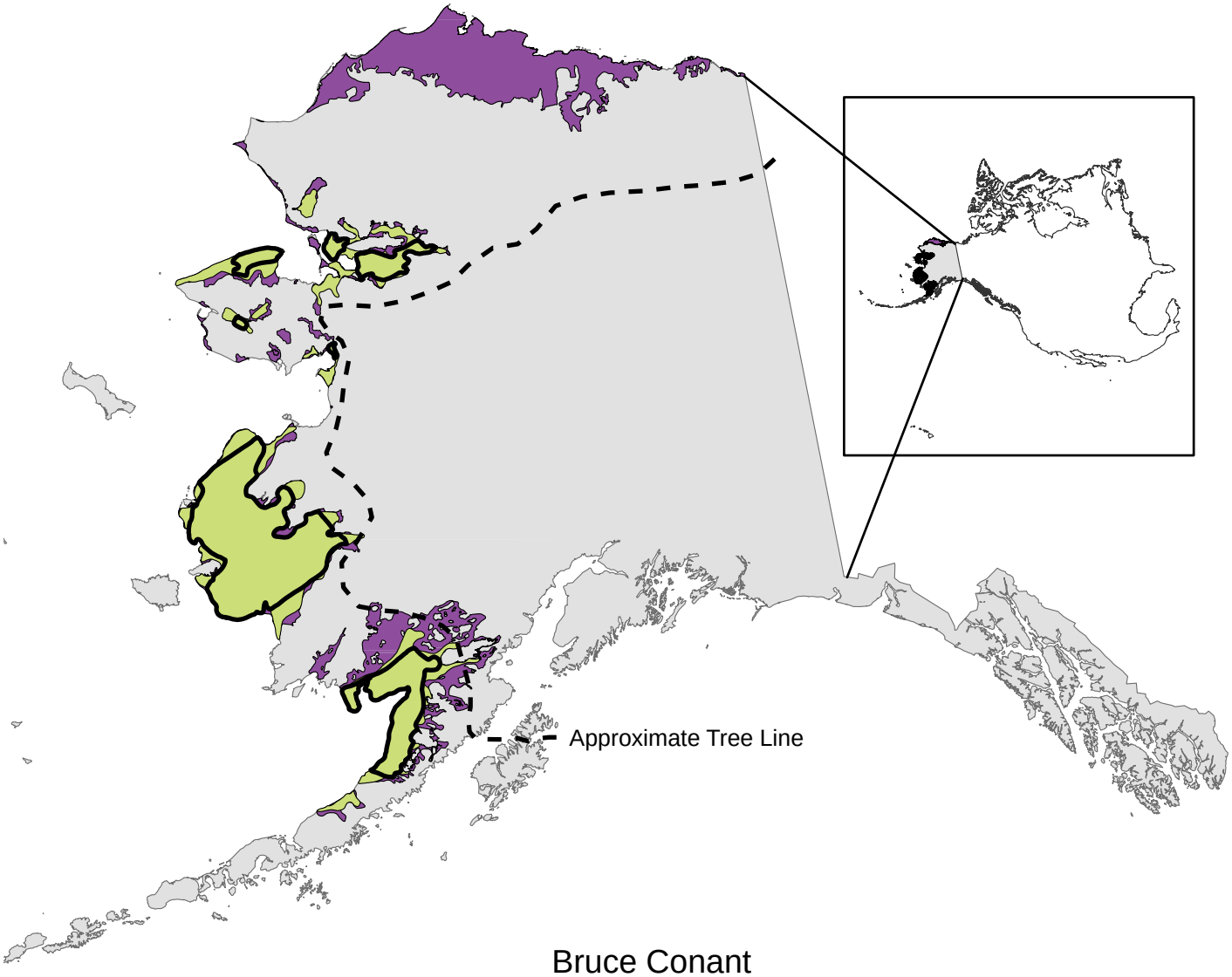
A Comparative Analysis of Waterfowl Breeding Population Surveys over Tundra Habitats in Alaska



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Abstract

The standardized Waterfowl Breeding Population Survey (WBPS) has been flown annually in Alaska since 1957. This traditional survey follows a standard protocol as part of a North American continental survey program (USFWS and CWS 1987). The traditional areas of the waterfowl breeding population habitat in Alaska were originally determined from fairly crude, small scale aeronautical maps. Questions about how well the survey represents waterfowl breeding populations in Alaska led to a multi-year, multi-faceted attempt to more precisely define the waterfowl breeding habitat and better measure the size of breeding waterfowl populations within it. Habitat areas were redefined and digitized from larger-scale U.S. Geological Survey maps. This resulted in a 20% increase in the amount of waterfowl breeding habitat on the western tundra. A series of intensive waterfowl breeding population surveys, utilizing many different survey crews and different aircraft, were flown from 1989-1997 over this better defined habitat. Comparisons of the average population estimates of waterfowl (total indicated birds) from these intensive surveys to the average results of the WBPS are presented, by survey area, for the western tundra habitats. Results showed an overall 14% increase in the number of total indicated ducks from the traditional estimates for the western tundra. The population estimates for the Arctic Coastal Plain, for the period 1986-2006, are also included. Qualifying factors of this comparison and some potential options for future modification of the traditional WBPS in Alaska are discussed.

Introduction

A standardized, fixed-wing, aerial Waterfowl Breeding Population Survey (WBPS) in Alaska has been part of the traditional continental waterfowl survey program since 1957 (Smith 1995). The main objective of this traditional survey has been to collect waterfowl population estimates for annually setting continental waterfowl hunting regulations. Although not intended, the data has been used in other endeavors, notably in establishing new National Wildlife Refuges in Alaska. The Waterfowl Management Project of the U.S. Fish and Wildlife Service (USFWS) in Juneau, Alaska was responsible for this traditional survey from the inception of the Juneau Project in 1954 through 2006. After an exploratory period, the annual survey was standardized in 1957. Various modifications were made until the present survey sampling design was finalized in 1964 (Figure 1 and Table 1). The current design samples approximately 1% of the habitat within eleven major waterfowl breeding survey areas in Alaska, which is similar to the sampling intensity in other regions of the continental survey.

In addition to the eleven major survey areas in Alaska, the Alaska survey crew has also been responsible for flying the Old Crow Flats area of the nearby Yukon Territory since 1966. This traditional survey is conducted from about mid-May to mid-June each year and is aimed to best obtain population estimates for breeding dabbling ducks. It requires about 100 hours of total flight time to complete, including the Old Crow Flats.

During this 50 year period (1957-2006), three Juneau Project Leaders have been responsible for flying this annual survey. In the early years, help was obtained from a few other pilots in some areas of Alaska and numerous right-seat observers were borrowed as necessary. Various fixed-wing aircraft have been used (Piper Pacer on straight floats; Cessna 180, standard, piston-powered de Havilland beaver, Cessna 185 all on amphibious floats; and since 1977 a one-of-a-kind, uniquely modified, turbine-powered de Havilland beaver on amphibious floats [N754]).

The traditional survey in Alaska has been flown essentially using just one survey crew annually since 1962. Although using just one dedicated survey crew helped standardize the left-seat observations, it required accepting a survey sequence that might not have optimized phenological timing for dabbling ducks for all areas of the whole survey. Borrowing various right-seat observers, with different aerial observing skills, probably introduced some undesirable variability to population estimates but, for the period 1964-1994, this was not found to be a significant factor for the purpose of monitoring long-term waterfowl population trends (Hodges *et al.*1996). In 1978, an additional full time pilot/biologist position was added to the up-to-then one person Juneau Waterfowl Project. In 1985 an additional full time biologist/observer position was established which provided more continuity for the right-seat position in the traditional survey aircraft since 1992.

Although exploratory waterfowl surveys were flown on the Arctic Coastal Plain (ACP) of Alaska in the early years, it was not until 1986 that a standardized waterfowl breeding population survey was established there (King, R.J. 1999). The ACP survey has been flown annually, with fixed-wing aircraft, since 1986 (Mallek 2007) but is not included in the continental survey program upon which continental waterfowl management decisions are based.

The Alaska traditional survey design went through a number of iterations of stratifying and sampling the waterfowl breeding habitat. From 1957-1963 the survey was divided into five, state-wide strata based on the average density of ducks (I/low to V/high). Stratum I was not routinely sampled (Hansen 1963). The sampling transects presently flown were finalized in 1964 (Figure 1). The data was analyzed and presented in reports by two strata (boreal forest interior and western tundra) for the period 1964-1973 (King, J.G. 1973). From 1974 to present the data has been analyzed and presented by the current eleven “strata” (Conant and Mallek 2006), which are not true strata in a statistical sense, but are simply large geographical areas of contiguous waterfowl breeding habitat (Figure 1 and Table 1). Most of the original boundaries of all these areas were obtained early on from fairly crude, 1:1,000,000 scale aeronautical (WAC) charts. Presently these boundaries are not precisely defined and vary from area to area in the degree to which they accurately delineate the waterfowl breeding habitat. Also, there has been some concern that the traditional sample is not representative (varies by area) of the habitat into which it is expanded.

Questions about how well the traditional survey represents the size of waterfowl breeding populations in Alaska led to a multi-year, multi-faceted attempt to more precisely define

the waterfowl breeding habitat and to better measure the size of waterfowl breeding populations on it. A program was initiated by the Alaska Region of USFWS in the 1980's to try to address these issues. Waterfowl breeding areas were more precisely defined using the more detailed 1:250,000 scale U.S. Geological Survey (USGS) maps (Figures 2 and 3). A series of intensive surveys were conducted over the extent of most of this better defined habitat to compare with the traditional survey conducted in these areas. Sample sizes were increased from the approximately 1%/year of the traditional survey to approximately 3-5%/year, depending on the survey area. Timing of these intensive surveys was aimed at best estimating the populations of dabbling ducks in each survey area. Intensive surveys over most of the interior boreal forest and all the western tundra habitats in Alaska have been completed. This report will summarize the comparisons of the traditional and intensive survey results for just the western tundra habitats (Platte and Butler 1993, Platte and Butler 1995, Platte 1989) and also include the results for the ACP tundra habitat as well (Mallek *et al.* 2007).

Study Area

Figure 4 depicts the western tundra survey areas where traditional and intensive surveys have been accomplished and the ACP survey area where surveys have been conducted annually since 1986. Individual survey areas are depicted in more detail (Figures 5-8) which show the general location of the traditional survey transects; a general core area which most closely shows what is actually sampled; a general traditional survey area into which the current traditional sample is expanded; and a refined habitat area which we believe more closely approximates the best definition of a survey area within which to conduct a reasonable fixed-wing, aerial survey for waterfowl. Because the ACP survey area (Figure 9) was defined later, it has been adequately sampled with an annual, aerial fixed-wing survey from its inception.

Table 1 shows the various measured areas of waterfowl breeding habitat layers by "stratum" or survey area. The core area is approximately what is sampled by the traditional survey transects. The traditional area, obtained from the early WAC maps, is what the sample is currently expanded to (Figure 1). From the larger scale, more detailed USGS maps, the primary area is a better definition of the most important waterfowl breeding habitat in Alaska while the secondary area is meant to include most of the rest of it (Figure 2). A refined area is an attempt to combine the primary area with parts of the secondary area to best define areas which include most of the waterfowl breeding habitat in Alaska that are reasonable to survey with fixed-wing aircraft (Figure 3).

Methods

Both the traditional survey crews and the crews conducting the more intensive surveys followed the same standardized, continental USFWS protocol for waterfowl breeding population surveys (USFWS and CWS 1987). Timing of the traditional survey was aimed at best estimating dabbler populations within the logistical constraints of

completing the entire state-wide survey in a reasonable time frame. Intensive surveys were timed individually to best estimate dabbler populations in each survey area. Both surveys used subjective factors to determine timing, such as the degree of ice melt, snow melt and leaf emergence. The centerline of each transect was flown at 30-45 m above ground level and at a speed of 145-170 km/hr. For the traditional survey, historically, handheld USGS 1:250,000 scale maps were used to navigate on transects. Starting in 1993, Global Positioning System (GPS) units in the aircraft panel were used to navigate along transects to preprogrammed endpoint coordinates. For the intensive surveys, Long Range Navigation (LORAN) was used for navigation on transects until GPS became available.

For the traditional survey, observations were recorded into tape recorders and later transcribed into laptop computers. Data was compartmentalized by 16-mile-long segments of the traditional transects. For the intensive surveys, in the early years observations were entered into continuously running tape recorders and (using time) were converted into coordinate locations. In later years, observations were entered directly into laptop computers as sound files using software developed by John I. Hodges (Waterfowl Management – Juneau). Each computer (one for each observer) was linked to an aircraft GPS unit. The program simultaneously recorded observations and their coordinates into linked sound and ASCII files, respectively. A second computer program, also developed by Jack Hodges, was used on the ground to replay the linked sound files and to combine the transcribed observation data with the geographic coordinates to produce a final ASCII data file. The transcribed ASCII files, from either method, were then used for data analysis.

