YELLOW-BILLED LOON POPULATIONS ON THE COLVILLE RIVER DELTA, ARCTIC ALASKA

Supplemental Project Report

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1 February 1986

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ABSTRACT

We estimated the sizes of the 1983 and 1984 yellow-billed loon (Gavia adamsii) populations on the Colville River delta. We also estimated the numbers of pairs and active nests. Wetlands were surveyed along transects in 1983 and in blocks in 1984. Estimates are 165.40 ± 202.36 total yellow-billed loons (0.33/km^2), 61.63 ± 47.49 pairs (0.12/km^2), and 54.74 ± 78.90 nests (0.11/km^2) for 1983. Estimates are 90.71 ± 88.24 loons (0.18/km^2), 46.12 ± 50.37 pairs (0.09/km^2), and 30.38 ± 38.01 nests (0.06/km^2) for 1984. We believe our 1984 point estimates are very good. Our 1983 estimates are too high because of under sampling class VIII wetlands, small class IV wetlands, and wetlands 0.5-1.0 ha in size.

INTRODUCTION

The yellow-billed loon is a relatively rare bird that breeds in arctic tundra regions of North America and Eurasia (Palmer 1962). Few ecological studies have been conducted on this species because of the remoteness of its breeding range and its low population densities. Sage (1971) found two breeding pairs in his study area in arctic Alaska. Sjolander and Agren (1976) conducted an eight-week study of the reproductive behavior of renesting yellow-billed loons in the Alaktak region of Alaska. Most information on yellow-billed loon biology comes from incidental observations made during other studies and from accounts of early expeditions to the arctic (e.g. Dixon 1916, Bailey 1948, Kessel and Cade 1958, Sutton 1963, Smith 1973).

The 575-km^2 Colville River delta, located 160 km southeast of Point Barrow, is one of two locations in Alaska where concentrations of breeding yellow-billed loons are known to occur. The delta also is an area of potential oil development. Texaco announced it discovered oil in a test well in the northeast part of the delta in 1985 (Anchorage Daily News, 9 May 1985). Because of the probability of oil development on the delta, the U. S. Fish and Wildlife Service, Office of Special Studies, and North Dakota State University initiated a Cooperative Education Agreement in 1983 to study yellow-billed loon breeding biology. Additional funding was provided by the North American Loon Fund. Our estimates of yellow-billed loon populations on the delta are presented in this report. An estimate of the pre-development yellow-billed loon population will allow resource agencies to monitor the specific impacts of development on the population. Included in this report is a comprehensive review of yellow-billed loon distributions in North America and Eurasia. Additional results of this study will be presented in a thesis.

The volunteer field services of Greg Hiemenz, Rochelle Renken and Jeri Schwerin were essential to the success of the project. Tom Rothe and Bay Simpson provided invaluable assistance in initiating the project and orienting us to the arctic. Jay Kitchens aided in data collection. Many USFWS personnel, especially Jon Nickles, provided logistical support in Anchorage. Pat Heglund, Jon and Carolyn Nickles, Dan Rosenberg, Tom and Ann Rothe, Ann Rappoport, and Bill Eldridge graciously provided housing while we were in Anchorage. Jim and Tina Helmericks provided logistical support in the field. James Grier, Doris

Hertsgaard, and NDSU zoology graduate students provided helpful statistical advice. Greg Hiemenz, George Allen, Jon Nickles and Rebecca Field reviewed manuscripts and provided many useful comments.

YELLOW-BILLED LOON DISTRIBUTIONS: A LITERATURE REVIEW

Distribution in Alaska

Yellow-billed loons breed sporadically throughout their Alaska breeding range (Appendix A). Bailey (1948) found the species nesting irregularly along the arctic coast northward from Cape Prince of Wales. He believed the majority of yellow-billed loons nested east of Point Barrow. Bent (1919), Bailey (1948), and Palmer (1962) believed the species rarely nested near the coast. Sage (1971) found no evidence of yellow-billed loons breeding within 110 km of the Arctic Ocean, between the Canning and Colville Rivers. He also found only two breeding pairs in his study area bounded by the two rivers, the Arctic Ocean, and the foothills of the Brooks Range. Dixon (1916) found no yellow-billed loon nests along the arctic coast in 1913. The fourteen adults he collected in June and July 1913, near Point Humphrey, showed no signs of breeding. Bergman et al. (1977) considered the yellow-billed loon to be casual or accidental at Storkersen Point, only 60 km east of the Colville River delta. They observed only four individuals during a five-year study. Yellow-billed loons have been found breeding close to coastal areas west of the Colville River. Sjolander and Agren (1976) found 33 nesting

pairs in the Alaktak area 80 km southeast of Point Barrow. They found no yellow-billed loons at Peard Bay, Teshekpuk Lake, nor the National Arctic Research Lab at Meade River. Derksen et al. (1981) found breeding yellow-billed loons on the Colville River delta. They rarely observed the species at their East Long Lake, Island Lake, and Meade River study sites, and no evidence of breeding was found.

