

# **WATERFOWL SURVEYS ALONG THE ALASKA HIGHWAY SOUTHERN YUKON, SPRING AND SUMMER 1989 AND SUGGESTIONS FOR AN ANNUAL TREND SURVEY**

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## **ABSTRACT**

Multiple surveys on 20 selected wetlands were conducted in May 1989 to determine their suitability for waterfowl population trends and to document waterfowl productivity in that year. Mean population estimates were highly variable between surveys and among waterbodies. Scaup species, American widgeon and Mallards were the most abundant species. Surveys of this magnitude and frequency are not sensitive enough to be relied upon for trend surveys. Increasing the number of wetlands surveyed or increasing the number of replicates will lower the confidence limits substantially. The logistical and financial constraints of intensifying the surveys are discussed.

## **RÉSUMÉ**

Des relevés multiples ont été faits dans vingt secteurs de terres humides en mai 1989. L'objectif était de savoir dans quelle mesure ces terres humides pouvaient se prêter à l'examen des tendances démographiques chez la sauvagine. On voulait aussi des évaluations de la productivité de la sauvagine cette année-là. Les estimations démographiques moyennes variaient fortement d'un relevé à l'autre ainsi que d'un plan d'eau à l'autre. Les Morillons, le Canard siffleur d'Amérique et le Colvert étaient les espèces trouvées en plus grande abondance. Les relevés de cette importance et pratiqués à cette fréquence ne sont pas assez sensibles pour fournir des estimations fiables des tendances démographiques. Le fait d'augmenter le nombre des terres humides servant aux relevés ou d'accroître le nombre des répétitions resserrerait sensiblement les intervalles de confiance. On examine les contraintes financières et logistiques associées à l'intensification des relevés.

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## 1. INTRODUCTION

In May of 1989, the Canadian Wildlife Service surveyed 20 wetlands along the Alaska Highway between Whitehorse and Watson Lake (Figures 1 and 2). The primary objective was to determine their suitability as an indicator of waterfowl population trends. The secondary objective was to determine waterfowl productivity in these wetlands. The wetlands were selected on the basis of ease of access and visibility.

## 2. STUDY AREA

This portion of the Alaska Highway lies within a zone of discontinuous permafrost, encompassed within two major ecoregions (Lake Laberge and Pelly Mountains) described by Oswald and Senyk (1977). This area was glaciated during the last advance, resulting in deposition of morainal and glaciofluvial materials in the valleys. Soils are often silty or sandy with some interspersions of gravels. The upland habitat of this area is generally classified as Continental High Boreal Forest characterized by black and white spruce, trembling aspen and balsam poplar with some lodgepole pine (Zoltai et al. 1988). Ericaceous shrubs and willows are also present.

## 3. METHODS

The roadside wetlands were surveyed for breeding waterfowl every 6 days between May 10 and May 28 for a total of 4 replicate surveys. Most of the wetlands were adjacent to or visible from the highway, and all were within one kilometre of the highway. Observations were made with spotting scopes and binoculars from vantage points when available. In some cases a section of the shore was walked in order to see all of the water area. The number, species, group designation (ie. pair, lone bird or group etc.) and sex of the ducks was recorded in field notebooks and later transferred to data sheets for entry into the computer.

Brood surveys were conducted on the same wetlands from 10-12 July. Observations were made from the same vantage points used in the pair surveys, but more time was spent at each wetland to give secretive broods time to emerge from cover. All broods were aged as per Gollup and Marshall (1954).

For the purpose of analyzing breeding pair data, waterfowl numbers were treated as indicated pairs and total birds. Indicated pairs included observed pairs (i.e. territorial or isolated pairs distinctly separate from groups) plus indicated pairs (males in all male groups of 5 or less). Total birds included all birds of each species seen on a survey. For this reason, the total number of birds represented by indicated pairs (ie. pairs x 2) often exceeds

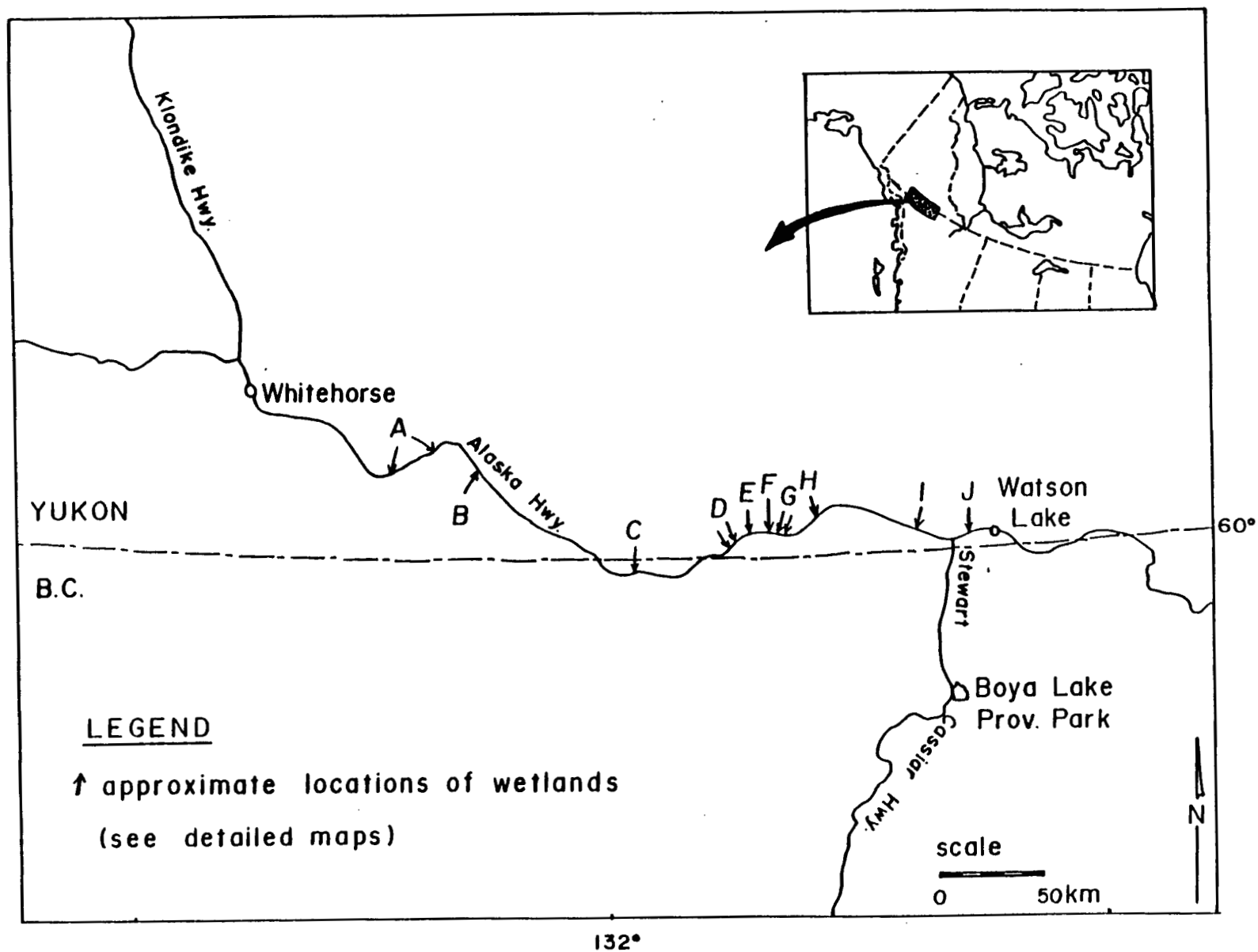


Figure 1. Locations of wetlands surveyed along the Alaska Highway in southern Yukon in Spring 1989. Letters (A, B, etc.) refer to individual map sections depicted in Fig. 2.