Observations of all waterfowl, from both the traditional and the intensive surveys, were recorded according to established survey protocol (USFWS and CWS 1987). All observations of lone male ducks (drakes) were recorded as singles. Drakes in flocks of two or more were recorded as flocked drakes. A male duck in close association with a female (hen) duck was recorded as a pair. A hen and two drakes were recorded as a pair and a lone drake, while a drake and two hens were recorded as one pair (the second hen was not recorded). Ducks in mixed-sex groupings of four or more of a given species were separated into singles and pairs if the pair associations were evident, otherwise they were recorded as groups. Observations of lone geese were recorded as singles; two geese in close association were recorded as a pair; and geese in groups of three or more of the same species that could not be separated into singles and pairs were recorded as groups. For the remaining species, simply the number of birds present was recorded.

Statistical procedures followed those reported by Smith (1995). Duck and goose population indices were based on indicated birds: $2^* (S + P) + G$, where S = the number of single birds observed, P = the number of pairs observed, and G = the number of birds in groups. For ducks, flocked drakes < 5 were considered as singles, while 5 or more flocked drakes were considered as a group. Scaup, redheads, ring-necked ducks and ruddy ducks were an exception in that neither lone nor flocked drakes were doubled. Population indices of the non-duck and non-goose species were based only on the number of total birds observed.

Design of intensive aerial surveys involved the use of geographic information system (GIS) software. The primary and secondary duck breeding area boundaries were modified to the refined survey areas by more accurately digitizing lines over digital raster graphics of USGS 1:250,000 scale topographic maps. A custom True BASIC program and ARC/INFO® (Environmental Systems Research Institute, Inc., Redlands, California) GIS software were used to generate a block of systematic strip transects to be flown from a random coordinate in each of the survey areas. Transects were oriented east/west along great circle routes and the refined survey area was used to clip the block of transects. Relatively large, non-wetland areas within a broad geographic area were also digitized. Portions of transects were erased over these areas to eliminate them from the survey sample and thus population estimates were not expanded into these areas. Latitude and longitude coordinates for the transect endpoints were then generated from the GIS, processed by another custom True BASIC program, and uploaded to the aircraft GPS units to allow for precise navigation of the transects. Hard copy navigation maps displaying the transects on topographic maps with transect numbers, latitude/longitude coordinates of transect endpoints and total transect lengths displayed on the maps were created in the GIS for use in flying the transects.

Analysis of the results from the traditional and refined surveys was also accomplished using GIS. Polygon coverages were created to define the core area surveyed by the traditional survey since the traditional transects did not sample the entire refined area. Definition of core areas was somewhat arbitrary because of non-systematic placement of traditional transects. Core areas were delineated by digitizing boundary lines connecting the ends of existing transects such that the area more accurately represented what was actually sampled in each survey area. Also, the boundary of the core area was generally extended out from perimeter transects one-half the distance of the transect spacing assuming a transect represented the area half way to the next transect on either side. The GIS then automatically calculated the areas for the new polygons.

Intensive survey strip transects were intersected with the core area coverage to obtain portions of the transects in and out of the core area. Thus population estimates based on the transect samples within and outside the core area could be derived. The intensive surveys required more survey crews and the fixed-wing aircraft utilized were the Cessna 206 and 185 on amphibious floats.

Waterfowl population estimates are compared using the total indicated birds category, as calculated by definition in the standard continental survey protocol (Smith 1995). This protocol uses visibility correction factors (VCF's) to account for birds not visible or recorded from fixed-wing aerial surveys. Prior to 1992, all survey observations for Alaska were corrected with long term, average (VCF's) obtained from ground counts on mid-continent prairie habitat. Starting in 1986, a six year study in Alaska of annual counts from fixed-wing surveys, obtained with N754 (1986-1988 in the interior boreal forest and 1989-1991 on the western tundra), were compared to those obtained with helicopters (Conant *et al.*1991). In 1992 the resulting new VCF's were applied to all the historical Alaska survey data for the traditional survey and have been used to date. The intensive and the ACP surveys use most of these newer, Alaska specific VCF's.

The comparison of population estimates of total indicated birds from both the traditional and intensive annual surveys were averaged over a range of years (Bristol Bay 1993-1994, Yukon Delta 1989-1992, Seward Peninsula 1992-1993, Kotzebue Sound 1992-1993 and 1996-1997).

The results of the intensive surveys sampled within and expanded to just the core area were compared to those sampled within and expanded to the refined area to develop a correction factor to apply to the traditional survey by individual survey area (Tables 2-5). This correction factor was then used to correct the results obtained from the traditional survey in the core area out into the refined area. In other words, the result is estimates for total indicated birds for the refined area as if the N754 platform and crew would have flown to those refined boundaries. These results were then compared to the results from the traditional survey expanded to the traditional area (Table 6) and also to the core area (Table 7).

Results

Table 1 and Figure 10 show a comparison of the measured areas of various waterfowl breeding habitat layers in Alaska, by stratum. For the western tundra component as a whole, there is 20 % increase in the amount of refined area over the traditional area expanded to currently. There is a 45 % increase in the refined area over the core area.

Tables 2-5 show how the various population estimate correction factors were developed from the intensive surveys for application to the traditional survey estimates for comparison of the core area, the traditional survey area and the refined area, by stratum.

Table 6 and Figure 11 give a comparison of the waterfowl population estimates for the traditional survey expanded to the traditional and refined areas with the proportional difference by species/group, by stratum and for the western tundra (strata 8-11) as a whole. Although it varies by stratum and species/group, there is a 14 % increase in the size of the total duck population estimate from the current traditional area to the refined area for the western tundra strata as a whole.

Table 7 and Figure 11 give a comparison of waterfowl population estimates from the traditional survey expanded to the core area, to the traditional area and corrected to the refined area by species/group, by stratum and for the western tundra (strata 8-11) as a whole. Although it varies by stratum and species/group, there is a 46 % increase in the size of the total duck population estimate from the core area to the traditional area and a 66 % increase from the core area to the refined area.

Table 8 gives the population estimates for the ACP by year, 1986-2006 and shows the mean.

Discussion

In 1985, special surveys were initiated on the coastal zone of the Yukon/Kuskokwim Delta specifically to assess the status of nesting geese, but counts of some ducks and other species were also included (Butler1995, Eldridge 2003). Beginning in 1992, special breeding ground surveys were initiated in Alaska specifically for eiders in response to their special endangered, threatened status (Larned *et al.* 2006). Special surveys aimed at better estimating the populations of sea ducks were initiated in the interior boreal forest (Mallek 2006) and on the western tundra (Stehn *et al.* 2005) because of concern over their continental population status. While most of these special surveys were conducted on tundra habitats, they are not included in the analyses for this report.

In comparing the traditional and intensive waterfowl surveys, it is difficult to evaluate the comparison of the results from different survey crews with varying amounts of experience, flying in different survey aircraft during different weather conditions. We do feel that all these effects have been minimized to the degree practical. All waterfowl survey crews were well trained, had extensive aerial waterfowl survey experience and followed the well established protocol for waterfowl surveys (USFWS and CWS 1987).

The intensive surveys generally found fewer ducks in the core area (varies by species/group) than the traditional survey (Tables 2-5). We feel that the main reason for this result is due to the increased visibility for making observations from N754, however different observers flying different transects could be a factor.

The timing of the traditional survey follows an established sequence of surveying strata, dictated by the logistical constraints of flying a state-wide survey. The objective is to try to best measure the size of the breeding populations of dabbling ducks, as adjusted from year to year by the general phenology of those individual years. One of the intents of the intensive surveys was to try to best estimate the size of the dabbling duck populations, in their final breeding destination areas, without the constraints of trying to complete a state-wide survey.

The delineations of the various waterfowl breeding habitat layers (Table 1) were admittedly somewhat subjective. However, we feel that the boundaries that were delineated and the areas within that were measured from the larger scale, more accurate USGS maps are a more accurate depiction of the waterfowl breeding habitat in Alaska.

There are varying amounts of validity in expanding bird numbers from the core area to the traditional area depending on the stratum and how well the sample represents that stratum. For the Yukon Delta, the traditional area does not differ much from the core or refined areas (Figure 6). However, these areas in Bristol Bay differ considerably (Figure 5). The Seward Peninsula and the Kotzebue Sound areas have some scattered, non-contiguous habitat which is not all sampled by the traditional survey (Figures 7 and 8).

Surveys on the Arctic Coastal Plain 1986-2006 found an average of almost four hundred thousand ducks, mostly pintail and long-tailed ducks (Table 8). The population estimates

for this area may be low because of the application of the VCF's derived with N754 (from which it is easier to see birds) while all surveys on the ACP used either the Cessna 206 or 185 aircraft. Because the ACP has not been considered a good production area, it has not been included in the continental survey design. Perhaps its exclusion should be reconsidered, especially in view of recent climate trends and predictions for global warming.

The VCF's used throughout were calculated from comparing helicopter to fixed-wing counts derived over a decade ago and are specific to N754. Consideration should be given to conducting more comparative fixed-wing/helicopter waterfowl surveys. This would be especially useful if different fixed-wing survey aircraft are used in the future. While there may be some opportunity for experimenting with the double-observer technique (Magnusson *et al.* 1978, Seber 1982, Pollock and Kendall 1987) for developing more specific VCF's in specific, more limited surveys, we feel that it will not be practical for multi-species waterfowl surveys over much of the waterfowl breeding habitat in Alaska.

There may be some better tools available now or in the future with which to better define the waterfowl breeding habitat of not just Alaska but for the whole continent. A wetland-by-wetland approach could be explored similar to that accomplished on the Yukon Flats (Heglund 1992, 1988).

It would be beneficial to complete a similar, comparative analysis of the results from the traditional Alaska survey to those from intensive surveys for the interior boreal forest habitat.

Some riparian waterfowl breeding habitat which is not now included in a state-wide survey design should be considered for inclusion, especially for species like Harlequin ducks (MacDonald 2005, McCaffery and Harwood 1996). This addition would require the use of helicopters as the aerial survey platform.

Consideration should be given to evaluating the South Coastal waterfowl breeding habitat of Alaska (that is not currently surveyed) to determine the total amount of it, its use by breeding waterfowl and whether it should be included in a periodic survey program.

Options

There are a number of possible options and considerations for the future:

1. Leave the current traditional survey design and operation unchanged. The survey has been successfully completed for 50 years, for the most part with the annual use of one aircraft and one survey crew.

2. Same as option one above but adjust population estimates to account for birds suspected to be present (but not sampled for) out to the limits of the refined

boundaries. This would be accomplished with the application of extended area expansion factors (EAEF's) by species/group, by stratum from this analysis (Tables 2-5).

3. Divide the traditional annual survey into two components, one for the interior boreal forest and the second for the coastal tundra, including or not the ACP. This would make it possible to sample all the refined areas.

4. Divide any of the options above into an early dabbling duck and later diver/sea duck survey.

Considerations

The current traditional survey design may yield biased population estimates, but it probably does provide a valid, reliable index and trend of waterfowl breeding population status through time. Because of the state-wide extent of the traditional survey, the timing of it probably does not optimize it for dabbling ducks for all survey areas. Further, because it is timed for dabbling ducks it does not do as well for estimating other species/groups of ducks (*e.g*. divers, sea ducks).

The annual application of EAEF's to the results from the traditional survey would increase the overall size of waterfowl population estimates. The resulting estimates should be closer to the true size of the waterfowl breeding populations for Alaska. The validity of this approach and the accuracy of the EAEF's used could be checked periodically.

Dividing the current traditional survey into two components (boreal forest and tundra) would require at least the use of two survey crews and aircraft. It could provide better timing for more of the dabbling ducks. The traditional transects could either be extended to the refined boundaries, or the intensive survey transects (or a sub-sample) could be used to sample the refined survey areas, or some combination thereof. This approach could increase the sample size to the 2-4 % range. If the traditional transects are not flown, a strict comparison of future data to the traditional, historical data would become more difficult. However, each component could further be subdivided into traditional and peripheral areas to allow for a better comparison to the traditional, historical record.

Dividing any of the options into an early dabbling duck and a later diver/sea duck survey would require a minimum of two survey crews and aircraft and possibly more to complete. It could yield better results for dabbling as well as diver/sea duck populations.

Stratification is often used in aerial waterfowl survey designs (Cowardin and Blohm 1992, Prenzlow and Lovvorn 1997). Much habitat information exists today that didn't 50 years ago including satellite imagery, hydrography, and land cover classifications, all of which could potentially be used to develop stratifications of the various survey areas. Also, the intensive surveys have provided information about bird density distribution

which also could be used for stratifying as was done for the black scoter population survey (Stehn et al. 2006) and the redesign of the ACP survey in 2007.

