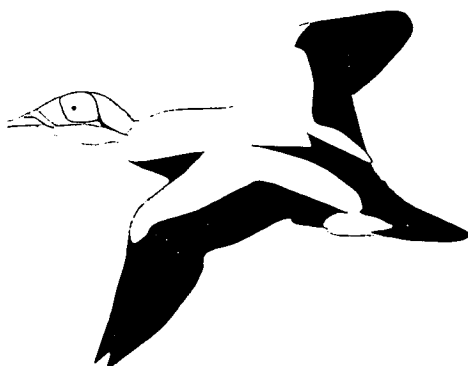


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SPECTACLED EIDERS (*Somateria fischeri*)
IN THE BERING SEA
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by

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Abstract.

We conducted aerial surveys in the northern Bering Sea in late winter 1995, 1996 and 1997 to estimate the population of spectacled eiders (*Somateria fischeri*) wintering together in a cluster of large flocks. Annual estimates, based on visual and photographic census techniques, varied from 148,059 to 363,030 birds. In 1998, to address the question of replicability, we conducted two surveys, on 11 and 21 March. The first of these surveys, under favorable survey conditions, produced an estimate of 374,792 (95%CI = 371,278-378,305) birds, which was not significantly different than the 1997 estimate. The estimate for the second survey was 282,311 (95% CI = 279,300-285,322), which was significantly lower. During this survey several of the large flocks observed were seen flying toward the area yet to be surveyed, so the crew elected not to record them to avoid the possibility of double counting. It is possible that these birds were never counted during the survey, which could account for the discrepancy between the two 1998 surveys. We experimented with lower altitude photography and found we were able to distinguish hatching-year males from females and older males, but were not able to obtain a representative sample of the surveyed population due to fuel limitations and other priorities. Techniques used were similar to previous years except that in 1998 instead of the slides being projected onto a white counting surface, they were digitized and counted using personal computers with photo processing software. The actual counting process consisted of hand counting on the screen using a projected counting grid and tally-counter. We attempted using an automated dot-counting programs to rapidly and precisely estimate flocks, but found that it is impractical to use with our oblique photographs.

Key Words: waterfowl, spectacled, eider, *Somateria fischeri*, aerial, survey, Bering Sea, Alaska

INTRODUCTION

Prior to 1993, the location and characteristics of habitats used by spectacled eiders (*Somateria fischeri*) outside of the breeding season were largely unknown. From 1993 through 1995 we conducted aerial surveys of known or suspected molting and wintering areas, in an effort to evaluate the relative importance of these habitats (Larned and McCaffery 1993, Larned et al. 1995a, b, c, d). The systematic searches were initially based on location data from a telemetry study in which satellite transmitters were surgically implanted into spectacled eiders on breeding grounds in Alaska and arctic Russia, and followed via ARGOS data for several months (Petersen et al. 1995). Interpretation of these survey and telemetry data led us to speculate that a major portion, if not the entire global population of this species wintered together in openings of the sea ice south of St. Lawrence Island. If we were correct, this fortuitous phenomenon provided a unique opportunity for periodic total counts of the world population of this species of concern. Therefore, having doubts that the 1995 count of 148,059 (95%CI = 137,136-158,982) represented the total wintering population, we conducted additional aerial surveys in March of 1996 and 1997. The highest estimate from these efforts was an aerial photographic count of 363,030 (95%CI = 333,526-392,532) on 8 March 1997 (Larned and Tiplady 1997). These birds were concentrated in the same location in 1996 and 1997. Due to the discrepancy among annual counts, the issue of replicability came into question, so in late winter 1998 we attempted two surveys. This paper reports the results of those efforts.

