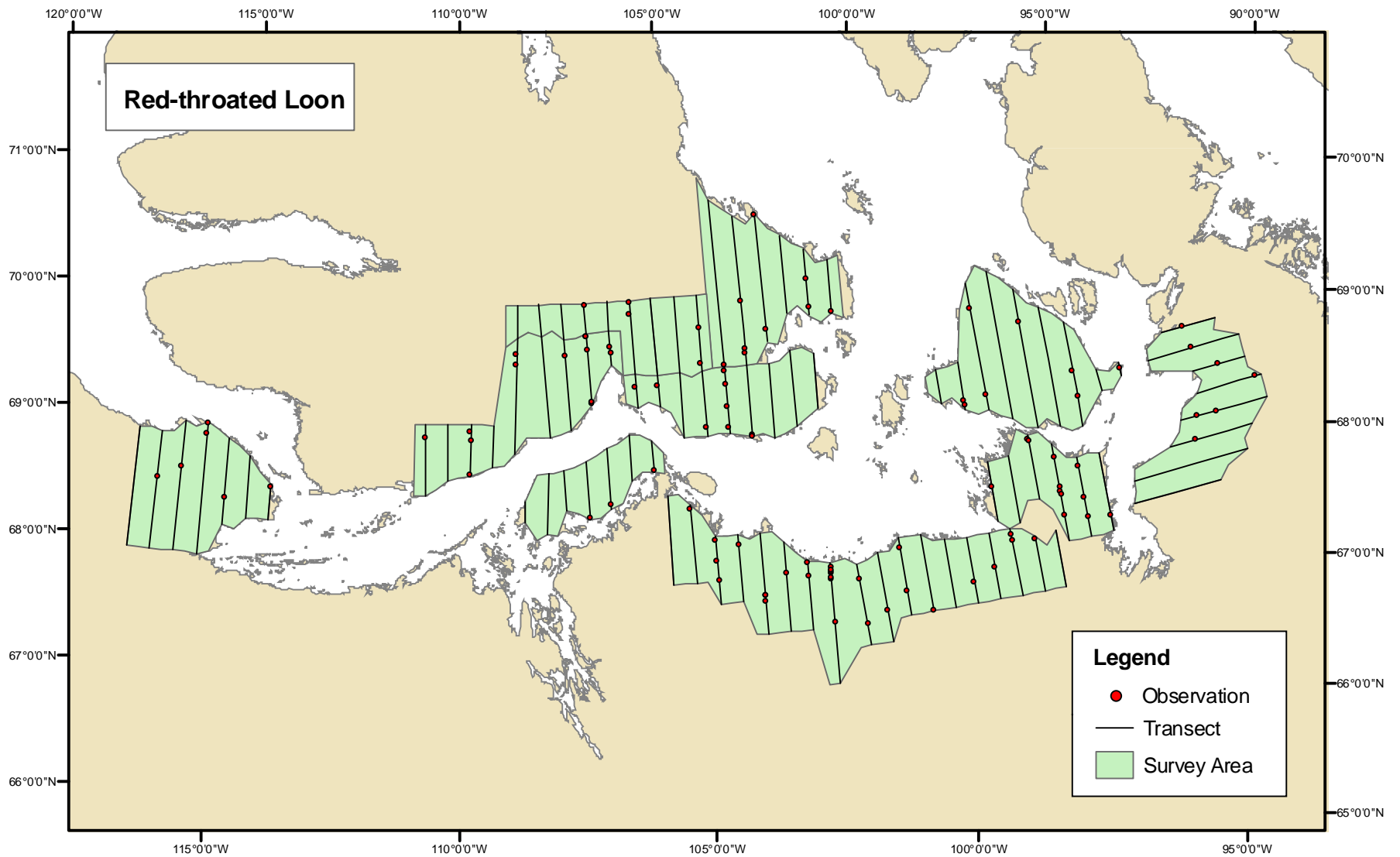


Figure 12. Locations of red-throated loon observations in 2009. Symbol size is proportional to the number of birds observed.

