WATER BIRD ABUNDANCE AND DISTRIBUTION IN THE BRISTOL BAY REGION, ALASKA

by

Robert M. Platte

and

William I. Butler Jr.

U.S. Fish and Wildlife Service
Migratory Bird Management Project
1011 East Tudor Road
Anchorage, Alaska 99503

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ABSTRACT

We flew aerial surveys to estimate abundance and delineate distribution of water birds in late May 1993 and 1994 in the Bristol Bay region (BBR), Alaska. We estimated about 360,000 ducks, 4,000 geese, and 4,000 loons were present on BBR, 1993-1994. Scaup were the most numerous duck species each year, comprising 27% of the duck population. Other abundant species included northern pintails, black scoters, green-winged teal and mallards. Coefficients of variation for population indices of abundant species were 10-15%.

We used a computerized geographic information system (GIS) to map water bird densities. Most species showed a highly patchy distribution reflecting the patchiness of habitat in the survey area. Scaup and black scoters occurred in relatively large, widely distributed patches whereas mallards, pintails and teal occurred in small patches scattered throughout the survey area. Wetlands along the upper Alaska Peninsula between Naknek and Pilot Point contained the highest densities of water birds in the survey area. Density distribution maps are presented for abundant species.

Our aerial survey design and GIS analyses provide detailed water bird abundance and distribution information. Results can be compared to the North American Waterfowl Breeding Population Survey data in the BBR to evaluate both surveys and to design subsequent surveys to meet specific objectives. Density maps can be used as data layers for creating stratified survey designs and examining relationships between remotely sensed habitat data and water bird distribution.

INTRODUCTION

An aerial waterfowl breeding population survey was initiated in 1957 and has been conducted annually in the BBR as part of the North American Waterfowl Breeding Population Survey (NAWBPS) (Conant and Groves 1992). The purpose of the NAWBPS is to provide population indices for use in developing waterfowl harvest regulations. Intensity of coverage in the BBR by this survey is limited because the BBR is only one of 12 strata surveyed annually by one crew in Alaska and the Yukon Territory. In the BBR, the NAWBPS consists of 11 transects totaling 592 km. Transect placement was based on landmarks as aids in navigation to facilitate annual repeatability of the survey. Consequently, important habitats may not have been adequately sampled, or conversely, could have been oversampled. Hence non-random placement of transects may result in biased estimates of bird abundance. Also, because NAWBPS data are recorded by 16 mile segments along each transect, the data provide limited information on water bird distribution.

Within the last 10 years, several improvements and advancements in technology have been incorporated into designing and conducting aerial surveys and analyzing data in Alaska by Migratory Bird Management. We began by using a statistically valid standard survey design with systematically spaced transects following suggestions of Caughley (1977). We developed a geographic information system consisting of custom True BASIC programs and PC ARC/INFO software which allows us to generate a set of transects for any geographic area and plot them on topographic maps for use in the aircraft. Use of LORAN and now, Global Positioning System (GPS) instruments, enabled us to accurately navigate systematic transects. We also used a technique to obtain geographic coordinates of every bird observation using continuously running cassette recorders and a computerized data entry program described by Butler et al. (1995a). Bird location data entered into the GIS allowed mapping of species density (Butler et al. 1995b). Additional analyses allow for developing stratifications for population estimates or overlays for correlation with habitat information.

This system has been used on Yukon Flats National Wildlife Refuge (Platte and Butler 1992), Yukon Delta National Wildlife Refuge (Balogh and Butler 1994) (Platte and Butler 1993), Copper River Delta (Butler and Eldridge 1991), the west coast of Alaska, and the arctic coastal plain of Alaska (Brackney and King 1993) (Larned and Balogh 1993). Improvements that have resulted include increased precision in population indices, greater resolution in density distribution maps, calculation of population indices on federal versus non-federal land, and identification of habitat selection by different species.

The objectives for the expanded aerial breeding population survey on BBR were:

1. Estimate the abundance of water birds.

2. Delineate the distribution of water birds.

3. Compare the new survey design with the historic design.

Comparison of the expanded breeding population survey results with those of the NAWBPS and development of an improved survey design will be addressed in a future report.