Yellow-billed loons have been reported at a few inland locations. Bee (1958) found breeding yellow-billed loons at only two (Lake Schrader and Wahoo Lake) of his 14 campsites across arctic Alaska. Irving (1960) reported that yellow-billed loon pairs were frequently observed near Amorgeayat, in the Killik Valley in the foothills of the Brooks Range, and that one pair was observed with a chick. Derksen et al. (1979, 1981) considered yellow-billed loons uncommon breeders at their Square Lake and Singiluk study sites. The density at Square Lake was 0.14/km . Bailey (1948) found yellow-billed loons common on lakes along a stretch of the Chipp River 160 km inland from the coast and he found them along the Alaktak River. Reed (1956) found the species on the Colville River only between the mouth of the Kikiakrorak River and the southern end of the delta. Kessel and Cade (1958) reported yellow-billed loons were regularly observed on stretches of the Colville River from the mouth of the Awuna River to Umiat in 1952 and 1957, but not in 1956. Neither Reed (1956) nor Kessel and Cade (1958) mentioned any evidence of breeding.

Most information on the distribution of yellow-billed loons west of Point Barrow is provided by Bailey (1948). He found the species along Lopp Lagoon, along the Mint River, and on the lakes and bays at

the extremity of the Seward Peninsula. He also believed it occurred at the head of Kotzebue Sound near the Kowak and Noatak Rivers. Bent (1919) reported eggs collected at Point Hope, Point Barrow, and the Salmon River in Alaska and the Mackenzie River delta in Canada. He also reported the species in summer at Norton Sound, Kotzebue Sound, and Selawik Lake. Yellow-billed loons also nested on St. Lawrence Island, possibly in fair numbers (Palmer 1962, Portenko 1981).

Distribution in Canada

Yellow-billed loons breed throughout much of mainland arctic Canada and the western high arctic islands (Appendix B), but little is known of their abundance. Bent (1919) reported yellow-billed loons to be numerous on Banks Island and he speculated that the species' main breeding grounds were on the Canadian arctic islands. Yellow-billed loons bred in fair numbers on large lakes on parts of Victoria Island (Sutton 1963, Smith 1973). Godfrey (1966) also reported the species on Prince of Wales Island and Herschel Island. Palmer (1962) listed the species as occasional on Foxe Peninsula and Baffin Island, and as a possible breeder on Somerset Island. Sutton (1963) observed a pair of yellow-billed loons along the coast of Jenny Lind Island but found no evidence of breeding there. Godfrey (1966) reported breeding grounds on the mainland on the Melville Peninsula, along the Hanbury and Thelon Rivers, and at Yathkyed and Angikuni Lakes. Bent (1919) reported yellow-billed loons breeding at Liverpool Bay and Franklin Bay and he believed the species to be common in the northern interior of the Mackenzie District, Northwest Territories. Bent also reported the

species in migration at Hay River on Great Slave Lake and on the Mackenzie River above Fort Simpson. Palmer (1962) stated that the species may have been a numerous breeder near Franklin Bay, but it was then scarce. Salter et al. (1980) found no evidence of yellow-billed loons breeding along the Yukon coast. They observed the species along the coast in small numbers during spring and fall migration and occasionally on coastal lakes during the summer.

Distribution in Eurasia

Little is known of the distribution of yellow-billed loons in Eurasia. Portenko (1981) reported the species had a sporadic distribution along the coast of the Chukchi Peninsula (Appendix C). It was common in some coastal areas from Anadyr Bay to the Kolyma River, but was rare inland and on Wrangel Island. Godfrey (1966) reported the species bred on Novaya Zemlya and in northern Finland. Dement'ev and Gladkov (1968) considered the yellow-billed loon to be a common breeder in northeast Siberia and a rare breeder across the rest of arctic Eurasia to Finland.

Winter Distribution

Yellow-billed loons winter at sea. The main winter range in North America is the coastal area from southern Alaska to Vancouver Island, British Columbia (Snyder 1957, Gabrielson and Lincoln 1959, Palmer 1962, Godfrey 1966). Bailey (1948) and Gabrielson and Lincoln (1959) reported the species to be common in the Icy Strait and Stephens Passage - Seymour Canal areas around Admiralty Island.

Yellow-billed loons also winter off the coasts of China and Japan (Palmer 1962). Individuals that breed in North America migrate along the coastline of Alaska and Canada to and from their breeding grounds (Gabrielson and Lincoln 1959, Palmer 1962). Yellow-billed loons that nest in eastern Siberia migrate along the coast of the Soviet Union (Burn and Mather 1974). The migration routes of both populations go through the Bering Strait. It is unknown if some individuals from either population cross the Bering Sea and winter along the coast of the opposite continent (Palmer 1962, Burn and Mather 1974). Some yellow-billed loons also winter off the coast of Norway. Burn and Mather (1974) believed these birds come only from the population nesting west of the Laptev Sea.