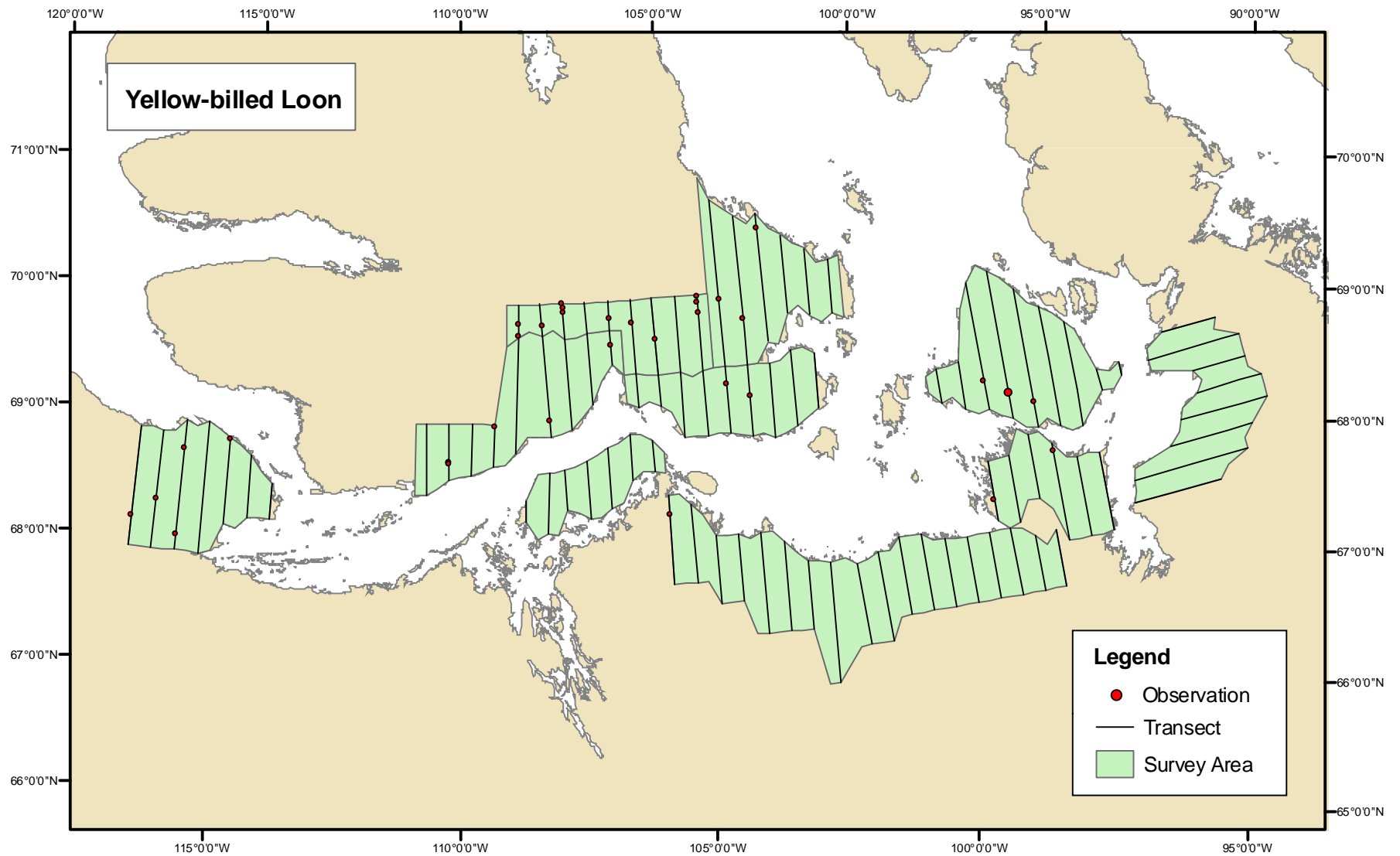


Figure 13. Locations of yellow-billed loon observations in 2009. Symbol size is proportional to the number of birds observed.

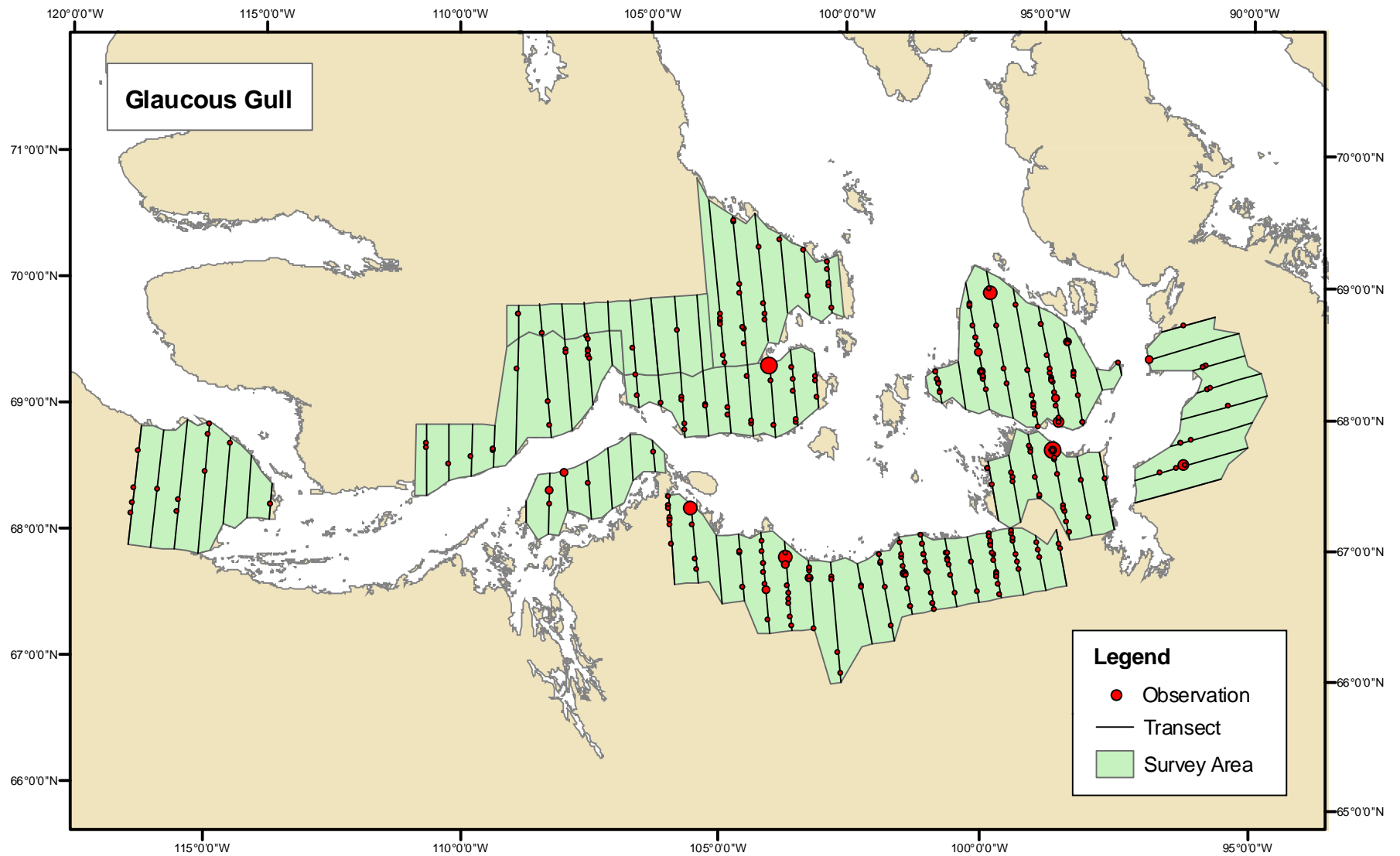


Figure 14. Locations of glaucous gull observations in 2009. Symbol size is proportional to the number of birds observed.