STUDY AREA

The Bristol Bay region is located in southwest Alaska (Fig. 1). The survey area extended 460 km north to south and 380 km east to west and occupied about 50,000 km^2 between the Ahklun Mountains and Bristol Bay on the west and the Alaska and Aleutian mountain ranges on the east. The area has a moderate polar maritime climate characterized by high winds, mild temperatures, cloud cover and frequent precipitation. No sharp distinction occurs between seasons because of the influence of surrounding oceans. Ice breakup generally occurs in May and ponds usually freeze by mid-October to early November.

The mountains along the edge of the survey area give way to a vast basin which slopes to a flat coastal plain along Bristol Bay (Michel et al. 1982). The basin includes rolling hills, flat upland tundra, and large glacial lakes and rivers. The plain bordering Bristol Bay varies from 15 - 76 m in elevation along the coast to 90 - 150 m further inland (USFWS 1976). It also varies in width from 16 - 80 kms and contains numerous thaw and morainal lakes. Wibbenmeyer et al (1982) described 10 major land cover types based on satellite imagery interpretation for the Bristol Bay region.

The large lagoons along the south shore of Bristol Bay provide critical habitat for brant, cackling Canada and Taverner's Canada geese, emperor geese, and Steller's eiders during migration. Other species of ducks such as northern pintails, scaup, scoters and green-winged teal also use the coastal lagoons. Prior to this survey, information on use of the Bristol Bay region by breeding waterfowl has been limited to the annual aerial breeding pair surveys.

For further information about the Bristol Bay region, see Arctic Environmental Information and Data Center and Institute of Social, Economic and Government Research (1974).

METHODS

Aerial survey technique

The traditional NAWBPS transects are shown in Figure 2. For the expanded survey, we used a True Basic program and PC ARC/INFO to generate systematically spaced transects from a random coordinate. Transects were oriented east-west along great circle routes and totaled 7,167 km (Fig. 3). Systematic sampling was appropriate for the dual objectives of mapping distributions and estimating total numbers when accuracy of the estimate's standard error was not critical (Caughley 1977). We eliminated portions of transects over non-wetland habitat, divided transects into 14.8 km segments and plotted transects and segments on 1:250,000 scale topographic maps for use in the aircraft.

Because time was insufficient to fly all transects in one year, a different set of transects was flown each year. Total length of transects flown annually was about 3,500 km. Distance between transects was about 15 km each year. When the 2 sets of transects were combined for distribution mapping, spacing between transects was about 7.5 km. Each year, the transects sampled about 1,300 km^2 (3%) of the 50,000 km^2 survey area.

Survey methods followed the conventions established for breeding ground surveys in North America (USFWS and CWS 1987). Surveys coincided with egg-laying or early incubation stages of breeding waterfowl. Survey dates were as follows: 28-31 May, 1993 and 25-28 May, 1994. Aircraft were flown at 137 to 153 km hr^{-1}, 30 to 46 m of altitude, with wind speed < 24 km hr^{-1}, with ceilings > 152 m and with visibility > 16 km. Pilots used global positioning systems and the survey maps to maintain a precise course while flying transects. The same three pilot and observer teams (R. King, A. Brackney, W. Butler, R. Platte, W. Larned, and G. Balogh) flew the transects each year.

Pilots and observers each recorded transect numbers, segment numbers, segment start and stop points, direction of flight and bird observations on continuously running cassette tapes. Birds observed in a 200 m strip on each side of the aircraft were identified to species and counted as a single, pair, or flock.

Geographic coordinates of each observed bird were captured using a technique developed by Butler et al. (1995a). Tapes were replayed and data were entered simultaneous with the recording into a computer in real time using a True BASIC program. Distances along segments to observations were calculated based on elapsed time to an observation in proportion to elapsed time to fly the segment of known length. These observation distances were then converted to geographic coordinates using another True BASIC program.

Population indices

We calculated densities, population indices and variability for each species in each year using a ratio estimate described by Cochran (1977). Mean indices were also calculated from pooled 1993-1994 data to determine the relative importance of particular species and species groups. Indices were based on indicated total birds: 2*(S+P)+F where S = number of single birds observed, P = number of bird pairs observed, and F = number of birds in flocks. For ducks, a single male was assumed to represent a breeding pair with the nesting hen not easily observable. Single male ducks were doubled for all observed species except scaup. Single observations of other water bird species (geese, swans, cranes, grebes and loons) were not doubled. Population indices were corrected for visibility bias using correction factors from Conant and Groves (1992) (Table 1). Indices for other water bird species were not corrected for visibility bias.

