Waterbird Surveys of McKinley Bay Northwest Territories, 1984

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CANADIAN WILDLIFE SERVICE

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SUMMARY

A monitoring study of waterbird abundance and distribution at McKinley Bay, NWT, was initiated in 1981 (Scott-Brown et al. 1981) and has been continued annually since then. This report presents the results of aerial surveys conducted in 1984. The main objective was to gain baseline data on annual population fluctuations of moulting diving ducks, prior to extensive development of the bay as a medium draft harbour base to support oil and gas production in the Beaufort Sea. Since 1982, Hutchison Bay was also surveyed as a control.

The aerial surveys in 1984 were carried out on August 3, 4 and 5. On August 3, when surveying conditions were the best, the number of diving ducks at McKinley Bay was estimated to be 17 183 $\pm$ 4739, while at Hutchison Bay on the same day, the estimated population was 17 311 $\pm$ 1178 diving ducks.

As in previous years of this study, scoter and Oldsquaw were by far the most common species of diving duck observed at both bays. Compared to the surveys from 1981 through 1983, at McKinley Bay considerably more scoters were counted in 1984, although this increase was not detected statistically. At Hutchison Bay, significantly more Oldsquaw were counted in 1984 than in other years ($p < 0.05$), while numbers of scoters decreased significantly in 1984.

At McKinley Bay, diving ducks were concentrated in the Atkinson Point area and at the south end of the bay, as in previous years. In 1984, about 94% of scoters were seen in these two areas, while Oldsquaw were frequently observed in other areas of the bay as well. Unlike other years, most of the divers seen in the Atkinson Point area were scoters.

'Overall densities of birds using the terrestrial component at McKinley Bay were greater than at Hutchison Bay. The shallow lagoon system at the south end of McKinley Bay was especially important for Brant and Greater White-fronted Geese, while Tundra Swans were scattered on lakes and ponds in the area as well as on the lagoon. At both McKinley Bay and Hutchison Bay, the most common birds seen on the terrestrial component were the dabbling ducks.

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1.0 INTRODUCTION

McKinley Bay is a shallow protected bay on the north side of the Tuktoyaktuk Peninsula, NWT, in the eastern Beaufort Sea. Since 1979, it has been the site of a winter harbour and support base used by Dome Petroleum Limited for oil and gas exploration in the Beaufort Sea. Dredging in the bay began in September of 1979 with construction of an entrance channel and mooring basin in the northeast portion of the bay. Storm-driven ice shoved against the ships moored in this basin the following winter. Consequently, in 1980, another mooring basin was dredged in a more sheltered location to the southwest. An island to the north of the basin was created with the dredged spoils to further protect the moored ships from storms and ice movement. In 1981, docking facilities were constructed, and the artificial island and the mooring basin were expanded. Major activity directed towards continuing the development of the harbour has not occurred since 1981.

As in previous years, the drillships and associated supply vessels of the Canmar drilling fleet, along with 2 icebreakers, a drydock, a floating personnel camp, 4 dredges and the Canmar Shuttle fuel barge, were moored in McKinley Bay in the winter of 1983-84. In the 1984 summer months, there was vessel traffic, as well as aircraft traffic (Twin Otters twice daily until August), to and from the harbour through much of the summer.

In the future, McKinley Bay may become a major year-round support base for Beaufort Sea oil and gas development (Dome, Esso and Gulf 1982). Proposals for development of the harbour include expanded accommodation for up to 500 personnel, a floating topping plant, power

generators, a marine maintenance and repair facility, an expanded mooring basin, equipment storage and fuel storage to refuel the drillships.

The Canadian Wildlife Service is concerned that these developments could adversely affect the birds that use the area. A bird monitoring study involving aerial surveys with joint government and industry participation was therefore initiated in 1981 (Scott-Brown et al. 1981) and continued annually since then (Cornish and Allen 1983; Cornish and Dickson 1984), to describe waterbird usage of McKinley Bay prior to extensive development. Several years of monitoring were needed to establish natural annual fluctuations in the number of birds in the bay. In the future, assuming development proceeds at McKinley Bay, this baseline data can be used as a benchmark to indicate possible development-related changes in diving duck numbers. Beginning in 1982, Hutchison Bay, a relatively undeveloped area on the Tuktoyaktuk Peninsula 45 km southwest of McKinley Bay, was also surveyed annually, as a control. This report presents the results of the 1984 continuation of the study. Emphasis remained on documenting the number and distribution of moulting diving ducks due to their abundance in McKinley Bay and their vulnerability to oil spills.

2.0 METHODS

2.1 Aerial Surveys

The 1984 aerial surveys of McKinley Bay and Hutchison Bay were carried out using the same design and methods as in the previous three years of the bird monitoring study. This allowed a statistical comparison between the four years of data on abundance of moulting diving

ducks. East-west transects were flown 2 km apart (Figs. 1 and 2) in a Cessna 185 with floats at an elevation of 30 m above ground level (agl) at an average speed of 145 km/h. One observer on each side of the aircraft counted all birds seen within 180 m of the flightline, so that the total transect width was 360 m. When time permitted, "off transect" birds, more than 180 m from the plane, were also recorded. These off transect observations were not included in calculations, but helped assess the distribution of birds. Observations were dictated into tape recorders so that observers never had to look away from the transect.

In 1981 and 1982, the surveys were flown at 10-day intervals to measure seasonal variations in abundance. The surveys by boat in 1982 showed that in a typical year the first half of August was the peak period of moult for diving ducks in McKinley Bay. Also, it became apparent that good survey conditions were imperative for accurate survey results. Thus, in 1983, starting at the beginning of August, we waited to survey only on days when it appeared survey conditions would be good. The same approach was used in 1984, and aerial surveys were flown on August 3, 4 and 5.

As in previous years, the study area at McKinley Bay was divided into three components: a marine component inside McKinley Bay, a terrestrial component, and a section of marine habitat outside McKinley Bay called the outside component (Fig. 1). The marine component encompassed all saltwater areas within McKinley Bay including exposed sandspits which were intermittently washed over by tides. The terrestrial component covered all land areas including inland lakes and

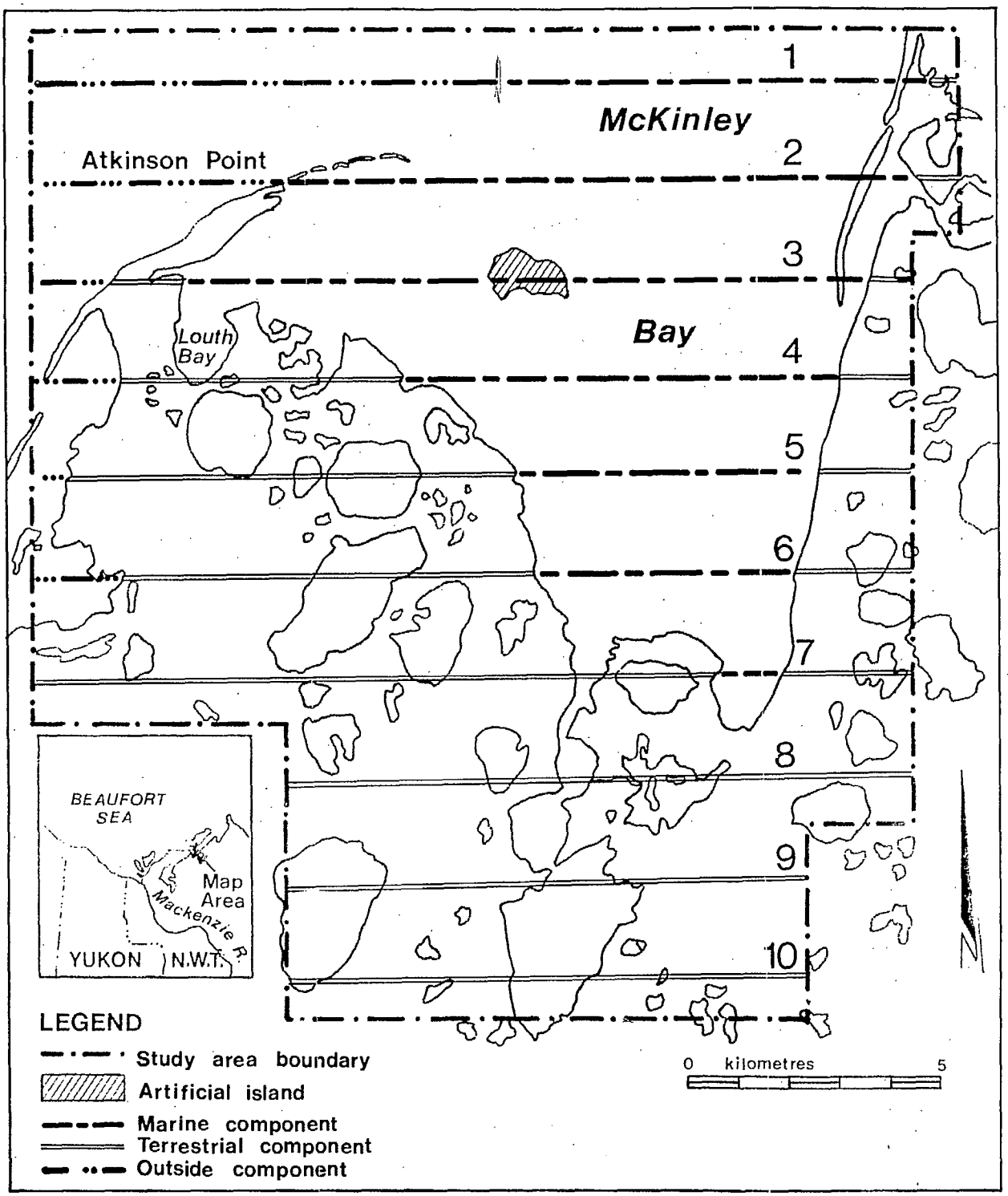

Figure 1. Aerial transects flown at McKinley Bay, August 3, 4 and 5, 1984, showing the divisions of the study area into marine, terrestrial and outside components.

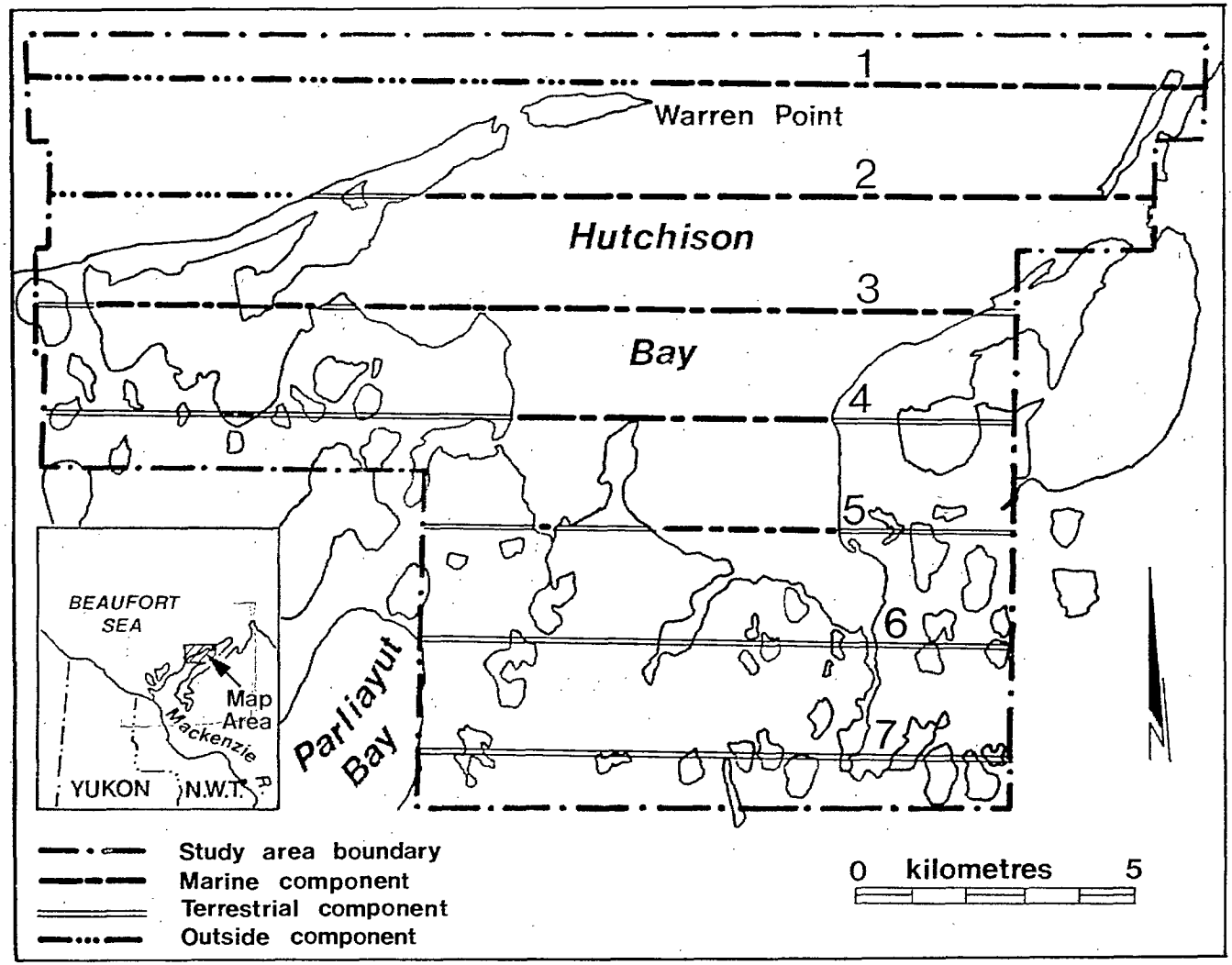

Figure 2. Aerial transects flown at Hutchison Bay, August 3, 4 and 5, 1984, showing the divisions of the study area into marine, terrestrial and outside components.

the lagoon system at the south end of the bay. The area west of Atkinson Point, the small bay at the west end of transects 4 to 6, and the western half of transect 1 were considered the outside component and were omitted from the data analysis. The areas of each component and the proportions surveyed are listed in Table 1.