METHODS

Since we had no satellite telemetry data for 1998 on which to base our surveys, we simply flew a search grid based on 1996 and 1997 flock locations, assuming persistence of the birds in that area. The surveys were simple adaptive censuses, similar to those conducted in 1995, 1996 and 1997 (Larned and Tiplady 1997). The survey crews consisted of pilot Douglas Burts for both surveys, with forward right observer and photographer Bill Larned, and left rear observer Christian Dau for the 11 March survey, and, for the 21 March survey, Tim Tiplady as forward right observer and Michael Wege as left rear observer. We used the same chartered Aero-Commander Model AC-50 high-winged twin-engine aircraft which we flew at 222 km/hr (120 kts) and 123-246 m (400-800 ft) altitude. This aircraft is equipped with a removable 60-U.S. gallon auxiliary fuel tank in the baggage compartment, for extended range on long offshore flights. Observations were made as far out from the aircraft as we could detect flocks, a distance which varied from about 2 to 10 km depending on flock densities, water surface conditions, presence of sun glare, and atmospheric conditions. During both surveys we strayed freely from the survey lines to closely examine each open lead visible from the flight path, resulting in complete coverage of open water within the systematic search grids. We used image-stabilized 12X36 binoculars to examine distant open leads for the presence of birds. When a flock was detected by either observer, the aircraft was maneuvered to put the birds on the starboard side. The photographer took photos obliquely through the open window, while the rear observer shifted over to the starboard side to make a visual estimate, which was recorded into a cassette tape recorder.

Our primary navigation instrument was a GPS with a grid-plotting feature which automated laying out and navigating a search grid. We recorded the flight path using a GPS data-logging program called GPSTRAK8 (Anthony and Stehn 1994). The output file contained position coordinates, logged at 3- or 4-second intervals, and the current time for each position, from the computer clock. Coordinates for each observation of eiders were obtained indirectly by recording the exact time of the observation, from

a watch synchronized with the computer clock, into audio tapes. The observations were then entered into the track file by matching corresponding times. We then mapped flight paths and locations of observations using Atlas GIS software.

We photographed eider flocks using a 35 mm camera with motor drive and 28-105 mm variable focal length lens, with 200 ISO color slide film. The camera was equipped with a data imprinting system which was set to record the date and time of each photograph, allowing us to match each photograph with a location from the recorded flight path. In previous years we counted birds in photographs by projecting the color transparencies onto 27 inch X 34 inch white paper ("flip charts") or erasable "white blackboards" using a standard slide projector with zoom lens and remote control. We drew a grid of parallel lines through each flock, and counted birds between the lines using a hand tally counter. To avoid double-counting areas of overlap between slides in multi-frame sequences we either marked directly on the slides using a fine permanent marker, or projected adjacent slides simultaneously using two projectors and drew match lines on the projected images. Total birds were counted in flocks photographed in flight. However, in sitting and swimming flocks, only birds showing white (adult or subadult male) plumage were counted, because the dark plumage of females and first-year males was difficult or impossible to see against the dark water on many slides. A sub-sample of images that were sharp and clear enough to show all of both brown and white birds was selected and used to generate a ratio from which to correct the male-only counts to obtain an estimate of total birds. The variance of this ratio was calculated using the formula presented in Cochran (1963) for cluster sampling for proportions, with each slide as the sampling unit.

In 1998 we processed some of the images as in previous years, but had most digitized and stored on CD-ROMs, then cropped areas of overlap and manipulated scale and contrast using photo processing software on a personal computer. We then used a computer-generated grid overlay to count the birds on the screen with a hand tally-counter. This substantially reduced fatigue, created a permanent record of each counted flock, and perhaps saved some processing time. We also evaluated dot-counting programs to estimate the flocks, but determined that we would need at least a 50% random sample to achieve a 5% maximum error rate. Also, due to variation of relative bird size across the image resulting from the oblique exposure angle, and other variables, the time required for preparation, processing, and analysis would be greater than that required for the tally-counter method, and with less reliable results. Good quality vertical imagery would solve most of those problems, but would add exponentially to the cost.

Since some interpretation was necessary to distinguish individuals in large dense flocks, there was a potential for differences among photo interpreters, so we ran a simple test of bias between the two primary image counters. We did independent counts of three images using the computer-assisted tally count method described above, with the results shown in Table 1 below:

Table 1. Results of counts of birds in aerial photographs by two independent observers, Spectacled Eider Surveys, north-central Bering Sea, Alaska, March 1998.