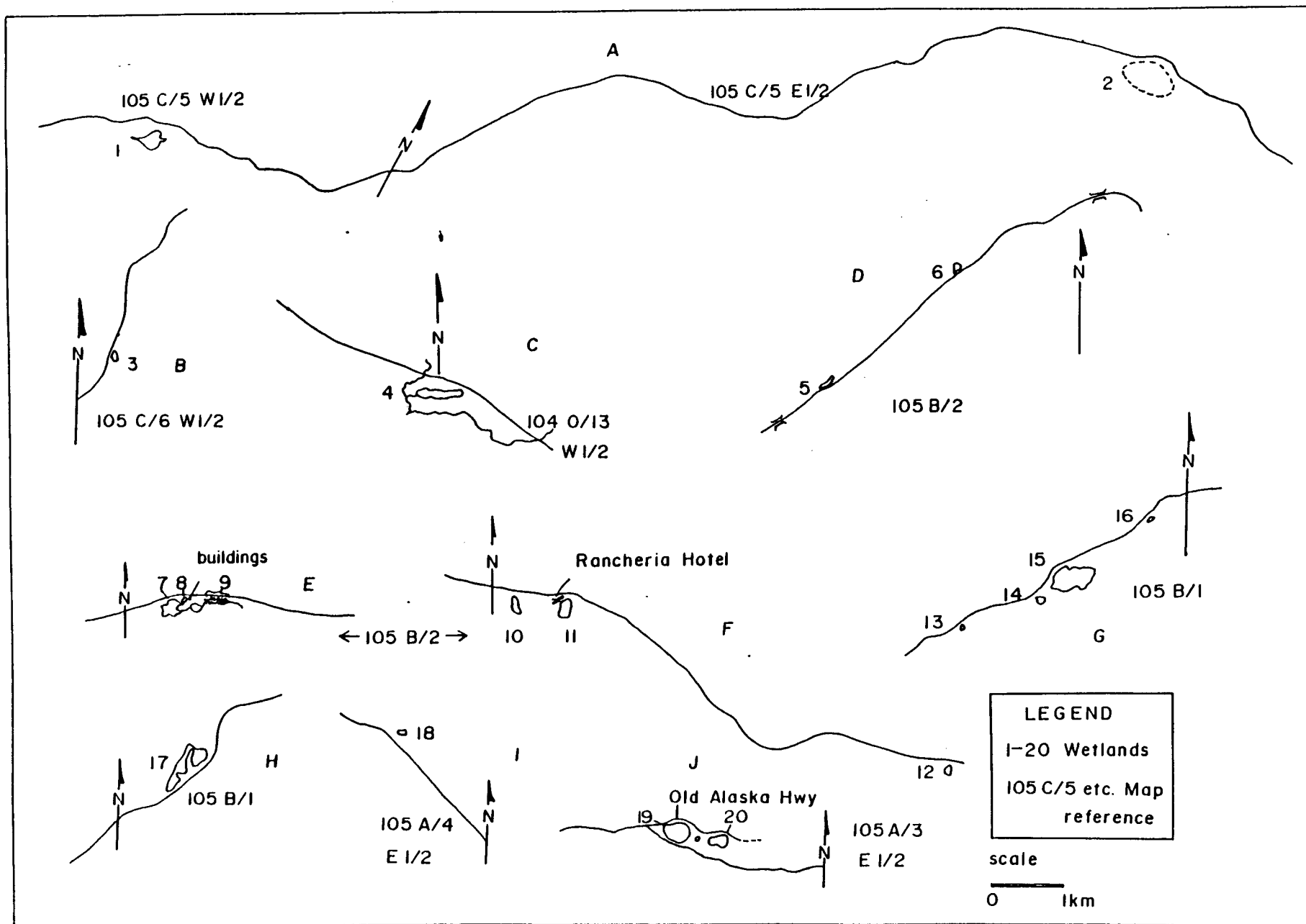


Figure 2. Detailed locations of wetlands surveyed along the Alaska Highway in southern Yukon in spring 1989. Letters (A, B, etc.) refer to general locations indicated in Fig. 1.

the "total" birds actually observed on a particular survey.

Survey data were entered on a SAS database and analyses were conducted using SAS (SAS Institute 1985). The mean number and 95% confidence intervals were calculated for each species of waterfowl observed on more than one survey.

Each wetland was classified as small or large, and wetland characteristics were classified according to Cowardin et al. (1979). The shores and shallow water areas of deep water habitats (Lacustrine system) were classified under the Palustrine System. Water quality parameters (pH, conductivity, and temperature) were recorded in most wetlands in conjunction with brood surveys.

#### 4. RESULTS AND DISCUSSION

##### 4.1 Breeding Pair Surveys

The most frequently observed species during the surveys were Scaup and American Wigeon (Tables 1 and 2). Other common divers included Barrow's Goldeneye and Bufflehead, while other dabblers included Mallard and Green-winged Teal.

The greatest total number of waterbirds (227) was observed during survey 1 (10 May) and the least number (93) was observed on survey 3 (22 May, Table 1). For survey 1, 2 and 4 the most abundant species was Scaup followed by American Wigeon, but on survey 3 Mallards were more abundant than American Wigeon.

The same trend was observed in the pair numbers, which were greatest during survey 1 at 116 pairs and lowest for survey 3 at 57 pairs (Table 1). The most abundant pair species for survey 1, 2 and 3 was Scaup followed by Mallard. On the 4th survey American Wigeon were more abundant than Mallard. During the first survey, staging migrants of most species seem to have inflated the counts (Table 1).

Mean population estimates derived from the 4 replicate surveys were quite variable, with 95% confidence intervals ranging from  $\pm 21\%$  for pairs of Barrow's Goldeneye to  $\pm 173\%$  for total Northern Pintails (Table 2). For Mallards and American Wigeon confidence intervals were  $\pm 60-70\%$ . This indicates that only population changes of twice this magnitude or larger would be detectable at the 95% confidence level with this amount of survey effort.

