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GROUND SURVEYS TO EVALUATE HABITAT USE BY BIRDS ALONG THE CANADIAN BEAUFORT SEA COAST 1981-1982

by
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ABSTRACT

The study was undertaken to obtain information on the distribution, species composition and habitat preferences of birds found along the Canadian portion of the Beaufort Sea coast during mid-summer of 1981 and 1982. Thirty ground transects, totalling 107.7 km in length, were surveyed at nine sites. This report represents part of the ongoing Canadian Wildlife Service project entitled "Coastal Distribution of Migratory Bird Resources of the Beaufort Sea", which is presently funded, in part, by the Northern Oil and Gas Activities Program (NOGAP). A total of 7795 birds, comprised of 51 species, were recorded. One hundred and thirty vascular plant species (including subspecies) were collected in the habitats along the transects.

Habitat features which were the most important factors governing bird distribution and abundance were as follows: 1) the abundance of lakes and ponds; 2) moisture levels; 3) upland versus lowland habitats; 4) substrate type and; 5) whether the habitat was coastal or inland. Differences in vascular plant species composition within otherwise similar habitats had no apparent effect on the degree of habitat utilization by birds.

Waterfowl densities were highest in the ponded well-vegetated coastal habitats below the storm tide line. Shorebird densities were highest inland on monocot wetlands with ponds, although substantial numbers also used the coastal ponded habitats that were either well-vegetated or sparsely vegetated mudflats. Sparsely vegetated sand beaches had low densities of birds, but contained the highest densities of glaucous gulls and attracted certain uncommon shorebird species including the semipalmated sandpiper and sanderling. Upland habitats, dominated by monocots, harboured the highest densities of passerine birds, most of which were lapland longspurs.

ACKNOWLEDGEMENTS

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The authors thank Brian Herbert for his assistance in preparing for the 1982 field season and the following people for their assistance in determining or verifying the numerous vascular plant specimens collected: G.W. Argus of the National Museums of Canada for identifying the Salix specimens and; P. LeClair, S.J. Darbyshire and P. Catling, all of the Biosystematics Research Institute of Agriculture Canada, for identifying a number of monocot specimens.

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1.0 INTRODUCTION

There is an increasing concern, as oil and gas development proceeds in the Beaufort Sea region (Figure 1), for the large populations of migratory birds that utilize coastal habitats for breeding, moulting and staging. An off shore oil spill and/or the construction and operation of shore-based facilities associated with development along the Beaufort Sea coast could directly effect the birds and habitats of this region.

A knowledge of the relative importance of various coastal habitats to migratory birds is essential in order to minimize the impact of development on bird populations. In the event of an oil spill, this knowledge would be critical during cleanup operations to protect the most sensitive stretches of coastline.

Bird studies carried out since 1970 in response to actual or proposed resource development have been extensive, but provide only limited information on bird usage of coastal habitats. Thus the present study was initiated in 1981 and continued in 1982 with the following objectives:

a) to provide baseline information on bird usage of habitats along the Beaufort Sea coast, from the Alaska-Yukon Territory border to Cape Dalhousie on the Tuktoyaktuk Peninsula; and

b) to add information on bird species abundance and distribution along the Beaufort Sea coastline in mid-summer.

The present study is part of a larger project, to map the coastal areas of the Beaufort Sea that are of major importance to birds. These maps will enable more effective decisions or recommendations to be made as to the deployment of equipment used in the event of an oil spill. The maps will also be useful for land-use planning and for evaluating the impact of proposed developments on birds and recommending mitigative measures.

As mentioned previously, only limited information has been collected on bird usage of coastal habitats within the Beaufort Sea region. Habitat preferences of birds in the Mackenzie River delta, Northwest Territories have been examined from ground transects conducted by Slaney and Company (1979) and Ward (1975), but most of the study sites were situated inland from the Beaufort Sea coast.