	Observer 1	Observer 2	% difference obs1:obs 2
slide 1	2759	2713	1.7
slide 2	3766	3656	2.9
slide 3	677	659	2.7
Totals	7202	7028	2.4

Though observer 1 was consistently slightly higher than observer 2, we concluded that observer bias is not an important source of error in these counts, and we assumed it to be zero in our calculations.

RESULTS

On 11 March 1998, using a search grid based on flock locations from 1996 and 1997 survey data, we located 43 flocks of spectacled eiders (Fig. 1). The distribution of flocks was central to those of 1996 and 1997 (Fig. 4). Our estimate for the 11 March survey was 374,792 (95% CI = 371,278-378,305) (Table 2).

Table 2. Calculations for population estimates for wintering spectacled eiders, north-central Bering Sea, Alaska, 1997-98.

	8 March 1997	11 March 1998	21 March 1998
A. Total birds (σ + ϕ) in small and flying flocks	13,529	63,104	15,219
B. Total white birds in sitting flocks	190,132	171,221	146,723
C. Total white birds in selected sex ratio slides ¹	13,084	12,109	12,109
D. Total birds in selected sex ratio slides	24,051	22,043	22,043
E. Total birds per male in sex ratio slides	1.8382	1.8204	1.8204
F. Lower 95% CI for sex ratio (total birds per male)	1.6830	1.7999	1.7999
G. Upper 95% CI for sex ratio	1.9934	1.8409	1.8409
H. Total birds: (E*B)+A	363,030	374,792	282,311
I. Lower 95% CI (F*B)+A	333,526	371,278	279,300
J. Upper 95% CI (G*B)+A	392,532	378,305	285,322

1. Thirteen slides were used in 1997, and for 1998 we used 36 slides combined from both 1998 surveys.

The National Weather Service ice analysis estimated ice coverage for the survey area at 70 to 80 percent for 11 March, and 70 to 90 percent for 25 March. We found the ice slightly less extensive (about 90 percent coverage) on 11 March than during the 1997 survey. Some flocks were scattered in open leads several km in extent, challenging our ability to obtain complete contiguous photographic coverage of all flocks. Some flocks required two passes to photograph the entire flock in mosaic, and bird movement between passes made it difficult to determine areas of overlap. However, after careful analysis of all images and recorded tracks we felt good about the accuracy of the counts. Some flocks flew from their resting spots on our approach, and we photographed them in flight, but we saw most land again, which convinced us that we did not double-count or under-count as a result of these movements.

Due to a period of cold calm weather, by the second survey on 21 March many of the open leads skimmed over with thin ice making locating and photographing individual flocks easier. We observed 50 flocks located in the same general area as in the 11 March survey (Figs. 2 and 3). However, as we worked westward along the survey grid several large flocks were seen flying. In most cases we elected not to photograph them as they were flying westward toward the area yet to be surveyed. It is not known where these birds settled and whether or not they were included in the count. The total for the 21 March survey was 282,311 (95% CI = 279,300-285,322) (Table 2). The flying flocks were large enough that they could have accounted for the discrepancy between the two 1998 survey totals.

During the survey on 11 March we noticed that three small flocks had a color ratio skewed toward brown birds, many of which looked like juveniles (hatching year). We made passes over these flocks at approximately 100 ft. and obtained 6 photographs of sufficient scale and clarity to enable us to readily distinguish juvenile males. From these photos we counted adult males, juvenile males, and total females. Assuming equal sex ratios for juveniles, we then subtracted the assumed juvenile females from total females to calculate adult females. Table 3 below presents the results of these calculations. We initially thought that perhaps hatching year birds were wintering together in "brood flocks" that remained isolated from the larger adult flocks, and this may have been the case to a limited extent. However, during photo analysis we were able to identify some juveniles in the larger flocks. Unfortunately we did not have adequate flight time during either survey to photograph a representative sample of all flocks from which to estimate recruitment for the population, though we felt it would have been possible to do so. A future attempt would probably require an entire day's flight to obtain such a sample. There is probably no way to isolate the different breeding populations in such a study, as wintering flocks appear to mix freely at this location.