STUDY AREA

The Colville River is the major river of arctic Alaska (Walker 1983). Its delta is a region of dendritic river channels, fluvial deposits of various ages, low relief, and numerous thaw lakes at different stages of development. The northern and eastern regions of the delta are dominated by young islands and silt deposits with relatively few large wetlands. The rest of the delta is older geomorphologically and has numerous wetlands and well-developed permafrost-related landforms. Wetlands in the older regions form a spectrum in size and abundance from ubiquitous, 0.1-ha pools in polygon basins to a few tapped and untapped wetlands larger than 100 ha. Tapped wetlands are connected to river channels through direct breeches or

through a series of channels running from lake to lake and eventually into a river. Tapped-lake water levels fluctuate with river level fluctuations. Surfaces of untapped lakes are elevated above river surfaces. The degree to which a lake is drained upon tapping is determined by differences in elevation between lake surface and river surface, as well as by lake depth (pers. obs.). Lakes within 9 km of the coast tend to drain less extensively than lakes farther inland where portions of the lake basins become exposed upon tapping. Hydrology along the Arctic Coastal Plain is further described in Black (1970), Bergman et al. (1977), and Walker (1978, 1983).

METHODS

Our estimates of the yellow-billed loon populations on the delta were derived from two other sets of estimates: the number of yellow-billed loons per wetland for each wetland class and the number of wetlands of each class on the study area. Bergman et al. (1977) recognized 8 classes of wetlands on the Arctic Coastal Plain. Because the Bergman et al. (1977) classification system does not incorporate some wetland characteristics pertinent to loons, we recognized three basic wetland types: 1. wetlands smaller than 1.0 ha, which we divided into two groups based on size; 2. non-tapped wetlands larger than 1.0 ha; and 3. tapped wetlands larger than 1.0 ha. Non-tapped wetlands larger than 1.0 ha were further grouped according to the Bergman et al. (1977) classification system. Class II and III wetlands were combined for analysis because of similarities in size. We believed yellow-billed

loons selected for or against these wetlands because of size, not because of presence or absence of Arctophila fulva. In this section we use the term "class" to refer to all wetland groups.

Wetland Estimates

In August, 1983, we took aerial photographs (scale = 1:12,000) along transects covering approximately 2 percent of the delta to determine the density of wetlands in each class. The photographs proved unsatisfactory for estimating wetland densities because we could not determine the class of wetlands from them.

In 1984, we divided the delta into 48 7.81-km^2 blocks. The 80-km^2 area west and south of the Nechelik Channel was excluded from the study area because of time and fuel constraints. Twenty-three randomly selected blocks were surveyed by foot or boat from 18 June to 20 July. All wetlands (except Class I and Class VII wetlands) wholly or partially within blocks were initially classified according to Bergman et al. (1977). We also recorded whether each wetland was tapped or non-tapped and we estimated the sizes of wetlands smaller than 1.0 ha. We regrouped wetlands according to the criteria mentioned on the previous page after we left the study area. Sizes of wetlands larger than 1.0 ha were measured from USFWS maps (scale = 1:33,540) with a Houston Instruments HIPAD digitizer. Wetland sizes obtained from USFWS maps were verified from USGS maps (scale = 1:63,360) which showed less detail.

Proportions of wetlands partially within each block were calculated by dividing the area of the wetland within the block by the

total area of the wetland. The number of wetlands wholly within a block and the proportions of wetlands partially within a block were summed by block for each class. Means and variances of number of wetlands per block were calculated for each wetland class. We used equation 2.24 in Cochran (1977, p. 27) to estimate wetland densities in the 494-km^2 area of the delta that comprised the study area. A finite population correction factor, based on the areal proportion of the delta surveyed (23 blocks = 36 % of the delta), was applied.

Loon Densities on Wetland Classes

We used different methods in 1983 and 1984 to estimate loon densities on wetlands of each class. In 1983, we surveyed wetlands along transects. Transects radiated from a 15.30-km^2 central core area and extended until an impassable body of water (e.g. distant river, Arctic Ocean) or the edge of the delta was encountered. All wetlands in the core area and along approximately 125 km of transects were surveyed from 18 June to 14 July. All wetlands (except Class I and Class VII wetlands) in the core area and those intercepted by transects were classified, determined to be tapped or not, and surveyed for yellow-billed loons. We surveyed wetlands by walking or slowly boating along the entire shoreline. Frequent stops were made to scan the lake with binoculars. Islands were surveyed with binoculars or, if possible, by boating to them. For each wetland we recorded the total number of yellow-billed loons present and the number of pairs and nests present. We occasionally found single loons with nests. Those individuals were tallied as pairs, but only the single loon was tallied in the total

number of loons using that wetland. We found a few pairs that nested on small wetlands but reared their young exclusively on large, nearby lakes. Attributing a pair to each wetland would result in an overestimate of the number of pairs on the delta. Therefore, we considered the brood-rearing wetland to contain the pairs, instead of dividing pair usage equally between the nesting and brood-rearing wetlands. Brood-rearing wetlands were occupied by at least one adult or the chicks throughout the breeding season. Nesting wetlands that were separate from brood-rearing wetlands were occupied only during the pre-nesting and nesting periods, and usually by only one adult.