The species composition of broods seen along the Alaska Highway was almost identical with that of breeding pairs observed in May (Table 3). However, there were an average of five to eight pairs observed for each brood observed (Table 4). This is somewhat higher than the one to six pairs per brood observed by Mossop (in progress) or the one to four pairs per brood observed by Johnston et al. (1985). However, a direct comparison is not possible because of our small

Table 1. Species composition of indicated pairs and total birds seen on each survey of the Alaska Highway wetlands, spring 1989 (n=20).

SPECIES	DATE																TOTAL			
	10 MAY				16 MAY				22 MAY				28 MAY							
	PAIRS		TOTAL		PAIRS		TOTAL		PAIRS		TOTAL		PAIRS		TOTAL		PAIRS		TOTAL	
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Horned Grebe	3	3	6	3	0	0	0	0	0	0	0	0	0	0	0	0	3	1	6	1
Common Loon	0	0	3	1	1	1	3	2	1	2	2	2	0	0	1	1	2	1	9	2
Pacific Loon	0	0	0	0	1	1	3	2	1	2	3	3	3	4	6	5	5	2	12	2
Common Merganser	0	0	0	0	2	3	2	1	0	0	0	0	0	0	0	0	2	1	2	0
Mallard	17	15	21	9	12	16	14	10	8	14	10	11	9	11	12	9	46	14	57	10
American Wigeon	14	12	25	11	11	15	18	12	4	7	8	9	10	13	14	11	39	12	65	11
American Green-winged Teal	10	9	16	7	2	3	4	3	5	9	5	5	7	9	8	6	24	7	33	6
Blue-winged Teal	1	1	1	0	0	0	0	0	1	2	1	1	0	0	0	0	2	1	2	0
Northern Shoveler	3	3	6	3	0	0	0	0	0	0	0	0	0	0	0	0	3	1	6	1
Northern Pintail	3	3	4	2	1	1	1	1	3	5	4	4	0	0	0	0	7	2	9	2
Canvasback	3	3	4	2	1	1	1	1	3	5	4	4	0	0	0	0	3	1	4	1
Scaup Sp.	22	19	32	14	21	29	48	33	20	35	30	32	29	37	45	35	92	28	155	26
Ring-necked Duck	9	8	21	9	8	11	11	8	0	0	7	8	3	4	3	2	20	6	42	7
Goldeneye Sp.	0	0	0	0	0	0	1	1	1	2	2	2	0	0	0	0	1	0	3	0
Barrow's Goldeneye	8	7	20	9	8	11	12	8	6	11	7	8	8	10	10	8	30	9	49	8
Bufflehead	10	9	15	7	5	7	7	5	7	12	8	9	10	13	13	10	32	10	43	7
Oldsquaw	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Surf Scoter	11	9	23	10	0	0	0	0	0	0	0	0	0	0	0	0	11	3	23	4
Canada Goose	1	1	26	11	1	1	21	14	0	0	6	6	0	0	16	13	2	1	69	12
Swan sp.	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
TOTAL	116	100	227	100	73	100	145	100	57	100	93	100	79	100	128	100	325	100	593	100

Table 2. Mean numbers of total birds observed on 4 replicate surveys of 20 wetlands along the Alaska Highway, May 1989.

Species	Total Birds				Indicated Pairs			
	Mean <sup>1</sup>	SD <sup>2</sup>	95%CI <sup>3</sup>	% <sup>4</sup>	Mean	SD	95%CI	%
Mallard	14.25	4.78	±8.36	63	11.5	4.04	±6.4	61
Northern Pintail	2.25	2.06	±3.28	173	1.75	1.5	±2.39	136
American Wigeon	16.25	7.14	±11.35	68	9.75	4.19	±6.66	68
Green-Winged Teal	8.25	5.44	±8.65	105	6.0	3.37	±5.36	89
Scaup sp.	38.75	9.1	±14.4	37	23.0	4.08	±6.49	28
Ring-necked Duck	10.0	7.7	±12.3	117	5.0	4.24	±6.75	135
Barrow's Goldeneye	12.25	2.56	±8.8	72	7.5	1.0	±1.59	21
Bufflehead	10.75	3.86	±6.1	57	8.0	2.45	±3.9	49

<sup>1</sup> Mean of 4 surveys

<sup>2</sup> Standard Deviation

<sup>3</sup> 95% Confidence Interval about the mean. Obtained as follows:  $CI = \pm(SD/n) \cdot t_{.05, n-1}$ . In this case  $n=4$  and  $t_{.05, 3} = 3.182$

<sup>4</sup> 95% CI as a percentage of the mean. This allows direct comparison of the precision of the means of different species. A low % indicates a high degree of precision.

Table 3. Number of broods and juveniles observed along the Alaska Highway, July 1989.

Species	Broods		Juveniles	
	No.	%	No.	%
Mallard	2	13	10	10
American Wigeon	2	13	15	15
Scaup sp.	7	47	54	53
Barrow's Goldeneye	2	13	14	14
Bufflehead	2	13	8	8
TOTAL	15	99	101	100

Table 4. Ratios of mean number of indicated pairs of waterfowl : Number of broods observed on 20 wetlands along the Alaska Highway, May and July 1989.

Species	Ratio <sup>1</sup>
Mallard	7 : 1
American Wigeon	8 : 1
Green-Winged Teal	6 : 0
Scaup sp.	5.5 : 1
Barrow's Goldeneye	6 : 1
Bufflehead	5.5 : 1

<sup>1</sup> (Mean no. of indicated pairs in 4 surveys) :  
(no. of broods during brood survey)

sample size. Species, age and size of all waterfowl broods observed are listed in Table 5. We found mean brood sizes similar to those of Mossop (in progress). Appendix II itemizes the numbers of broods, juveniles, and total birds of all waterbird species seen on each wetland. The mean number of broods per wetland was 0.75.

## 4.2 Habitat

Small patches of ice were present during the 10 May survey but all wetlands were ice-free by the 16 May survey. Some waterbodies had extreme water level fluctuations and wetland 18 had no open water by 10 July. Most waterbodies had some Palustrine characteristics, most commonly some area of persistent emergents (Table 6).

A more detailed wetlands description and water quality information are appended to this report (Appendix III and IV).

## 4.3 Relationships Between Waterfowl and Habitat

### 4.3.1 Wetland Size

Generally more birds were seen in larger wetlands than in smaller ones (Tables 7 and 8) as one would expect. The combined results of the four breeding pair surveys (Table 9) suggest that American Wigeon have the greatest preference for medium (1.5 -15 ha) versus small (<1.5 ha) waterbodies and Pacific Loons and Mallards have the least preference. This may be misleading with respect to loons as we know they are frequently found in larger, deeper wetlands, and no large wetlands (>15 ha) were surveyed.

### 4.3.2 Shoreline Habitat

Fewer birds were seen in wetlands with little or no persistent emergent vegetation except for Barrow's Goldeneye and Pacific Loons (Tables 10 and 11). Scaup sp., American Wigeon and Green-winged Teal had the highest ratios of pairs in wetlands with emergent vegetation present vs. no emergent vegetation (Table 12).