Table 3. Sex and age composition of a sex-biased sample of three flocks of spectacled eiders in the northern Bering Sea, Alaska, March 1998. Juvenile females are assumed to be equal to Juvenile males.

	Total birds	Adult ♂	Juv. ♂	Ad.+Juv. ♀	Ad. ♀	Juv. ♀	Juv. %
1	497	187	23	287	264	23	9.3
2	1137	398	64	675	611	64	11.3
3	1816	363	316	1137	821	316	34.8
Totals	3450	948	403	2099	1696	403	23.4

CONCLUSIONS

The point estimate from the 11 March survey was slightly larger but not significantly different than the 1997 estimate; the highest previous estimate. Though there were observations on the furthest west transect, the survey could not be continued further due to fuel considerations. There may have been more flocks further west, but there was unbroken ice with no more open leads visible within our approximately 10 km range of view west of the last transect, so it is possible that we photographed all or nearly all flocks in the vicinity.

The flock locations for surveys 1996-98 (Fig. 4) describe an oblong distribution running northeast to southwest, suggesting a benthic food source with that distribution, or a persistent pattern of unstable ice providing a consistent narrow window of access to a food source with a broader distribution.

RECOMMENDATIONS

1. We feel that the close agreement between the 1997 and 1998, and the composite of other survey and satellite telemetry data reinforces our hypothesis that essentially the entire world's population of this species winters together in a predictable location in the Bering Sea. This knowledge puts us as resource managers in the enviable position of being able to periodically monitor, with a high degree of precision, the worldwide population of a species that is of interest, concern, and possibly a good indicator of large scale changes in the Bering Sea ecosystem. While the current immediate concern is focused on the Yukon-Kuskokwim Delta and the Alaska arctic slope breeding populations, which have been shown to be genetically distinct, worldwide concern for declines in boreal sea duck populations should demonstrate the prudence of capitalizing on such opportunities for obtaining precise population estimates and trend data. We recommend attempting this survey at least every second year, recognizing that conditions will not permit a successful mission for every attempt. We also recommend supporting additional studies of the wintering ecology of this species, which would help place our trend data in context.
2. Our work in 1998 suggests it is possible to estimate range wide production by taking a representative sample of photographs of portions of wintering flocks, from which juvenile and adult males may be counted. This task will require at least one full day flight to the wintering area, assuming the birds are in the same location as during the last three years. We recommend making this a priority during late winter 1999 if a location flight is conducted in preparation for the planned shipboard bottom sampling survey in early spring.

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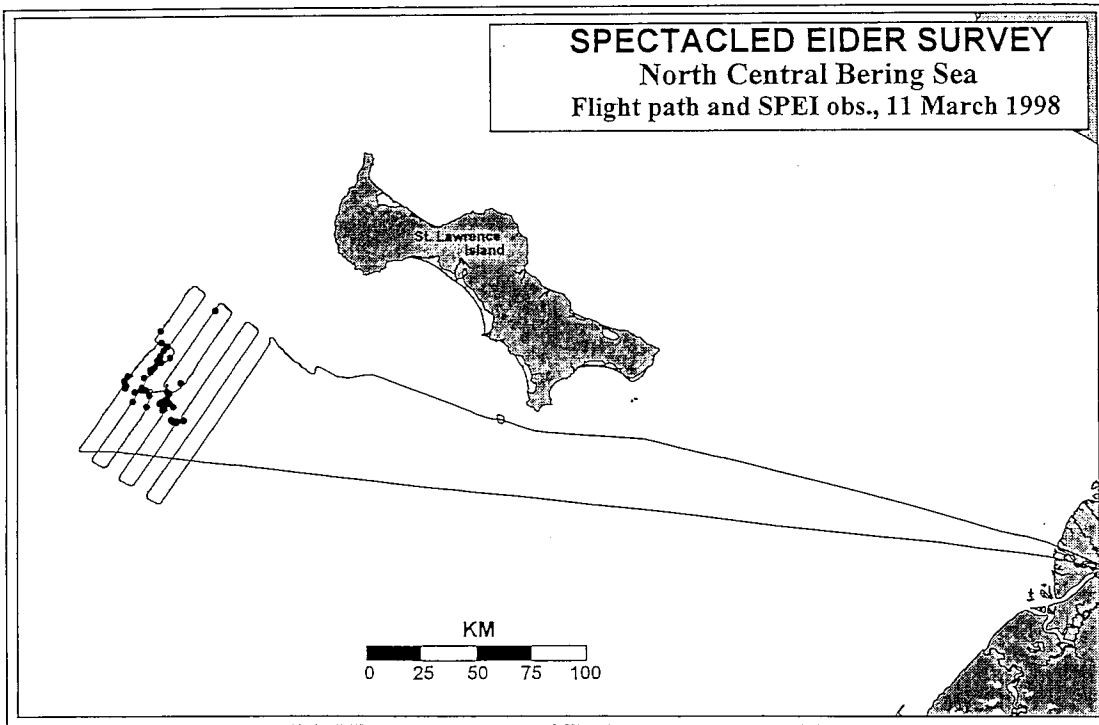