A systematic sample of strip transects can be rotated from year to year as was done with the intensive surveys and many of the multi-year surveys flown in Alaska (Eldridge 2003, Larned et al. 2006). Recently, a rotating strip transect sampling design has been used to increase waterfowl distribution information on the ACP. A valid sample was obtained each year for population analysis while accumulating distribution information over multiple years. When bird observations were combined for the intensive multi-year surveys, GIS allowed mapping of the predicted distribution of most species (Butler et al. 1995). The entire process was greatly improved and more efficient with the use of GIS. After several years of data collection, the observation locations can be interpolated into estimated bird distribution maps which have proven to be very valuable for management purposes and could be very useful in the formulation of future survey designs. A potential disadvantage in moving the sample from year to year would be a possible increase in the variance of the population index. However, no comparison of the between transect variance with same transect variance between years has been done. There may not be much of a difference between the two. If possible, repositioning of transects within a given survey area could make them more of a representative, systematic sample, without increasing overall sampling intensity.

When nesting data are available (Yukon Delta), it has been possible to correlate weather data with nesting chronology and thus consistently better time the specialized aerial survey there for geese. If nesting data for more species/groups of waterfowl are available for other waterfowl breeding areas, it may be possible to do the same elsewhere. If it were possible to somewhat adjust the traditional survey timing to account for phenology, it might help to decrease some of the large fluctuations, from year to year, in the population numbers of some species/groups.

Undoubtedly, there are more options and considerations. All should be considered in the larger context of the whole continental waterfowl habitat picture along with the whole continental waterfowl survey program's expected future funding and staffing levels. There are other large areas of waterfowl breeding habitat that are not routinely surveyed (e.g. Nunavut in Canada). Global warming has the potential to greatly alter the distribution of breeding waterfowl across Alaska and the continental landscape. We should all strive to best monitor, through time, the continental breeding population levels of the greatest proportion of the most species/groups of water birds that we can consistently sustain.

Recommendation

Because of the complexity of the factors to be considered in making any changes to existing survey strategies and the need to consider any changes in the broader continental context, we recommend that a joint Migratory Bird Management (Alaska and continental)

task force be created to carefully consider all options and considerations and to formulate recommendations on future directions for the whole survey program.

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Table 1. Measured areas of various waterfowl breeding habitat layers in Alaska in square kilometers.

Stratum	Core Area	Traditional Area	Primary Area	Secondary Area	Primary & Secondary	Refined Area	Refined Area / Traditional Area	Refined Area / Core Area
Boreal Forest								
Kenai-Susitna	4,490	5,698	26,482	9,189	35,671	18,533	3.25	4.13
Nelchina	5,223	10,101	14,395	13,614	28,009	14,395	1.43	2.76
Tanana-Kuskokwim	18,638	24,087	50,007	42,173	92,180	52,732	2.19	2.83
Yukon Flats	11,499	27,972	18,783	31,356	50,139	30,460	1.09	2.65
Innoko	5,032	8,806	15,538	4,881	20,419	12,995	1.48	2.58
Koyukuk	12,254	10,619	24,762	9,103	33,864	22,846	2.15	1.86
Copper River Delta	420	1,036	no data	no data	no data	692	0.67	1.65
Subtotal	57,554	88,319	149,966	110,316	260,282	152,652	1.73	2.65
Tundra								
Bristol Bay	17,797	25,641	60,589	13,325	73,914	52,273	2.04	2.94
Yukon Delta	58,570	68,894	76,551	12,843	89,394	71,894	1.04	1.23
Seward Peninsula	3,540	9,972	12,936	7,659	20,594	14,208	1.42	4.01
Kotzebue Sound	7,194	13,857	18,658	20,585	39,243	15,751	1.14	2.19
North Slope	61,645	61,645	85,902	30,026	115,928	61,645	1.00	1.00
Subtotal	148,746	180,008	254,635	84,438	339,074	215,770	1.20	1.45
Total	206,300	268,327	404,602	194,754	599,356	368,422	1.37	1.79

Table 2. Comparison of population estimates in the Bristol Bay stratum from the traditional Waterfowl Breeding Population Survey and the Intensive Survey. All estimates are total indicated birds, averaged from 1993 and 1994 surveys and are in thousands.

Species	a Traditional survey expanded only to core area	b Intensive survey expanded only to core area	c Intensive survey expanded to refined boundary	d c/b	e Traditional survey expanded to traditional boundary	f Traditional survey corrected a*c/b	g f/e
Mallard	23.4	16.3	43.2	2.65	34.1	62.1	1.82
Gadwall	0.9	3.9	6.1	1.58	1.3	1.4	1.07
American Wigeon	16.8	10.3	19.6	1.91	24.4	32.0	1.31
Green-winged Teal	27.2	17.4	48.8	2.80	39.6	76.3	1.93
Northern Shoveler	11.5	7.0	12.4	1.77	16.7	20.3	1.22
Northern Pintail	26.0	30.7	54.4	1.77	37.7	46.0	1.22
Dabblers	105.8	85.6	184.6	2.16	153.8	228.0	1.48
Redhead	0.0	0.0	0.0	---	0.0	---	---
Canvasback	0.0	0.2	0.2	1.00	0.0	0.0	---
Scaup Spp.	49.7	42.0	97.2	2.32	72.3	115.1	1.59
Ring-necked Duck	0.0	0.0	0.0	---	0.0	---	---
Goldeneye Spp.	0.3	0.1	12.7	94.72	0.4	25.3	65.18
Bufflehead	0.1	0.1	0.2	3.07	0.2	0.4	2.12
Divers	50.1	42.4	110.3	2.60	72.9	130.5	1.79
Long-tailed Duck	7.7	2.1	5.3	2.55	11.3	19.8	1.75
Eider Spp.	0.3	0.6	1.6	2.60	0.4	0.7	1.79
Scoter Spp.	41.1	31.4	49.3	1.57	59.8	64.6	1.08
Merganser Spp.	2.3	2.1	8.7	4.12	3.3	9.3	2.83
Miscellaneous	51.4	36.2	64.9	1.79	74.7	92.2	1.23
Total Ducks	207.3	164.2	359.8	2.19	301.4	454.3	1.51
Canada Goose	0.8	1.6	1.9	1.16	1.1	0.9	0.80
White-fronted Goose	2.1	2.0	2.3	1.18	3.1	2.5	0.81
Black Brant	0.0	0.0	0.0	---	0.0	---	---
Emperor Goose	0.0	0.0	0.0	---	0.0	---	---
Tundra Swan	7.0	8.6	14.1	1.64	10.2	11.5	1.13
Sandhill Crane	2.7	1.6	2.9	1.88	4.0	5.1	1.29
Red-throated Loon	0.8	0.7	0.9	1.33	1.1	1.0	0.91
Pacific Loon	1.6	0.8	2.0	2.43	2.3	3.9	1.67
Common Loon	0.4	0.4	0.8	2.24	0.6	1.0	1.54
Grebe Spp.	0.9	0.4	0.5	1.35	1.2	1.1	0.93

Table 3. Comparison of population estimates in the Yukon Delta stratum from the traditional Waterfowl Breeding Population Survey and the Intensive Survey. All estimates are total indicated birds, averaged from 1989-1992 surveys and are in thousands.

Species	a Traditional survey expanded only to core area	b Intensive survey expanded only to core area	c Intensive survey expanded to refined boundary	d c/b	e Traditional survey expanded to traditional boundary	f Traditional survey corrected a*c/b	g f/e
Mallard	63.9	46.8	59.1	1.26	78.5	80.8	1.03
Gadwall	0.6	0.8	1.1	1.40	0.8	0.9	1.14
American Wigeon	78.7	52.5	68.0	1.29	96.5	101.8	1.05
Green-winged Teal	123.3	94.2	119.6	1.27	151.4	156.7	1.03
Northern Shoveler	75.3	60.2	81.8	1.36	92.4	102.3	1.11
Northern Pintail	258.3	203.6	291.7	1.43	317.0	370.0	1.17
Dabblers	600.1	458.1	621.4	1.36	736.6	814.0	1.11
Redhead	0.0	0.6	0.7	1.21	0.0	0.0	---
Canvasback	3.6	3.7	5.6	1.52	4.5	5.6	1.24
Scaup Spp.	161.3	135.2	166.6	1.23	197.9	198.8	1.00
Ring-necked Duck	1.0	0.4	0.4	1.00	1.2	1.0	0.81
Goldeneye Spp.	6.0	8.4	12.8	1.54	7.4	9.3	1.25
Bufflehead	0.3	0.2	0.2	1.00	0.4	0.3	0.81
Divers	172.2	148.4	186.4	1.26	211.4	216.2	1.02
Long-tailed Duck	38.6	25.3	30.7	1.21	47.4	46.8	0.99
Eider Spp.	4.8	7.8	12.4	1.58	5.9	7.5	1.29
Scoter Spp.	88.2	65.2	75.6	1.16	108.2	102.2	0.94
Merganser Spp.	4.0	6.3	7.7	1.22	5.0	4.9	0.99
Miscellaneous	135.6	104.6	126.3	1.21	166.4	163.7	0.98
Total Ducks	907.8	711.2	934.2	1.31	1114.3	1192.4	1.07
Canada Goose	29.0	30.9	51.3	1.66	35.6	48.2	1.35
White-fronted Goose	22.9	16.6	24.9	1.50	28.2	34.4	1.22
Black Brant	2.8	0.7	3.3	5.11	3.5	14.5	4.16
Emperor Goose	3.8	9.6	19.4	2.02	4.7	7.7	1.65
Tundra Swan	82.7	42.9	55.8	1.30	101.6	107.5	1.06
Sandhill Crane	21.9	18.0	24.9	1.39	26.8	30.3	1.13
Red-throated Loon	3.8	3.2	4.4	1.34	4.6	5.0	1.09
Pacific Loon	23.2	22.9	28.7	1.26	28.4	29.1	1.02
Common Loon	1.7	1.2	1.5	1.23	2.1	2.1	1.00
Grebe Spp.	2.2	3.2	3.7	1.15	2.7	2.5	0.94

Table 4. Comparison of population estimates in the Seward Peninsula stratum from the traditional Waterfowl Breeding Population Survey and the Intensive Survey. All estimates are total indicated birds, averaged from 1992 and 1993 surveys and are in thousands.

Species	a Traditional survey expanded only to core area	b Intensive survey expanded only to core area	c Intensive survey expanded to refined boundary	d c/b	e Traditional survey expanded to traditional boundary	f Traditional survey corrected a*c/b	g f/e
Mallard	2.1	1.6	6.6	4.20	6.1	9.0	1.48
Gadwall	0.0	0.0	0.0	---	0.0	---	---
American Wigeon	8.5	6.1	22.0	3.60	24.3	30.7	1.26
Green-winged Teal	2.0	4.8	12.7	2.62	5.7	5.3	0.92
Northern Shoveler	3.5	5.4	12.1	2.23	9.9	7.8	0.79
Northern Pintail	38.0	26.7	112.4	4.22	108.2	160.3	1.48
Dabblers	54.2	44.6	165.9	3.72	154.2	201.4	1.31
Redhead	0.0	0.0	0.0	---	0.0	---	---
Canvasback	0.9	1.8	2.0	1.16	2.5	1.0	0.41
Scaup Spp.	14.9	8.9	36.6	4.12	42.3	61.2	1.45
Ring-necked Duck	0.0	0.0	0.0	---	0.0	---	---
Goldeneye Spp.	0.0	0.0	0.0	---	0.0	---	---
Bufflehead	0.0	0.0	0.0	---	0.0	---	---
Divers	15.8	10.6	38.7	3.63	44.8	57.2	1.28
Long-tailed Duck	3.9	4.3	18.5	4.34	11.2	17.1	1.53
Eider Spp.	1.7	3.2	18.5	5.78	4.9	10.0	2.03
Scoter Spp.	8.5	5.8	18.9	3.28	24.1	27.7	1.15
Merganser Spp.	0.3	1.0	8.0	7.71	0.9	2.4	2.71
Miscellaneous	14.4	14.3	63.9	4.48	41.0	64.6	1.57
Total Ducks	84.4	69.5	268.4	3.86	240.1	325.7	1.36
Canada Goose	2.6	2.6	13.8	5.23	7.4	13.6	1.84
White-fronted Goose	0.1	0.5	3.8	8.04	0.4	1.2	2.82
Black Brant	0.0	0.1	1.4	9.91	0.0	0.0	---
Emperor Goose	0.0	0.1	0.2	1.74	0.0	0.0	---
Tundra Swan	1.6	1.2	11.9	9.57	4.5	15.0	3.36
Sandhill Crane	3.3	2.0	5.7	2.92	9.3	9.5	1.02
Red-throated Loon	0.8	1.4	5.1	3.74	2.3	3.1	1.32
Pacific Loon	1.8	0.5	2.0	3.81	5.0	6.7	1.34
Common Loon	0.0	0.0	0.1	---	0.0	---	---
Grebe Spp.	0.1	0.1	0.4	7.87	0.4	1.1	2.76

Table 5. Comparison of population estimates in the Kotzebue Sound stratum from the traditional Waterfowl Breeding Population Survey and the Intensive Survey. All etimates are total indicated birds, averaged from 1992-1993 and 1996-1997 surveys for the Intensive Survey and 1996-1997 for the traditional survey and are in thousands.