## 5. CONCLUSIONS AND RECOMMENDATIONS

### 5.1 Suggestions for an Annual Breeding Pair Trend Survey

Part of the reason for undertaking this survey was to evaluate its feasibility as an annual trend survey for waterfowl breeding populations. There are two types of variation which could influence the results of a survey such as this: (1) variation in time within each year (i.e. weekly and daily) and between years; and (2) variation in space (i.e. between wetlands and between regions). The replicate surveys each year are designed to account for the variation over time within each year thereby allowing it to



Table 5. Broods observed on 20 wetlands along the Alaska Highway, 10 July 1989. Age class of broods is given according to Gollop and Marshall (1954).

Species	Wetland No.						Total Broods	Total young
	1	2	4	10	11	15		
Mallard				10 <sup>1</sup> x III			2	10
American Wigeon	6 x Ic				9 x Ic		2	15
Scaup sp.			7 x Ia 17 <sup>1</sup> x Ia 7 x Ia 8 x Ia	10 x Ia	5 x Ib		7	54
Barrow's Goldeneye	7 x Ib					7 x II	2	14
Bufflehead	7 x Ia	1 x ?					2	8
TOTALS	3	1	5	3	2	1	15	101

<sup>1</sup> a creche of 2 broods with 2 females in attendance.

Table 6. Wetland classification according to Cowardin et al. (1979). (Most wetlands contain elements of more than one system and class.)

SYSTEM	SUBSYSTEM	CLASS	SUBCLASS	WETLANDS
Lacustrine	Littoral	Unconsolidated bottom	mud or sand	5, 7, 11
	Littoral	Unconsolidated bottom	organic	20
	Littoral	Unconsolidated bottom	cobble - gravel	12
	Littoral	Unconsolidated shore	cobble - gravel	5, 7, 17
	Littoral	Unconsolidated shore	sand	19
	Littoral	Aquatic bed	rooted vascular	3, 10, 17, 18, 19
Palustrine		Unconsolidated bottom	mud and organic	13, 14
		Unconsolidated shore	cobble - gravel	15, 16
		Emergent	persistant	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15
		moss - lichen wetland	moss	18

Table 7. Mean number of total birds observed in small wetlands (N=10) vs. medium wetlands (N=10).

SPECIES	SURVEY							
	10 May		16 May		22 May		28 May	
	small	medium	small	medium	small	medium	small	medium
Horned Grebe	0.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0
Common Loon	0.1	0.2	0.0	0.3	0.0	0.2	0.0	0.1
Pacific Loon	0.0	0.0	0.2	0.1	0.2	0.1	0.2	0.4
Common Merganser	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
Mallard	0.4	1.7	0.5	0.9	0.2	0.8	0.5	0.7
American Wigeon	0.0	2.5	0.2	1.6	0.0	0.8	0.2	1.2
American Green-winged Teal	0.8	0.8	0.0	0.4	0.0	0.5	0.0	0.8
Blue-winged Teal	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Northern Shoveler	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0
Northern Pintail	0.2	0.2	0.0	0.1	0.0	0.4	0.0	0.0
Canvasback	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
Scaup Sp.	0.9	2.3	0.4	4.4	1.1	1.9	0.9	3.6
Ring-necked Duck	0.3	1.8	0.0	1.1	0.0	0.7	0.0	0.3
Goldeneye Sp.	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.0
Barrow's Goldeneye	0.6	1.4	0.0	1.2	0.1	0.6	0.0	1.0
Bufflehead	0.2	1.3	0.3	0.4	0.2	0.6	0.2	1.1
Oldsquaw	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Surf Scoter	1.2	1.1	0.0	0.0	0.0	0.0	0.0	0.0
Canada Goose	0.2	2.4	0.2	1.9	0.0	0.6	0.0	1.6
Swan sp.	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0

Table 8. Mean number of indicated pairs observed in small wetlands (N=10) vs. medium wetlands (N=10).

SPECIES	SURVEY							
	10 May		16 May		22 May		28 May	
	small	medium	small	medium	small	medium	small	medium
Horned Grebe	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Common Loon	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0
Pacific Loon	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.2
Common Merganser	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
Mallard	0.3	1.4	0.4	0.8	0.2	0.6	0.4	0.5
American Wigeon	0.0	1.4	0.1	1.0	0.0	0.4	0.1	0.9
American Green-winged Teal	0.5	0.5	0.0	0.2	0.0	0.5	0.0	0.7
Blue-winged Teal	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Northern Shoveler	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Northern Pintail	0.1	0.2	0.0	0.1	0.0	0.3	0.0	0.0
Canvasback	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Scaup Sp.	0.6	1.6	0.2	1.9	0.7	1.3	0.6	2.3
Ring-necked Duck	0.2	0.7	0.0	0.8	0.0	0.0	0.0	0.3
Goldeneye Sp.	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Barrow's Goldeneye	0.3	0.5	0.0	0.8	0.1	0.5	0.0	0.8
Bufflehead	0.2	0.8	0.2	0.3	0.1	0.6	0.2	0.8
Oldsquaw	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Surf Scoter	0.5	0.6	0.0	0.0	0.0	0.0	0.0	0.0
Canada Goose	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Swan sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 9. Ratios of indicated pairs of waterfowl in medium (1.5-15 ha) vs. small (<1.5 ha) wetlands on 4 surveys of 20 wetlands along the Alaska Highway, May 1989.

SPECIES	Ratio <sup>1</sup>
Mallard	2.5 : 1
American Wigeon	18.5 : 1
Green-Winged Teal	3.8 : 1
Scaup sp.	3.4 : 1
Ring-necked Duck	9.0 : 1
Barrow's Goldeneye	6.9 : 1
Bufflehead	6.2 : 1
Pacific Loon	0.7 : 1

<sup>1</sup> (no. of pairs in medium wetlands) : (no. of pairs in small wetlands).

Table 10. Mean number of indicated pairs in wetlands with persistent emergents present (N=14) vs. persistent emergents absent (N=6).

SPECIES	SURVEY							
	10 May		16 May		22 May		28 May	
	emergents present	emergents absent	emergents present	emergents absent	emergents present	emergents absent	emergents present	emergents absent
Horned Grebe	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Common Loon	0.0	0.0	0.0	0.2	0.0	0.2	0.0	0.0
Pacific Loon	0.0	0.0	0.0	0.2	0.0	0.2	0.1	0.3
Common Merganser	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Mallard	0.8	1.0	0.6	0.5	0.6	0.0	0.6	0.0
American Wigeon	0.9	0.2	0.8	0.0	0.3	0.0	0.8	0.0
American Green-winged Teal	0.5	0.5	0.1	0.0	0.4	0.0	0.5	0.0
Blue-winged Teal	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Northern Shoveler	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Northern Pintail	0.0	0.5	0.0	0.2	0.2	0.0	0.0	0.0
Canvasback	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scaup Sp.	1.4	0.3	1.4	0.2	1.4	0.0	2.1	0.0
Ring-necked Duck	0.4	0.5	0.6	0.0	0.0	0.0	0.2	0.0
Goldeneye Sp.	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Barrow's Goldeneye	0.4	0.5	0.4	0.5	0.2	0.5	0.5	0.2
Bufflehead	0.6	0.2	0.4	0.0	0.5	0.0	0.7	0.0
Oldsquaw	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Surf Scoter	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0
Canada Goose	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Swan sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 11. Mean number of total birds in wetlands with persistent emergents present (N=14) vs. persistent emergents absent (N=6).