Figure 1. Flight path and flocks of spectacled eiders observed during an aerial survey, 11 March 1998.

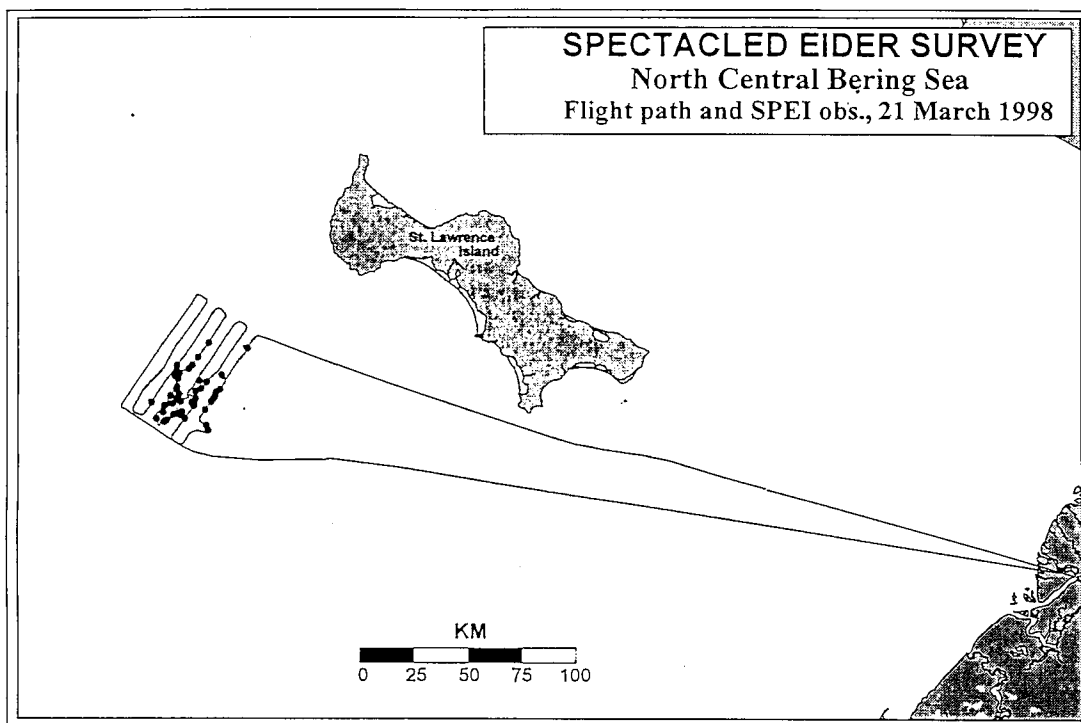


Figure 2. Flight path and flocks of spectacled eiders observed during an aerial survey, 21 March 1998.