Aerial surveys were conducted at Hutchison Bay on the same day as McKinley Bay, using identical procedures. The study area at Hutchison Bay was divided into marine, terrestrial and outside components comparable to the McKinley Bay components (Fig. 2). Sandspits intermittently washed over by tides were considered marine. Other land areas and all inland lakes were part of the terrestrial component. The saltwater areas west of Warren Point and the area covered by the western half of transect 1 were considered outside of Hutchison Bay. Table 1 presents the areas of the components at Hutchison Bay and proportions surveyed.

The terms "diving ducks" and "divers", which are used throughout this report in tables and discussions, refer to ducks belonging to both tribes Aythyinae and Merginae.

2.2 Analysis of Data

With the systematic survey design presented above, the mean densities and population totals for the various species were estimated by the standard ratio estimator. Estimates of the standard errors of these variables were calculated using the method by Kingsley and Smith (1980). These equations are summarized below.

Table 1. Division of the McKinley Bay and Hutchison Bay study areas into three components for the aerial surveys.

	McKinley Bay		Hutchison Bay	
Component	Total area (km^2)	Area surveyed (km^2)	Total area (km^2)	Area surveyed (km^2)
Marine	108.5	19.6	100.5	17.8
Terrestrial	158.5	28.3	91.0	16.3
Outside	38.0	6.9	31.5	5.8
TOTAL	305.0	54.8	223.0	39.9

Let N = number of possible transects in the study area

n = number of transects sampled

f = n/N

y_i = number of observations recorded on the ith transect

x_i = area of the ith transect

Then:

(1) The standard ratio estimate $\hat{R}$ of the true mean density was given by:

$$\hat{R} = \frac{\sum_{i=1}^{n} y_i}{\sum_{i=1}^{n} x_i}$$

(2) The standard error of the mean density was estimated by the following:

Standard error = $\sqrt{s_1^2}$

$$s_1^2 = \frac{(1-f) \sum_{i=1}^{n-1} (d_i - d_{i+1})^2}{2 \cdot (n-1) \cdot n \cdot \bar{x}^2}$$

where $d = y_i - \hat{R}x_i$

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

(3) The population estimate ($\hat{Y}$) was calculated by multiplying the estimated mean density of birds ($\hat{R}$) by the total area of the study component (Table 1).

(4) The estimated standard error of the total population was found by multiplying $\sqrt{s_i^2}$ by the total area of the study component (Table 1).

Three aerial surveys were conducted each year from 1981 to 1984. Survey conditions varied for each survey, and the survey with the best conditions was chosen from each year for comparison with other years. The August 10 surveys in 1981 and 1982, the August 5 survey in 1983, and the August 3 survey in 1984 were chosen for comparison because on these dates the survey conditions were regarded as superior to conditions during the other two surveys conducted each year. The differences and standard errors of the changes in population estimates between the four years were calculated using the same formula as above. The y_i value then became the difference between years of counts on each transect ($_i$). The confidence intervals were calculated at the 0.10 and 0.05 levels of significance. The difference in population estimates between years was considered significant if the confidence interval did not include zero.

3.0 RESULTS

3.1 Survey Conditions

On August 3, the aerial surveys at McKinley and Hutchison bays were conducted between the hours of 1240 and 1610. During the surveys, there was 95-100% cover of thin cloud. Although minor glare sometimes occurred through the thin cloud, this was not considered a serious problem. Wind speeds were visually estimated from the aircraft, and winds on this day were light (less than 15 km/h) from the north at both

bays, producing small waves with no whitecaps. The temperature was 4°C and there was no precipitation. Survey conditions at both McKinley and Hutchison bays were considered "good".

Aerial surveys on August 4 were conducted from 1600 to 1825 hours. Survey conditions varied between the two bays. There was a thick overcast layer of cloud at both bays. This produced some light rain showers at McKinley Bay, although visibility was not seriously impaired. There was no precipitation at Hutchison Bay. Winds were moderate (15-20 km/h) from the north-northeast at Hutchison Bay, producing waves with very few whitecaps. At McKinley Bay, however, the north-northeast winds were slightly stronger, gusting to 25 km/h and causing higher waves with frequent whitecaps. Glare was not a problem at either bay. Survey conditions were described as "fair to good" at both bays.

Survey conditions during the August 5 survey, conducted between 1255 and 1650 hours, were described as "good to excellent" at McKinley Bay, and "fair to good" at Hutchison Bay. For surveys at both bays, there was 100% cover of thin high cloud and no precipitation. At McKinley Bay, light winds (less than 10 km/h) from the north produced small waves. There was occasional moderate glare, but it was not considered significant. Within half an hour before the survey at McKinley Bay, however, one of Dome's support vessels, the Supplier 5, crossed the eastern sections of transects 1, 2 and 3. This may have affected our survey results, and will be discussed below. At Hutchison Bay, winds were very light (about 5 km/h) from the north-northeast and sea conditions were almost calm, so that diving ducks on the water were

easily detected. However, glare made it difficult to identify diving ducks to species.

3.2 Abundance

3.2.1 Marine Component

Numbers and densities of birds seen on the marine components of McKinley and Hutchison bays are presented in Tables 2 and 3. At McKinley Bay, the largest number of birds was observed on August 3, while at Hutchison Bay, more birds were seen on August 5 than on any other day. Observed densities of diving ducks on the marine component at McKinley Bay varied from 120.56 divers/km^2 on August 5, the day a ship moved across the study area just before the survey, to 158.37 divers/km^2 on August 3. Diving duck densities were slightly higher at Hutchison Bay, varying from 140.67 divers/km^2 on August 4 to 246.52 divers/km^2 on August 5.

Tables 4 and 5 give the species composition and densities of diving ducks observed at each bay. At both bays, Oldsquaw and scoters were the most common species of diving duck, although the relative numbers of Oldsquaw and scoters varied between the two bays. At McKinley Bay, scoters represented about 62% of identified diving ducks on all three surveys, while about 37% of all identified diving ducks were Oldsquaw. At Hutchison Bay, Oldsquaw outnumbered scoters (about 53% and 38% respectively) on both the August 3 and 4 surveys. On August 5, glare from the sun during the survey at Hutchison Bay made identification of ducks unreliable.

Table 2. Number and density of birds observed on the marine component during aerial surveys at McKinley Bay, 1984. Area of marine component surveyed = 19.6 km^2.

Species	August 3		August 4		August 5	
	Number	Density (birds/km^2)	Number	Density (birds/km^2)	Number	Density (birds/km^2)
Loons	8	0.41	6	0.31	9	0.46
Swans	0	0	0	0	0	0
Geese	34	1.73	2	0.10	0	0
Dabbling ducks	0	0	0	0	1	0.05
Diving ducks	3104	158.37	2987	152.40	2363	120.56
Unidentified ducks	1	0.05	0	0	0	0
Shorebirds	0	0	35	1.79	0	0
Jaegers	0	0	0	0	1	0.05
Gulls	39	1.99	24	1.22	30	1.53
Terns	53	2.70	23	1.17	22	1.12
Guillemot	1	0.05	0	0	0	0
TOTAL BIRDS	3240	165.31	3077	156.99	2426	123.77

Table 3. Number and density of birds observed on the marine component during aerial surveys at Hutchison Bay, 1984. Area of marine component surveyed = 17.8 km^2.

Species	August 3		August 4		August 5	
	Number	Density (birds/km^2)	Number	Density (birds/km^2)	Number	Density (birds/km^2)
Loons	21	1.18	8	0.45	20	1.12
Swans	0	0	0	0	0	0
Geese	89	5.00	15	0.84	34	1.91
Dabbling ducks	26	1.46	18	1.01	102	5.73
Diving ducks	3066	172.25	2504	140.67	4388	246.52
Unidentified ducks	77	4.33	28	1.57	30	1.68
Shorebirds	0	0	0	0	0	0
Jaegers	0	0	0	0	0	0
Gulls	27	1.52	18	1.01	20	1.12
Terns	2	0.11	1	0.06	9	0.51
Guillemot	0	0	0	0	0	0
TOTAL BIRDS	3308	185.84	2592	145.62	4603	258.60

Table 4. Species composition and density of diving ducks observed on the marine component during aerial surveys at McKinley Bay, 1984. Area of marine component surveyed = 19.6 km^2.

Species	August 3			August 4			August 5		
	Number	Percent	Density (birds/km^2)	Number	Percent	Density (birds/km^2)	Number	Percent	Density (birds/km^2)
Oldsquaw	913	37.7	46.58	959	36.9	48.93	793	36.6	40.46
Scoter	1466	60.6	74.80	1599	61.6	81.58	1370	63.3	69.90
Scaup	20	0.8	1.02	39	1.5	1.99	0	0	0
Merganser	20	0.8	1.02	0	0	0	2	0.1	0.10
Eider	1	<0.1	0.05	0	0	0	0	0	0
TOTAL IDENTIFIED DIVING DUCKS	2420	100.0	123.47	2597	100.0	132.50	2165	100.0	110.46
Unidentified diving ducks	684	...	34.90	390	...	19.90	198	...	10.10

Table 5. Species composition and density of diving ducks observed on the marine component during aerial surveys at Hutchison Bay, 1984. Area of marine component surveyed = 17.8 km^2.

Species	August 3			August 4			August 5[a]		
	Number	Percent	Density (birds/km^2)	Number	Percent	Density (birds/km^2)	Number	Percent	Density (birds/km^2)
Oldsquaw	1488	56.0	83.59	1059	50.6	59.49	1435	38.3	80.62
Scoter	1006	37.9	56.52	808	38.6	45.39	2143	57.2	120.39
Scaup	159	6.0	8.93	215	10.3	12.08	161	4.3	9.04
Merganser	4	0.1	0.22	12	0.5	0.67	7	0.2	0.39
Eider	0	0	0	0	0	0	0	0	0
TOTAL IDENTIFIED DIVING DUCKS	2657	100.0	149.27	2094	100.0	117.64	3746	100.0	210.45
Unidentified diving ducks	409	...	22.98	410	...	23.03	642	...	36.07

[a]Species identification during this survey was difficult due to glare.

Separate counts of Surf Scoters and White-winged Scoters were made whenever time permitted. Surf Scoters were more abundant than White-winged Scoters at both bays, although the relative proportions varied. On the average, the ratio of White-winged Scoters to Surf Scoters was 1:5 at McKinley Bay and about 1:2 at Hutchison Bay.

Scaup were seen in much greater densities at Hutchison Bay than at McKinley Bay. The greatest density of scaup observed on the aerial surveys at Hutchison Bay was about 12 birds/km^2, representing about 10% of identified divers, while at McKinley Bay, scaup were never seen in densities greater than 2 birds/km^2.

Red-breasted Mergansers were observed in small numbers on the surveys at both bays, although none were seen on August 4 at McKinley Bay. This species represented less than one percent of identified divers on any survey. Only one eider was seen on the marine component, on August 3 at McKinley Bay.