Species	a Traditional survey expanded only to core area	b Intensive survey expanded only to core area	c Intensive survey expanded to refined boundary	d c/b	e Traditional survey expanded to traditional boundary	f Traditional survey corrected a*c/b	g f/e
Mallard	19.2	13.2	17.8	1.35	35.8	25.9	0.72
Gadwall	0.0	0.0	0.0	---	0.0	---	---
American Wigeon	66.4	55.9	84.1	1.51	123.7	99.9	0.81
Green-winged Teal	21.5	13.0	27.3	2.10	40.1	45.1	1.13
Northern Shoveler	32.6	12.1	20.2	1.67	60.8	54.4	0.89
Northern Pintail	43.6	33.0	78.5	2.38	81.2	103.8	1.28
Dabblers	183.3	127.2	227.9	1.79	341.6	328.5	0.96
Redhead	0.0	0.04	0.1	1.48	0.0	0.0	---
Canvasback	0.0	0.6	1.0	1.67	0.0	0.0	---
Scaup Spp.	32.6	39.1	64.0	1.64	60.7	53.4	0.88
Ring-necked Duck	0.4	0.1	0.3	2.56	0.7	0.9	1.37
Goldeneye Spp.	0.6	0.2	0.3	1.34	1.2	0.9	0.72
Bufflehead	0.2	0.2	0.3	1.62	0.4	0.4	0.87
Divers	33.8	40.2	65.9	1.64	63.0	55.5	0.88
Long-tailed Duck	2.9	5.6	11.3	2.01	5.4	5.9	1.08
Eider Spp.	0.0	0.1	1.1	8.43	0.0	0.0	---
Scoter Spp.	7.8	8.6	14.4	1.68	14.5	13.0	0.90
Merganser Spp.	0.3	1.0	2.5	2.60	0.6	0.8	1.40
Miscellaneous	11.0	15.3	29.4	1.92	20.5	21.1	1.03
Total Ducks	228.1	182.6	323.2	1.77	425.0	403.6	0.95
Canada Goose	7.4	9.3	15.4	1.67	13.9	12.4	0.89
White-fronted Goose	4.1	5.6	11.3	2.02	7.6	8.3	1.09
Black Brant	0.0	0.0	0.1	---	0.0	---	---
Emperor Goose	0.0	0.0	0.1	---	0.0	---	---
Tundra Swan	5.2	9.6	13.2	1.37	9.6	7.1	0.73
Sandhill Crane	2.3	1.5	2.7	1.76	4.3	4.1	0.95
Red-throated Loon	0.2	0.2	0.7	3.08	0.3	0.6	1.65
Pacific Loon	1.4	1.5	3.1	2.06	2.6	2.8	1.11
Common Loon	0.1	0.1	0.1	1.32	0.2	0.2	0.71
Grebe Spp.	2.3	1.5	2.7	1.87	4.3	4.3	1.00

Table 6. Comparison of uncorrected (to traditional boundary) and corrected (to refined boundary), average population estimates for the traditional tundra strata (8-11) from the traditional Waterfowl Breeding Population Survey. All estimates are total indicated birds and are in thousands.

	Bristol Bay			Yukon Delta			Seward Peninsula			Kotzebue Sound			Strata 8-11		
	e	f		e	f		e	f		e	f		e	f	
Species	Traditional survey expanded to traditional boundary	Traditional survey corrected[a]	f/e	Traditional survey expanded to traditional boundary	Traditional survey corrected[a]	f/e	Traditional survey expanded to traditional boundary	Traditional survey corrected[a]	f/e	Traditional survey expanded to traditional boundary	Traditional survey corrected[a]	f/e	Traditional survey expanded to traditional boundary	Traditional survey corrected[a]	f/e
Mallard	34.1	62.1	1.82	78.5	80.8	1.03	6.1	9.0	1.48	35.8	25.9	0.72	154.4	177.7	1.15
Gadwall	1.3	1.4	1.07	0.8	0.9	1.14	0.0	---	---	0.0	---	---	2.1	2.3	1.10
American Wigeon	24.4	32.0	1.31	96.5	101.8	1.05	24.3	30.7	1.26	123.7	99.9	0.81	268.9	264.4	0.98
Green-winged Teal	39.6	76.3	1.93	151.4	156.7	1.03	5.7	5.3	0.92	40.1	45.1	1.13	236.8	283.4	1.20
Northern Shoveler	16.7	20.3	1.22	92.4	102.3	1.11	9.9	7.8	0.79	60.8	54.4	0.89	179.8	184.8	1.03
Northern Pintail	37.7	46.0	1.22	317.0	370.0	1.17	108.2	160.3	1.48	81.2	103.8	1.28	544.2	680.1	1.25
Dabblers	153.8	228.0	1.48	736.6	814.0	1.11	154.2	201.4	1.31	341.6	328.5	0.96	1386.2	1571.9	1.13
Redhead	0.0	---	---	0.0	0.0	---	0.0	---	---	0.0	0.0	---	0.0	---	---
Canvasback	0.0	0.0	---	4.5	5.6	1.24	2.5	1.0	1.00	0.0	0.0	---	7.0	6.6	0.94
Scaup Spp.	72.3	115.1	1.59	197.9	198.8	1.00	42.3	61.2	1.45	60.7	53.4	0.88	373.2	428.5	1.15
Ring-necked Duck	0.0	---	---	1.2	1.0	0.81	0.0	---	---	0.7	0.9	1.37	1.8	1.9	1.02
Goldeneye Spp.	0.4	25.3	65.18	7.4	9.3	1.25	0.0	---	---	1.2	0.9	0.72	9.0	35.4	3.94
Bufflehead	0.2	0.4	2.12	0.4	0.3	0.81	0.0	---	---	0.4	0.4	0.87	1.0	1.1	1.10
Divers	72.9	130.5	1.79	211.4	216.2	1.02	44.8	57.2	1.28	63.0	55.5	0.88	392.0	459.4	1.17
Long-tailed Duck	11.3	19.8	1.75	47.4	46.8	0.99	11.2	17.1	1.53	5.4	5.9	1.08	75.2	89.5	1.19
Eider Spp.	0.4	0.7	1.79	5.9	7.5	1.29	4.9	10.0	2.03	0.0	0.0	---	11.2	18.2	1.63
Scoter Spp.	59.8	64.6	1.08	108.2	102.2	0.94	24.1	27.7	1.15	14.5	13.0	0.90	206.5	207.6	1.00
Merganser Spp.	3.3	9.3	2.83	5.0	4.9	0.99	0.9	2.4	2.71	0.6	0.8	1.40	9.7	17.4	1.79
Miscellaneous	74.7	92.2	1.23	166.4	163.7	0.98	41.0	64.6	1.57	20.5	21.1	1.03	302.6	341.5	1.13
Total Ducks	301.4	454.3	1.51	1114.3	1192.4	1.07	240.1	325.7	1.36	425.0	403.6	0.95	2080.8	2376.0	1.14
Canada Goose	1.1	0.9	0.80	35.6	48.2	1.35	7.4	13.6	1.84	13.9	12.4	0.89	58.0	75.1	1.29
White-fronted Goose	3.1	2.5	0.81	28.2	34.4	1.22	0.4	1.2	2.82	7.6	8.3	1.09	39.3	46.3	1.18
Black Brant	0.0	---	---	3.5	14.5	4.16	0.0	0.0	---	0.0	---	---	3.5	14.5	4.16
Emperor Goose	0.0	---	---	4.7	7.7	1.65	0.0	0.0	---	0.0	---	---	4.7	7.7	1.65
Tundra Swan	10.2	11.5	1.13	101.6	107.5	1.06	4.5	15.0	3.36	9.6	7.1	0.73	125.8	141.1	1.12
Sandhill Crane	4.0	5.1	1.29	26.8	30.3	1.13	9.3	9.5	1.02	4.3	4.1	0.95	44.4	49.1	1.10
Red-throated Loon	1.1	1.0	0.91	4.6	5.0	1.09	2.3	3.1	1.32	0.3	0.6	1.65	8.4	9.7	1.15
Pacific Loon	2.3	3.9	1.67	28.4	29.1	1.02	5.0	6.7	1.34	2.6	2.8	1.11	38.3	42.6	1.11
Common Loon	0.6	1.0	1.54	2.1	2.1	1.00	0.0	---	---	0.2	0.2	0.71	3.0	3.2	1.09
Grebe Spp.	1.2	1.1	0.93	2.7	2.5	0.94	0.4	1.1	2.76	4.3	4.3	1.00	8.7	9.1	1.06

[a] Corrected to refined area boundary

Table 7. Comparison of uncorrected (to core area and traditional boundary) and corrected (to refined boundary), average population estimates for traditional tundra strata (8-11) from the traditional Waterfowl Breeding Population Survey. All estimates are total indicated birds and are in thousands.

	Bristol Bay			Yukon Delta			Seward Peninsula			Kotzebue Sound			Strata 8-11		
Species	Traditional survey expanded to core area	Traditional survey expanded to traditional boundary	Traditional survey corrected[a]	Traditional survey expanded to core area	Traditional survey expanded to traditional boundary	Traditional survey corrected[a]	Traditional survey expanded to core area	Traditional survey expanded to traditional boundary	Traditional survey corrected[a]	Traditional survey expanded to core area	Traditional survey expanded to traditional boundary	Traditional survey corrected[a]	Traditional survey expanded to core area	Traditional survey expanded to traditional boundary	Traditional survey corrected[a]
Mallard	23.4	34.1	62.1	63.9	78.5	80.8	2.1	6.1	9.0	19.2	35.8	25.9	108.7	154.4	177.7
Gadwall	0.9	1.3	1.4	0.6	0.8	0.9	0.0	0.0	---	0.0	0.0	---	1.5	2.1	2.3
American Wigeon	16.8	24.4	32.0	78.7	96.5	101.8	8.5	24.3	30.7	66.4	123.7	99.9	170.3	268.9	264.4
Green-winged Teal	27.2	39.6	76.3	123.3	151.4	156.7	2.0	5.7	5.3	21.5	40.1	45.1	174.1	236.8	283.4
Northern Shoveler	11.5	16.7	20.3	75.3	92.4	102.3	3.5	9.9	7.8	32.6	60.8	54.4	122.9	179.8	184.8
Northern Pintail	26.0	37.7	46.0	258.3	317.0	370.0	38.0	108.2	160.3	43.6	81.2	103.8	365.9	544.2	680.1
Dabblers	105.8	153.8	228.0	600.1	736.6	814.0	54.2	154.2	201.4	183.3	341.6	328.5	943.4	1386.2	1571.9
Redhead	0.0	0.0	---	0.0	0.0	0.0	0.0	0.0	---	0.0	0.0	0.0	0.0	0.0	---
Canvasback	0.0	0.0	0.0	3.6	4.5	5.6	0.9	2.5	1.0	0.0	0.0	0.0	4.5	7.0	6.6
Scaup Spp.	49.7	72.3	115.1	161.3	197.9	198.8	14.9	42.3	61.2	32.6	60.7	53.4	258.4	373.2	428.5
Ring-necked Duck	0.0	0.0	---	1.0	1.2	1.0	0.0	0.0	---	0.4	0.7	0.9	1.3	1.8	1.9
Goldeneye Spp.	0.3	0.4	25.3	6.0	7.4	9.3	0.0	0.0	---	0.6	1.2	0.9	6.9	9.0	35.4
Bufflehead	0.1	0.2	0.4	0.3	0.4	0.3	0.0	0.0	---	0.2	0.4	0.4	0.7	1.0	1.1
Divers	50.1	72.9	130.5	172.2	211.4	216.2	15.8	44.8	57.2	33.8	63.0	55.5	271.8	392.0	459.4
Long-tailed Duck	7.7	11.3	19.8	38.6	47.4	46.8	3.9	11.2	17.1	2.9	5.4	5.9	0.0 53.2	75.2	89.5
Eider Spp.	0.3	0.4	0.7	4.8	5.9	7.5	1.7	4.9	10.0	0.0	0.0	0.0	6.8	11.2	18.2
Scoter Spp.	41.1	59.8	64.6	88.2	108.2	102.2	8.5	24.1	27.7	7.8	14.5	13.0	145.5	206.5	207.6
Merganser Spp.	2.3	3.3	9.3	4.0	5.0	4.9	0.3	0.9	2.4	0.3	0.6	0.8	6.9	9.7	17.4
Miscellaneous	51.4	74.7	92.2	135.6	166.4	163.7	14.4	41.0	64.6	11.0	20.5	21.1	212.4	302.6	341.5
Total Ducks	207.3	301.4	454.3	907.8	1114.3	1192.4	84.4	240.1	325.7	228.1	425.0	403.6	1427.6	2080.8	2376.0
Canada Goose	0.8	1.1	0.9	29.0	35.6	48.2	2.6	7.4	13.6	7.4	13.9	12.4	39.8	58.0	75.1
White-fronted Goose	2.1	3.1	2.5	22.9	28.2	34.4	0.1	0.4	1.2	4.1	7.6	8.3	29.3	39.3	46.3
Black Brant	0.0	0.0	---	2.8	3.5	14.5	0.0	0.0	0.0	0.0	0.0	---	2.8	3.5	14.5
Emperor Goose	0.0	0.0	---	3.8	4.7	7.7	0.0	0.0	0.0	0.0	0.0	---	3.8	4.7	7.7
Tundra Swan	7.0	10.2	11.5	82.7	101.6	107.5	1.6	4.5	15.0	5.2	9.6	7.1	96.5	125.8	141.1
Sandhill Crane	2.7	4.0	5.1	21.9	26.8	30.3	3.3	9.3	9.5	2.3	4.3	4.1	30.2	44.4	49.1
Red-throated Loon	0.8	1.1	1.0	3.8	4.6	5.0	0.8	2.3	3.1	0.2	0.3	0.6	5.5	8.4	9.7
Pacific Loon	1.6	2.3	3.9	23.2	28.4	29.1	1.8	5.0	6.7	1.4	2.6	2.8	27.9	38.3	42.6
Common Loon	0.4	0.6	1.0	1.7	2.1	2.1	0.0	0.0	---	0.1	0.2	0.2	2.3	3.0	3.2
Grebe Spp.	0.9	1.2	1.1	2.2	2.7	2.5	0.1	0.4	1.1	2.3	4.3	4.3	5.5	8.7	9.1

[a] Corrected to refined area boundary

Table 8. Population estimates of waterfowl and related species on the Arctic Coastal Plain, Alaska 1986-2006. All estimates are total indicated birds and are in thousands.