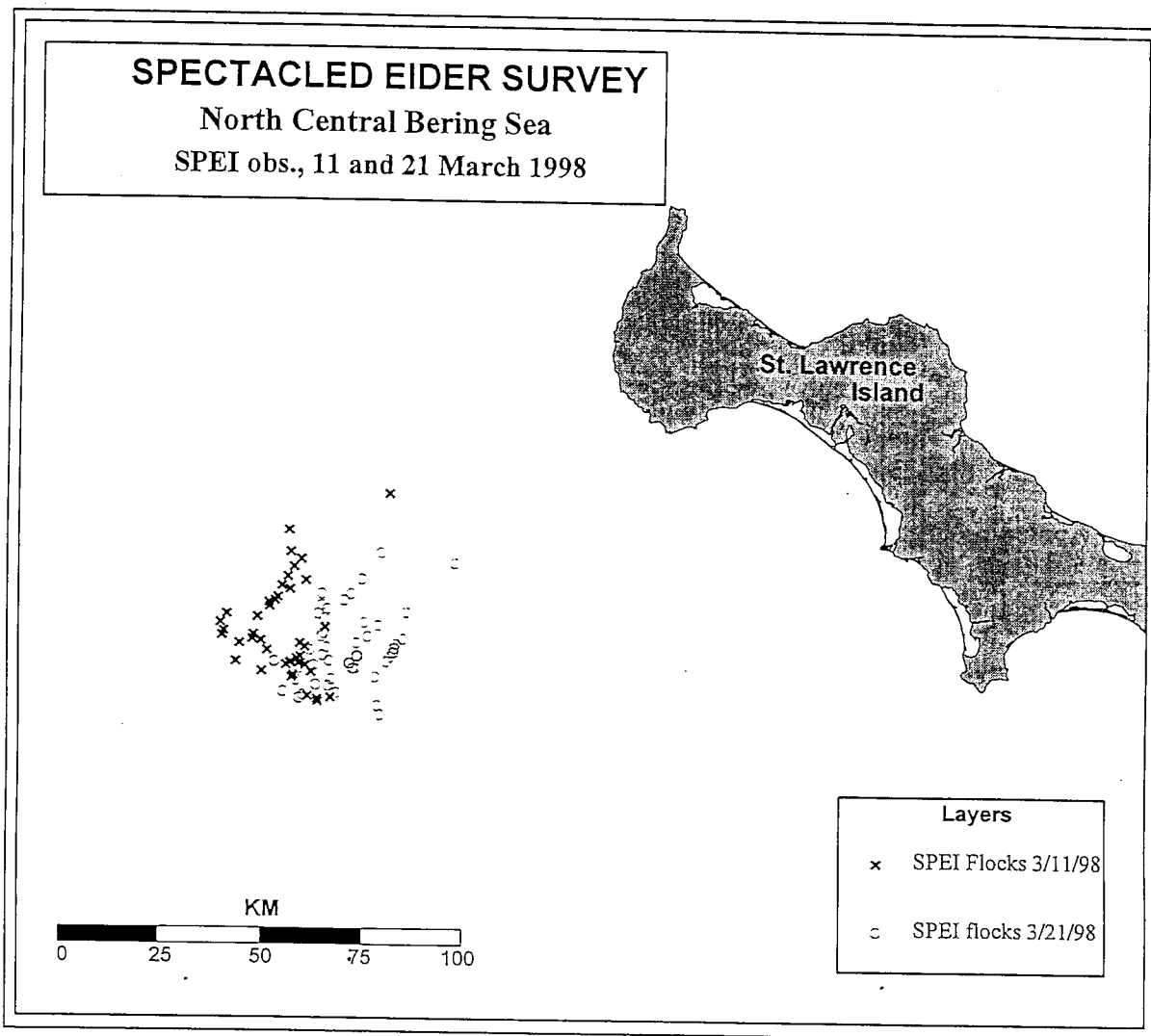


Figure 3. Locations of flocks of spectacled eiders observed during an aerial survey, northern Bering Sea, Alaska, 11 and 21 March 1998.