In 1984, we sampled loon densities and wetland densities concurrently. All wetlands surveyed to estimate wetland density also were surveyed for numbers and species of loons.

Population Estimate and Statistical Analysis

We estimated the densities of yellow-billed loons, pairs, and active nests per wetland. Densities per wetland were calculated for each class and year.

Wetland densities and yellow-billed loon densities were used to estimate the sizes of the 1983 and 1984 populations. The point estimate for each population is a product of the estimates of the population density per wetland class and the density of wetlands by class. Point estimates for each class were summed to obtain a total estimate for each population on the delta.

Confidence intervals were calculated using the equation:

$$C.I. = (t)(\sqrt{Var\ XY})(N)[\sqrt{(\hat{N}-n)/\hat{N}}]$$

where $$Var\ XY = (S_x^2/n_x)(S_y^2/n_y) + (\mu_y)(S_x^2/n_x) + (\mu_x)(S_y^2/n_y)$$

where X represents the number of wetlands per block, Y represents the number of loons (or nests or pairs) per wetland, and N = 63.23, the number of 7.81-km^2 blocks that could fit into the study area. The square root of $(\hat{N}-n)/\hat{N}$ is the finite population correction factor, where $\hat{N}$ equals the estimate of the number of wetlands/494 km^2 for each wetland group (see Table 1) and n equals the number of wetlands sampled in each group (see Table 2, 3 or 4). The equation for calculating (Var XY) is found in exercise 4.92 (p. 178) in Hogg and Craig (1978).

We assumed our point estimates of the number of wetlands of each class to be the actual numbers present on the delta. The finite population correction factor was based on the proportion of those wetlands sampled for loons. Lower confidence limits equal the point estimate less the 95 percent confidence interval or the actual number of loons (or pairs or nests) observed, whichever is higher. Upper confidence limits equal the point estimate plus the 95 percent confidence interval. Results reported were rounded to two significant digits after all calculations were made.

RESULTS AND DISCUSSION

Mean wetland densities per block and estimated wetland densities on the delta are presented in Table 1. Wetlands smaller than 0.5 ha are excluded because they were so numerous that their density could not be readily estimated. Non-tapped Class IV wetlands were most abundant. We probably overestimated the density of tapped wetlands. Many tapped wetlands were clustered in the north central section of the delta. A

Table 1. Densities of wetlands per block* and estimates of wetlands per 494 km^2 on the Colville River delta, Alaska, 1984.

	No. Wetlands/block*		
Wetland Group	Mean	S^2	No. Wetlands/494 km^2
0.5 - 1.0 ha	3.02	7.15	191.16 ± 58.31**
> 1.0 ha			
Non-tapped			
C-II/III	0.75	0.67	47.60 ± 17.80
C-IV	3.67	8.18	232.02 ± 62.38
C-V	0.61	1.00	38.69 ± 21.83
C-VI	0.17	0.70	11.00 ± 18.19
C-VIII	0.38	2.21	23.86 ± 32.45
Tapped	0.98	1.28	62.06 ± 24.72

* n=23
**95% confidence interval

relatively high proportion of the randomly-selected blocks sampled were clustered in the same area.

The densities and variances of yellow-billed loons per wetland are presented in Table 2. Highest densities were found on non-tapped Class V wetlands. No yellow-billed loons were found on sampled wetlands smaller than 0.5 ha. However, one pair was found, both years, nesting on an unsampled 0.1-ha wetland. The pair raised their broods on an adjacent Class VIII wetland. Table 3 shows the densities of yellow-billed loon pairs per wetland. Highest densities were found on Class V wetlands. No pairs were found on tapped wetlands nor on the sampled wetlands less than 1.0 ha in size. One pair was found nesting on a wetland less than 1.0 ha in size (Table 4), however, pair usage was attributed to the wetland on which the brood was raised. Highest nest densities were found on Class V wetlands (Table 4). No nests were found on tapped wetlands nor on the Class VIII wetlands sampled.

Population, pair and nest estimates, confidence intervals, and ranges are presented in Tables 5-7. We believe the 1984 estimates are very good, but the 1983 estimates are too high. Large wetlands were more likely to be sampled than smaller wetlands by our 1983 sampling method. Large Class IV wetlands were utilized more frequently by yellow-billed loons than smaller Class IV wetlands, therefore the observed proportion of wetlands with loons was inflated in 1983. The estimate of loons using Class IV wetlands (Table 5) is thus too high. Large confidence intervals for Class VIII and 0.5-ha to 1.0-ha wetlands reflect insufficient sample sizes in 1983. The estimates of yellow-billed loons that used Class V wetlands (Table 5) are similar for

Table 2. Densities of yellow-billed loons per wetland on the Colville River delta, Alaska, 1983 and 1984.