SPECIES	SURVEY							
	10 May		16 May		22 May		28 May	
	emergents present	emergents absent	emergents present	emergents absent	emergents present	emergents absent	emergents present	emergents absent
Horned Grebe	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Common Loon	0.0	0.5	0.0	0.5	0.0	0.3	0.0	0.2
Pacific Loon	0.0	0.0	0.0	0.5	0.0	0.5	0.1	0.7
Common Merganser	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Mallard	1.0	1.2	0.8	0.5	0.7	0.0	0.7	0.0
American Wigeon	1.6	0.3	1.3	0.0	0.6	0.0	1.1	0.0
American Green-winged Teal	0.7	1.0	0.3	0.0	0.4	0.0	0.6	0.0
Blue-winged Teal	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Northern Shoveler	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Northern Pintail	0.0	0.7	0.0	0.2	0.3	0.0	0.0	0.0
Canvasback	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scaup Sp.	2.1	0.5	3.3	0.3	2.1	0.0	3.2	0.0
Ring-necked Duck	0.6	2.2	0.8	0.0	0.5	0.0	0.2	0.0
Goldeneye Sp.	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0
Barrow's Goldeneye	1.1	0.8	0.5	0.8	0.2	0.7	0.6	0.3
Bufflehead	0.9	0.3	0.5	0.0	0.6	0.0	0.9	0.0
Oldsquaw	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Surf Scoter	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0
Canada Goose	1.9	0.0	1.5	0.0	0.4	0.0	1.1	0.0
Swan sp.	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 12. Ratios of indicated pairs of waterfowl in wetlands with emergent vegetation present (N=14) vs. emergent vegetation absent (N=6). Based on 4 surveys along the Alaska Highway, May 1989.

SPECIES	Ratio <sup>1</sup>
Mallard	1.7 : 1
American Wigeon	3.2 : 1
Green-Winged Teal	3.0 : 1
Scaup sp.	11.6 : 1
Ring-necked Duck	1.8 : 1
Barrow's Goldeneye	0.8 : 1
Bufflehead	0.9 : 1
Pacific Loon	0.1 : 1

<sup>1</sup> (no. of pairs in wetlands with emergent vegetation present)  
: (no. of pairs in wetlands without emergent vegetation).



be separated from the variation between years. It is this yearly variation that we are trying to measure in a trend survey.

A very important question is, "what amount of change do we wish to be able to detect?" Naturally, we would like to be able to detect even small changes in the population. As a working goal, we could say that we would like to be able to detect a 20% change in the five most common species with 95% confidence. This means that we need an annual survey yielding confidence limits of  $\pm 10\%$  for each of these 5 species, much more precise than any estimates in the present study. The current best estimates of indicated pairs and total birds for each species have 95% confidence limits of  $\pm 20\%$  and many are in the range of  $\pm 60-70\%$ . Our goal is fairly ambitious. For example, using these data we can estimate (Cochran 1977: 77) that to obtain 95% confidence limits of  $\pm 10\%$  (which means annual changes of about 20% or larger can be detected) for Scaup pairs would require about 16 replicate surveys of the 20 ponds, and for mallard pairs about 60 replicates. This is obviously not feasible. Setting confidence limits of  $\pm 20\%$  (which we have for Scaup pairs already) would require 20 replicates for Mallard pairs, still an unrealistic number. Clearly, a reduction in the variation between surveys is going to be necessary to achieve these confidence limits within the constraints of available time and resources.

The only sure way to improve the precision of our estimates is by increasing the number of replicates (i.e. the sample size) from four to some larger number. Logistic constraints will probably limit the number of replicates to less than ten. Sampling more wetlands would probably improve the precision as well by minimizing the random variations caused by individual birds moving among wetlands within their breeding territory and thus being counted on one survey but not on the next. For example, each of the more common species in the 1989 surveys was seen on only 7 to 10 wetlands on each survey. A few pairs of ducks missing from one pond on one survey can make a big difference in such a small sample. Increasing the number of wetlands surveyed to 100 in total would probably result in each species being seen on 35 to 50 wetlands, a statistically much more reasonable sample.

A sample of 100 wetlands in a roadside survey would probably require much of the Yukon highway system to be covered. Choosing several regions in which to sample ponds would be beneficial as it is likely that waterfowl breeding in different regions (e.g. Tintina Trench vs. Southern Lakes) are affiliated with different migration routes and wintering areas and therefore subjected to different pressures causing population fluctuations. This will also ensure that the results of the survey apply to areas large enough to be meaningful at the Flyway level.

The Alaska Highway wetlands in the present study were surveyed in one day by a two person crew, but it is feasible for wetlands which are easily accessed by road to be surveyed by one person. If the

goal is to survey 5 times as many wetlands, it would likely require about 5 times the effort, i.e. 5 crew-days per survey. With the relatively short breeding season in the Yukon, 4 to 6 replicate surveys at intervals from about 15 May to 15 June would be a reasonable schedule.

The 5 crew days could be designated in a number of ways, however the proposed regions would be as follows:

- 1 Alaska Highway: Whitehorse to Watson Lake
- 2 Alaska Highway: Whitehorse to Beaver Creek
- 3 Campbell Highway: Watson Lake to Carmacks
- 4 North Klondike Highway: Carmacks to Dawson
- 5 North Klondike Highway: Whitehorse to Carmacks

The project could be set up as a contract whereby the contractor would make circuits of these areas each week for four weeks with ample time for report writing at the end. An alternative would be to have a jointly conducted survey utilizing staff from the Canadian Wildlife Service, the Yukon Territorial Government and Ducks Unlimited. A third option is some combination of contractors and staff.

If done by a contractor the costs would be roughly as follows:

Contractor

Surveys

28 days @\$200-\$300	5,600-8,400
(contractor provides vehicle, gas, food, lodging)	

Help with data analysis and report

10 days @\$200	2,000
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Total	\$ 7,600-10,400
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There are advantages to having several crews afield at once: All regions are covered in a relatively short time, thus minimizing the effect of time differences within each survey. Also, the time demands on each individual are greatly reduced. It should be remembered that this amount of effort corresponds to counts from one or two observation points per wetland rather than a more time-consuming perimeter search such as is employed in some areas. This also places some constraints on the size and type of wetland which can be surveyed without risking substantial undercounting and possible biases caused by differential visibility of duck species.