Species	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	1986-2006 Mean
Mallard	0.4	1.1	1.4	1.8	1.8	1.1	2.3	1.1	0.8	1.1	2.4	1.4	5.3	11.1	1.2	1.9	1.1	0.9	0.8	0.0	0.0	1.8
Gadwall	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Wigeon	2.1	5.5	0.3	1.5	7.0	3.1	10.3	0.4	3.8	1.8	7.9	14.9	7.9	7.7	4.7	0.4	0.4	3.1	0.4	0.0	3.5	4.1
GW Teal	6.0	6.3	1.5	3.7	4.5	0.7	2.4	2.4	1.6	1.6	5.3	2.0	14.1	5.8	0.9	0.8	0.0	3.3	1.6	0.8	2.4	3.2
Shoveler	2.0	0.0	1.3	0.3	1.0	0.7	1.4	1.4	0.4	0.7	3.3	0.0	2.5	4.2	0.0	0.0	1.4	0.0	0.0	0.0	0.0	1.0
Pintail	123.6	253.5	223.8	307.5	230.8	313.6	239.2	212.4	137.4	231.8	252.7	226.6	268.1	283.1	131.1	238.5	178.6	227.7	243.4	156.8	150.2	220.5
Dabblers	134.0	226.3	228.4	314.9	245.1	319.2	255.9	217.7	144.0	237.0	271.6	244.9	298.7	312.0	137.9	241.6	181.4	235.0	246.1	157.5	156.0	228.8
Scaup	21.6	21.8	42.8	45.6	33.9	27.0	36.1	27.9	30.1	35.7	33.9	40.8	33.1	32.8	43.3	28.3	27.5	37.4	36.6	27.0	23.9	32.7
Goldeneye	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Bufflehead	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long-tailed Duck	114.6	120.4	148.2	142.6	114.2	116.0	103.5	110.9	120.6	120.2	129.2	98.7	92.5	85.7	67.0	104.1	96.9	87.9	101.1	84.2	89.4	107.0
Scoter Sp[a]	6.9	9.3	10.6	21.9	8.4	15.4	17.8	11.2	7.8	18.0	11.7	8.0	8.1	5.4	4.6	14.3	11.9	5.1	4.7	7.7	9.3	10.4
RB Merganser	1.2	2.1	0.9	0.9	1.8	3.0	1.3	1.9	1.7	5.0	3.9	0.7	3.7	7.0	0.1	2.1	2.5	1.5	1.5	2.4	3.8	2.3
Common Eider	0.0	0.7	0.3	0.2	0.4	0.4	0.2	0.0	0.1	0.7	2.0	0.0	0.9	0.0	1.0	0.2	0.0	0.6	1.0	0.4	0.3	0.4
King Eider	2.5	1.6	1.1	3.9	3.1	6.9	1.0	4.0	1.6	1.3	3.5	6.4	3.6	4.2	1.7	7.9	4.5	6.5	5.0	7.6	5.9	4.0
Steller's Eider	0.0	0.0	0.0	2.0	0.5	1.1	1.0	1.3	2.5	0.9	2.5	1.3	0.3	1.3	0.6	0.2	0.0	0.0	0.0	0.1	0.0	0.7
Spectacled Eider	—[b]	—[b]	—[b]	—[b]	—[b]	0.3	0.0	1.1	0.5	0.3	0.4	0.6	0.3	0.1	0.0	0.7	0.7	0.3	0.8	3.5	0.4	0.6
Unidentified Eider	1.4	2.4	1.0	1.2	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.6	0.0	1.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.4
Divers	148.7	158.3	205.2	218.2	162.5	170.1	160.9	158.3	164.8	182.3	188.9	157.0	142.6	137.6	118.7	157.7	144.1	139.3	150.6	132.9	133.0	158.7
Total Ducks	282.8	384.6	433.6	533.1	407.6	489.3	416.8	376.0	308.8	419.3	460.5	402.0	441.3	449.5	256.7	399.3	325.5	374.3	396.7	290.4	289.0	387.5
WF Goose	119.9	91.4	98.2	148.6	90.3	121.3	122.5	100.3	93.4	84.2	131.0	177.9	128.3	192.4	138.0	155.5	120.3	108.1	138.2	129.4	113.9	124.0
Canada Goose	47.2	20.8	5.8	2.2	12.5	95.6	27.4	4.9	3.6	7.0	20.6	18.7	33.3	47.6	24.6	23.8	9.3	11.4	15.1	21.2	17.9	22.4
Snow Goose	0.2	0.0	0.9	4.0	0.0	0.1	0.3	0.7	0.5	0.9	0.5	0.2	0.1	2.6	0.6	29.3	0.5	2.6	3.8	14.7	1.0	3.0
Black Brant	8.9	4.0	11.4	18.3	3.8	2.4	10.0	12.8	4.6	13.4	7.1	16.3	11.1	8.1	1.1	22.0	10.2	12.9	5.3	15.6	6.0	9.8
Total Geese	176.2	116.3	116.3	173.2	106.6	133.4	160.1	118.6	102.1	105.6	159.3	213.1	172.8	250.6	164.3	230.6	140.4	135.0	162.4	180.9	138.9	155.1
Swans	6.7	7.2	6.9	10.5	6.2	7.3	9.7	6.9	9.0	8.8	10.5	13.6	12.6	16.1	17.2	10.5	9.4	9.1	8.7	12.0	10.2	10.0
Pacific Loon	23.0	23.8	31.3	27.7	23.7	29.6	20.1	27.9	26.6	36.3	32.2	34.2	29.9	34.2	20.0	22.2	22.7	22.5	22.9	25.0	29.1	26.9
RT Loon	3.1	2.4	2.2	1.7	3.7	3.4	1.8	1.8	2.9	2.2	3.5	2.2	3.0	5.3	4.6	5.3	2.9	3.6	4.2	3.0	5.1	3.2
YB Loon	3.2	1.5	1.9	3.3	2.1	3.4	3.1	2.6	3.4	4.3	5.0	3.1	3.6	3.1	2.5[c]	1.3	1.9	3.3	2.3	1.9	1.7	2.8
Common Loon	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unidentified Loon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	0.6	0.3	0.0	0.0	0.0	0.0	0.4
Total Loons	29.3	27.8	35.5	32.7	29.5	36.4	25.2	32.4	33.0	42.8	40.7	39.4	36.4	42.6	33.6[d]	29.5	27.9	29.4	29.4	29.9	35.9	33.3
Jaegers	9.4	6.6	12.8	3.5	8.8	9.1	7.1	9.1	5.6	4.4	7.7	6.9	7.1	6.3	5.2	5.9	5.3	6.7	4.8	5.8	13.1	7.2

[a] Includes all scoters identified and unidentified

[b] -- Indicates that observations of this species not delineated during that year

[c] Estimate based on left-observer data only

[d] Number based on all loon observations from left and right observer

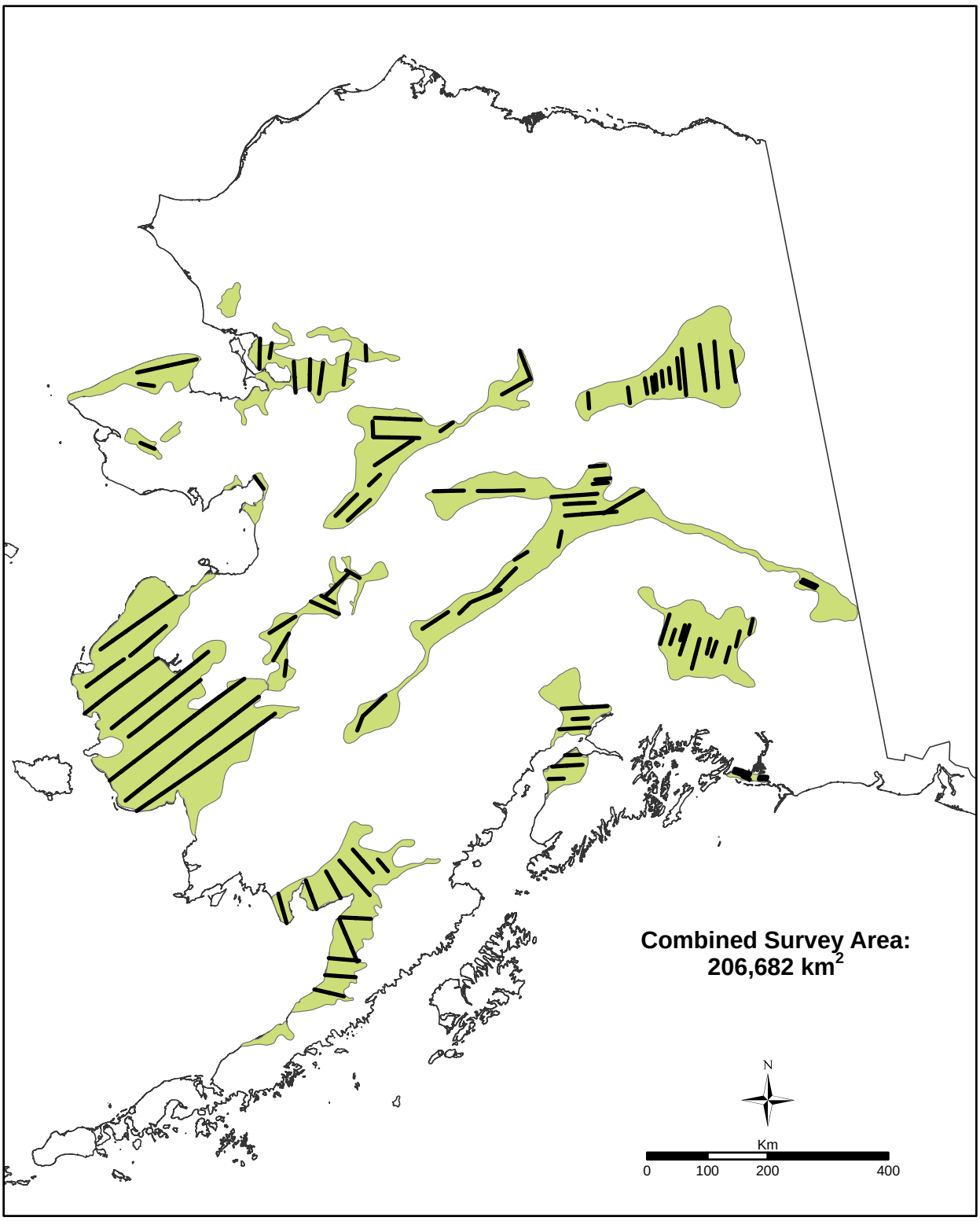

Figure 1. Traditional Waterfowl Breeding Population Survey in Alaska, with transects and approximate traditional survey areas. Areas were delineated from 1:1,000,000 scale aeronautical maps (WAC) in the 1950's.