Observers saw geese on the marine component on two of the surveys at McKinley Bay, but larger numbers of geese were consistently seen on the marine component at Hutchison Bay. At McKinley Bay, a total of 34 geese was counted on August 3, while 2 geese were seen on August 4 (Table 2). Whenever these geese were identified to species, they were Brant, while the remainder were all dark geese. A maximum of 89 geese was observed on the marine component at Hutchison Bay (Table 3); this occurred on August 3 and included 60 Brant and 8 Snow Geese (4 adults, 4 immatures). On August 4 and 5, 15 and 34 geese, respectively, were counted on the Hutchison Bay marine component. No Greater White-fronted Geese were identified on the marine component at either bay.

A list of common and scientific names of observed species is presented in Appendix A.

3.2.2 Terrestrial Component

Tables 6 and 7 list the numbers and densities of birds observed on the terrestrial components of McKinley Bay and Hutchison Bay, respectively. More species groups were represented on the terrestrial component at both bays than on the marine component.

McKinley Bay

Overall densities of birds using the terrestrial component at McKinley Bay were greater than at Hutchison Bay, primarily due to greater densities of dabbling and diving ducks seen at McKinley Bay. Dabbling ducks were the most abundant species group recorded on the terrestrial component at McKinley Bay. On August 4 and 5, this group was observed in densities of just over 10 birds/km^2 (Table 6), accounting for over 30% of all birds observed on the terrestrial component during these surveys. On August 3, a density of 5.30 dabblers/km^2 was recorded. Nearly all dabblers that were identified to species were Northern Pintail, although American Wigeon and Mallard, in order of abundance, were also noted.

Diving ducks were the second most common species group observed on the terrestrial component at McKinley Bay. The highest density of diving ducks observed was 9.86 birds/km^2 on August 3, while about 7 divers/km^2 were recorded on both August 4 and 5 (Table 6). Nearly 64% of identified diving ducks on the terrestrial component were Oldsquaw, while less than 1% were scoters. Scaup and Red-breasted Mergansers were

Table 6. Number and density of birds observed on the terrestrial component during aerial surveys at McKinley Bay, 1984. Area of terrestrial component surveyed = 28.3 km^2.

Species	August 3		August 4		August 5	
	Number	Density (birds/km^2)	Number	Density (birds/km^2)	Number	Density (birds/km^2)
Loons	57	2.01	68	2.40	71	2.51
Swans	71	2.51	70	2.47	57	2.01
Geese	121	4.28	89	3.14	32	1.13
Dabbling ducks	150	5.30	285	10.07	286	10.11
Diving ducks	279	9.86	186	6.57	199	7.03
Unidentified ducks	65	2.30	57	2.01	35	1.24
Raptors	2	0.07	3	0.11	1	0.04
Ptarmigan	2	0.07	0	0	0	0
Cranes	2	0.07	2	0.07	0	0
Shorebirds	62	2.19	108	3.82	34	1.20
Jaegers	5	0.18	2	0.07	1	0.04
Gulls	47	1.66	32	1.13	42	1.48
Terns	17	0.60	39	1.38	65	2.30
Owls	1	0.04	0	0	0	0
Passerines	3	0.11	3	0.11	3	0.11
TOTAL BIRDS	884	31.24	944	33.36	826	29.19

Table 7. Number and density of birds observed on the terrestrial component during aerial surveys at Hutchison Bay, 1984. Area of terrestrial component surveyed = 16.3 km^2.

Species	August 3		August 4		August 5	
	Number	Density (birds/km^2)	Number	Density (birds/km^2)	Number	Density (birds/km^2)
Loons	45	2.76	46	2.82	43	2.64
Swans	75	4.60	41	2.52	47	2.88
Geese	40	2.45	51	3.13	30	1.84
Dabbling ducks	92	5.64	114	6.99	97	5.95
Diving ducks	3	0.18	32	1.96	65	3.99
Unidentified ducks	108	6.63	37	2.27	3	0.18
Raptors	0	0	0	0	1	0.06
Ptarmigan	0	0	0	0	0	0
Cranes	0	0	2	0.12	1	0.06
Shorebirds	27	1.66	1	0.06	13	0.80
Jaegers	0	0	2	0.12	0	0
Gulls	22	1.35	35	2.15	24	1.47
Terns	17	1.04	8	0.49	14	0.86
Owls	0	0	0	0	0	0
Passerines	3	0.18	0	0	2	0.12
TOTAL BIRDS	432	26.50	369	22.64	340	20.86

recorded in densities that resembled counts on the marine component, or about 1.0 scaup/km^2 and 0.5 mergansers/km^2. Scaup were the second most abundant diving duck on the terrestrial component. Seven eider were observed in one group, on August 5.

Tundra Swans were scattered on lakes and ponds and on the lagoon system at McKinley Bay in densities that were about the same on all three days, or 2.33 birds/km^2 on the average. Numbers of geese observed on the terrestrial component varied greatly, from 32 geese on August 5 to 121 geese on August 3. Two species were identified on the terrestrial component, Brant and Greater White-fronted Geese. Brant were the more common species on all surveys except August 3, when a group of 55 Greater White-fronted Geese was recorded on the lagoon.

Loon densities averaged 2.31 birds/km^2 on the terrestrial component, a much higher count than on the marine component where an average of 0.39 loons/km^2 were observed (Tables 2 and 6). Two species of loons were identified, Red-throated Loons and Arctic Loons. At McKinley Bay, observers saw about three times more Red-throated Loons than Arctic Loons on the terrestrial component.

Shorebirds were also noted frequently on the terrestrial component, at times in large groups. Groups of 50 and 100 shorebirds, on August 3 and 4 respectively, were seen on the lagoon system at the south end of the bay.

The average density of gulls on the three surveys was 1.42 birds/km^2. Most were Glaucous Gulls, although a few Sabine's Gulls were seen. Average numbers of Arctic Terns were comparable to numbers of

gulls, at 1.43 terns/km^2. Other species groups, such as jaegers, raptors and cranes, were recorded on the survey in relatively low numbers (Table 6; Appendix A).

Hutchison Bay

Densities of waterfowl, with the exception of Tundra Swans, were lower on the terrestrial component at Hutchison Bay than at McKinley Bay. Diving ducks especially were observed in substantially fewer numbers. A maximum of 3.99 diving ducks/km^2 was seen on August 5 at Hutchison Bay when a total of 65 divers were counted, while only 3 divers were seen on August 3 (Table 7). At Hutchison Bay, as at McKinley Bay, the most common species group observed on the terrestrial component were dabbling ducks, with an average density of about 6 birds/km^2. This group accounted for an average of 26% of birds observed on the Hutchison Bay terrestrial component over all three surveys. Most identified dabblers were Northern Pintail. Totals of 40, 51 and 30 geese were seen on the terrestrial component at Hutchison Bay on August 3, 4 and 5, respectively (Table 7). All geese that were identified were Greater White-fronted Geese.

Densities of Tundra Swans at Hutchison Bay were greater than at McKinley Bay. Swan densities at Hutchison Bay ranged from 2.52 birds/km^2 on August 4, to 4.60 birds/km^2 on August 3 (Table 7).

Loon densities on the terrestrial component at Hutchison Bay averaged 2.74 birds/km^2. An average of 63% of identified loons were Arctic Loons, while the remainder were Red-throated Loons. The average density of gulls over the three surveys was 1.65 birds/km^2, slightly

higher than at McKinley Bay. Other groups, including shorebirds, terns, jaegers and raptors were seen in lower numbers than at McKinley Bay.

3.3 Comparison of Surveys, 1981-1984

Diving duck populations on the marine components of the study areas were compared between the four years of surveys. Of the three surveys in 1984, surveying conditions were considered good at both bays only on August 3. Therefore, the results of the survey on August 3 were chosen to best represent the 1984 diving duck population estimates in our comparison with results from previous years. The population of diving ducks on the marine components on August 3, 1984 was estimated to be 17 183 $\pm$ 4739 birds at McKinley Bay, and 17 311 $\pm$ 1178 birds at Hutchison Bay (Table 8). Standard errors were high, particularly for scoters, because of their uneven distribution in the bay, resulting in a high variation in the density of these birds from one transect to the next.

This study could not detect any significant changes in total numbers of diving ducks over the four years of surveys at McKinley Bay, although the relative abundance of scaup and of scoter varied significantly throughout the 4-year period (Table 9). As in 1982 and 1983, the number of scaup in the bay in 1984 was significantly less than in 1981 ($p<0.05$). Although our counts of scoters during the McKinley Bay surveys from 1981 to 1984 increased each year, the only statistically significant change detected ($p<0.05$) was between the 1981 survey and 1983 survey. Annual changes in numbers of observed Oldsquaw at McKinley Bay were generally much less than the variations in scoter counts.

Table 8. Population estimates of the diving ducks on the marine component at McKinley Bay and Hutchison Bay, August 3, 1984 based on aerial survey data.

Species	Location	Total count on all transects	Density (birds/km^2)	Population estimate	Standard error of population estimate
Oldsquaw	McKinley Bay	913	46.58	5054	1140
	Hutchison Bay	1488	83.59	8401	1185
Scoter	McKinley Bay	1466	74.80	8116	3970
	Hutchison Bay	1006	56.52	5680	1461
Scaup	McKinley Bay	20	1.02	111	103
	Hutchison Bay	159	8.93	897	423
Merganser	McKinley Bay	20	1.02	111	82
	Hutchison Bay	4	0.22	22	20
TOTAL DIVERS+	McKinley Bay	3104	158.37	17 183	4739
	Hutchison Bay	3066	172.25	17 311	1178

+Includes unidentified divers.

Table 9. Comparison of results of aerial surveys conducted August 10 in 1981 and 1982, August 5 in 1983 and August 3 in 1984 on the marine component, McKinley Bay.

Species	Year	Density (birds/km^2)	Population estimate	Standard error of population estimate	Change in population estimate from previous year	Standard error of change
Oldsquaw	1981	46.43	5038	777		
	1982	54.23	5884	2153	846	2351
	1983	41.53	4506	1364	-1378	2339
	1984	46.58	5054	1140	548	1907
Change (1983-1981)					-532	1759
Change (1984-1982)					-830	1800
Change (1984-1981)					16	1640
Scoter	1981	31.22	3387	469		
	1982	40.05	4345	1023	958	993
	1983	50.51	5480	1007	1135	1200
	1984	74.80	8116	3970	2636	4656
Change (1983-1981)					2093**	1055
Change (1984-1982)					3771	4144
Change (1984-1981)					4729	3704
Scaup	1981	18.77	2036	836		
	1982	1.73	188	71	-1849**	864
	1983	4.74	514	347	326	383
	1984	1.02	111	103	-404	432
Change (1983-1981)					-1522**	567
Change (1984-1982)					-77	82
Change (1984-1981)					-1926**	882
Merganser	1981	0	0			
	1982	0.41	44	24	44*	24
	1983	0	0		-44	24
	1984	1.02	111	82	111	82
Change (1983-1981)					0	
Change (1984-1982)					66	92
Change (1984-1981)					111	82
TOTAL DIVERS+	1981	110.82	12 024	959		
	1982	114.59	12 433	1639	409	1259
	1983	117.96	12 799	2299	366	3462
	1984	158.37	17 183	4739	4384	6441
Change (1983-1981)					775	2545
Change (1984-1982)					4750	3345
Change (1984-1981)					5159	4464

*Indicates difference is significant, $p < 0.10$
**Indicates difference is significant, $p < 0.05$
+Includes unidentified divers.

At Hutchison Bay, significantly more divers were estimated to be present in 1984 than in 1983 ($p<0.05$; Table 10). Much of this increase is represented by numbers of Oldsquaws. The estimated population of Oldsquaw at Hutchison Bay in 1984 was significantly greater ($p<0.05$) than in 1983 or 1982 (not surveyed in 1981). At the same time, the number of scoters estimated to be present at Hutchison Bay in 1984 was significantly lower ($p<0.05$) than in 1983.

3.4 Distribution

3.4.1 McKinley Bay

The distribution of selected waterfowl groups observed during the aerial surveys of McKinley Bay is presented in Figures 3, 4 and 5, for August 3, 4 and 5 respectively. Isolated small groups of less than 10 divers are not shown.

Diving ducks

At McKinley Bay, there are two areas where large concentrations of diving ducks were seen on all three survey days. Large numbers of divers were seen in an area between the artificial island (Fig. 1) and Atkinson Point, and in the south end of the bay on transects 5, 6 and 7. An average of 94% of total observed scoters on a survey were in either of these two areas, although Oldsquaw were distributed over other areas of the bay as well.