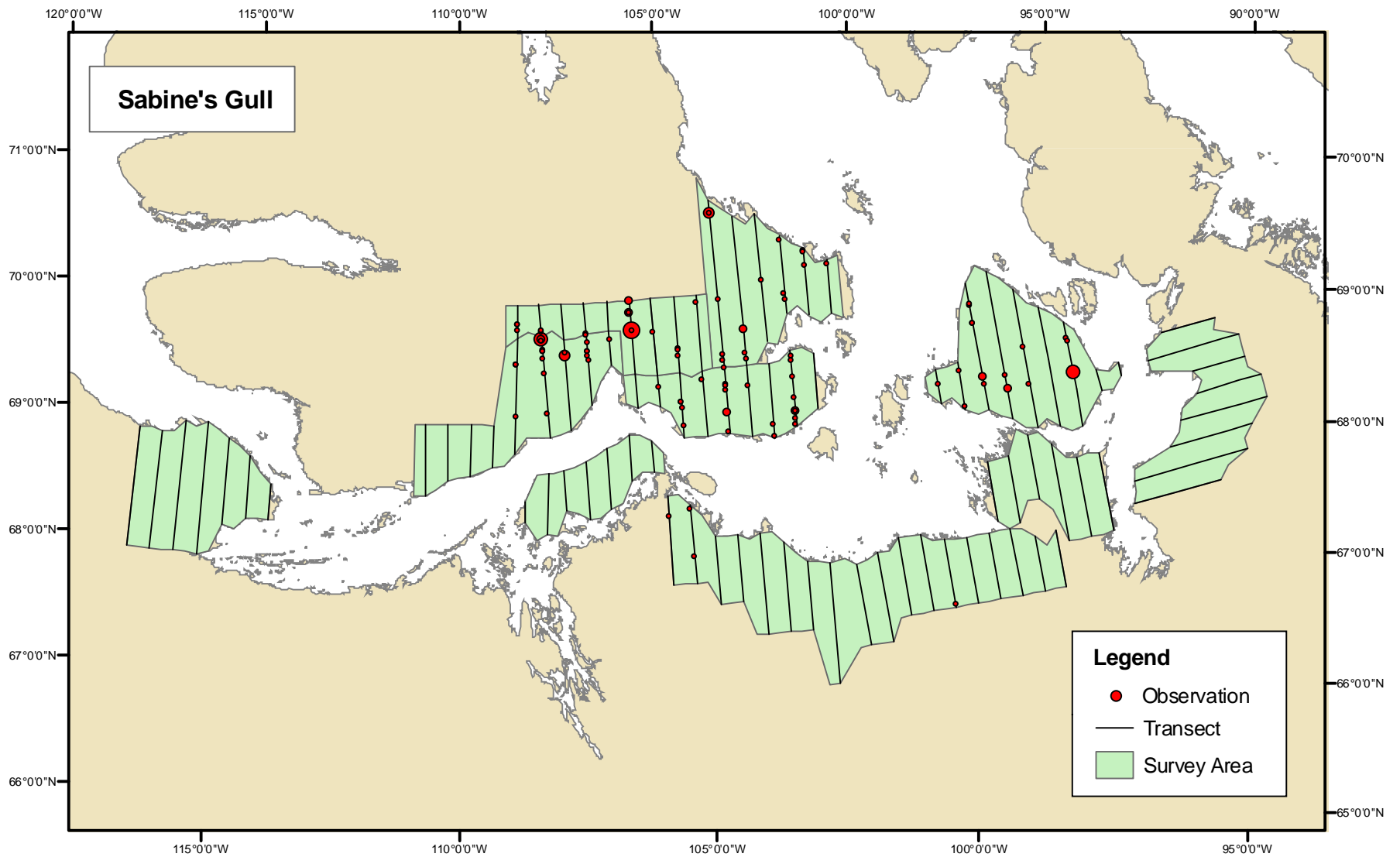


Figure 15. Locations of Sabine's gull observations in 2009. Symbol size is proportional to the number of birds observed.