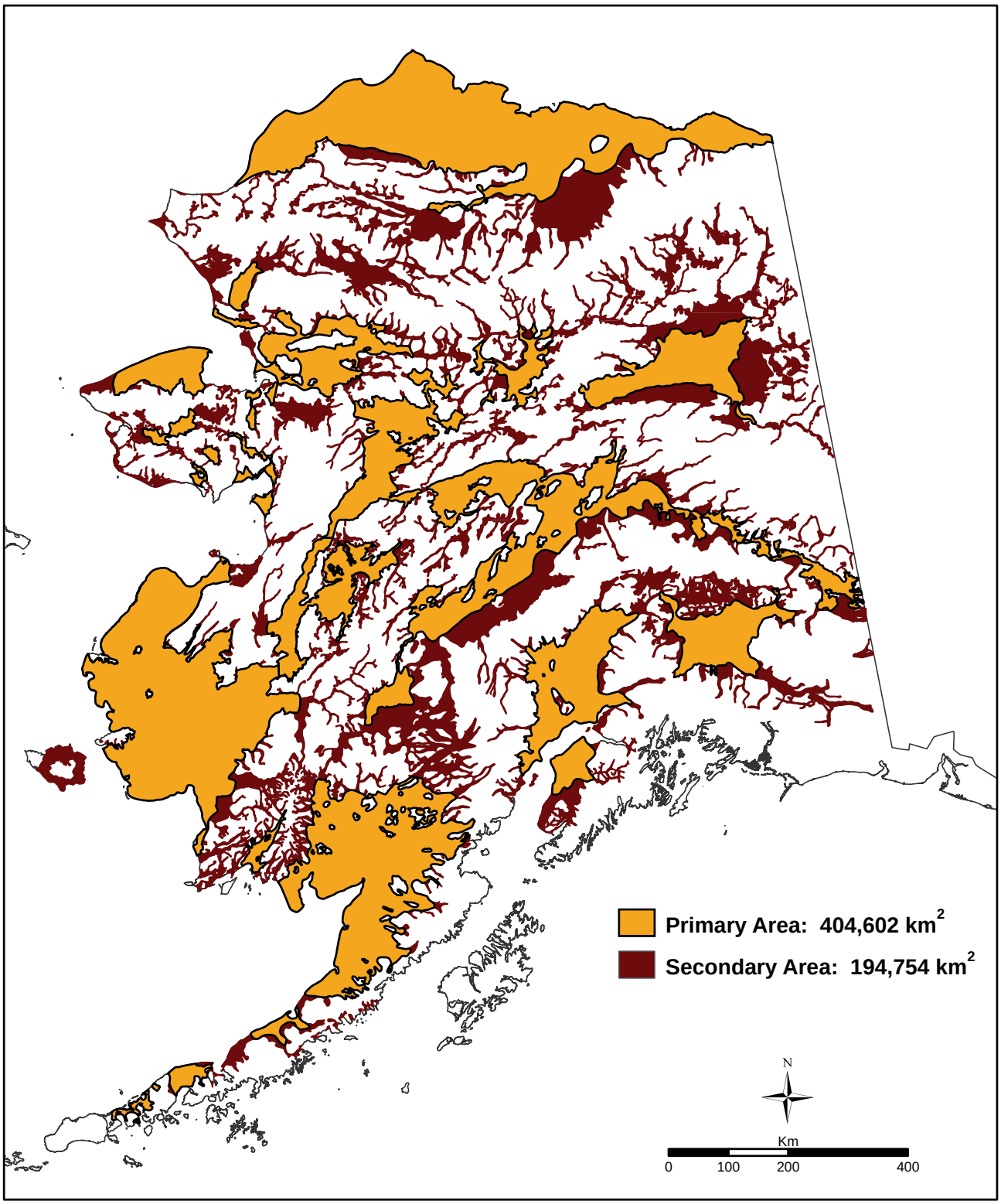

Figure 2. Primary and Seconday waterfowl habitat areas in Alaska (minus South Coastal habitat). Areas were delineated from 1:250,000 scale U.S. Geological Survey maps.

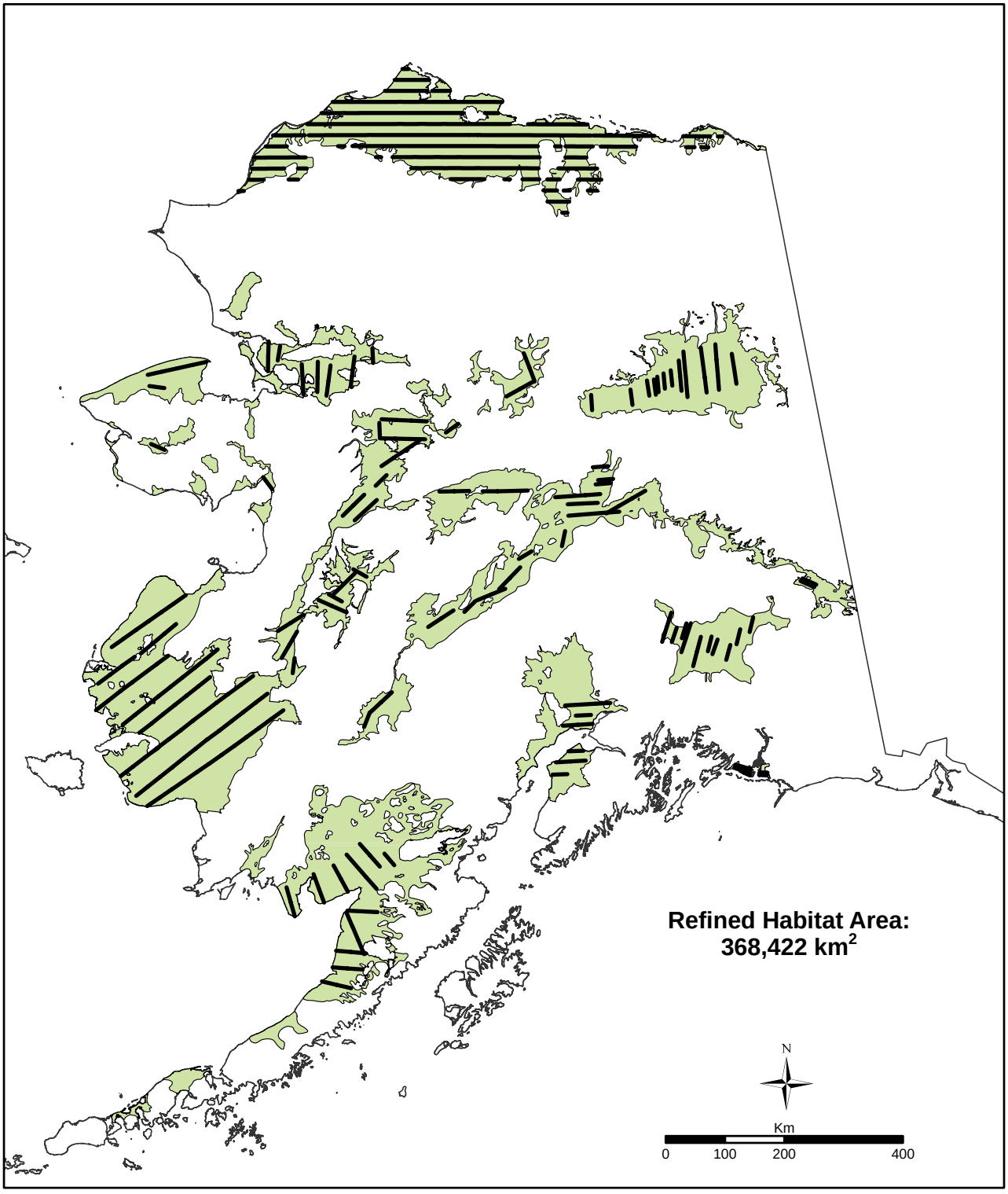

Figure 3. Refined waterfowl habitat areas in Alaska (minus South Coastal habitat), with traditional and Arctic Coastal Plain survey transects. Areas were delineated from 1:250,000 scale U.S. Geological Survey maps.

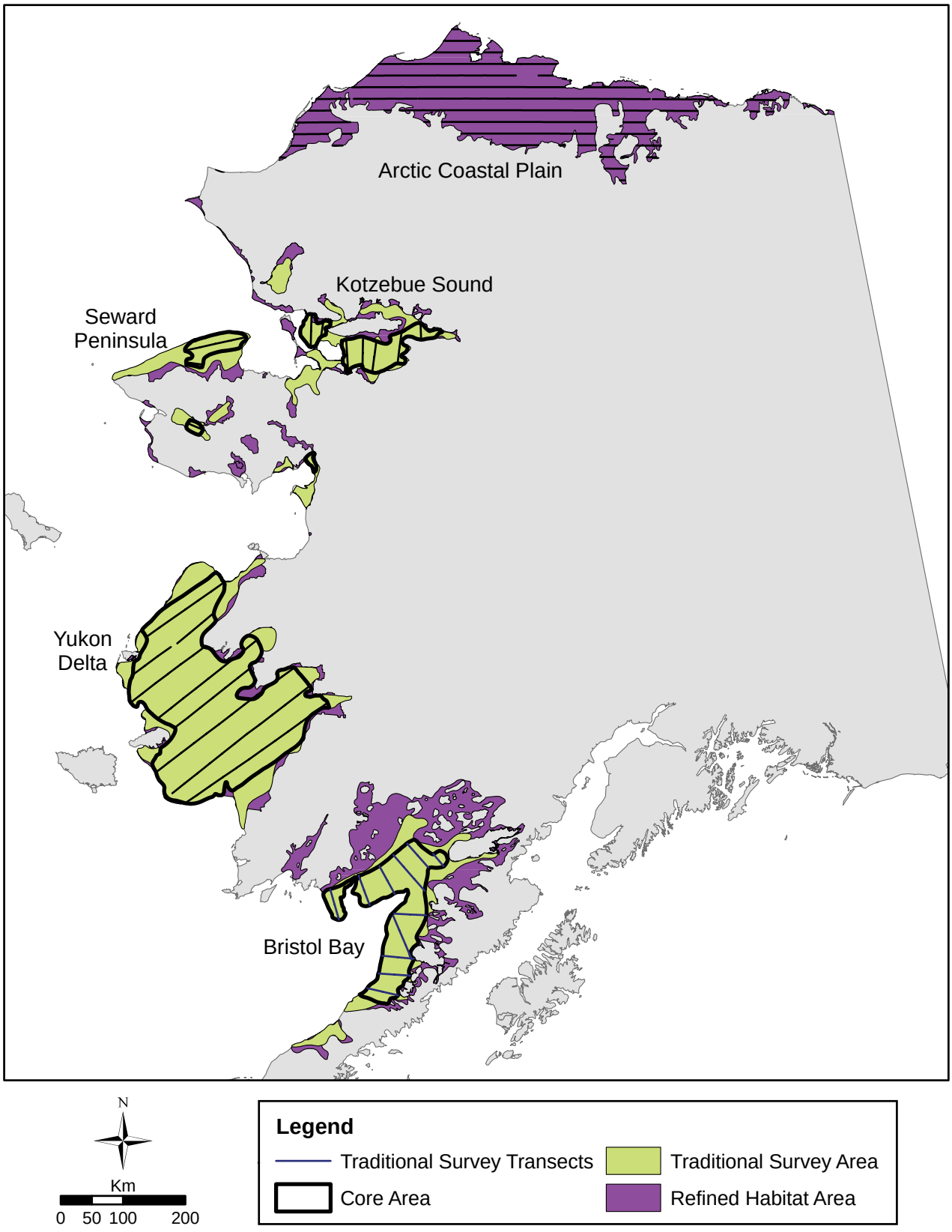

Figure 4. Areas of subarctic and arctic tundra waterfowl breeding habitat in Alaska.