The marine areas of transects 2 and 3 that were north, west or northwest of the artificial island, that is, approximately the west half of transects 2 and 3, were defined as the area between the artificial

Table 10. Comparison of results of aerial surveys conducted August 10, 1982, August 5 in 1983 and August 3 in 1984 on the marine component, Hutchison Bay.

Species	Year	Density (birds/km^2)	Population estimate	Standard error of population estimate	Change in population estimate from previous year	Standard error of change
Oldsquaw	1982	43.71	4393	419		
	1983	32.47	3263	1117	-1130	725
	1984	83.59	8401	1185	5138**	2052
Change 1984-1982					4009**	1519
Scoter	1982	64.94	6527	4143		
	1983	88.26	8870	1532	2343	5159
	1984	56.52	5680	1461	-3190**	819
Change 1984-1982					-847	5500
Scaup	1982	6.85	689	282		
	1983	5.56	559	322	-130	432
	1984	8.93	897	423	339	618
Change 1984-1982					209	346
Merganser	1982	8.82	886	665		
	1983	0.73	73	33	-813	635
	1984	0.22	22	20	50**	17
Change 1984-1982					-864	644
TOTAL DIVERS+	1982	133.99	13 461	3075		
	1983	135.67	13 635	2488	174	4613
	1984	172.25	17 311	1178	3675**	1546
Change 1984-1982					3850	3681

*Indicates difference is significant, $p < 0.10$
**Indicates difference is significant, $p < 0.05$
+Includes unidentified divers.

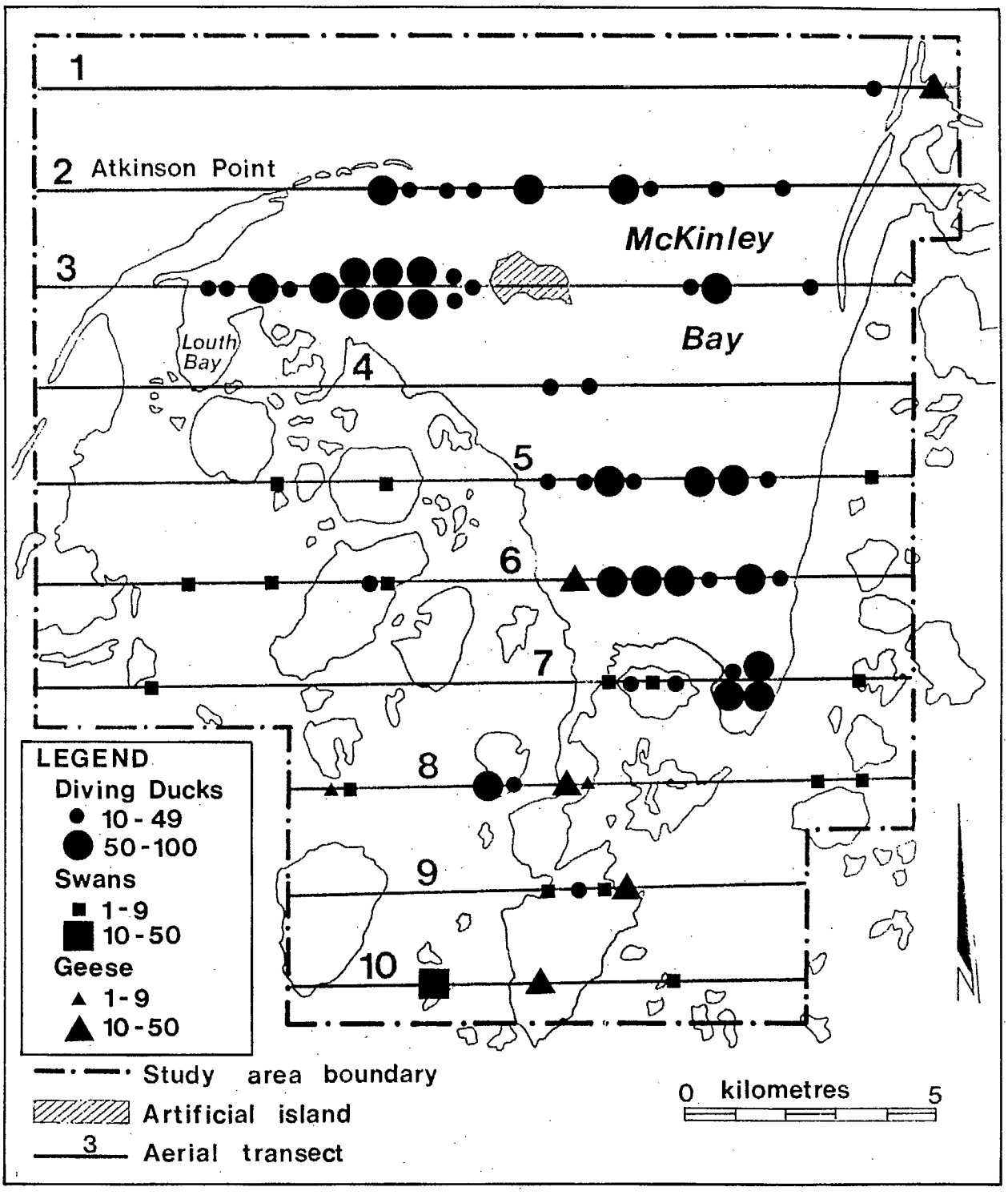

Figure 3. Distribution of selected waterfowl groups observed on aerial transects at McKinley Bay, August 3, 1984.

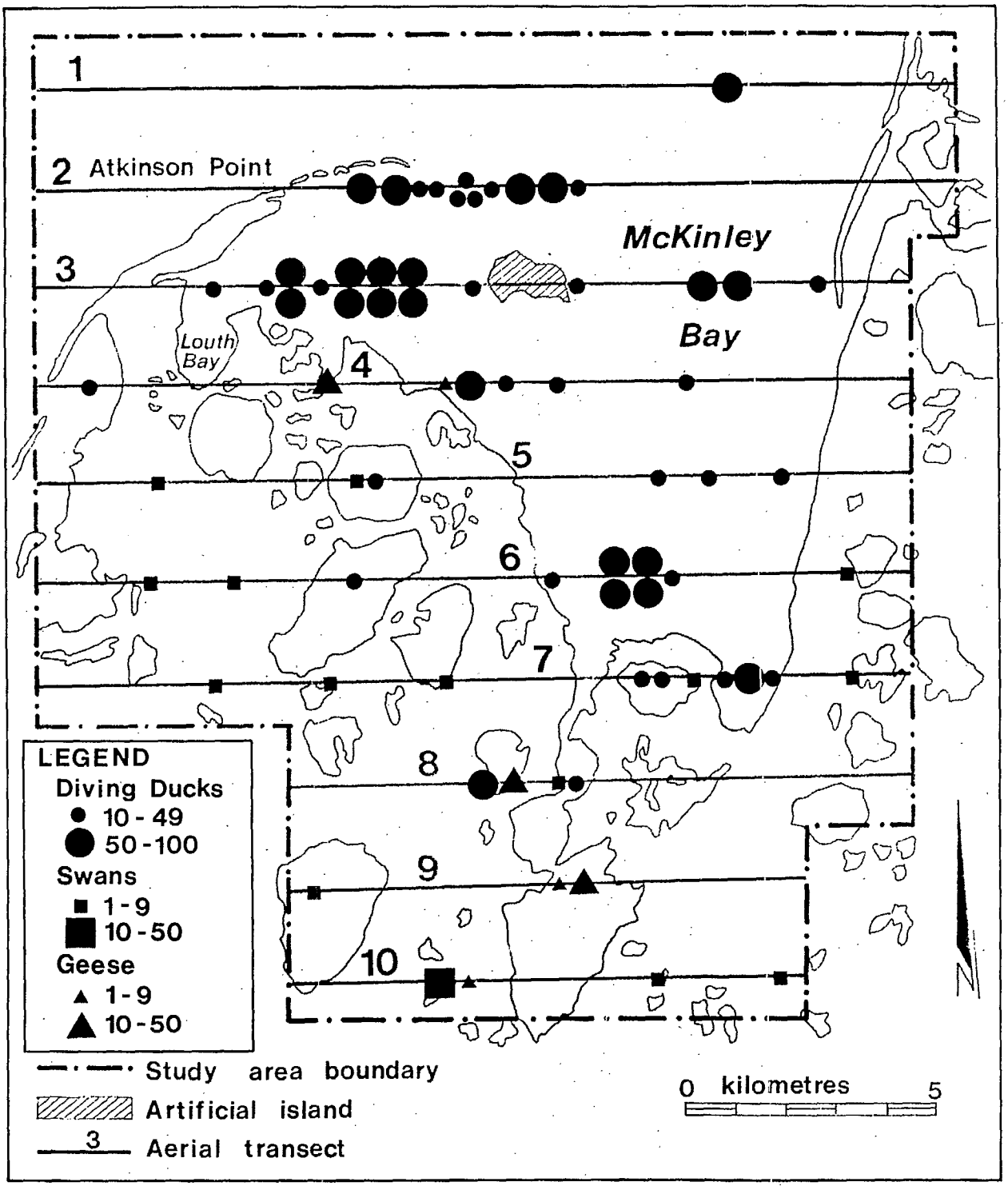

Figure 4. Distribution of selected waterfowl groups observed on aerial transects at McKinley Bay, August 4, 1984.

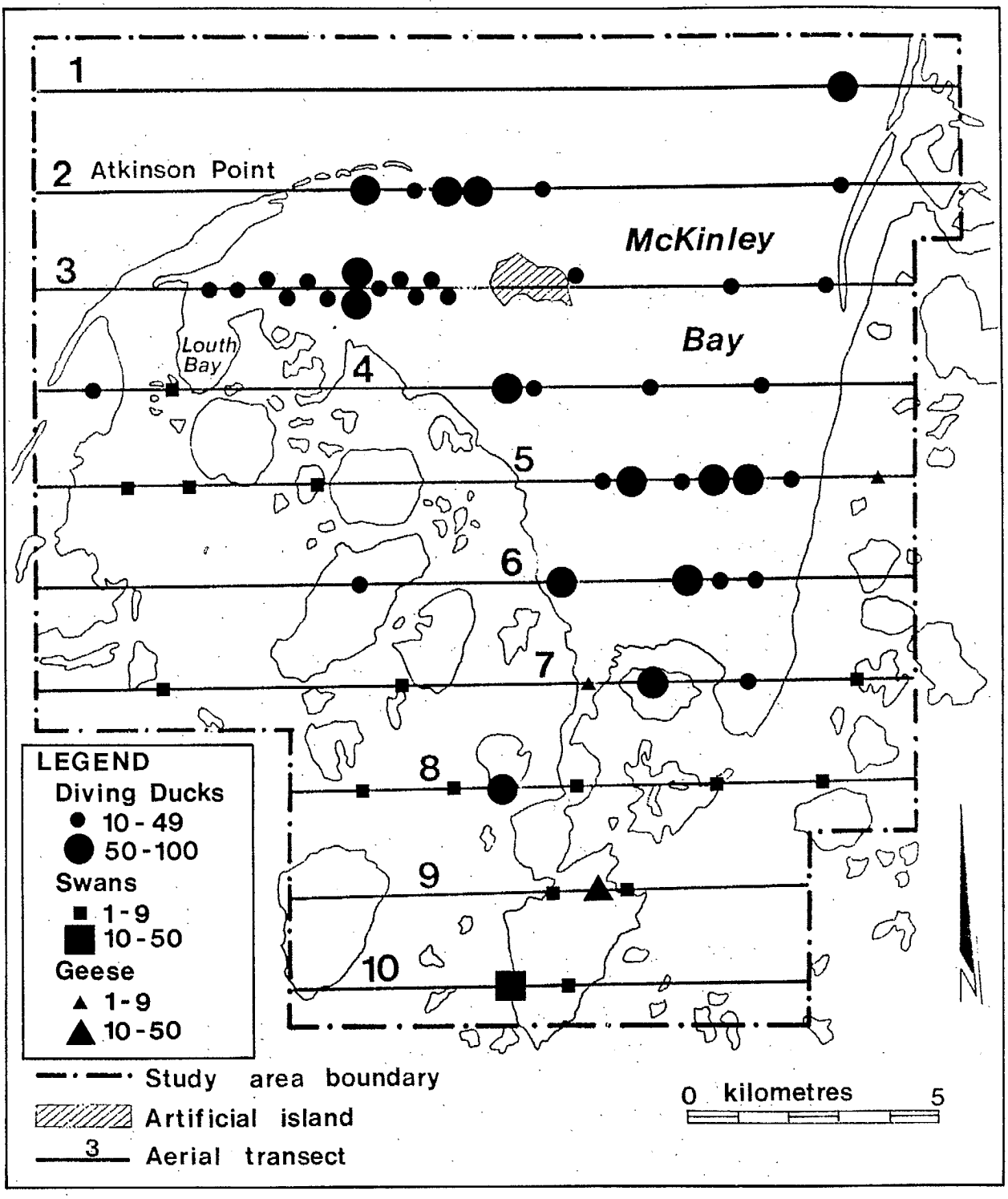

Figure 5. Distribution of selected waterfowl groups observed on aerial transects at McKinley Bay, August 5, 1984.

island and Atkinson Point. Over all three days of surveys, nearly 49% of observed divers were in this area. About 65% of the identified divers in the area were scoters, representing nearly half (49%) of the total scoters observed. Many Oldsquaw were also seen here; about 39% of all Oldsquaw observed were between the artificial island and Atkinson Point. Nearly all (95%) of observed scaup were also seen in this area, in numbers up to 35.