	1983				1984			
			Loons/wetland				Loons/wetland	
Wetland Group	Wetlands Sampled	No. Loons	Mean	s^2	Wetlands Sampled	No. Loons	Mean	s^2
< 0.5 ha	649	0	0.00	0.00	1992	0	0.00	0.00
0.5 - 1.0 ha	13	1	0.08	0.08	61	1	0.02	0.02
> 1.0 ha								
Non-tapped								
C-II/III	9	1	0.11	0.11	19	0	0.00	0.00
C-IV	37	15	0.41	0.58	89	14	0.16	0.27
C-V	24	25	1.04	2.13	20	20	1.00	1.16
C-VI	0				4	0	0.00	0.00
C-VIII	3	1	0.33	0.33	12	3	0.25	0.39
Tapped	20	1	0.05	0.05	29	3	0.10	0.10

Table 3. Densities of yellow-billed loon pairs per wetland on the Colville River delta, Alaska, 1983 and 1984.

	1983				1984			
			Pairs/wetland				Pairs/wetland	
Wetland Group	Wetlands Sampled	No. Pairs	Mean	S^2	Wetlands Sampled	No. Pairs	Mean	S^2
< 0.5 ha	649	0	0.00	0.00	1992	0	0.00	0.00
0.5 - 1.0 ha	13	0	0.00	0.00	61	0	0.00	0.00
> 1.0 ha								
Non-tapped								
C-II/III	9	0	0.00	0.00	19	0	0.00	0.00
C-IV	37	7	0.19	0.14	89	8	0.09	0.08
C-V	24	11	0.46	0.50	20	11	0.55	0.37
C-VI	0				4	0	0.00	0.00
C-VIII	3	0	0.00	0.00	12	2	0.17	0.15
Tapped	20	0	0.00	0.00	29	0	0.00	0.00

Table 4. Densities of yellow-billed loon nests per wetland on the Colville River delta, Alaska, 1983 and 1984.

	1983				1984			
			Nests/wetland				Nests/wetland	
Wetland Group	Wetlands Sampled	No. Nests	Mean	s^2	Wetlands Sampled	No. Nests	Mean	s^2
< 0.5 ha	649	0	0.00	0.00	1992	0	0.00	0.00
0.5 - 1.0 ha	13	1	0.08	0.08	61	1	0.02	0.02
> 1.0 ha								
Non-tapped								
C-II/III	9	1	0.11	0.11	19	0	0.00	0.00
C-IV	37	4	0.11	0.10	89	6	0.07	0.07
C-V	24	6	0.25	0.28	20	6	0.30	0.33
C-VI	0				4	0	0.00	0.00
C-VIII	3	0	0.00	0.00	12	0	0.00	0.00
Tapped	20	0	0.00	0.00	29	0	0.00	0.00

Table 5. Estimates of yellow-billed loon populations on the Colville River delta, Alaska, in 1983 and 1984.

Wetland Group	1983 Estimate	1983 Range**	1984 Estimate	1984 Range**
0.5 - 1.0 ha	14.70 ± 27.79*	1.00 - 42.49	3.13 ± 7.91*	1.00 - 11.04
> 1.0 ha				
Non-tapped				
C-II/III	5.29 ± 14.90	1.00 - 20.19	0.00 ± 0.00	0.00 - 0.00
C-IV	94.06 ± 51.73	42.33 - 145.79	36.50 ± 25.40	14.00 - 61.90
C-V	40.30 ± 25.92	25.00 - 66.22	38.69 ± 26.26	20.00 - 64.95
C-VI			0.00 ± 0.00	0.00 - 0.00
C-VIII	7.95 ± 74.03	1.00 - 81.98	5.97 ± 19.46	3.00 - 25.43
Tapped	3.10 ± 7.99	1.00 - 11.09	6.42 ± 9.21	3.00 - 15.63
Total	165.40 ± 202.36	71.33 - 367.76	90.71 ± 88.24	41.00 - 178.95

*95% confidence interval
**range of confidence interval. The methods used to derive the intervals are described on page 12.

Table 6. Estimates of numbers of yellow-billed loon pairs on the Colville River delta, Alaska, in 1983 and 1984.

Wetland Group	1983 Estimate	1983 Range**	1984 Estimate	1984 Range**
0.5 - 1.0 ha	0.00 ± 0.00*	0.00 - 0.00	0.00 ± 0.00*	0.00 - 0.00
> 1.0 ha				
Non-tapped				
C-II/III	0.00 ± 0.00	0.00 - 0.00	0.00 ± 0.00	0.00 - 0.00
C-IV	43.90 ± 32.72	11.18 - 76.62	20.86 ± 18.38	8.00 - 39.24
C-V	17.73 ± 14.77	11.00 - 32.50	21.28 ± 17.44	11.00 - 38.72
C-VI			0.00 ± 0.00	0.00 - 0.00
C-VIII	0.00 ± 0.00	0.00 - 0.00	3.98 ± 14.55	2.00 - 18.53
Tapped	0.00 ± 0.00	0.00 - 0.00	0.00 ± 0.00	0.00 - 0.00
Total	61.63 ± 47.49	22.18 - 109.12	46.12 ± 50.37	21.00 - 96.49

*95% confidence interval
**range of confidence interval. The methods used to derive the intervals are described on page 12.