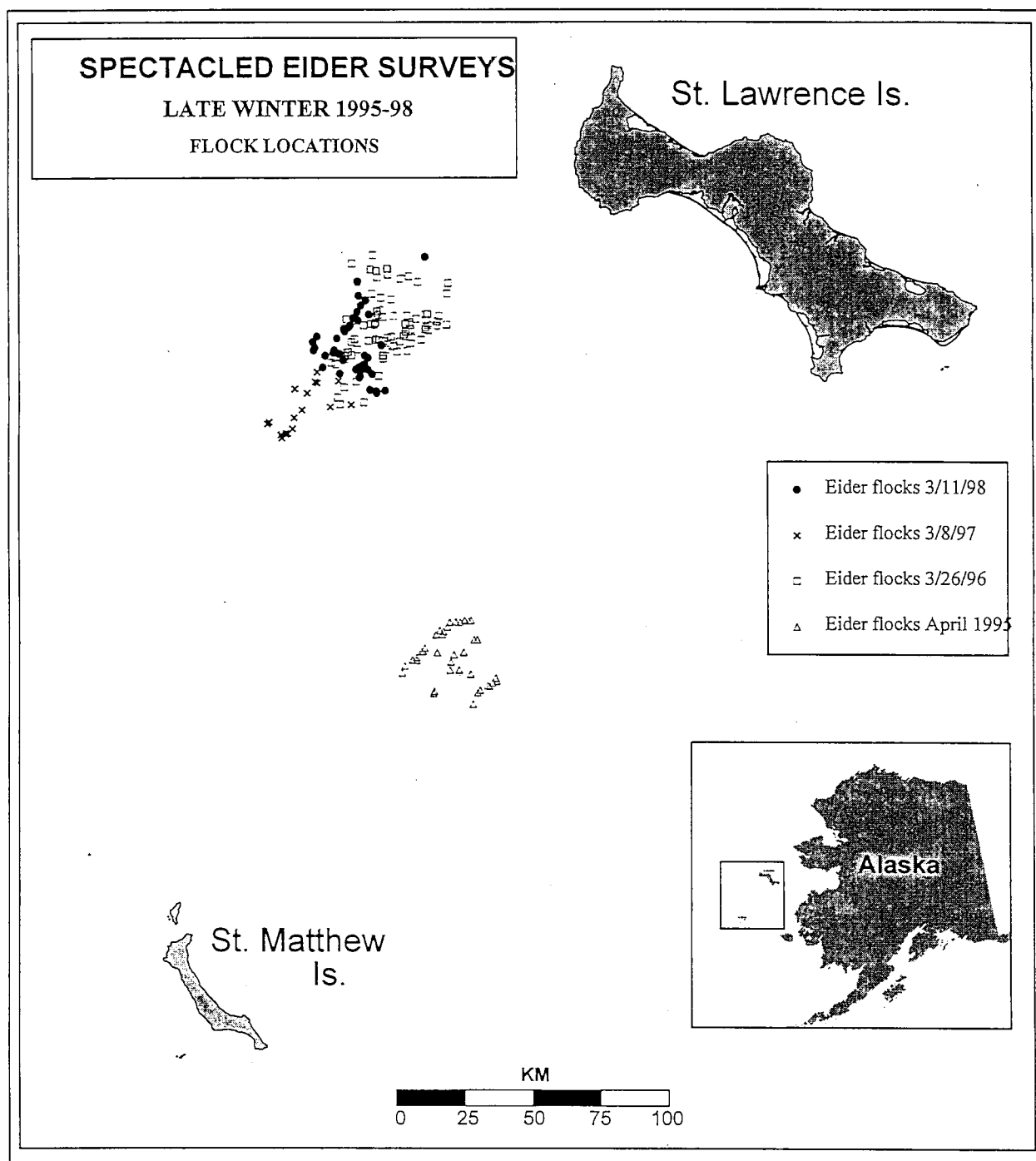


Figure 4. Locations of spectacled eider flocks observed during aerial surveys, northern Bering Sea, 1995-98.