A helicopter survey is also an option. Helicopter surveys have been shown to be comparable in cost to ground surveys in northern Ontario (Ross 1985). Helicopter surveys would be restricted to areas close to existing helicopter bases (Atlin, Dawson, Haines Junction, Ross River, Mayo, Carmacks?, Whitehorse). However within

range of each of those bases there is complete freedom to choose study areas, whereas the road-based survey is very limited. With the helicopter, all types of wetlands and duck species can be surveyed with reasonable efficiency, whereas certain species of ducks and types of wetlands such as swamps pose visibility problems to ground surveys especially if the survey method is a count from a fixed observation point. The budget for a ground-based survey by a hired contractor (\$7,600-10,400) would buy a maximum of 17 hours of helicopter time at \$600 per hour. If a plot-based survey design were used employing 2x2 km plots requiring 12 minutes each to survey, about 5 plots per hour or a total of 85 plots could be surveyed. If divided into 4 replicate surveys of 3 different regions, this would yield 7 plots per region per survey. If a greater sample size were desired this figure could be increased to 9-10 plots per region per survey by reducing the number of replicate surveys to 3. Other permutations are also possible. Ten plots per region is probably a desirable number as it makes full use of the machine's fuel capacity and thus minimizes the amount of ferrying time from the base. Appropriate bases to choose from would be Whitehorse, Haines Junction, Carmacks, Ross River, and Watson Lake.

## 5.2 Conclusion

Co-ordinated annual breeding pair surveys, on a large scale are needed to determine the broad population dynamics of waterfowl in the Yukon. As brood surveys tend to be less fruitful indicators of the population and productivity because of their dependence on weather, timing and visibility factors, the pair surveys could be used to determine productivity over the long term.

The methods presented herein would standardize data collection (ie; route, times, area covered and type of information to be gathered) and provide a good database available for future reference. The routes and areas covered could also be expanded in future years to include more remote regions such as Old Crow Flats and other parts of the northern Yukon.

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Appendix 1. Numbers of indicated pairs of each species seen on 20 Alaska Highway wetlands,  
10 May 1989.

SPECIES	WETLAND																				TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Horned Grebe	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	3
Common Loon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pacific Loon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Merganser	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mallard	2	2	0	0	0	0	0	1	0	2	4	0	0	0	0	0	5	0	1	0	17
American Wigeon	2	0	0	0	0	0	0	0	0	1	10	0	0	0	0	0	1	0	0	0	14
American Green-winged Teal	0	3	1	0	0	0	0	0	1	0	2	0	0	0	0	0	3	0	0	0	10
Blue-winged Teal	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Northern Shoveler	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3
Northern Pintail	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	3
Canvasback	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Scaup Sp.	7	0	0	4	0	0	0	0	0	0	5	0	0	4	0	2	0	0	0	0	22
Ring-necked Duck	2	0	0	1	0	0	0	0	0	0	1	0	0	2	0	0	3	0	0	0	9
Goldeneye Sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Barrow's Goldeneye	1	1	0	0	1	1	1	0	0	0	1	0	0	0	0	1	0	0	0	1	8
Bufflehead	1	1	0	3	0	0	0	0	0	1	2	0	0	1	0	0	1	0	0	0	10
Oldsquaw	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Surf Scoter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	6	0	0	0	11
Canada Goose	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Swan sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	19	7	1	8	1	1	1	1	2	4	30	1	0	7	0	9	22	0	1	1	116

Appendix 1. Numbers of total birds of each species seen on 20 Alaska Highway wetlands,  
10 May 1989.

SPECIES	WETLAND																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL
Horned Grebe	2	0	0	0	0	0	0	0	0	0	3	0	0	0	0	1	0	0	0	0	6
Common Loon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	3
Pacific Loon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Merganser	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mallard	2	2	0	0	0	0	0	2	0	2	6	0	0	0	0	0	6	0	1	0	21
American Wigeon	3	0	0	0	0	0	0	0	0	2	18	0	0	0	0	0	2	0	0	0	25
American Green-winged Teal	0	5	1	0	0	0	0	0	2	0	2	0	0	0	0	0	6	0	0	0	16
Blue-winged Teal	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Northern Shoveler	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	6
Northern Pintail	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	4
Canvasback	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Scaup Sp.	10	0	0	6	0	0	0	0	0	0	7	0	0	6	0	3	0	0	0	0	32
Ring-necked Duck	2	0	0	1	0	0	0	0	0	0	2	0	0	3	0	0	13	0	0	0	21
Goldeneye Sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Barrow's Goldeneye	1	2	0	6	2	2	2	0	0	0	2	0	0	0	0	2	0	0	0	1	20
Bufflehead	2	1	0	5	0	0	0	0	0	2	2	0	0	1	0	0	2	0	0	0	15
Oldsquaw	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Surf Scoter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	11	0	0	0	23
Canada Goose	0	0	0	0	0	0	0	0	2	0	24	0	0	0	0	0	0	0	0	0	26
Swan sp.	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
TOTAL	29	10	1	18	2	2	2	2	4	6	72	1	0	10	0	21	44	0	2	1	227

Appendix 1. Numbers of indicated pairs of each species seen on 20 Alaska Highway wetlands,  
16 May 1989.

SPECIES	WETLAND																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL
Horned Grebe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Loon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Pacific Loon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Common Merganser	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
Mallard	0	1	0	0	1	1	0	0	1	1	3	1	0	0	0	0	0	0	0	3	12
American Wigeon	1	0	0	1	1	0	0	0	0	0	7	1	0	0	0	0	0	0	0	0	11
American Green-winged Teal	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2
Blue-winged Teal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Shoveler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Pintail	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Canvasback	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scaup Sp.	0	0	0	6	4	1	0	0	0	0	9	0	0	0	0	1	0	0	0	0	21
Ring-necked Duck	0	0	0	1	6	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	8
Goldeneye Sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Barrow's Goldeneye	1	0	0	2	1	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0	8
Bufflehead	2	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	5
Oldsquaw	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surf Scoter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Canada Goose	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Swan sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	4	1	0	10	14	3	3	0	1	3	21	4	1	1	0	2	1	0	1	3	73

Appendix 1. Numbers of total birds of each species seen on 20 Alaska Highway wetlands,  
16 May 1989.