Densities of divers were also consistantly high on transects 5, 6 and 7 at the south end of the bay. On the average, 33% of all observed divers were in this area. Scoters were much more heavily represented here than were Oldsquaw; scoters outnumbered Oldsquaw on these three transects by more than four to one. About 44% of all observed scoters over the three days were on these transects, while, by contrast, an average of 17% of observed Oldsquaw were at the south end. A flock of 20 Red-breasted Mergansers was observed on August 3 in the heavily utilized southeast corner of the bay, on transect 7.

Groups of divers, especially Oldsquaw, were seen in other areas of the bay in smaller numbers. On all three survey days, between 80 and 160 divers, including both Oldsquaw and scoter, were seen in an area not far from the shoreline south of the artificial island. Oldsquaw were also seen mid-bay, in the open area east of the artificial island.

On August 5 at McKinley Bay, a large boat was seen heading north shortly after it had crossed transect 1. The boat was exiting the bay via the dredged ship's channel. This channel crosses the eastern half of transects 1, 2 and 3. Because the boat had crossed these three transects

just before the transects were surveyed, the observed distribution of diving ducks on the bay may be different than if no boat had passed.

Diving ducks were also observed on the larger lakes south of McKinley Bay and on the lagoon system entering the south end of the bay. On a lake just west of the lagoon system, on transect 8, a large flock ranging in size from 60 to 120 divers was seen on all three survey days. On August 4, the only day these divers were identified to species, 50 Oldsquaw were counted. On the lagoon system, an average of 45 Oldsquaw and 25 scaup were observed on all three days. Red-breasted Mergansers also utilized the lagoon system, especially on transects 8 and 9; flocks of 40 and 12 were seen here on August 3 and 4 respectively. Eiders and scoters were very rarely observed on the terrestrial component. Seven eiders were counted on the tidal flats east of Louth Bay (Fig. 1).

Other waterfowl

Geese were most commonly seen in two regions of the McKinley Bay study area: on the tidal flats east of Louth Bay and at the south end of the bay, including the lagoon system. In the former area, 18 Brant were observed on August 4, while on August 5, 30 dark geese were seen off transect. In the latter area, 13 dark geese were observed on transect 6 near the southwest shore on August 3, while on August 5, seven Brant were seen near the entrance to the lagoon system. Further south in the lagoon, 55 Greater White-fronted Geese were counted on transect 8, on August 3. Brant were consistently seen, in flocks ranging from 20 to 45, at the south end of the lagoon system on all three days. Other areas where geese were sometimes observed were inside the long spit at the

northeast corner of the bay, where 22 Brant were seen on August 3, and on tundra lakes.

Tundra Swans were fairly well-distributed, in pairs and family groups, over the entire terrestrial component. They were observed on tundra ponds, large lakes and on the lagoon system. On all three surveys, a flock ranging in size from 15 to 27 swans, apparently nonbreeders, was observed on a lake west of the lagoon system on transect 10.

Dabbling ducks, especially Northern Pintail, were well-distributed on tundra ponds throughout the study area. Numbers of Northern Pintail were especially high in the littoral flats area east of Louth Bay, in the southern sections of the lagoon system, as well as in an area at the west end of transect 7.

3.4.2 Hutchison Bay

Figures 6, 7 and 8 show the distribution of selected waterfowl groups observed on the marine component during aerial surveys at Hutchison Bay on August 3, 4 and 5.

Diving ducks

Although the observed distribution varied over the three surveys, in general diving ducks were well-distributed over the entire bay, with denser concentrations in the area south of Warren Point in the northeast corner of the bay, and at the south end of the bay (Figs. 6, 7 and 8). Flocks of 55 to 120 scaup were seen consistently at the south end of the anvil-shaped western arm of the bay. Small numbers of Oldsquaw and Red-breasted Mergansers were also regularly seen in the western arm.

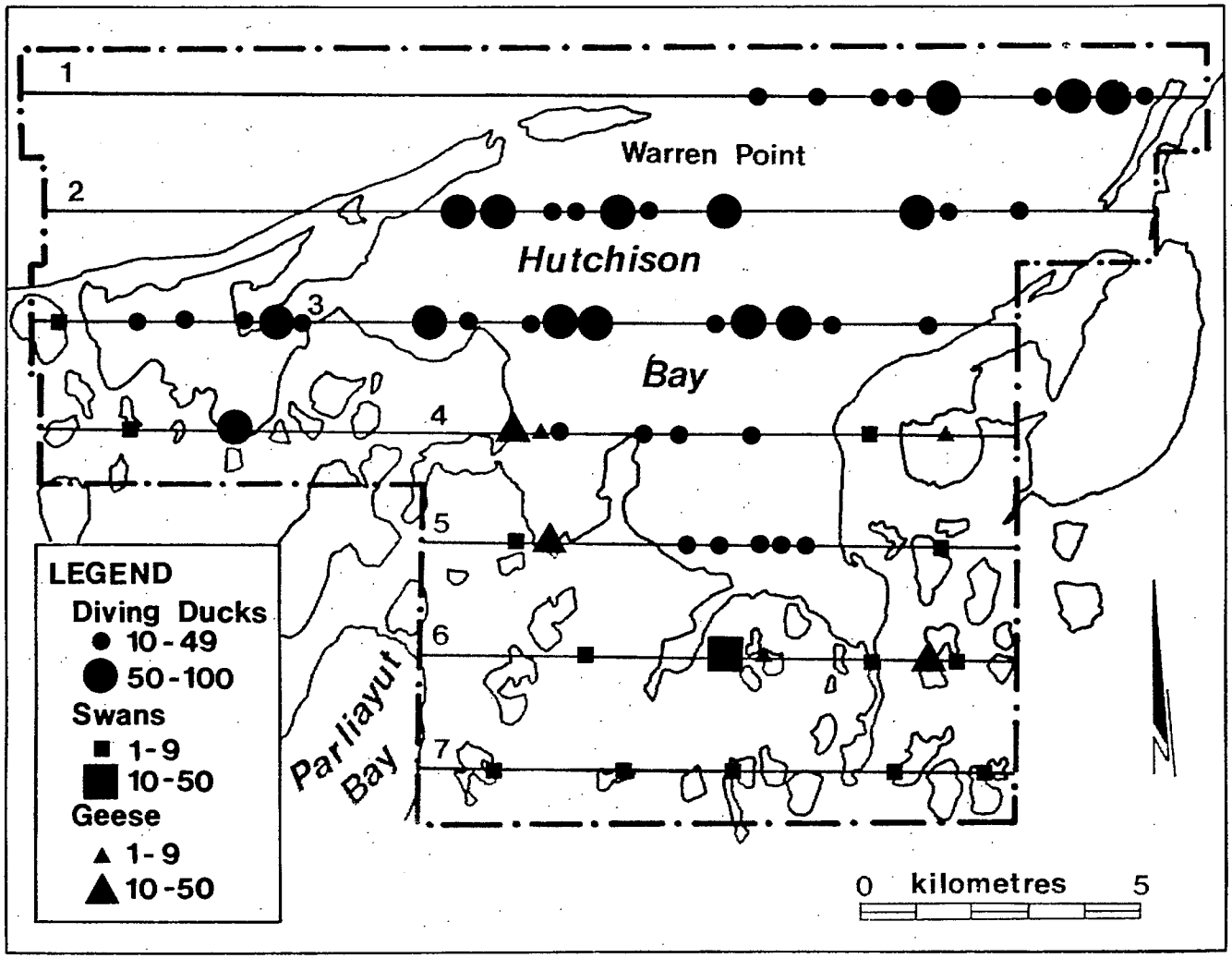

Figure 6. Distribution of selected waterfowl groups observed on aerial transects at Hutchison Bay, August 3, 1984.

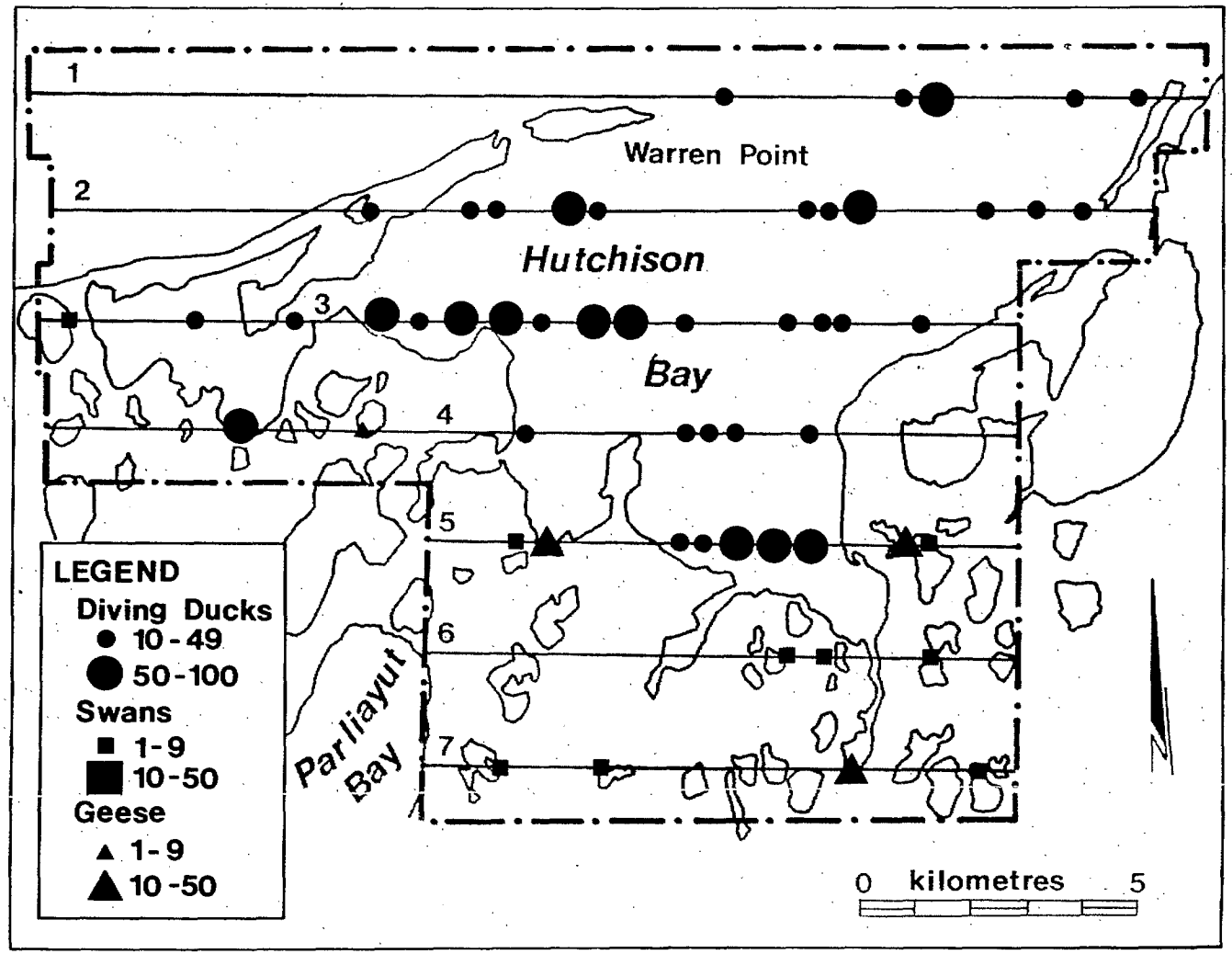

Figure 7. Distribution of selected waterfowl groups observed on aerial transects at Hutchison Bay, August 4, 1984.