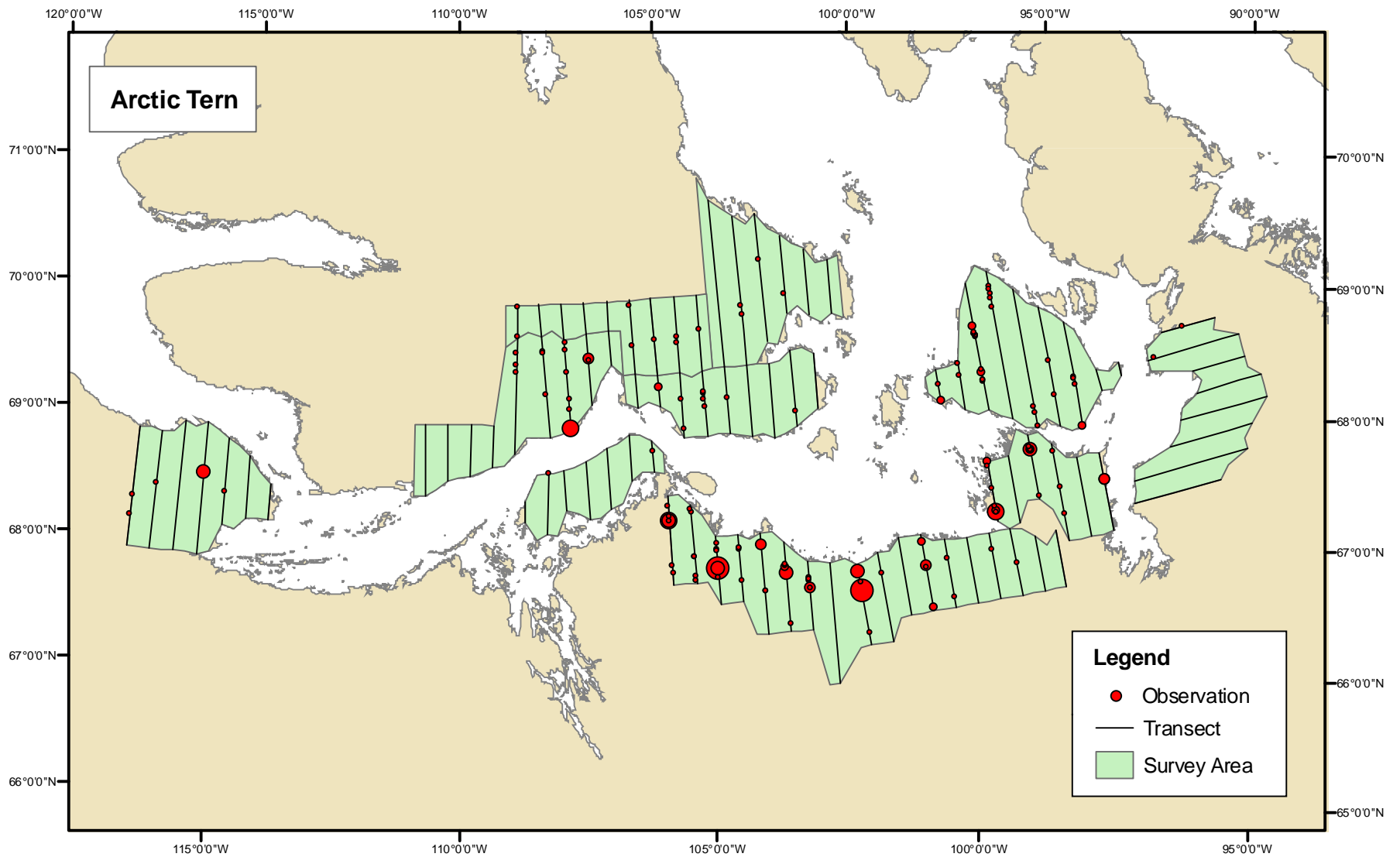


Figure 16. Locations of arctic tern observations in 2009. Symbol size is proportional to the number of birds observed.



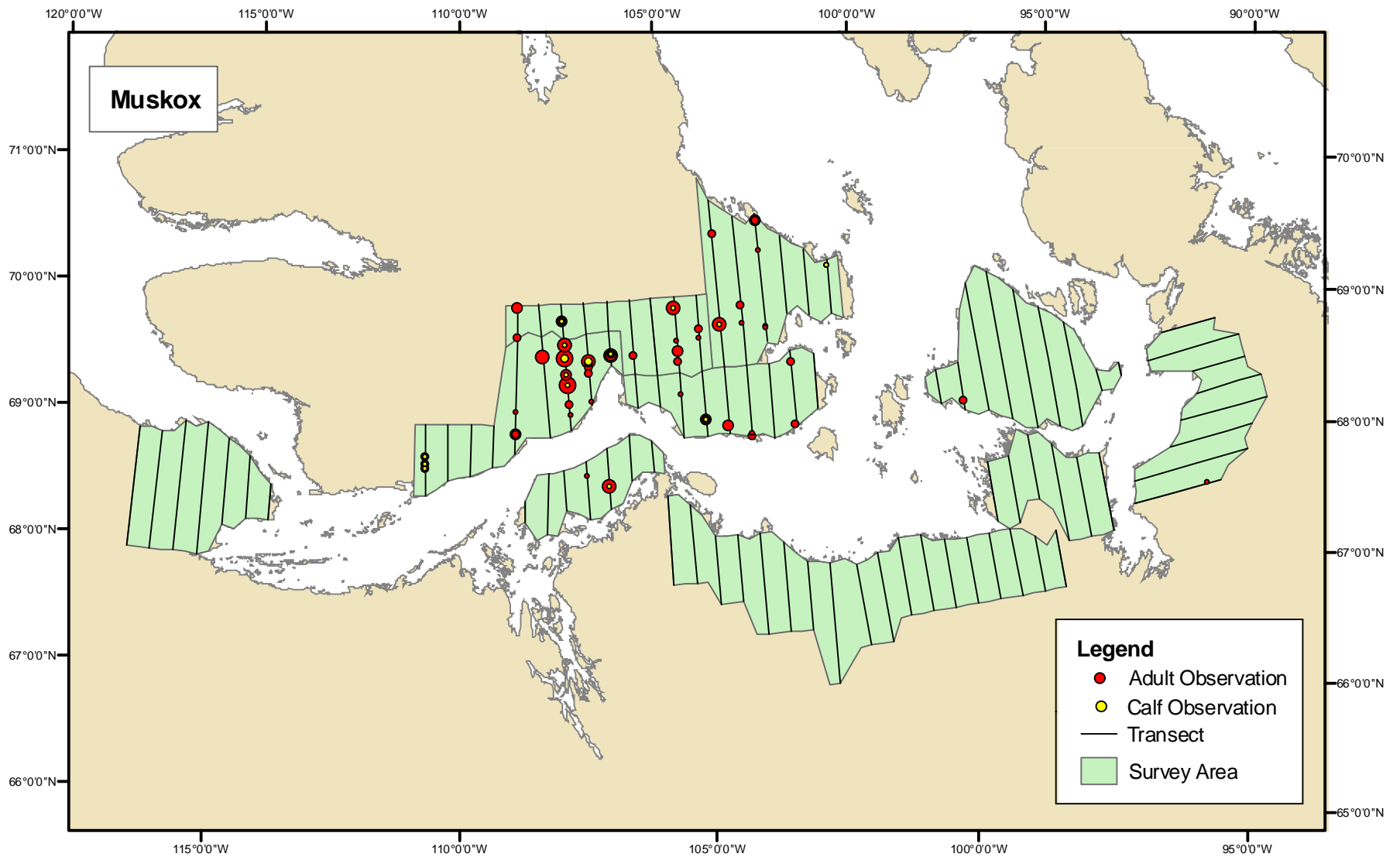


Figure 17. Locations of muskox observations in 2009. Symbol size is proportional to the number of animals observed.

Table 1. Survey design used for fixed-wing aerial surveys in Nunavut, Canada in June 2009.

	Kugluktuk	Byron Bay	Central Victoria Island	Southeast Victoria Island	Area C	East Victoria Island	Kent Peninsula	Queen Maud Gulf	Adelaide Peninsula	King William Island	Rasmussen Lowlands	All Areas
Survey Area (km <sup>2</sup> )	11,112	12,346	4,792	8,926	3,414	11,692	5,624	24,385	6,865	13,801	10,433	113,391
No. Transects	7	9	7	9	2	6	7	18	6	12	14	97
Total Transect Length (km)	611.5	568.6	278.2	482.5	135.8	575.5	282.2	1,248.0	402.1	677.0	581.8	5,843.2
Transect Coverage (km <sup>2</sup> )	244.6	227.4	111.3	193.0	54.3	230.2	112.9	499.2	160.9	270.8	232.7	2,337.3
% Coverage of Survey Area	2.2	1.8	2.3	2.2	1.6	2.0	2.0	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, 19 June-1 July 2009. Single birds (except snow/Ross's geese, 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 (Conant et al. 1991).