Table 7. Estimates of numbers of yellow-billed loon nests on the Colville River delta, Alaska, in 1983 and 1984.

Wetland Group	1983 Estimate	1983 Range**	1984 Estimate	1984 Range**
0.5 - 1.0 ha	14.70 ± 27.79*	1.00 - 42.49	3.13 ± 7.91*	1.00 - 11.04
> 1.0 ha				
Non-tapped				
C-II/III	5.29 ± 14.90	1.00 - 20.19	0.00 ± 0.00	0.00 - 0.00
C-IV	25.08 ± 25.21	4.00 - 50.29	15.64 ± 15.93	6.00 - 31.57
C-V	9.67 ± 11.00	6.00 - 20.67	11.61 ± 14.17	6.00 - 25.78
C-VI			0.00 ± 0.00	0.00 - 0.00
C-VIII	0.00 ± 0.00	0.00 - 0.00	0.00 ± 0.00	0.00 - 0.00
Tapped	0.00 ± 0.00	0.00 - 0.00	0.00 ± 0.00	0.00 - 0.00
Total	54.74 ± 78.90	12.00 - 133.64	30.38 ± 38.01	13.00 - 68.39

*95% confidence interval
**range of confidence interval. The methods used to derive the intervals are described on page 12.

1983 and 1984. Most Yellow-billed loons were found on Class IV and Class V wetlands (Table 5).

Non-tapped Class IV and Class V wetlands were the only sampled wetlands on which yellow-billed loon pairs were found in 1983 (Table 6). The estimate of pairs utilizing Class IV wetlands is probably too high (see previous paragragh). No pairs were observed on tapped wetlands (Table 5). The estimated number of pairs in 1984 (Table 6) is probably a little too high. We had traversed approximately 60 percent of the delta in 1983 and 1984, and we are aware of 32 pairs on the delta. Aerial photographs show that regions of the delta unsampled in both 1983 and 1984 contained very few large wetlands comparable to those on which yellow-billed loons were typically found. We believe the number of yellow-billed loon pairs on the delta in 1984 was closer to 40 than to 46. This belief is based on: 1. the number of known pairs on the delta, and 2. the low numbers of large wetlands in unsampled regions relative to sampled regions of the delta. The estimate of yellow-billed loon nests in 1983 is far too high, especially for non-tapped Class IV and 0.5-1.0 ha wetlands (Table 7). We believe the estimate of nests in 1984 (Table 7) is very good. Seventy-six and 79 percent of the pairs found in 1983 and 1984, respectively, nested (unpubl. data). These figures, projected to 40 pairs, would yield 30.40 - 31.60 expected nests in 1984.

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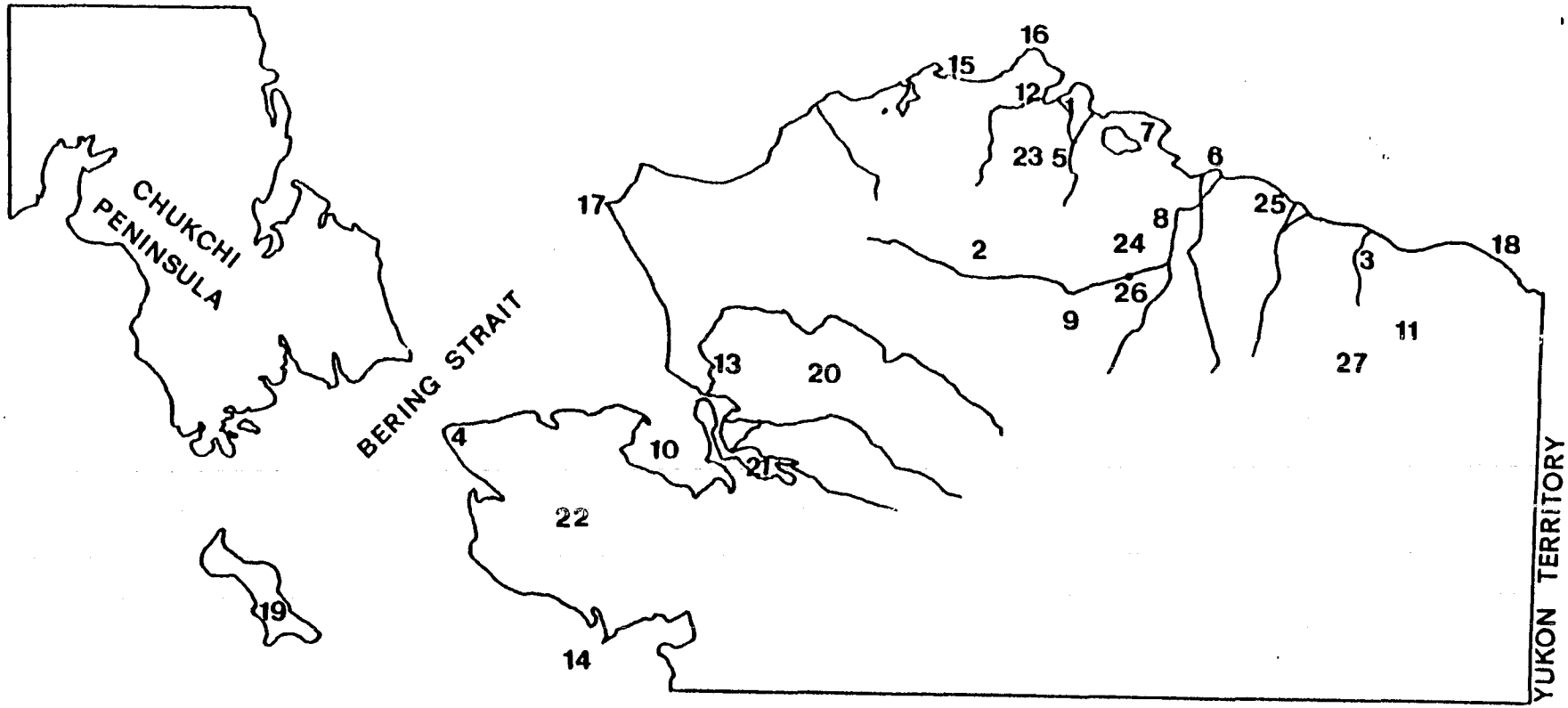
APPENDIX A