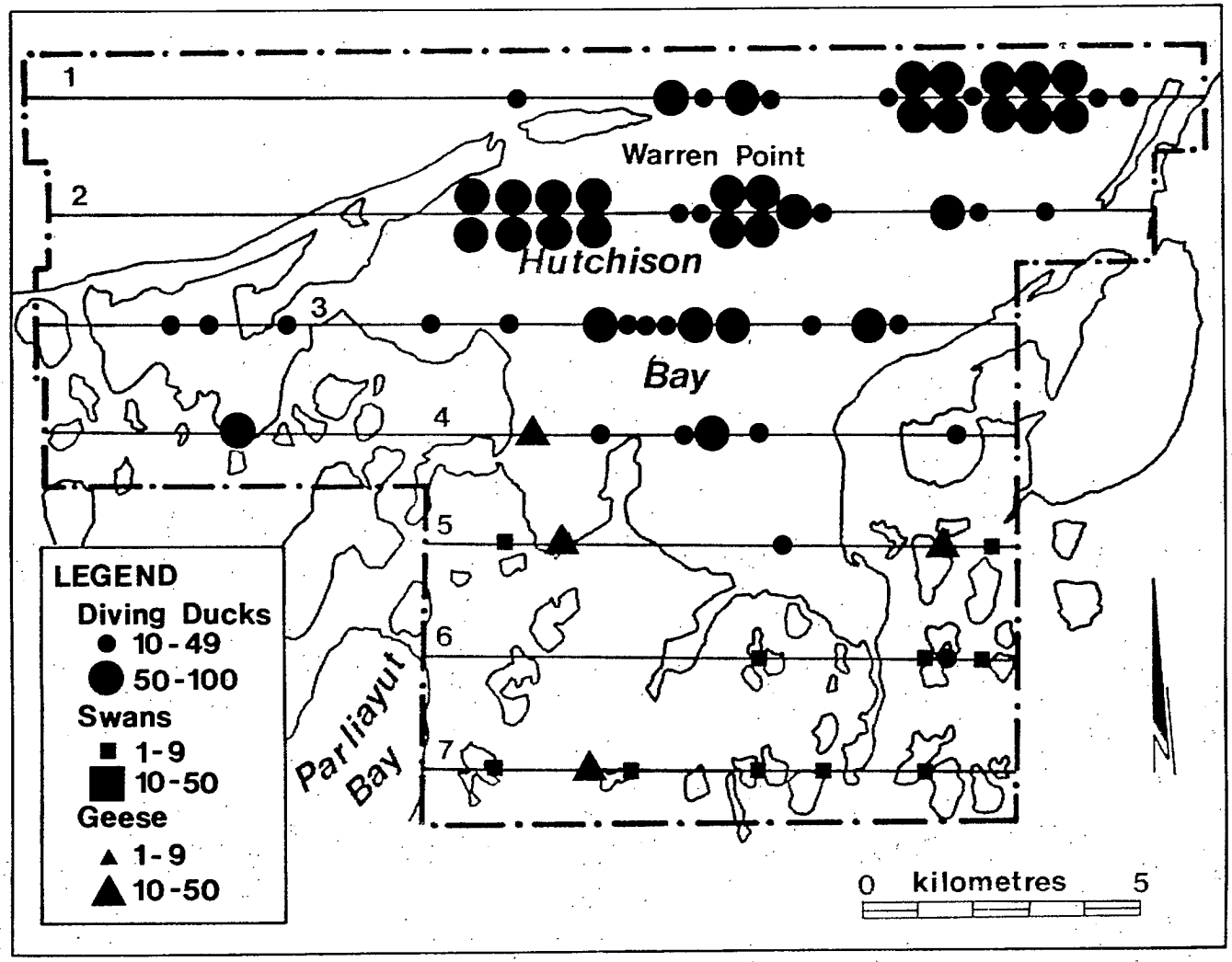

Figure 8. Distribution of selected waterfowl groups observed on aerial transects at Hutchison Bay, August 5, 1984.

On August 3, both Oldsquaw and scoters were distributed in several large groups on transects 1, 2 and 3 in the central sections of the bay and in the northeast corner. Oldsquaw, scoters and scaup were seen in small flocks at the south end of the bay.

On August 4, divers were heavily concentrated in the region south of Warren Point and at the south end of the bay. In the area just south of Warren Point, observers saw primarily Oldsquaw. About 260 scoters and 240 Oldsquaw were counted at the south end of the bay, on transects 5 and 6, with small groups of scaup.

More than 70% of total diving ducks observed on August 5 were on transects 1 and 2. About 400 scoters, mainly Surf Scoters, and 200 Oldsquaw were observed in the northeast corner of the bay. Flocks of 60-100 divers, both scoters and Oldsquaw, were also seen farther offshore on transect 1. Both scoters and Oldsquaw were also concentrated in large flocks on the west half of transect 2, southeast of Warren Point. Fewer divers were seen at the south end of the bay on August 5 than on the other two days.

Numbers of diving ducks observed on the lakes and ponds of the terrestrial component at Hutchison Bay were much lower than at McKinley Bay. Virtually no groups of diving ducks were observed on lakes in the area of Hutchison Bay on August 3 or 4. On August 5, 22 divers were seen on a lake on the east end of transect 6, and 35 Red-breasted Mergansers were seen on the little bay at the east end of transect 4.

Other waterfowl

Groups of geese were recorded on all three days in the little bay west of the peninsula jutting into the southwest section of Hutchison

Bay. Up to 60 Brant were seen on transect 4 west of this peninsula on August 3 and 5. Small groups of up to 11 Snow Geese, including some immatures, were seen on transect 5 in the same small bay. Geese also utilized the narrow bay channel at the south end of the study area. On August 4, 15 Greater White-fronted Geese were counted here, on transect 7. Groups of 15-25 geese were counted on various lakes within the study area, particularly southeast of the bay (Figs. 6, 7 and 8).

Tundra Swans were well-distributed on lakes and ponds, and were frequently observed in pairs or family groups. Dabbling ducks were seen throughout the study area, but large numbers were concentrated in three areas: in the small southwest embayment crossed by transects 4 and 5, on the lagoon at the east end of transect 4, and on lakes southeast of the bay.

3.5 Flock Size

From observations made during the aerial surveys, it was apparent that the relative distribution of diving ducks, in distinct flocks of different sizes, varied between species, between bays and between days of surveys. Scoters were more heavily represented in large flocks (greater than 50 birds) than were Oldsquaw. On all three days of surveys at McKinley Bay, nearly 60% of all scoters were seen in flocks of over 50 birds. Flock distribution of scoters at Hutchison Bay varied between the three days. On August 3, 37% of scoters were in flocks of over 50 birds, while on August 5, 69% were seen in these large flocks. On August 4, the day the fewest scoters were counted on any survey, none were seen in flocks of over 50 birds.

Most Oldsquaw, in comparison, were in smaller flocks of 50 birds or less, on all three surveys at both bays. However, the relative proportion of Oldsquaw in large flocks of over 50 birds varied between McKinley and Hutchison bays. On August 3 at McKinley Bay, 26% of the Oldsquaw were in large flocks, as were 40% on August 4 and 23% on August 5. A smaller proportion of Oldsquaw were in large flocks at Hutchison Bay. On August 3 and 4 at Hutchison Bay, only 9% and 13%, respectively, of Oldsquaw were seen in flocks of over 50 birds, while on August 5, this ratio was 33%.

4.0 DISCUSSION

During the surveys at McKinley Bay, concentrations of diving ducks were consistently seen in the area south of the spit at Atkinson Point in 1984. Several studies in other years have indicated that most ducks seen in this area were Oldsquaw (Cornish and Allen 1983; Cornish and Dickson 1984; Sharp 1978; Ward 1979; Ward 1981). However, in 1984, about 65% of identified diving ducks in this area were scoters. Karasiuk and Boothroyd (1982), during surveys conducted in 1980, also counted large numbers of scoters in the Atkinson Point area. Concentrations of divers, mainly scoters, were also seen at the south end of the bay in 1984, as in previous years (Cornish and Allen 1983; Cornish and Dickson 1984; Karasiuk and Boothroyd 1982; Scott-Brown et al. 1981). These two areas, south of the spit at Atkinson Point and in the south end of the bay, appear to be important areas of the bay for moulting diving ducks.

At Hutchison Bay, as in the two previous years of surveys, divers were most frequently seen in the area just south of Warren Point near the western arm of the bay, and in the northeast section of the bay. Divers at Hutchison Bay also utilized the open mid-bay areas in 1984, as in other years, and were in general more evenly distributed than at McKinley Bay.

Over the four years of the study, the number of Oldsquaw, scoters, scaup and mergansers found in each bay has sometimes fluctuated between years. For example, the number of Oldsquaw more than doubled between 1983 and 1984 in Hutchison Bay. Year-to-year variations in numbers of moulting diving ducks observed at approximately the same time of year, during aerial surveys repeated on the same flight path, have also been recorded by other researchers. During a series of aerial surveys conducted at the end of July in the three years from 1977 to 1979 at Simpson Lagoon in the Alaskan Beaufort Sea, estimates of the number of Oldsquaw present varied from 51 375 in 1977 to 12 068 in 1978 and 23 192 in 1979 (Johnson and Richardson 1981).

Many factors could be involved in causing year to year fluctuations in the number of moulting ducks at McKinley and Hutchison bays. In years of low nesting success, due to, for example, high levels of predation, the moulting flocks of male and non-breeding ducks may be augmented by failed-nesting birds. Also, the timing of the moult will vary from year-to-year depending on the timing of breeding and nest initiation (Salomonsen 1968). Hence, the size of a population of moulting ducks in McKinley Bay or Hutchison Bay at any time may reflect

the timing of breeding and the nesting success in that year. The site selected for moulting may also shift, depending perhaps on ice conditions in the bays and lagoons when the birds first arrive to moult in July (Barry et al. 1981). It is possible that moulting diving ducks swim from one bay to the next. However, daily shoreline surveys during July and August in 1982 along a section of shoreline near Atkinson Point in McKinley Bay showed no sudden large change in the numbers of divers (Cornish and Allen 1983).

The distribution and local abundance of a population of moulting diving ducks at any particular time could depend on the physical parameters of the environment which affect the divers' food supply. Feeding studies in two areas of the western Beaufort Sea indicated that, in these areas, Oldsquaw fed mainly on epibenthos, primarily mysids and amphipods which were the invertebrate prey organisms most available to them (LGL 1983). According to Griffiths and Dillinger (1981), the distribution of epibenthic invertebrates in the Beaufort coastal regions may be associated with the dynamic local pattern of water movements. However, at McKinley and Hutchison bays, no studies have been carried out to indicate which organisms comprise the greatest proportion of the diets of Oldsquaw and scoter, and we have little information on the abundance and distribution of the invertebrate prey organisms.

Other factors may affect the results of a seabird monitoring study, including variability in observer skill, survey conditions such as amount of glare and sea state, and differences in bird densities due to flocking behaviour.

To avoid bias due to differences in observer skill, the same observers were used for all four years of the study with the exception of one of the observers in 1981. Also, only observers with current experience in aerial surveys were used. LeResche and Rausch (1974) found that current experience significantly affected accuracy and precision of counts during aerial surveys of a known population of moose.

Survey conditions seem to be a crucial factor affecting survey results. Stott and Olson (1972) discussed the effects of weather on aerial surveys of a population of sea ducks on the New Hampshire coastline. Aerial surveys were compared with ground surveys which were assumed to count 100% of the population. They found that scoter counts during aerial surveys were significantly more accurate ($p<0.05$) when done on overcast days than on clear or partly cloudy days. Also, Oldsquaw were more difficult to count on a day when the ocean was turbulent, because of their light colour and tendency to stay in small flocks (Stott and Olson 1972). In order to reduce the effects of weather and sea state on our results, we chose the best of three surveys, with respect to conditions (the August 3 survey in 1984), for determining diving duck population estimates and for comparisons with previous years' counts.

The tendency for some duck species to aggregate into large flocks may affect variability of aerial survey results. Stott and Olson (1972) noted that large flocks were more visible than small flocks, especially when conditions were less than favourable. In a comparison between observers' estimates on several aerial surveys of waterfowl, Savard (1982) found that bird densities affected accuracy of observer estimates,

and differences between estimates were larger for species that aggregated into flocks than for species with a more scattered distribution. This flocking tendency may have affected the accuracy of our counts of scoters. In 1984, during all surveys at McKinley Bay and during the August 5 survey at Hutchison Bay, 60-70% of scoters were in flocks of more than 50 birds.