Species	VCF	Kugluktuk	SE	Byron Bay	SE	Central Victoria Island	SE	Southeast Victoria Island	SE	Area C	SE	East Victoria Island	SE
Small Canada Goose	---	18,899	4,602	31,811	6,726	9,646	1,771	30,661	3,153	5,278	1,999	56,225	8,677
Large Canada Goose	---	0	0	0	0	0	0	0	0	0	0	0	0
White-fronted Goose	---	12,811	2,907	8,794	2,545	2,067	458	12,255	2,609	2,702	1,439	13,815	1,888
Brant	---	0	0	0	0	0	0	1,572	1,533	0	0	203	226
Snow/Ross's Goose	---	1,227	807	814	518	0	0	31,586	19,474	251	252	8,990	5,206
Mallard	---	409	397	0	0	0	0	0	0	0	0	0	0
Mallard	4.01	1,640	1,595	0	0	0	0	0	0	0	0	0	0
Am. Green-winged Teal	---	409	389	0	0	0	0	0	0	0	0	0	0
Am. Green-winged Teal	8.36	3,418	3,255	0	0	0	0	0	0	0	0	0	0
Northern Pintail	---	3,725	451	4,940	3,993	345	310	0	0	0	0	0	0
Northern Pintail	3.05	11,362	1,616	15,067	12,198	1,051	946	0	0	0	0	0	0
Scaup sp.	---	363	165	0	0	0	0	0	0	0	0	0	0
Scaup sp.	1.93	701	326	0	0	0	0	0	0	0	0	0	0
White-winged Scoter	---	91	86	0	0	0	0	0	0	0	0	0	0
White-winged Scoter	1.17	106	101	0	0	0	0	0	0	0	0	0	0
Common Eider	---	1,635	659	0	0	0	0	740	346	0	0	508	287
King Eider	---	999	333	11,671	2,899	6,201	1,293	8,417	2,139	3,770	495	9,396	1,122
Long-tailed Duck	---	8,632	2,864	8,577	1,180	4,995	1,779	7,076	1,752	2,513	759	3,403	1,000
Long-tailed Duck	1.87	16,141	5,796	16,039	3,196	9,341	3,561	13,232	3,769	4,700	1,563	6,364	2,068
Red-breasted Merganser	---	409	290	543	333	0	0	0	0	0	0	0	0
Red-breasted Merganser	1.27	519	382	689	448	0	0	0	0	0	0	0	0
Tundra Swan	---	2,090	413	4,180	878	1,550	455	3,099	521	1,194	65	2,590	657
Tundra Swan Nest	---	227	102	597	131	301	168	509	151	63	63	254	140

Table 2 (continued). Population indices, by area, of waterfowl from the fixed-wing survey in Nunavut, Canada, 19 June-1 July 2009. Single birds (except snow/Ross's geese, 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 (Conant et al. 1991).

Species	VCF	Kent Peninsula	SE	Queen Maud Gulf	SE	Adelaide Peninsula	SE	King William Island	SE	Rasmussen Lowlands	SE	Total	SE
Small Canada Goose	---	8,670	1,676	55,883	4,887	27,312	4,472	42,501	6,021	18,872	4,595	305,758	16,212
Large Canada Goose	---	0	0	104,976	41,389	1,494	901	2,905	1,685	3,855	1,597	113,230	41,464
White-fronted Goose	---	9,467	1,170	57,153	8,614	11,096	1,791	13,657	2,795	48,503	9,378	192,320	14,217
Brant	---	0	0	1,124	1,124	0	0	0	0	0	0	2,899	1,914
Snow/Ross's Goose	---	897	711	1,556,859	749,912	433,878	220,619	107,577	29,176	159,899	46,754	2,301,978	783,891
Mallard	---	0	0	0	0	0	0	0	0	0	0	409	397
Mallard	4.01	0	0	0	0	0	0	0	0	0	0	1,640	1,595
Am. Green-winged Teal	---	0	0	195	133	0	0	0	0	90	89	694	421
Am. Green-winged Teal	8.36	0	0	1,634	1,129	0	0	0	0	750	745	5,802	3,525
Northern Pintail	---	8,520	7,279	53,734	8,698	4,438	742	357	249	2,510	1,415	78,569	12,145
Northern Pintail	3.05	25,986	22,224	163,888	29,176	13,537	2,475	1,088	761	7,657	4,343	239,636	39,026
Scaup sp.	---	0	0	195	194	0	0	0	0	0	0	558	255
Scaup sp.	1.93	0	0	377	374	0	0	0	0	0	0	1,078	496
White-winged Scoter	---	0	0	0	0	0	0	0	0	0	0	91	86
White-winged Scoter	1.17	0	0	0	0	0	0	0	0	0	0	106	101
Common Eider	---	797	356	3,224	3,024	171	178	204	151	0	0	7,279	3,156
King Eider	---	1,495	257	10,161	1,445	3,414	647	5,504	898	3,810	1,230	64,838	4,600
Long-tailed Duck	---	6,079	2,598	47,628	4,589	13,272	2,066	4,434	984	5,828	1,170	112,437	7,199
Long-tailed Duck	1.87	11,367	5,082	89,064	15,488	24,819	5,258	8,291	2,183	10,898	2,683	210,256	19,563
Red-breasted Merganser	---	100	105	0	0	0	0	0	0	0	0	1,052	454
Red-breasted Merganser	1.27	127	133	0	0	0	0	0	0	0	0	1,335	604
Tundra Swan	---	2,242	629	8,646	1,052	3,798	1,600	5,504	1,012	4,348	903	39,241	2,785
Tundra Swan Nest	---	349	173	537	166	128	49	713	170	359	122	4,037	454

Table 3. Population indices, by area, of additional bird and mammal species from the fixed-wing survey in Nunavut, Canada, 19 June-1 July 2009. Indices were not adjusted to account for incomplete detection.