SPECIES	WETLAND																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL
Horned Grebe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Loon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	3
Pacific Loon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	3
Common Merganser	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
Mallard	0	1	0	0	1	1	0	0	1	1	4	2	0	0	0	0	0	0	0	3	14
American Wigeon	1	0	0	2	2	0	0	0	0	0	11	2	0	0	0	0	0	0	0	0	18
American Green-winged Teal	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	4
Blue-winged Teal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Shoveler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Pintail	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Canvasback	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scaup Sp.	0	0	0	9	7	2	0	0	0	0	28	0	0	0	0	2	0	0	0	0	48
Ring-necked Duck	0	0	0	2	8	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	11
Goldeneye Sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Barrow's Goldeneye	1	0	0	2	2	0	5	0	0	0	2	0	0	0	0	0	0	0	0	0	12
Bufflehead	2	0	0	0	0	0	0	0	0	2	0	0	1	2	0	0	0	0	0	0	7
Oldsquaw	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surf Scoter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Canada Goose	0	0	0	0	0	2	0	0	0	0	19	0	0	0	0	0	0	0	0	0	21
Swan sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	4	1	0	16	22	5	5	0	1	5	65	6	1	2	0	4	2	0	2	4	145



Appendix 1. Numbers of indicated pairs of each species seen on 20 Alaska Highway wetlands, 22 May 1989.

SPECIES	WETLAND																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL	
Horned Grebe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Common Loon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	
Pacific Loon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	
Common Merganser	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Mallard	0	2	0	0	1	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	8	
American Wigeon	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	4	
American Green-winged Teal	0	0	0	3	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	5	
Blue-winged Teal	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	
Northern Shoveler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Northern Pintail	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	
Canvasback	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Scaup Sp.	0	0	0	1	5	3	0	3	0	2	5	0	1	0	0	0	0	0	0	0	20	
Ring-necked Duck	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Goldeneye Sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
Barrow's Goldeneye	1	0	0	0	0	0	2	0	0	0	0	0	1	0	1	0	0	0	0	1	6	
Bufflehead	2	0	0	0	1	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	7	
Oldsquaw	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Surf Scoter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Canada Goose	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Swan sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TOTAL	3	2	0	7	8	3	2	3	0	4	17	0	2	1	2	1	0	0	1	1	57	

Appendix 1. Numbers of total birds of each species seen on 20 Alaska Highway wetlands,  
22 May 1989.

SPECIES	WETLAND																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL
Horned Grebe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Loon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
Pacific Loon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	3
Common Merganser	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mallard	0	2	0	0	1	0	0	0	0	1	6	0	0	0	0	0	0	0	0	0	10
American Wigeon	0	0	0	0	0	0	0	0	0	2	6	0	0	0	0	0	0	0	0	0	8
American Green-winged Teal	0	0	0	3	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	5
Blue-winged Teal	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Northern Shoveler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Pintail	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Canvasback	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scaup Sp.	0	0	0	2	6	5	0	4	0	3	8	0	2	0	0	0	0	0	0	0	30
Ring-necked Duck	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	7
Goldeneye Sp.	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2
Barrow's Goldeneye	1	0	0	0	0	0	2	0	0	0	0	0	1	0	1	0	0	0	0	2	7
Bufflehead	2	0	0	0	1	0	0	0	0	1	1	0	0	2	1	0	0	0	0	0	8
Oldsquaw	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surf Scoter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Canada Goose	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	6
Swan sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3	2	0	9	9	5	2	4	0	8	37	0	3	2	2	2	1	0	2	2	93

Appendix 1. Numbers of indicated pairs of each species seen on 20 Alaska Highway wetlands,  
28 May 1989.

SPECIES	WETLAND																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL
Horned Grebe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Loon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pacific Loon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	3
Common Merganser	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mallard	0	3	0	0	0	0	0	0	0	1	4	0	0	1	0	0	0	0	0	0	9
American Wigeon	3	1	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	10
American Green-winged Teal	0	0	0	1	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	7
Blue-winged Teal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Shoveler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Pintail	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Canvasback	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scaup Sp.	1	0	0	5	6	3	0	0	0	2	6	0	3	0	3	0	0	0	0	0	29
Ring-necked Duck	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3
Goldeneye Sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Barrow's Goldeneye	1	0	0	2	2	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	8
Bufflehead	2	0	0	2	1	0	0	0	0	1	0	0	1	1	2	0	0	0	0	0	10
Oldsquaw	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surf Scoter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Canada Goose	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Swan sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	7	4	0	10	9	3	0	0	0	7	23	0	4	2	7	1	1	0	0	1	79

Appendix 1. Numbers of total bird of each species seen on 20 Alaska Highway wetlands,  
28 May 1989.

SPECIES	WETLAND																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL
Horned Grebe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Loon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Pacific Loon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	0	0	0	6
Common Merganser	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mallard	0	3	0	0	0	0	0	0	0	2	5	0	0	2	0	0	0	0	0	0	12
American Wigeon	4	2	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	14
American Green-winged Teal	0	0	0	1	0	0	0	0	0	4	3	0	0	0	0	0	0	0	0	0	8
Blue-winged Teal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Shoveler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Pintail	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Canvasback	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scaup Sp.	1	0	0	8	10	5	0	0	0	3	8	0	4	0	6	0	0	0	0	0	45
Ring-necked Duck	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3
Goldeneye Sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Barrow's Goldeneye	1	0	0	2	2	0	0	0	0	0	2	0	0	0	1	0	0	0	0	2	10
Bufflehead	4	0	0	2	1	0	0	0	0	2	0	0	1	1	2	0	0	0	0	0	13
Oldsquaw	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surf Scoter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Canada Goose	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	16
Swan sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	10	5	0	13	13	5	0	0	0	11	45	0	5	3	11	2	2	0	1	2	128

Appendix II. Observed Broods (B), Juveniles (J) and Total Birds (T) seen on each waterbody of the Alaska Highway wetlands.

WETLAND NUMBER	S T A T U S	SPECIES								TOTAL
		Common Loon	Pacific Loon	Mallard	American Wigeon	Scaup Sp.	Ring- necked duck	Goldeneye Sp.	Buffle- head	
1	B	0	0	0	1	0	0	1	1	3
	J	0	0	0	6	0	0	7	7	20
	T	0	0	0	7	0	6	8	9	30
2	B	0	0	0	0	0	0	0	1	1
	J	0	0	0	0	0	0	0	0	1
	T	0	0	0	0	0	0	0	2	2
4	B	0	0	0	0	5	0	0	0	5
	J	0	0	0	0	39	0	0	0	39
	T	0	0	0	0	46	0	3	0	49
10	B	0	0	2	0	1	0	0	0	3
	J	0	0	10	0	10	0	0	0	20
	T	0	0	12	0	11	0	1	0	24
11	B	0	0	0	1	1	0	0	0	2
	J	0	0	0	9	5	0	0	0	14
	T	0	0	0	11	10	1	0	0	22
14	B	0	0	0	0	0	0	0	0	0
	J	0	0	0	0	0	0	0	0	0
	T	0	0	0	0	0	0	0	0	1
15	B	0	0	0	0	0	0	1	0	1
	J	0	0	0	0	0	0	7	0	7
	T	0	0	0	0	1	0	8	0	9
17	B	0	0	0	0	0	0	0	0	0
	J	0	0	0	0	0	0	0	0	0
	T	0	2	0	0	0	0	0	0	0
19	B	0	0	0	0	0	0	0	0	0
	J	0	0	0	0	0	0	0	0	0
	T	1	0	0	0	0	0	0	0	0
20	B	0	0	0	0	0	0	0	0	0
	J	0	0	0	0	0	0	0	0	0
	T	1	2	0	0	0	5	0	0	5
TOTAL FOR ALL WETLANDS	B	0	0	2	2	7	0	2	2	15
	J	0	0	10	15	54	0	14	8	101
	T	1	2	12	18	68	12	20	12	145