In our comparisons of the 1981 to 1984 survey results, some very large differences in numbers of diving ducks between years were observed, but could not be described as statistically significant. Because of the tendency for the ducks to concentrate in certain areas of the bays, especially at McKinley Bay, densities between transects were often quite pronounced, which resulted in large estimates of standard error. Because the standard errors were so high, differences in duck populations had to be very large in order to be statistically significant. This problem was especially apparent for scoters, which tended to be more clumped than Oldsquaw. For example, at McKinley Bay in 1984, scoter densities were much higher on transects 5, 6 and 7 at the south end of the bay than elsewhere so that the standard error was nearly half the value of the population estimate (8116 $\pm$ 3970). As a result, even though scoter numbers increased by about one third from 1983 to 1984, this increase could not be termed significant at even the ten percent level.

Oldsquaw, on the other hand, tended to be more evenly distributed throughout each bay, and densities were similar from one transect to the next. As a result, the standard errors were much smaller for this species. Thus, the statistical model described in the methods is more suitable for monitoring Oldsquaw than scoter.

Since the diving ducks are not evenly distributed, an alternative statistical approach is recommended. Using the number of birds/km counted on each individual transect for each year, we could apply a Friedman Rank test (Conover 1980), with the transects representing blocks and the years representing treatments. With this method, the observed numbers in the array are ranked and the test statistic is computed from the sums of the ranks in each treatment. In this way, we reduce the effects of uneven distribution of birds. Errors associated with visual counts are also reduced.

Another alternative would be to stratify the bay based on where the birds concentrate in the bay (Cornish and Allen 1983). Estimates for each stratum would then be combined into a total population estimate.

To help provide a better understanding of the reasons for the observed variations in abundance and distribution of diving ducks in these bays, it is further recommended that ecological studies be conducted in McKinley Bay and Hutchison Bay. In order to gain a better understanding of the relationship between the diving ducks and their food supply, studies should be initiated to examine the major food organisms consumed by each duck species. In addition, the relative abundance, the distribution, and the annual fluctuations in numbers of these food organisms should be monitored. This information would aid researchers in distinguishing between natural and man-caused changes in diving duck numbers in these areas.

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Appendix A. Scientific names of species of birds observed at McKinley Bay and Hutchison Bay during aerial surveys in 1984.

Appendix A. Scientific names of species of birds observed at McKinley Bay and Hutchison Bay during aerial surveys in 1984.

Common name	Scientific name
Common Loon	Gavia immer
Yellow-billed Loon	Gavia adamsii
Arctic Loon	Gavia arctica
Red-throated Loon	Gavia stellata
Tundra Swan	Cygnus columbianus
Brant	Branta bernicla
Greater White-fronted Goose	Anser albifrons
Snow Goose	Chen caerulescens
Mallard	Anas platyrhynchos
Northern Pintail	Anas acuta
American Wigeon	Anas americana
Scaup sp.	Aythya sp.
Eider sp.	Somateria sp.
Oldsquaw	Clangula hyemalis
White-winged Scoter	Melanitta fusca
Surf Scoter	Melanitta perspicillata
Red-breasted Merganser	Mergus serrator
Northern Harrier	Circus cyaneus
Rough-legged Hawk	Buteo lagopus
Ptarmigan sp.	Lagopus sp.
Sandhill Crane	Grus canadensis
Black-bellied Plover	Pluvialis squatarola
Yellowlegs sp.	Tringa sp.
Phalarope sp.	Phalaropus sp.
Parasitic Jaeger	Stercorarius parasiticus
Long-tailed Jaeger	Stercorarius longicaudus
Glaucous Gull	Larus hyperboreus
Sabine's Gull	Xema sabini
Arctic Tern	Sterna paradisaea
Guillemot sp.	Cepphus sp.
Short-eared Owl	Asio flammeus
Snowy Owl	Nyctea scandiaca
Common Raven	Corvus corax

Appendix B. Birds observed on aerial fixed-wing surveys at McKinley Bay in August, 1984.

Table B1. Birds observed on marine component of aerial transects at McKinley Bay on August 3, 1984.

Species	Transect number										Total on all transects
	1	2	3	4	5	6	7	8	9	10	
Common Loon											
Yellow-billed Loon											
Arctic Loon		1	1								2
Red-throated Loon				6							6
Loon sp.											
Tundra Swan											
Brant	22										22
Greater White-fronted Goose											
Dark Goose						12					12
Snow Goose											
Mallard											
Northern Pintail											
American Wigeon											
Dabbling duck											
Eider sp.		1									1
Scaup sp.			20								20
Oldsquaw	3	244	361	84	57	124	40				913
Scoter sp.		16	136		203	120	40				515
White-winged Scoter		21	24	1							46
Surf Scoter	12	8	587		168	30	100				905
Red-breasted Merganser							20				20
Diving duck		215	90	1	38	190	150				684
Unidentified duck			1								1
Raptor											
Ptarmigan sp.											
Sandhill Crane											
Shorebird											
Jaeger sp.											
Glaucous Gull	2	35	2								39
Sabine's Gull											
Arctic Tern	25	26			2						53
Guillemot sp.					1						1
Snowy Owl											
Common Raven											
Passerine											

Table B2. Birds observed on marine component of aerial transects at McKinley Bay on August 4, 1984.

Species	Transect number										Total on all transects
	1	2	3	4	5	6	7	8	9	10	
Common Loon											
Yellow-billed Loon											
Arctic Loon	3	1									4
Red-throated Loon				1							1
Loon sp.					1						1
Tundra Swan											
Brant				2							2
Greater White-fronted Goose											
Dark Goose											
Snow Goose											
Mallard											
Northern Pintail											
American Wigeon											
Dabbling duck											
Eider sp.											
Scaup sp.			35		4						39
Oldsquaw	60	307	413	60	70	49					959
Scoter sp.		33	552	23	42	61	185				896
White-winged Scoter		3	10	7							20
Surf Scoter		64	127	120	23	336	13				683
Red-breasted Merganser											
Diving duck		262	120	5	3						390
Unidentified duck											
Raptor											
Ptarmigan sp.											
Sandhill Crane											
Shorebird	35										35
Jaeger sp.											
Glaucous Gull		16	5	1	2						24
Sabine's Gull											
Arctic Tern		3	2	3	15						23
Guillemot sp.											
Snowy Owl											
Common Raven											
Passerine											

Table B3. Birds observed on marine component of aerial transects at McKinley Bay on August 5, 1984.

Species	Transect number										Total on all transects
	1	2	3	4	5	6	7	8	9	10	
Common Loon											
Yellow-billed Loon											
Arctic Loon	2	3									5
Red-throated Loon	2	1			1						4
Loon sp.											
Tundra Swan											
Brant											
Greater White-fronted Goose											
Dark Goose											
Snow Goose											
Mallard											
Northern Pintail	1										1
American Wigeon											
Dabbling duck											
Eider sp.											
Scaup sp.											
Oldsquaw	82	118	305	175	65	42	6				793
Scoter sp.	7	149	322	2	190	157					827
White-winged Scoter		114	65		27	29	1				236
Surf Scoter			60	5	149	82	11				307
Red-breasted Merganser		2									2
Diving duck	8	41	85	63		1					198
Unidentified duck											
Raptor											
Ptarmigan sp.											
Sandhill Crane											
Shorebird											
Jaeger sp.						1					1
Glaucous Gull	2	17	7	2	1		1				30
Sabine's Gull											
Arctic Tern	5	13	4								22
Guillemot sp.											
Snowy Owl											
Common Raven											
Passerine											

Table B4. Birds observed on terrestrial component of aerial transects at McKinley Bay on August 3, 1984.

Species	Transect number										Total on all transects
	1	2	3	4	5	6	7	8	9	10	
Common Loon											
Yellow-billed Loon											
Arctic Loon					2		3	2	1		8
Red-throated Loon				4	7	3	10	8	4		36
Loon sp.			1	2		4		3	3		13
Tundra Swan					10	8	11	18	6	18	71
Brant								25			25
Greater White-fronted Goose							2	59			61
Dark Goose										35	35
Snow Goose											
Mallard											
Northern Pintail				30	19	1	32		18	10	110
American Wigeon						1	6				7
Dabbling duck		1		4	5	1	1	8	7	6	33
Eider sp.											
Scaup sp.						16	35				51
Oldsquaw						2	32	3			37
Scoter sp.											
White-winged Scoter											
Surf Scoter						1				1	2
Red-breasted Merganser									40		40
Diving duck						10	16	123			149
Unidentified duck		15			8	1	20	1	17	3	65
Raptor					1		1				2
Ptarmigan sp.						1			1		2
Sandhill Crane							2				2
Shorebird				1	2		3	55	1		62
Jaeger sp.								1		4	5
Glaucous Gull			1	1	12	9	11	3	1		38
Sabine's Gull								9			9
Arctic Tern						2		4	11		17
Guillemot sp.											
Snowy Owl							1				1
Common Raven											
Passerine	1					1				1	3

Table B5. Birds observed on terrestrial component of aerial transects at McKinley Bay on August 4, 1984.

Species	Transect number										Total on all transects
	1	2	3	4	5	6	7	8	9	10	
Common Loon											
Yellow-billed Loon											
Arctic Loon						1	2	3	1	6	13
Red-throated Loon				1	7	5	4	10	3		30
Loon sp.					3	4	12	5		1	25
Tundra Swan					4	6	25	2	1	32	70
Brant				18					45		63
Greater White-fronted Goose										8	8
Dark Goose								10	8		18
Snow Goose											
Mallard											
Northern Pintail				91	11	12	42	17	61	7	241
American Wigeon							3				3
Dabbling duck			7	6	19	6	3				41
Eider sp.											
Scaup sp.						2					2
Oldsquaw			2		45	12	59	50			168
Scoter sp.											
White-winged Scoter											
Surf Scoter											
Red-breasted Merganser								12			12
Diving duck						1				3	4
Unidentified duck				15		9		33			57
Raptor			1	1			1				3
Ptarmigan sp.											
Sandhill Crane					2						2
Shorebird			1			2	104	1			108
Jaeger sp.					1	1					2
Glaucous Gull		1	1	1	3	8	9	4	1		28
Sabine's Gull				1				3			4
Arctic Tern							23	16			39
Guillemot sp.											
Snowy Owl											
Common Raven										3	3
Passerine											

Table B6. Birds observed on terrestrial component of aerial transects at McKinley Bay on August 5, 1984.

Species	Transect number										Total on all transects
	1	2	3	4	5	6	7	8	9	10	
Common Loon											
Yellow-billed Loon											
Arctic Loon			1			6	2	4			13
Red-throated Loon				8	6	2	14	2	6	1	39
Loon sp.						6	5	4	1	3	19
Tundra Swan				1	12		9	11	7	17	57
Brant							9		20		29
Greater White-fronted Goose					3						3
Dark Goose											
Snow Goose											
Mallard									5		5
Northern Pintail	3	4	5	55	29	7	43	21	63		230
American Wigeon							1				1
Dabbling duck		7		3	5	8	8	8	7	4	50
Eider sp.				7							7
Scaup sp.						13	25				38
Oldsquaw						18	53	2			73
Scoter sp.										2	2
White-winged Scoter											
Surf Scoter											
Red-breasted Merganser					3				2		5
Diving duck						12	2	60			74
Unidentified duck							11	8	15		35
Raptor								1			1
Ptarmigan sp.											
Sandhill Crane											
Shorebird					4	6	16	3	3	2	34
Jaeger sp.						1					1
Glaucous Gull				8	5	11	8	4	3		39
Sabine's Gull								3			3
Arctic Tern		1		1			5	13	45		65
Guillemot sp.											
Snowy Owl											
Common Raven										1	1
Passerine									2		2

Table B7. Birds observed on outside component of aerial transects at McKinley Bay on August 3, 1984.

Species	Transect number 1	2	3	4	5	6	7	8	9	10	Total on all transects
Common Loon											
Yellow-billed Loon											
Arctic Loon	1					1					2
Red-throated Loon											
Loon sp.											
Tundra Swan											
Brant											
Greater White-fronted Goose											
Dark Goose											
Snow Goose											
Mallard											
Northern Pintail											
American Wigeon											
Dabbling duck											
Eider sp.											
Scaup sp.											
Oldsquaw											
Scoter sp.											
White-winged Scoter	2										2
Surf Scoter											
Red-breasted Merganser											
Diving duck		2		1							3
Unidentified duck											
Raptor											
Ptarmigan sp.											
Sandhill Crane											
Shorebird											
Jaeger sp.											
Glaucous Gull											
Sabine's Gull											
Arctic Tern				10		1					11
Guillemot sp.											
Snowy Owl											
Common Raven											
Passerine											

Table B8. Birds observed on outside component of aerial transects at McKinley Bay on August 4, 1984.