Species	Kugluktuk	SE	Byron Bay	SE	Central Victoria Island	SE	Southeast Victoria Island	SE	Area C	SE	East Victoria Island	SE
Sandhill Crane	636	302	1,303	318	43	39	185	108	0	0	51	48
Pacific Loon	1,545	286	1,574	435	818	270	2,220	597	1,068	61	3,047	649
Red-throated Loon	409	166	1,249	447	258	163	647	283	189	188	711	200
Yellow-billed Loon	363	153	380	194	603	253	92	59	377	376	203	73
Glaucous Gull	681	170	1,303	414	258	126	2,220	873	63	63	1,575	319
Sabine's Gull	0	0	2,551	1,131	1,593	1,000	1,572	601	377	126	1,473	392
Herring Gull	0	0	54	57	0	0	0	0	0	0	0	0
Thayer's Gull	0	0	109	63	0	0	0	0	0	0	0	0
Unidentified Large Gull	45	50	0	0	0	0	0	0	0	0	0	0
Unidentified Small Gull	0	0	271	263	0	0	0	0	0	0	0	0
Arctic Tern	636	397	2,117	1,069	258	115	647	279	314	189	254	122
Jaeger spp.	363	161	434	237	215	112	462	304	0	0	965	233
Ptarmigan spp.	636	405	1,954	983	646	188	1,110	358	503	1	3,606	1,178
Common Raven	0	0	54	57	0	0	0	0	0	0	0	0
Rough-legged Hawk	136	60	217	87	0	0	92	57	0	0	51	46
Bald Eagle	0	0	0	0	0	0	0	0	0	0	0	0
Gyr Falcon	45	43	0	0	0	0	0	0	0	0	0	0
Peregrine Falcon	45	44	0	0	0	0	92	91	0	0	0	0
Short-eared Owl	45	43	0	0	0	0	46	46	0	0	0	0
Snowy Owl	0	0	163	79	43	38	509	164	0	0	102	50
Muskox Adult	0	0	9,283	3,679	1,077	594	1,480	470	1,885	1,009	1,930	679
Muskox Calf	0	0	977	471	129	135	46	46	126	126	152	98
Caribou Adult	5,043	4,475	1,954	335	215	188	370	256	377	252	508	221
Caribou Calf	1,999	1,943	0	0	0	0	0	0	0	0	51	56
Arctic Fox	0	0	271	149	43	46	0	0	63	63	51	46
Wolf	0	0	0	0	0	0	0	0	0	0	0	0
Grizzly Bear	0	0	0	0	0	0	0	0	0	0	0	0

Table 3 (continued). Population indices, by area, of additional bird and mammal species from the fixed-wing survey in Nunavut, Canada, 19 June-1 July 2009. Indices were not adjusted to account for incomplete detection.

Species	Kent Peninsula	SE	Queen Maud Gulf	SE	Adelaide Peninsula	SE	King William Island	SE	Rasmussen Lowlands	SE	Total	SE
Sandhill Crane	2,093	509	6,937	977	555	179	102	94	2,241	682	14,145	1,388
Pacific Loon	1,295	278	3,908	914	555	226	1,070	243	852	482	17,953	1,543
Red-throated Loon	199	96	2,052	419	811	254	662	260	403	127	7,591	862
Yellow-billed Loon	0	0	49	48	85	53	255	125	0	0	2,408	544
Glaucous Gull	448	201	8,060	1,306	2,475	1,328	5,504	1,247	1,210	401	23,798	2,512
Sabine's Gull	0	0	195	114	0	0	1,835	650	0	0	9,597	1,801
Herring Gull	0	0	928	304	0	0	0	0	0	0	982	309
Thayer's Gull	0	0	684	150	0	0	0	0	0	0	792	163
Unidentified Large Gull	50	48	1,368	668	341	304	204	78	179	76	2,188	745
Unidentified Small Gull	0	0	0	0	0	0	0	0	0	0	271	263
Arctic Tern	100	65	9,574	3,184	3,286	1,606	2,650	983	134	91	19,971	3,890
Jaeger spp.	50	47	830	248	341	127	561	173	1,166	863	5,388	1,047
Ptarmigan spp.	249	99	1,905	296	213	113	1,070	164	628	301	12,520	1,706
Common Raven	0	0	98	96	0	0	0	0	45	45	197	120
Rough-legged Hawk	0	0	195	113	85	49	0	0	0	0	777	179
Bald Eagle	0	0	49	48	0	0	0	0	0	0	49	48
Gyrfalcon	0	0	0	0	0	0	0	0	0	0	45	43
Peregrine Falcon	0	0	147	82	0	0	0	0	45	47	329	139
Short-eared Owl	149	104	147	81	213	200	0	0	0	0	601	248
Snowy Owl	0	0	0	0	171	84	204	108	0	0	1,191	236
Muskox Adult	648	503	0	0	0	0	153	159	45	45	16,500	3,984
Muskox Calf	100	95	0	0	0	0	0	0	0	0	1,530	526
Caribou Adult	199	189	70,098	24,638	11,565	4,363	204	147	11,745	2,535	102,278	25,551
Caribou Calf	0	0	38,737	15,689	5,718	2,723	0	0	1,748	733	48,254	16,059
Arctic Fox	0	0	195	90	85	55	204	115	45	44	958	238
Wolf	0	0	293	174	0	0	0	0	134	142	428	225
Grizzly Bear	0	0	49	49	0	0	0	0	0	0	49	49

Table 4. Population densities (number per km<sup>2</sup>), by area, of waterfowl from the fixed-wing survey in Nunavut, Canada, 19 June-1 July 2009. Densities were not adjusted to account for incomplete detection.