# Appendix III. Description of wetlands.

LOCATION: ALASKA HIGHWAY

DATE: MAY 18-20 1993

COMMENTS: ROADSIDE WETLANDS FROM WHITENORSE TO WAYSON LAKE

WET SITE #	W COVER	EMERGENT VEGETATION				AQUATIC BOD MARL, ALGAL ROCK	SUBMERGENT VEG		SHORELINE	UPLAND VEGETATION		SHRUBS	MIXED ASPEN/POPLAR	SHRUBS	BRAVER DAM/HOUSE	SLOPE OF SHORE	WTO COLOUR	COMMENTS
		SPECIES	1 END	BOTH	DISTRIBUTION		SPECIES	%COVER		OPEN	CLOSED							
					SHORE	ENTIRE	CLUMPS											
					LINE													
1	med size	40-45%	Carex meadow to R,V		strip all around					spruce to shore flooded to east & standing dead			P		none	clear	highway to the W channels to E side	
2	<1.5 ha		Carex	flooded to East			sedge areas		willows shrub/spruce	flooded spruce & side/standing dead			P		none		flooded roadside wetland boggy with tall grass-mustrat	
3	<1.5 ha	40%	Carex		band @ shore			Myrioph. or Utrich.	none evid.	willow @ 1 shore	spruce beyond sedge 2 shores				mod all sides	brown	small gravel area to road lots of inverts/no ducks	
4	med size	30-40%	Carex sedge	widest S side	all around			fine grain and marl		Carex	willow off sedge	spruce to shore in spots	mixed beyond spr		low	clear	couldn't see far west end bays entirely	
5	med size	10% of basin	Carex	small W meadow	thin strip			marl sand	moss	rocky shore	willow all around edge	spruce to S/some on W hill	some poplar	P lots		clear	shallow, deep spots in centre 75% ice survey 1	
6	<1.5 ha	20-30%	Carex	meadows B, W	most shore					moss/sedge	willow to S edge	spr. to shore R/W spr. beyond willow		P 1 1			at gravel pit, centre iced survey 1- may be C.rostrata	
7	med size		Carex		a bit @ shore			clay marl	none evid.	moss/steep 1 gravel bay		closed spruce/pine to shore			steep bank	clear	roadside pond, centre iced survey 1-green/blue bottom	
8	<1.5 ha	85-90% in spots	Carex basin		all around			marl moss		willow @ S/W shore	spruce beyond willow				bank to E	clear	beside house & highway, small washout W side of Hwy	
9	<1.5 ha		Carex		some flooded meadows					some willow in basin	around basin/standing dead throughout		P 1 1 downstr.		steep NE	clear brown	river bank. Widened part of r. old flooded orbow-connected Dried up July 11 survey	
10	med size	30-40%	Carex 2 sp.	meadows	shore 2 ends strip			marl brown bottom	moss 70-80% eelgrass	willow beyond sedge	spruce upland-old burn to S				hill to E	clear	shallow, medium size. Beside campground-channel to river	
11	med size	10%	tall sedge		most of shore	some wide areas		marl		Carex/clay at 1 end	some willow beyond sedge	spruce to shore R and part of W				clear	large, shallow, deep spots. Spruce to basin. Houses on W bank	
12	<1.5 ha	30-40%	sedge	meadow @ 1 end	1-2m all around			sedge		flooded sedge	some willow @ shore	spruce to W shore dead pile W shore		P lots	steep all sides	clear	small flooded, connected to the river. Steep gravel bank to Hwy	

WET SITE #	WET SIZE	% COVER	EMERGENT VEGETATION					AQUATIC BED MARL,ALGAR ROCK	SUBMERGENT VEG		SHORELINE	UPLAND VEGETATION			SNAGS	DEBRIS DAM/ROUSE	SLOPE OF SHORE	W20 COLOUR	COMMENTS
			SPECIES	DISTRIBUTION			% COVER		SHRUBS	SPRUCE		MIXED ASPEN/POPLAR							
				1 END	BOTH	SHORE ENTIRE CLUMPS				OPEN			CLOSED						
13	(1.5 ha	10-15%	Carex 2 sp.	strip			marl algae		shrubs/ Carex	willow,soap-berry,cinquefoil	some spr. to shore/dead		P lots			clear	lots of standing dead spruce C.aquat.1 end/C.rostr. other		
14	(1.5 ha	10-15%	Carex Equisetum	meadow sedge	1 end	flooded basin	marl,algae rocks @ shore	1 end	flooded Carex	willow off sedge	sparse spruce at shore		P		sloped 2 shores	clear	open spruce surrounds basin S side of Hwy		
15	med size	<5%	Carex				meadows	marl	Pot.sp. algae	low rocky shore	some willow to shore	mostly spruce to shore		P		steep 3 sides	clear	large lake;shallow with deep spots.Muskrats	
16	(1.5 ha	small %	Carex	far W end				silty,rocks on bank	none evid.	willow/spr. to shore	many dead floating logs			P		steep all sides		large, long skinny.Water levels fluctuate.W side Hwy	
17	med size								lily <1%	some moss	spruce to shore					steep all sides		large,little shore development 25-30% ice survey 1	
18	(1.5 ha	80%	Carex Equisetum				vegetation	Equis-etum/ other	100%	Carex grass	willow in spots	spruce to basin				low slope		sphagnum bog,open water(20% day use area.Muskrat W side of road	
19	med size	<2%	Carex				marl,sandy on shore	lily charra	<2%		willow to W shore band	spruce to shore				sloped all sides		large, shallow spots.Little sh. dev.Between old/new Hwy	
20	med size								marl	lilies in patches	some birch/ willow to shore	spruce to shore				clear green		submerged logs @ 1shore.No sh. dev.Lots of standing dead spr.	

Appendix IV. Water quality measurements of 20 wetlands adjacent to the Alaska Highway taken during July 10-12 1989.

Wetland Number	pH	Conductivity µmhos	Water Temp °C	Air Temp °C
1				
2				
3			24	29
4	7.1	92	14.5	22
5	8.2	168	19	24
6	7.3	132	13	
7	7.1	123	19	25
8	7.6	118	22	25
9	6.9	95		
10	6.7	76	22	21
11	7.9	263		
12	6.5	66	23	24.5
13	7.9	263	23	
14	6.9	49	25	
15	8.1	194	22	
16	8.3	212	22	
17	8.5	181	25	
18				
19	8.2	216	21.5	21.5
20	8.1	228	21	21.5