Species	Transect number										Total on all transects
	1	2	3	4	5	6	7	8	9	10	
Common Loon											
Yellow-billed Loon											
Arctic Loon						3					3
Red-throated Loon											
Loon sp.				2							2
Tundra Swan											
Brant											
Greater White-fronted Goose											
Dark Goose											
Snow Goose											
Mallard											
Northern Pintail											
American Wigeon											
Dabbling duck											
Eider sp.											
Scaup sp.											
Oldsquaw											
Scoter sp.											
White-winged Scoter											
Surf Scoter											
Red-breasted Merganser				7							7
Diving duck											
Unidentified duck				30							30
Raptor											
Ptarmigan sp.											
Sandhill Crane											
Shorebird											
Jaeger sp.											
Glaucous Gull						1					1
Sabine's Gull											
Arctic Tern						1					1
Guillemot sp.											
Snowy Owl											
Common Raven											
Passerine											

Table B9. Birds observed on outside component of aerial transects at McKinley Bay on August 5, 1984.

Species	Transect number										Total on all transects
	1	2	3	4	5	6	7	8	9	10	
Common Loon											
Yellow-billed Loon						2					2
Arctic Loon	4	2	1								7
Red-throated Loon		3			1	2					6
Loon sp.	1	2				1					4
Tundra Swan											
Brant											
Greater White-fronted Goose											
Dark Goose											
Snow Goose											
Mallard											
Northern Pintail						2					2
American Wigeon											
Dabbling duck						4					4
Eider sp.											
Scaup sp.											
Oldsquaw				27							27
Scoter sp.											
White-winged Scoter											
Surf Scoter											
Red-breasted Merganser											
Diving duck											
Unidentified duck			10								10
Raptor											
Ptarmigan sp.											
Sandhill Crane											
Shorebird											
Jaeger sp.											
Glaucous Gull	1	4	4	1	1	2					13
Sabine's Gull											
Arctic Tern		22		18		1					41
Guillemot sp.											
Snowy Owl											
Common Raven											
Passerine											

Appendic C. Birds observed on aerial fixed-wing surveys at Hutchison Bay in August, 1984.

Table C1. Birds observed on marine component of aerial transects at Hutchison Bay on August 3, 1984.

Species	Transect number										Total on all transects
	1	2	3	4	5	6	7	8	9	10	
Common Loon											
Yellow-billed Loon											
Arctic Loon											
Red-throated Loon		1	3	4							8
Loon sp.		1	10	1	1						13
Tundra Swan											
Brant				60							60
Greater White-fronted Goose											
Dark Goose					21						21
Snow Goose					8						8
Mallard											
Northern Pintail				15	2						17
American Wigeon											
Dabbling duck				6	3						9
Eider sp.											
Scaup sp.			30	92	37						159
Oldsquaw	278	530	379	135	166						1488
Scoter sp.	37	15	97	9	2						160
White-winged Scoter	3	22	179	10							214
Surf Scoter	234	126	169	44	59						632
Red-breasted Merganser			4								4
Diving duck	29	90	212	40	38						409
Unidentified duck			41	35	1						77
Raptor											
Ptarmigan sp.											
Sandhill Crane											
Shorebird											
Jaeger sp.											
Glaucous Gull	5	4	12	4	2						27
Sabine's Gull											
Arctic Tern			1	1							2
Guillemot sp.											
Snowy Owl											
Common Raven											
Passerine											

Table C2. Birds observed on marine component of aerial transects at Hutchison Bay on August 4, 1984.

Species	Transect number										Total on all transects
	1	2	3	4	5	6	7	8	9	10	
Common Loon											
Yellow-billed Loon											
Arctic Loon											
Red-throated Loon	1	3	3								7
Loon sp.			1								1
Tundra Swan											
Brant											
Greater White-fronted Goose											
Dark Goose					15						15
Snow Goose											
Mallard											
Northern Pintail				18							18
American Wigeon											
Dabbling duck											
Eider sp.											
Scaup sp.	8	27	49	81	50						215
Oldsquaw	31	348	441	133	106						1059
Scoter sp.	101	99	103	73	76						452
White-winged Scoter	86	77	2	3							168
Surf Scoter	5	10	68	20	85						188
Red-breasted Merganser			12								12
Diving duck	9	35	276	5	85						410
Unidentified duck			28								28
Raptor											
Ptarmigan sp.											
Sandhill Crane											
Shorebird											
Jaeger sp.											
Glaucous Gull	2	1	13		2						18
Sabine's Gull											
Arctic Tern			1								1
Guillemot sp.											
Snowy Owl											
Common Raven											
Passerine											

Table C3. Birds observed on marine component of aerial transects at Hutchison Bay on August 5, 1984.

Species	Transect number										Total on all transects
	1	2	3	4	5	6	7	8	9	10	
Common Loon		1									1
Yellow-billed Loon											
Arctic Loon			1								1
Red-throated Loon	2	2	3	4	4						15
Loon sp.			1		2						3
Tundra Swan											
Brant				12							12
Greater White-fronted Goose											
Dark Goose				11							11
Snow Goose					11						11
Mallard											
Northern Pintail	5			72							77
American Wigeon											
Dabbling duck				10	15						25
Eider sp.											
Scaup sp.			30	122	9						161
Oldsquaw	471	612	294	52	6						1435
Scoter sp.	285	708	329	92							1414
White-winged Scoter	45	146	6	1							198
Surf Scoter	393	41	97								531
Red-breasted Merganser			5	2							7
Diving duck	254	160	95	126	7						642
Unidentified duck	6		10		14						30
Raptor											
Ptarmigan sp.											
Sandhill Crane											
Shorebird											
Jaeger sp.											
Glaucous Gull	3	2	5	8	2						20
Sabine's Gull											
Arctic Tern		8			1						9
Guillemot sp.											
Snowy Owl											
Common Raven											
Passerine											

Table C4. Birds observed on terrestrial component of aerial transects at Hutchison Bay on August 3, 1984.

Species	Transect number										Total on all transects
	1	2	3	4	5	6	7	8	9	10	
Common Loon											
Yellow-billed Loon											
Arctic Loon				2	9	5	9				25
Red-throated Loon				5	3	1	7				16
Loon sp.					2		2				4
Tundra Swan			2	9	7	32	25				75
Brant											
Greater White-fronted Goose											
Dark Goose				6		34					40
Snow Goose											
Mallard											
Northern Pintail		8	1	28	8	28	2				75
American Wigeon											
Dabbling duck		2		3	7	4	1				17
Eider sp.											
Scaup sp.											
Oldsquaw					2		1				3
Scoter sp.											
White-winged Scoter											
Surf Scoter											
Red-breasted Merganser											
Diving duck											
Unidentified duck		2	30	10	29	6	31				108
Raptor											
Ptarmigan sp.											
Sandhill Crane											
Shorebird					12	15					27
Jaeger sp.											
Glaucous Gull		4		2	7		9				22
Sabine's Gull											
Arctic Tern		1			1	1	14				17
Guillemot sp.						1	2				3
Snowy Owl											
Common Raven											
Passerine											

Table C5. Birds observed on terrestrial component of aerial transects at Hutchison Bay on August 4, 1984.

Species	Transect number										Total on all transects
	1	2	3	4	5	6	7	8	9	10	
Common Loon											
Yellow-billed Loon											
Arctic Loon						8	14				22
Red-throated Loon		8			4	2	8				22
Loon sp.				2							2
Tundra Swan			1		4	17	19				41
Brant											
Greater White-fronted Goose				1	35		15				51
Dark Goose											
Snow Goose											
Mallard											
Northern Pintail				30	30	8					68
American Wigeon				2	11	1					14
Dabbling duck			1	7	16	8					32
Eider sp.											
Scaup sp.											
Oldsquaw		2									2
Scoter sp.		10									10
White-winged Scoter		20									20
Surf Scoter											
Red-breasted Merganser											
Diving duck											
Unidentified duck				30		3	4				37
Raptor											
Ptarmigan sp.											
Sandhill Crane							2				2
Shorebird		1									1
Jaeger sp.					1		1				2
Glaucous Gull		4	1	1	18		11				35
Sabine's Gull											
Arctic Tern		3			1	1	3				8
Guillemot sp.											
Snowy Owl											
Common Raven											
Passerine											

Table C6. Birds observed on terrestrial component of aerial transects at Hutchison Bay on August 5, 1984.

Species	Transect number										Total on all transects
	1	2	3	4	5	6	7	8	9	10	
Common Loon											
Yellow-billed Loon											
Arctic Loon				3	8	5	13				29
Red-throated Loon		1			2		4				7
Loon sp.				1	3	2	1				7
Tundra Swan					7	13	27				47
Brant											
Greater White-fronted Goose							15				15
Dark Goose					15						15
Snow Goose											
Mallard											
Northern Pintail		4		45	11	6	5				71
American Wigeon											
Dabbling duck					6	13	7				26
Eider sp.											
Scaup sp.											
Oldsquaw		5			2						7
Scoter sp.											
White-winged Scoter											
Surf Scoter											
Red-breasted Merganser				35		1					36
Diving duck						22					22
Unidentified duck					3						3
Raptor						1					1
Ptarmigan sp.											
Sandhill Crane							1				1
Shorebird		6			6	1					13
Jaeger sp.											
Glaucous Gull		4			3	7	10				24
Sabine's Gull											
Arctic Tern		2					12				14
Guillemot sp.											
Snowy Owl											
Common Raven				1		1					2
Passerine											

Table C7. Birds observed on outside component of aerial transects at Hutchison Bay on August 3, 1984.

Species	Transect number										Total on all transects
	1	2	3	4	5	6	7	8	9	10	
Common Loon											
Yellow-billed Loon											
Arctic Loon	1										1
Red-throated Loon											
Loon sp.											
Tundra Swan											
Brant											
Greater White-fronted Goose											
Dark Goose											
Snow Goose											
Mallard											
Northern Pintail											
American Wigeon											
Dabbling duck											
Eider sp.											
Scaup sp.											
Oldsquaw		8									8
Scoter sp.											
White-winged Scoter											
Surf Scoter											
Red-breasted Merganser											
Diving duck		1									1
Unidentified duck											
Raptor											
Ptarmigan sp.											
Sandhill Crane											
Shorebird											
Jaeger sp.											
Glaucous Gull	7	1									8
Sabine's Gull											
Arctic Tern											
Guillemot sp.											
Snowy Owl											
Common Raven											
Passerine											

Table C8. Birds observed on outside component of aerial transects at Hutchison Bay on August 4, 1984.

Species	Transect number 1	2	3	4	5	6	7	8	9	10	Total on all transects
Common Loon											
Yellow-billed Loon											
Arctic Loon											
Red-throated Loon											
Loon sp.											
Tundra Swan											
Brant											
Greater White-fronted Goose											
Dark Goose											
Snow Goose											
Mallard											
Northern Pintail											
American Wigeon											
Dabbling duck											
Eider sp.											
Scaup sp.											
Oldsquaw											
Scoter sp.	1										1
White-winged Scoter											
Surf Scoter											
Red-breasted Merganser											
Diving duck	2										2
Unidentified duck											
Raptor											
Ptarmigan sp.											
Sandhill Crane											
Shorebird											
Jaeger sp.											
Glaucous Gull		1									1
Sabine's Gull											
Arctic Tern											
Guillemot sp.											
Snowy Owl											
Common Raven											
Passerine											

Table C9. Birds observed on outside component of aerial transects at Hutchison Bay on August 5, 1984.

Species	Transect number										Total on all transects
	1	2	3	4	5	6	7	8	9	10	
Common Loon											
Yellow-billed Loon											
Arctic Loon	4										4
Red-throated Loon	1										1
Loon sp.		3									3
Tundra Swan											
Brant											
Greater White-fronted Goose											
Dark Goose											
Snow Goose											
Mallard											
Northern Pintail											
American Wigeon											
Dabbling duck											
Eider sp.											
Scaup sp.											
Oldsquaw											
Scoter sp.											
White-winged Scoter											
Surf Scoter											
Red-breasted Merganser											
Diving duck	20										20
Unidentified duck											
Raptor											
Ptarmigan sp.											
Sandhill Crane											
Shorebird											
Jaeger sp.	1										1
Glaucous Gull	10	3									13
Sabine's Gull											
Arctic Tern	1										1
Guillemot sp.											
Snowy Owl											
Common Raven											
Passerine											

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