Species	Kugluktuk	SE	Byron Bay	SE	Central Victoria Island	SE	Southeast Victoria Island	SE	Area C	SE	East Victoria Island	SE
Small Canada Goose	1.701	0.414	2.577	0.545	2.013	0.369	3.435	0.353	1.546	0.586	4.809	0.742
Large Canada Goose	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
White-fronted Goose	1.153	0.262	0.712	0.206	0.431	0.096	1.373	0.292	0.791	0.422	1.182	0.161
Brant	0.000	0.000	0.000	0.000	0.000	0.000	0.176	0.172	0.000	0.000	0.017	0.019
Snow/Ross's Goose	0.110	0.073	0.066	0.042	0.000	0.000	3.539	2.182	0.074	0.074	0.769	0.445
Mallard	0.037	0.036	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Am. Green-winged Teal	0.037	0.035	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Northern Pintail	0.335	0.041	0.400	0.323	0.072	0.065	0.000	0.000	0.000	0.000	0.000	0.000
Scaup sp.	0.033	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
White-winged Scoter	0.008	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Common Eider	0.147	0.059	0.000	0.000	0.000	0.000	0.083	0.039	0.000	0.000	0.043	0.025
King Eider	0.090	0.030	0.945	0.235	1.294	0.270	0.943	0.240	1.104	0.145	0.804	0.096
Long-tailed Duck	0.777	0.258	0.695	0.096	1.042	0.371	0.793	0.196	0.736	0.222	0.291	0.085
Red-breasted Merganser	0.037	0.026	0.044	0.027	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tundra Swan	0.188	0.037	0.339	0.071	0.324	0.095	0.347	0.058	0.350	0.019	0.222	0.056
Tundra Swan Nest	0.020	0.009	0.048	0.011	0.063	0.035	0.057	0.017	0.018	0.018	0.022	0.012

Table 4 (continued). Population densities (number per km<sup>2</sup>), by area, of waterfowl from the fixed-wing survey in Nunavut, Canada, 19 June-1 July 2009. Densities were not adjusted to account for incomplete detection.

Species	Kent		Queen		Adelaide		King		Rasmussen	
	Peninsula	SE	Maud Gulf	SE	Peninsula	SE	William Island	SE	Lowlands	SE
Small Canada Goose	1.541	0.298	2.292	0.200	3.979	0.651	3.080	0.436	1.809	0.440
Large Canada Goose	0.000	0.000	4.305	1.697	0.218	0.131	0.210	0.122	0.370	0.153
White-fronted Goose	1.683	0.208	2.344	0.353	1.616	0.261	0.990	0.203	4.649	0.899
Brant	0.000	0.000	0.046	0.046	0.000	0.000	0.000	0.000	0.000	0.000
Snow/Ross's Goose	0.159	0.126	63.844	30.753	63.206	32.139	7.795	2.114	15.327	4.482
Mallard	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Am. Green-winged Teal	0.000	0.000	0.008	0.005	0.000	0.000	0.000	0.000	0.009	0.009
Northern Pintail	1.515	1.294	2.204	0.357	0.647	0.108	0.026	0.018	0.241	0.136
Scaup sp.	0.000	0.000	0.008	0.008	0.000	0.000	0.000	0.000	0.000	0.000
White-winged Scoter	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Common Eider	0.142	0.063	0.132	0.124	0.025	0.026	0.015	0.011	0.000	0.000
King Eider	0.266	0.046	0.417	0.059	0.497	0.094	0.399	0.065	0.365	0.118
Long-tailed Duck	1.081	0.462	1.953	0.188	1.933	0.301	0.321	0.071	0.559	0.112
Red-breasted Merganser	0.018	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tundra Swan	0.399	0.112	0.355	0.043	0.553	0.233	0.399	0.073	0.417	0.087
Tundra Swan Nest	0.062	0.031	0.022	0.007	0.019	0.007	0.052	0.012	0.034	0.012



Table 5. Population densities (number per km<sup>2</sup>), by area, of additional bird and mammal species from the fixed-wing survey in Nunavut, Canada, 19 June-1 July 2009. Densities were not adjusted to account for incomplete detection.

Species	Kugluktuk	SE	Byron Bay	SE	Central Victoria Island	SE	Southeast Victoria Island	SE	Area C	SE	East Victoria Island	SE
Sandhill Crane	0.057	0.027	0.106	0.026	0.009	0.008	0.021	0.012	0.000	0.000	0.004	0.004
Pacific Loon	0.139	0.026	0.128	0.035	0.171	0.056	0.249	0.067	0.313	0.018	0.261	0.056
Red-throated Loon	0.037	0.015	0.101	0.036	0.054	0.034	0.073	0.032	0.055	0.055	0.061	0.017
Yellow-billed Loon	0.033	0.014	0.031	0.016	0.126	0.053	0.010	0.007	0.110	0.110	0.017	0.006
Glaucous Gull	0.061	0.015	0.106	0.034	0.054	0.026	0.249	0.098	0.018	0.018	0.135	0.270
Sabine's Gull	0.000	0.000	0.207	0.092	0.333	0.209	0.176	0.067	0.110	0.037	0.126	0.034
Herring Gull	0.000	0.000	0.004	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Thayer's Gull	0.000	0.000	0.009	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Unidentified Large Gull	0.004	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Unidentified Small Gull	0.000	0.000	0.022	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Arctic Tern	0.057	0.036	0.171	0.087	0.054	0.024	0.073	0.031	0.092	0.055	0.022	0.010
Jaeger spp.	0.033	0.015	0.035	0.019	0.045	0.023	0.052	0.034	0.000	0.000	0.083	0.020
Ptarmigan spp.	0.057	0.036	0.158	0.080	0.135	0.039	0.124	0.040	0.147	0.000	0.308	0.101
Common Raven	0.000	0.000	0.004	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Rough-legged Hawk	0.012	0.005	0.018	0.007	0.000	0.000	0.010	0.006	0.000	0.000	0.004	0.004
Bald Eagle	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gyrfalcon	0.004	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Peregrine Falcon	0.004	0.004	0.000	0.000	0.000	0.000	0.010	0.010	0.000	0.000	0.000	0.000
Short-eared Owl	0.004	0.004	0.000	0.000	0.000	0.000	0.005	0.005	0.000	0.000	0.000	0.000
Snowy Owl	0.000	0.000	0.013	0.006	0.009	0.008	0.057	0.018	0.000	0.000	0.009	0.004
Muskox Adult	0.000	0.000	0.752	0.298	0.225	0.124	0.166	0.053	0.552	0.296	0.165	0.058
Muskox Calf	0.000	0.000	0.079	0.038	0.027	0.028	0.005	0.005	0.037	0.037	0.013	0.008
Caribou Adult	0.454	0.403	0.158	0.027	0.045	0.039	0.041	0.029	0.110	0.074	0.043	0.019
Caribou Calf	0.180	0.175	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.005
Arctic Fox	0.000	0.000	0.022	0.012	0.009	0.010	0.000	0.000	0.018	0.018	0.004	0.004
Wolf	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Grizzly Bear	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 5 (continued). Population densities (number per km<sup>2</sup>), by area, of additional bird and mammal species from the fixed-wing survey in Nunavut, Canada, 19 June-1 July 2009. Densities were not adjusted to account for incomplete detection.