Population index variance was based on the variation among sampling units defined as entire transects. Segments were not used in calculation of variance nor was any stratification employed in the analysis. The additional variance associated with visibility correction factors was not included in our calculations.

Water bird distribution

We produced water bird density distribution maps from combined 1993-1994 data using a technique developed by Butler et al. (1995b). Geographic coordinates of observed birds were calculated in True BASIC by combining transect position and length files with bird observation files. Another True BASIC program used a moving average technique (Eberhardt and Thomas, 1991) to calculate bird density in blocks of specified area at specified regular intervals along each transect. The resulting location and density data were input into PC TIN, a 3-dimensional terrain modelling software package. Isopleth maps of water bird density for abundant species were generated. Density values were based on indicated total birds uncorrected for visibility bias.

RESULTS AND DISCUSSION

Population indices

We estimated an average of 355,172 ± 48,106 ducks, 4,255 ± 2,930 geese and 3,693 ± 914 loons (mean ± 95% CI) in the Bristol Bay region (Tables 2-4). Mean density for scaup was about 2/km^2 and northern pintails about 1/km^2 (Table 4). Total duck densities averaged 7/km^2 on BBR. Scaup were the most abundant ducks in both years averaging over 90,000 birds; about 27% of the estimated BBR duck population. The species composition of the remainder of the duck population was: 15% northern pintail, 14% green-winged teal, 13% black scoter, 12% mallard, 5% American widgeon, 3% northern shoveler, 3% goldeneye, 2% red-breasted merganser, and 1% oldsquaw. The goose population was comprised of 55% white-fronted geese and 45% Canada geese. There was no significant difference (i.e. no non-overlapping confidence intervals) in population size for any species between 1993 and 1994. Coefficients of variation for the dabbling duck species, except for gadwalls, ranged from 11 - 15%. Variability was also relatively low for scaup and black scoters at 10 and 11%, respectively. All other species had fairly high coefficients of variation.

Population indices for abundant species such as northern pintails and scaup were less variable than those for scarcer species. Observers were constant throughout the survey and teams surveyed the same areas each year thus minimizing variability from this source. Coefficients of variation were relatively low for abundant species despite the variability of the habitat in the survey area. However, some sort of stratification by land cover or habitat would likely improve the precision of our indices.

Lensink and Rothe (1986) reported that duck densities obtained by aerial survey were similar between the BBR and Yukon Delta National Wildlife Refuge. Total duck density on BBR during 1993-1994 averaged about 7/km^2 whereas average density in the Yukon Delta area from 1989-1992 was about 16/km^2 (Table 5). The Bristol Bay region was comparable to the arctic coastal plain of Alaska for overall density of ducks (Table 5).

Water bird distribution

We obtained over 7,000 geographic locations of birds during the 2 years of the survey. Water bird distribution has been mapped for the major species occurring in the BBR (Appendices 1-13). Water birds were widely scattered throughout the survey area, reflecting the patchiness of the habitat. Scaup and black scoters tended to have more widespread continuous distributions whereas pintails, mallards and teal occurred in smaller disjunct patches.

Establishing correlations of density classes with habitat or land cover types could allow identification of high quality, but presently unoccupied, habitat. It may also be possible to incorporate land cover classifications into designing surveys or stratifications for analyzing survey results .

SUMMARY AND RECOMMENDATIONS

Accurate water bird abundance and distribution information over large geographic areas provides baseline information for management decision-making. Annual surveys would allow detection of change in abundance and change in distribution of species. The information can be used for land acquisition planning, mitigation planning, permit reviews, harvest regulation, and identification of unique ecological areas. Waterfowl density maps for the Yukon Delta and Yukon Flats National Wildlife refuges have been incorporated into the Division of Realty Acquisition Priority System model for ranking private lands within refuges for acquisition.

Two aerial survey designs have been used in the BBR. Analyses should be conducted to compare the results from the designs. This information is important for developing future survey designs to meet specific objectives.