Locations of Places in Northern Alaska Mentioned in the Text

Location	Number On Map	Location	Number On Map
Alaktak	1	Norton Sound	14
Awuna River	2	Peard Bay	15
Canning River	3	Point Barrow	16
Cape Prince of Wales	4	Point Hope	17
Chipp River	5	Point Humphrey	18
Colville River Delta	6	St. Lawrence Island	19
East Long Lake	7	Salmon River	20
Island Lake	7	Selawik Lake	21
Kikiakrorak River	8	Seward Peninsula	22
Killik Valley	9	Singiluk	23
Kotzebue Sound	10	Square Lake	24
Lake Schrader	11	Storkersen Point	25
Lopp Lagoon	4	Teshekpuk Lake	7
Meade River	12	Umiat	26
Noatak River	13	Wahoo Lake	27


CHUKCHI PENINSULA
BERING STRAIT
YUKON TERRITORY
16
15
12
23 5
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17
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24
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3
26
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21 5
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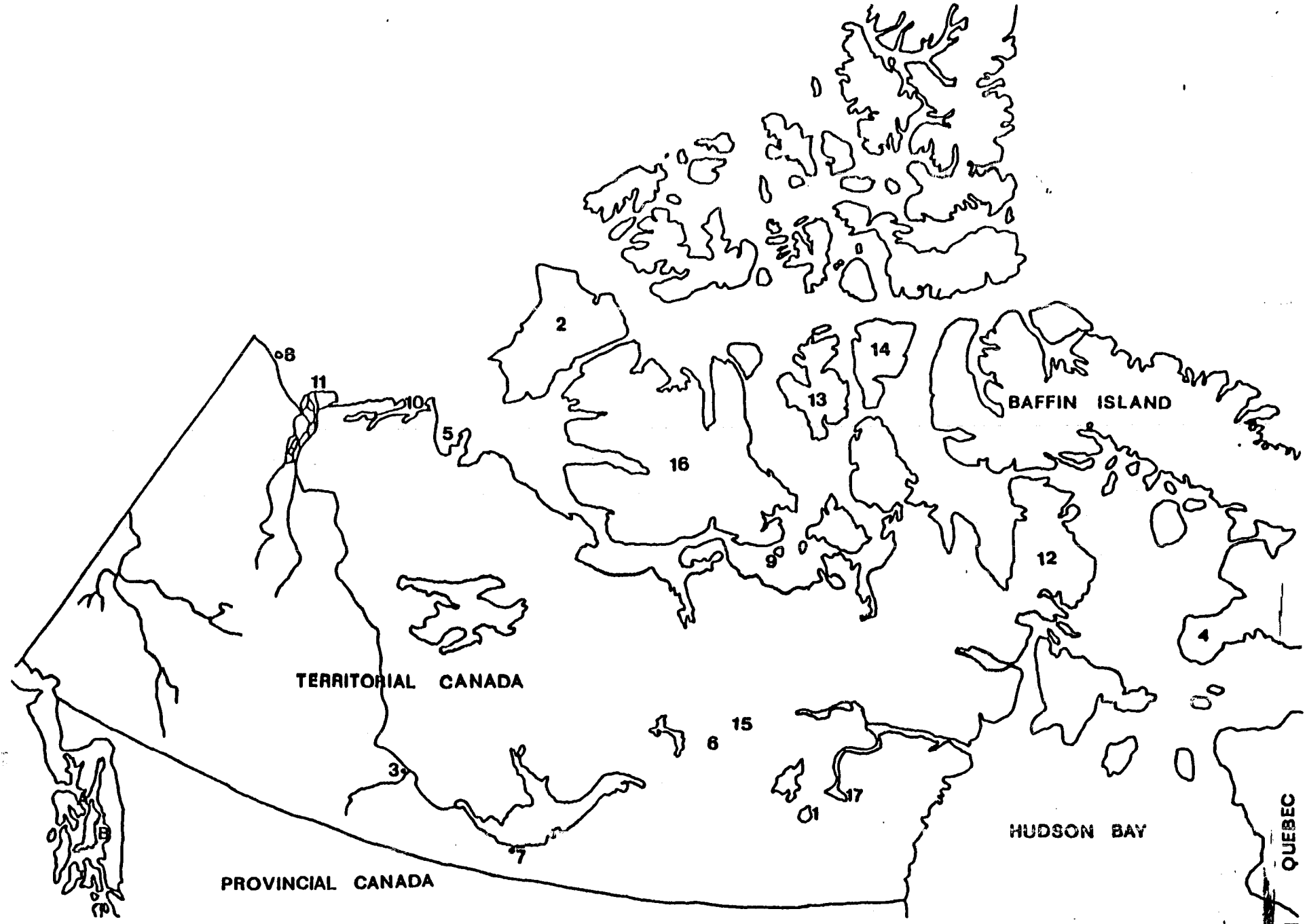
19
14