Species	Kent Peninsula	SE	Queen Maud Gulf	SE	Adelaide Peninsula	SE	King William Island	SE	Rasmussen Lowlands	SE
Sandhill Crane	0.372	0.090	0.284	0.040	0.081	0.026	0.007	0.007	0.215	0.065
Pacific Loon	0.230	0.049	0.160	0.037	0.081	0.033	0.078	0.018	0.082	0.046
Red-throated Loon	0.035	0.017	0.084	0.017	0.118	0.037	0.048	0.019	0.039	0.012
Yellow-billed Loon	0.000	0.000	0.002	0.002	0.012	0.008	0.018	0.009	0.000	0.000
Glauous Gull	0.080	0.036	0.331	0.054	0.361	0.194	0.399	0.090	0.116	0.038
Sabine's Gull	0.000	0.000	0.008	0.005	0.000	0.000	0.133	0.047	0.000	0.000
Herring Gull	0.000	0.000	0.038	0.012	0.000	0.000	0.000	0.000	0.000	0.000
Thayer's Gull	0.000	0.000	0.028	0.006	0.000	0.000	0.000	0.000	0.000	0.000
Unidentified Large Gull	0.009	0.008	0.056	0.027	0.050	0.044	0.015	0.006	0.017	0.007
Unidentified Small Gull	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Arctic Tern	0.018	0.012	0.393	0.131	0.479	0.234	0.192	0.071	0.013	0.009
Jaeger spp.	0.009	0.008	0.034	0.010	0.050	0.019	0.041	0.013	0.112	0.083
Ptarmigan spp.	0.044	0.018	0.078	0.012	0.031	0.016	0.078	0.012	0.060	0.029
Common Raven	0.000	0.000	0.004	0.004	0.000	0.000	0.000	0.000	0.004	0.004
Rough-legged Hawk	0.000	0.000	0.008	0.005	0.012	0.007	0.000	0.000	0.000	0.000
Bald Eagle	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
Peregrine Falcon	0.000	0.000	0.006	0.003	0.000	0.000	0.000	0.000	0.004	0.004
Short-eared Owl	0.027	0.019	0.006	0.003	0.031	0.029	0.000	0.000	0.000	0.000
Snowy Owl	0.000	0.000	0.000	0.000	0.025	0.012	0.015	0.008	0.000	0.000
Muskox Adult	0.115	0.089	0.000	0.000	0.000	0.000	0.011	0.012	0.004	0.004
Muskox Calf	0.018	0.017	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Caribou Adult	0.035	0.034	2.875	1.010	1.685	0.636	0.015	0.011	1.126	0.243
Caribou Calf	0.000	0.000	1.589	0.643	0.833	0.397	0.000	0.000	0.168	0.070
Arctic Fox	0.000	0.000	0.008	0.004	0.012	0.008	0.015	0.008	0.004	0.004
Wolf	0.000	0.000	0.012	0.007	0.000	0.000	0.000	0.000	0.013	0.014
Grizzly Bear	0.000	0.000	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000

**APPENDIX 1.** Common and scientific names of species included in this report.

<b><u>Common Name</u></b>	<b><u>Scientific Name</u></b>
Tundra swan	<i>Cygnus columbianus</i>
Greater white-fronted goose	<i>Anser albifrons</i>
Snow goose	<i>Chen caerulescens</i>
Ross's goose	<i>Chen rossii</i>
Canada goose	<i>Branta canadensis</i>
Brant	<i>Branta bernicla</i>
Mallard	<i>Anas platyrhynchos</i>
Green-winged teal	<i>Anas crecca</i>
Northern pintail	<i>Anas acuta</i>
Greater scaup	<i>Aythya marila</i>
Lesser scaup	<i>Aythya affinis</i>
Common eider	<i>Somateria mollissima</i>
King eider	<i>Somateria spectabilis</i>
White-winged scoter	<i>Melanitta fusca</i>
Long-tailed duck	<i>Clangula hyemalis</i>
Red-breasted merganser	<i>Mergus serrator</i>
Sandhill crane	<i>Grus canadensis</i>
Pacific loon	<i>Gavia pacifica</i>
Red-throated loon	<i>Gavia stellata</i>
Yellow-billed loon	<i>Gavia adamsii</i>
Glaucous gull	<i>Larus hyperboreus</i>
Herring gull	<i>Larus argentatus</i>
Thayer's gull	<i>Larus thayeri</i>
Sabine's gull	<i>Xema sabini</i>
Arctic tern	<i>Sterna paradisaea</i>
Pomarine jaeger	<i>Stercorarius pomarinus</i>
Parasitic jaeger	<i>Stercorarius parasiticus</i>
Long-tailed jaeger	<i>Stercorarius longicaudus</i>
Rock ptarmigan	<i>Lagopus mutus</i>
Willow ptarmigan	<i>Lagopus lagopus</i>
Common raven	<i>Corvus corax</i>
Rough-legged hawk	<i>Buteo lagopus</i>
Bald eagle	<i>Haliaeetus leucocephalus</i>
Gyr Falcon	<i>Falco rusticolus</i>
Peregrine falcon	<i>Falco peregrinus</i>
Short-eared owl	<i>Asio flammeus</i>
Snowy owl	<i>Bubo scandiaca</i>
Muskox	<i>Ovibos moschatus</i>
Caribou	<i>Rangifer tarandus</i>
Arctic fox	<i>Vulpes lagopus</i>
Gray wolf	<i>Canis lupus</i>
Grizzly bear	<i>Ursus arctos</i>