Water bird distribution and abundance have been mapped on many of the important wetlands in Alaska using the survey techniques and geographic information system developed by Migratory Bird Management. However, important areas that have not been intensively surveyed remain. These areas are generally smaller than those already surveyed. An individual area could thus be sampled in one year, given adequate time, personnel and aircraft availability, at sufficient intensity for detailed distribution mapping. It is recommended that expanded surveys be conducted in these areas to contribute to a standardized water bird database for the State of Alaska.

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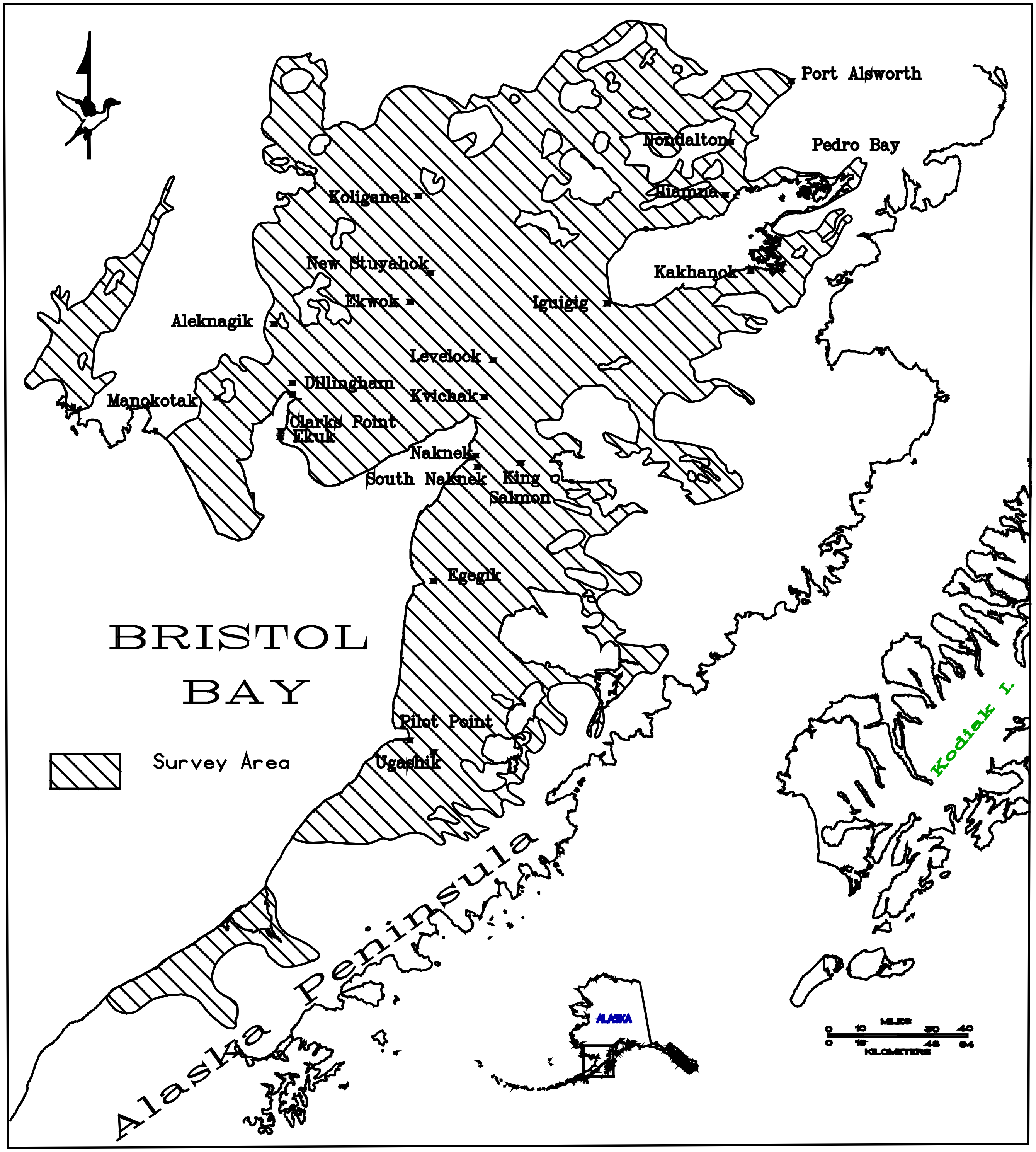

Figure 1. Location of survey area in the Bristol Bay region of Alaska.