APPENDIX B

Locations of Places in Canada and Southeast Alaska Mentioned in the Text

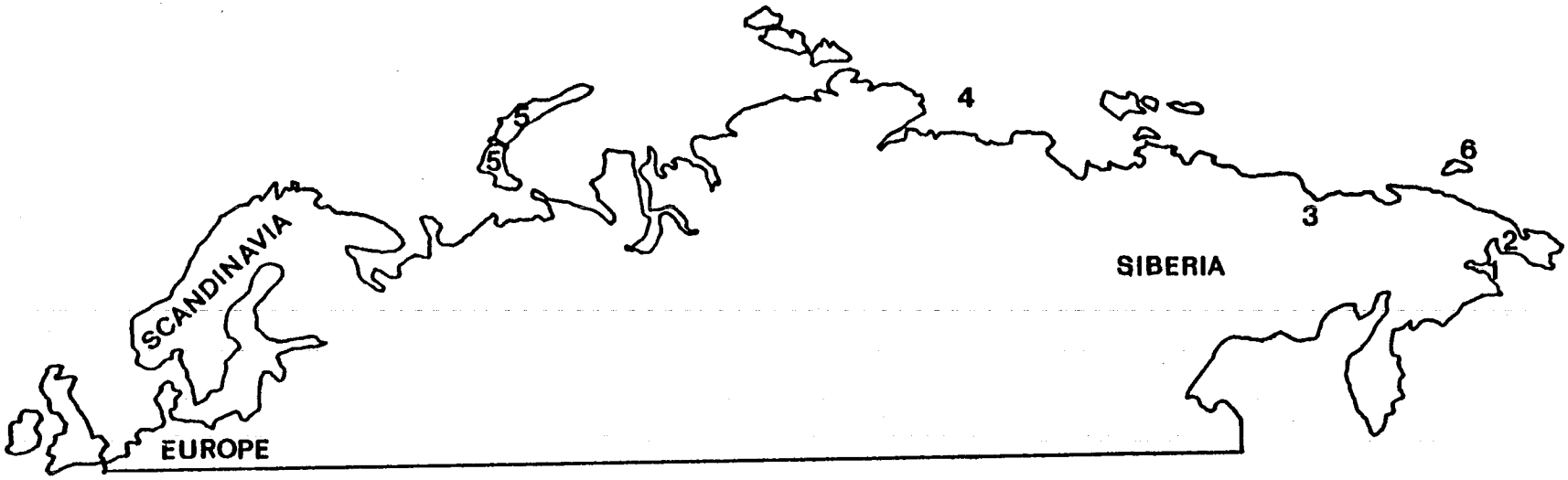
Location	Number On Map
Angikuni Lake	1
Banks Island	2
Fort Simpson	3
Foxe Peninsula	4
Franklin Bay	5
Hanbury River	6
Hay River (town)	7
Herschel Island	8
Jenny Lind Island	9
Liverpool Bay	10
Mackenzie River Delta	11
Melville Peninsula	12
Prince of Wales Island	13
Somerset Island	14
Thelon River	15
Victoria Island	16
Yathkyed Lake	17
Icy Strait	A
Stephens Passage - Seymour Canal	B


2
8
11
10
5
16
13
14
BAFFIN ISLAND
9
12
4
TERRITORIAL CANADA
6
15
3
17
1
7
HUDSON BAY
PROVINCIAL CANADA
QUEBEC

APPENDIX C

Locations of Places in Northern Eurasia Mentioned in the Text

Location	Number on Map
Anadyr Bay	1
Chukchi Peninsula	2
Kolyma River Delta	3
Laptev Sea	4
Novaya Zemlya	5
Wrangel Island	6


SCANDINAVIA
EUROPE
SIBERIA
1
2
3
4
5
5
6