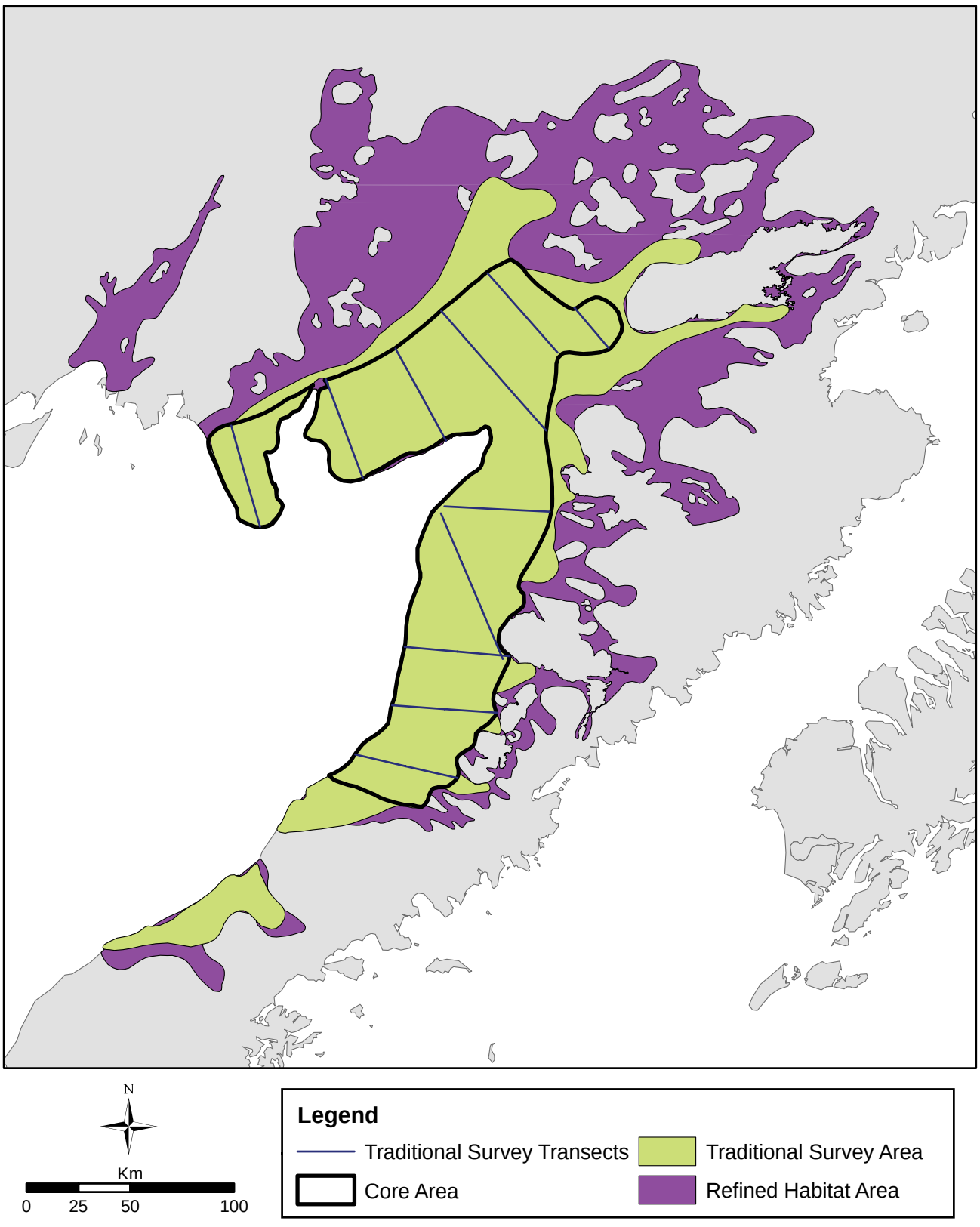

Figure 5. Bristol Bay survey area showing the traditional survey transects, core area, traditional survey area, and refined habitat area.

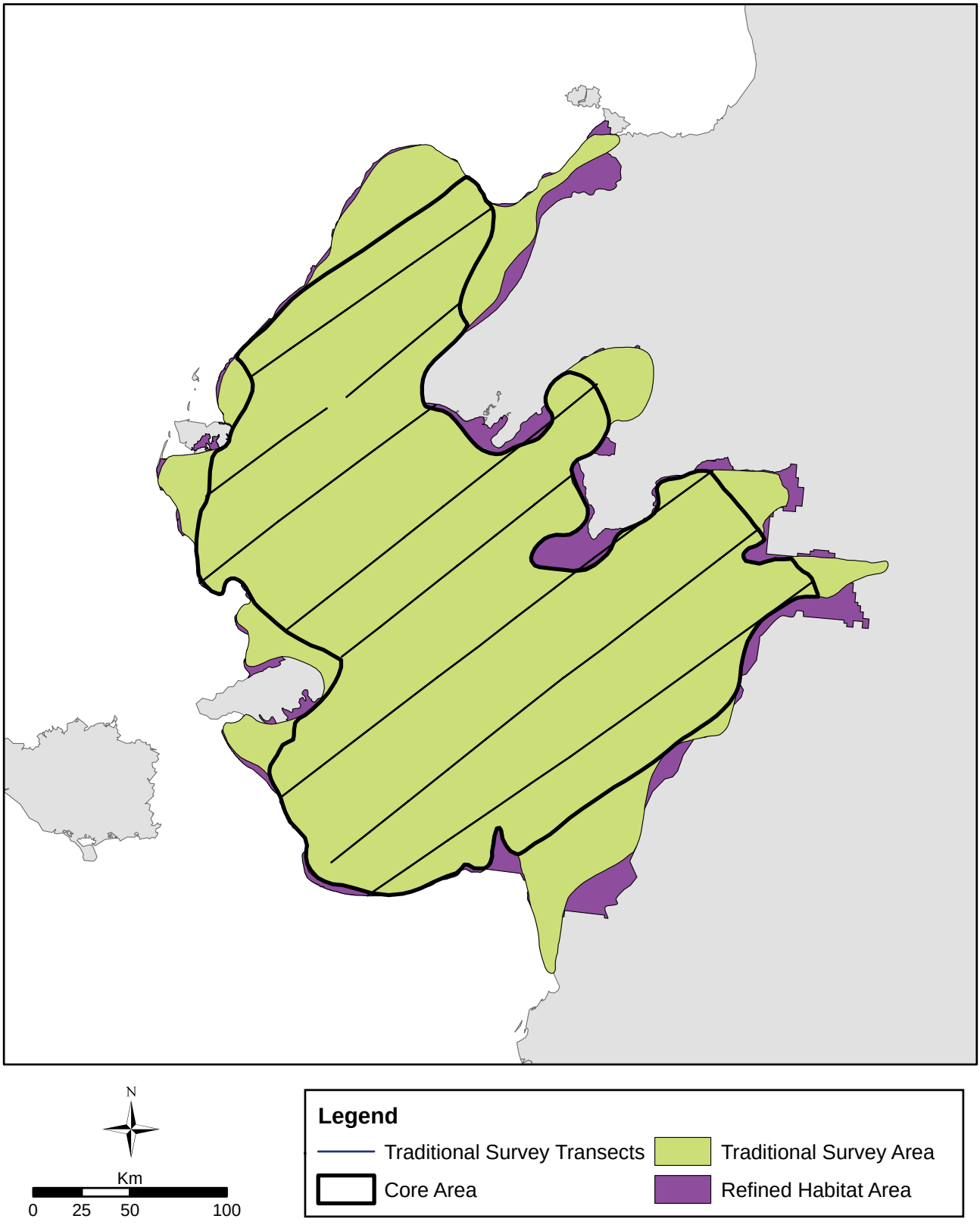

Figure 6. Yukon Delta survey area showing the traditional survey transects, core area, traditional survey area, and refined habitat area.

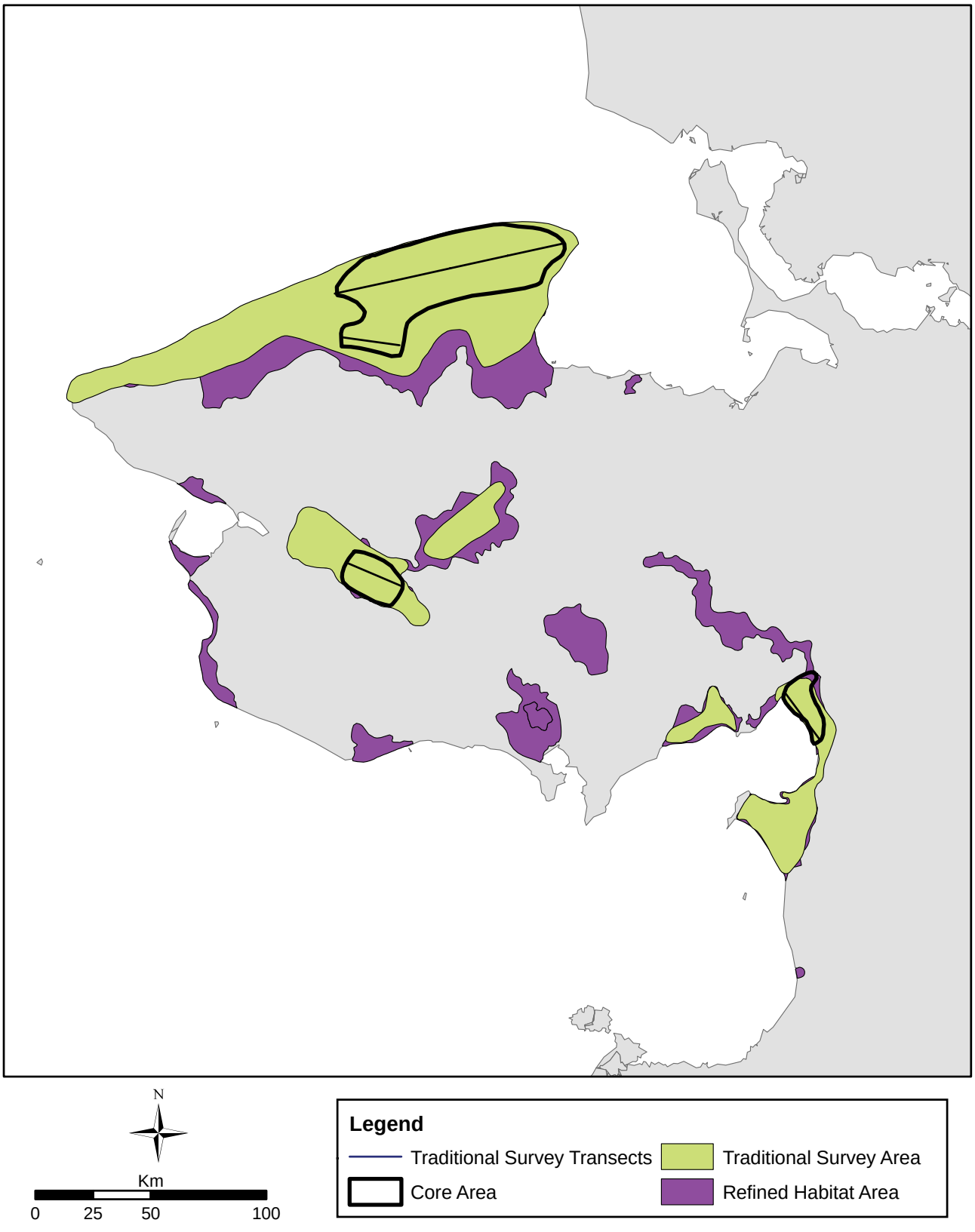

Figure 7. Seward Peninsula survey area showing the traditional survey transects, core area, traditional survey area, and refined habitat area.

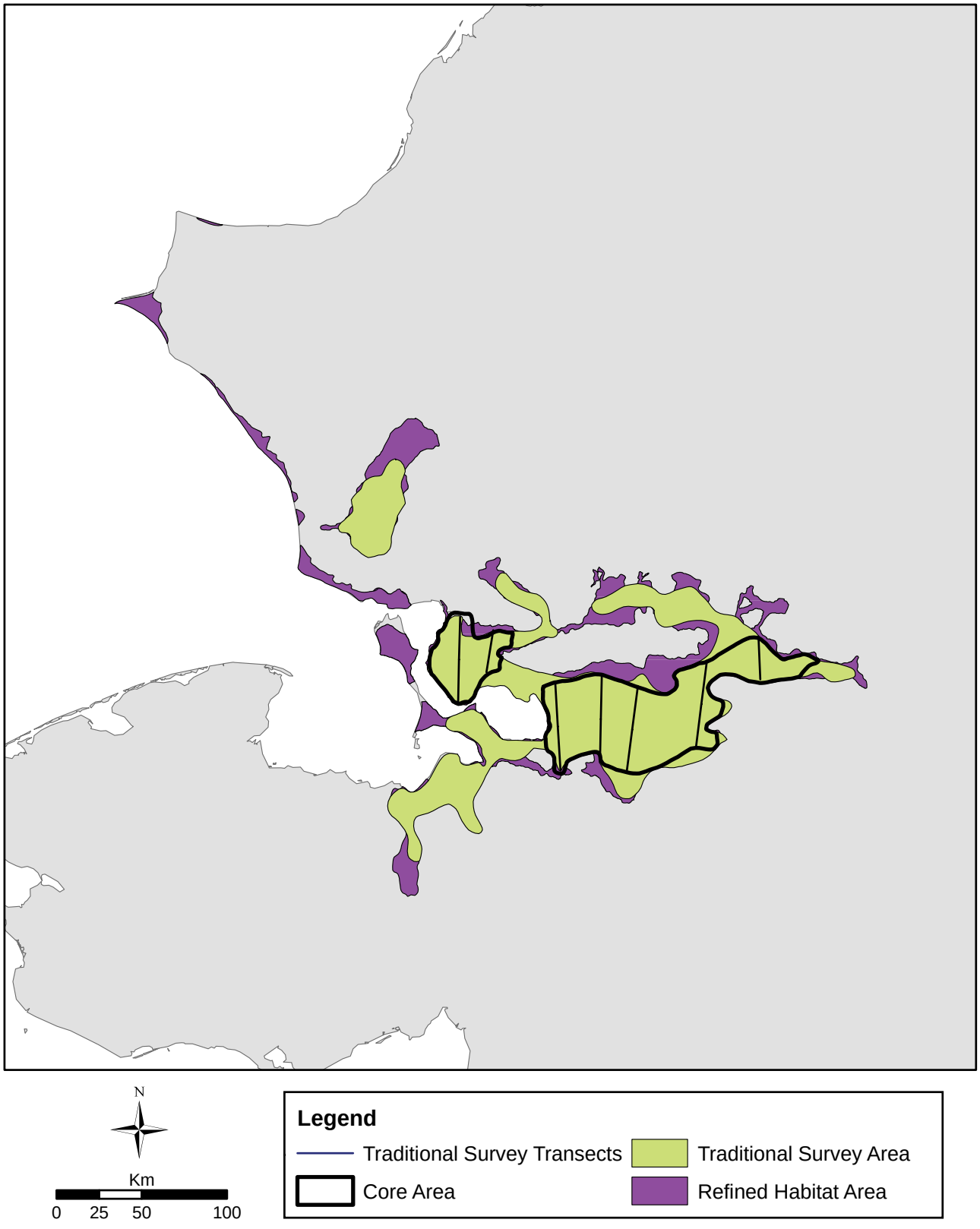

Figure 8. Kotzebue Sound survey area showing the traditional survey transects, core area, traditional survey area, and refined habitat area.