Figure 2. Location of traditional breeding pair survey flightlines.

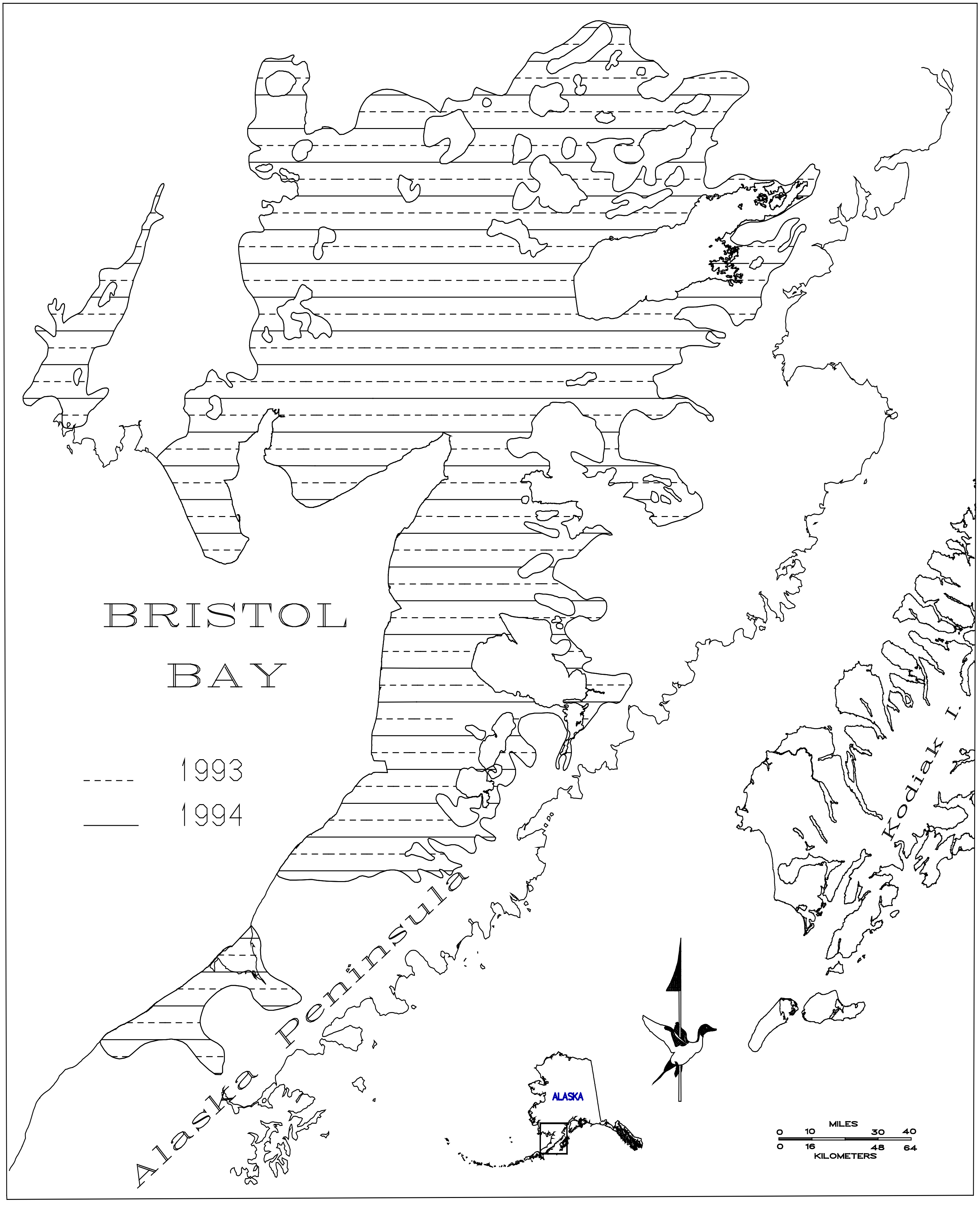

Figure 3. Location of flightlines on the survey area in the Bristol Bay region, Alaska.