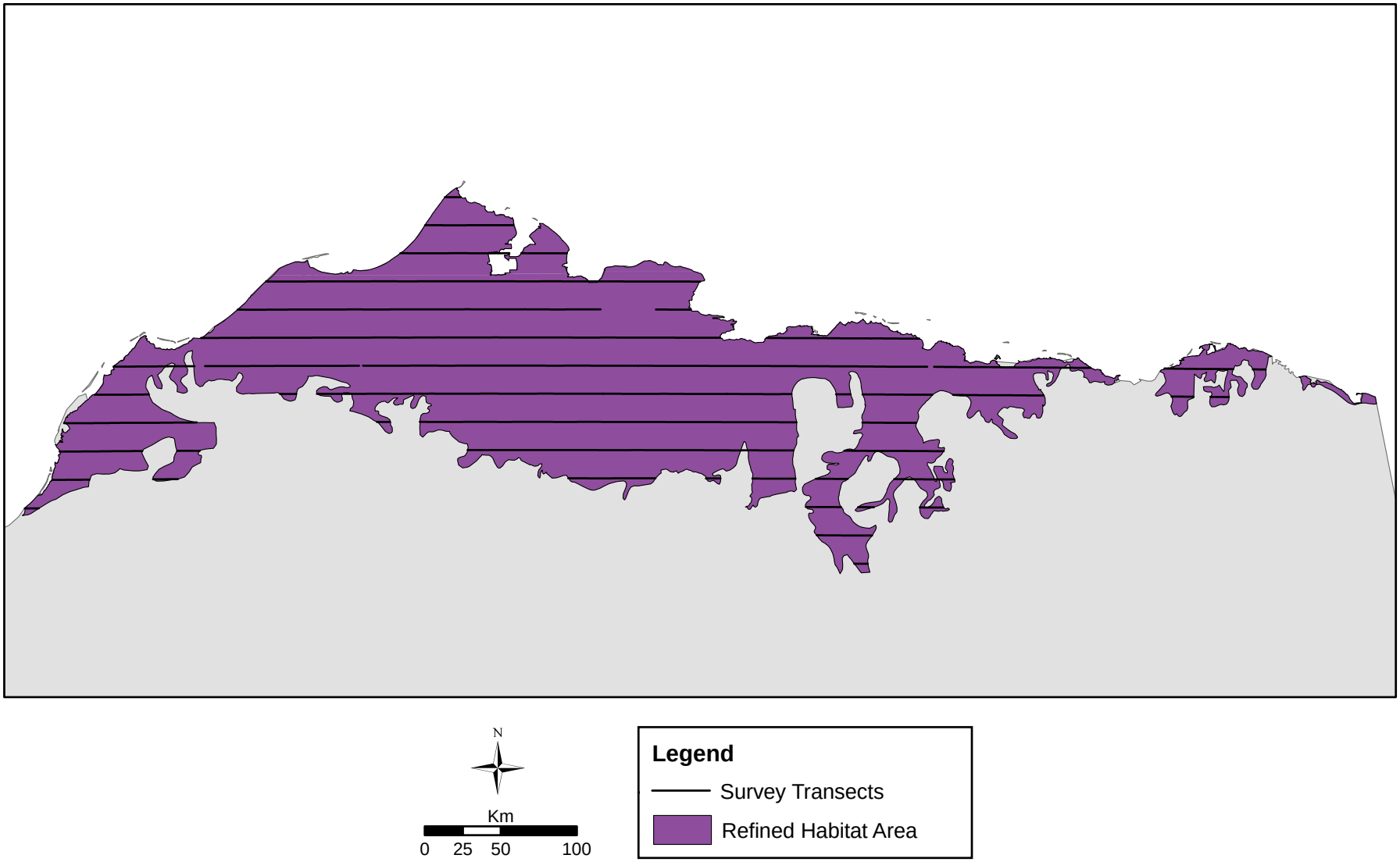

Figure 9. Arctic Coastal Plain survey area showing the ACP survey transects and refined habitat area.

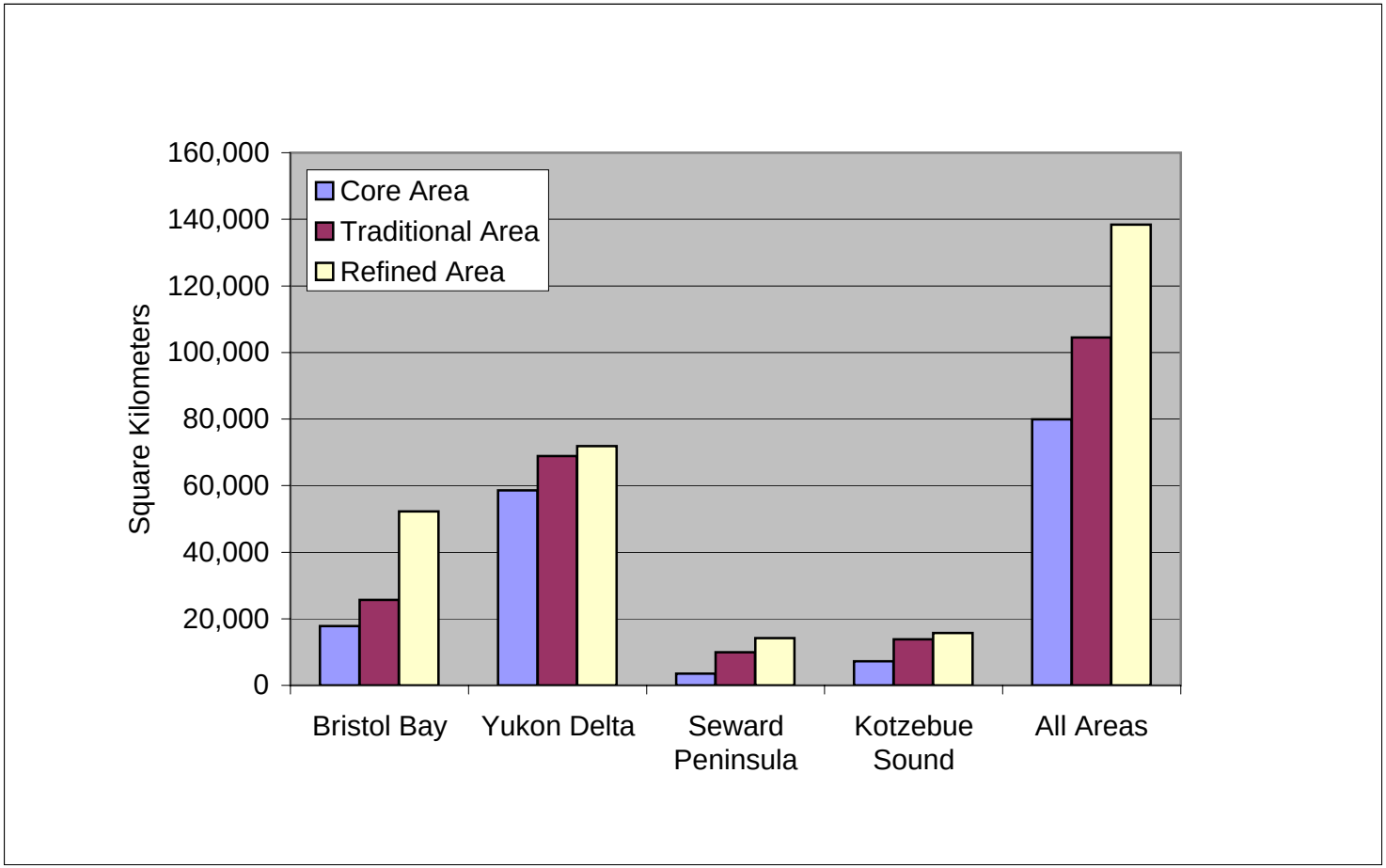

Figure 10. Comparison of three measured areas of waterfowl breeding habitat in western tundra of Alaska.

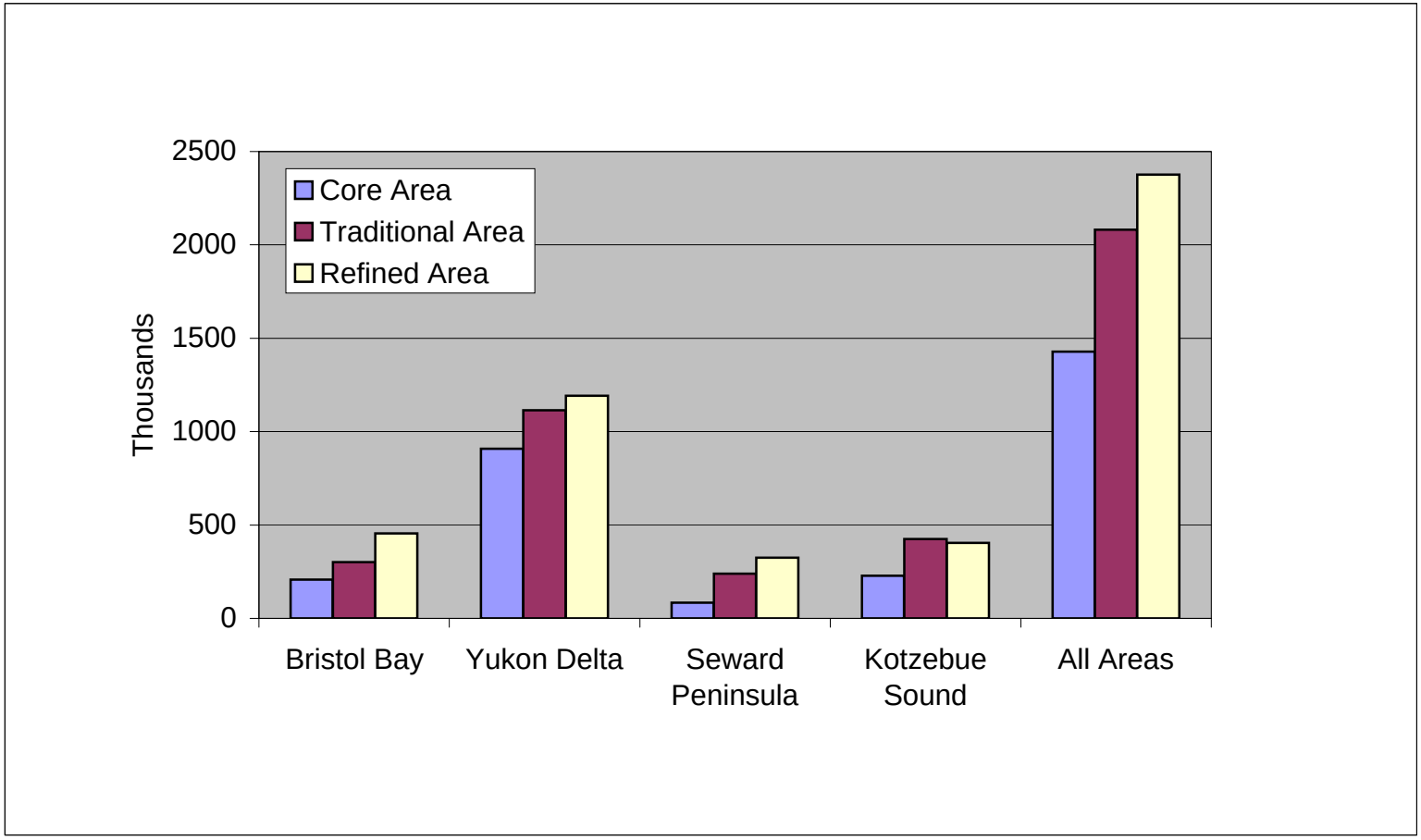

Figure 11. Comparison of average total indicated duck population estimates for three measured areas of waterfowl breeding habitat in western tundra of Alaska.