Koski and Tull (1981) have reviewed the literature that pertains to the breeding biology, status and distribution of birds in the coastal Beaufort Sea region, while a bird species checklist of the arctic coastal plain of the northern Yukon Territory and adjacent Northwest Territories is provided by Salter et al. (1980). Karasiuk and Boothroyd (1982) give a preliminary checklist of the birds known to

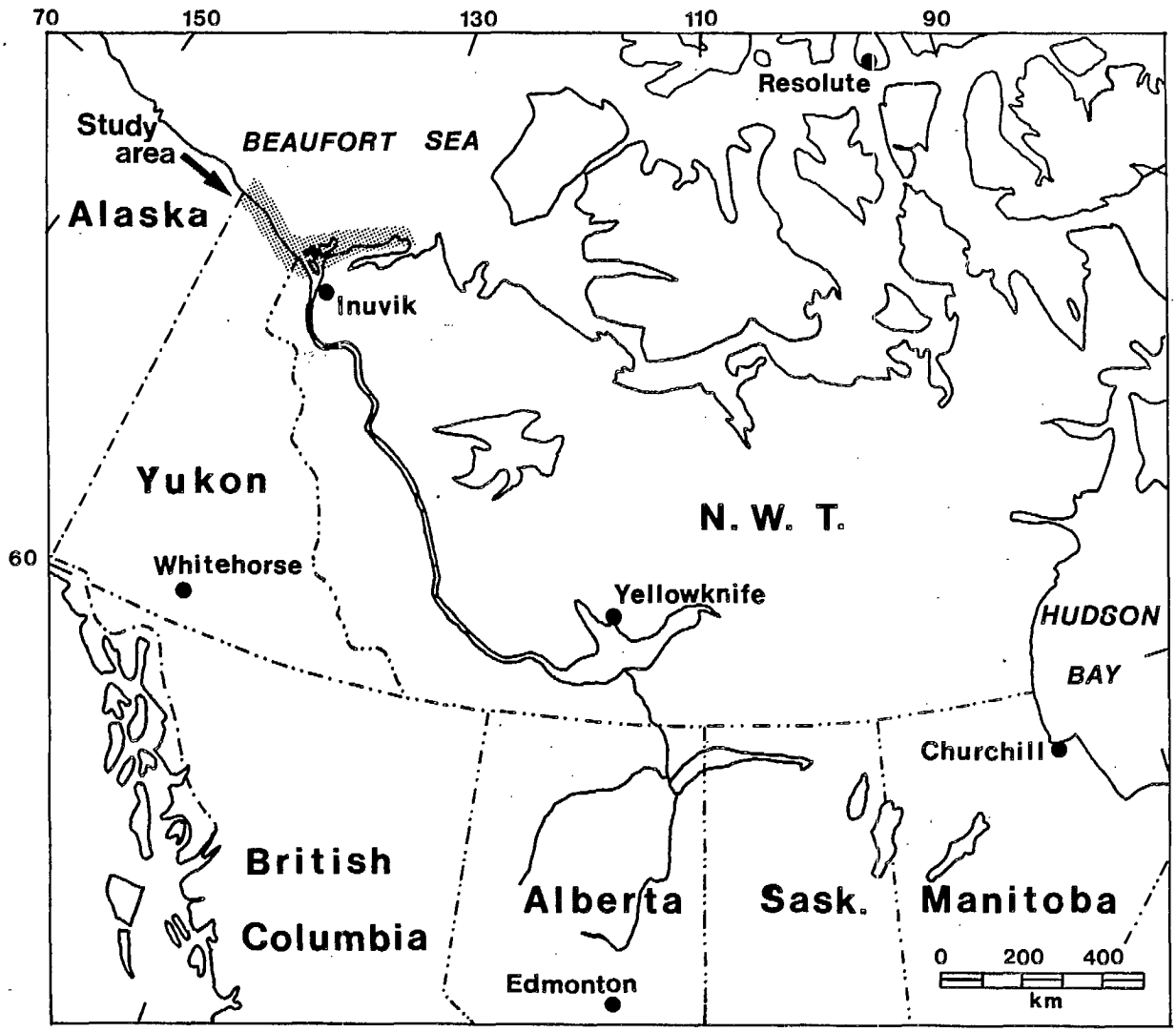

Figure 1. Location of the Study Area.

occur in the McKinley Bay area of the Tuktoyaktuk Peninsula. A similar list is provided for the Mackenzie River delta by Slaney and Company (1974).

Several reports provide preliminary information on bird utilization of inland habitats in the northern Yukon Territory (Salter and Davis 1974; Richardson and Gallop 1974; Koski 1975a) while Schweinsburg (1974) provides data on transects surveyed at several sites along the Yukon coast of the Beaufort Sea. Gollop and Davis (1974b) and Sharp et al. (1974) provide data on the bird productivity of small lakes in the same region.

Recent studies which will provide pertinent information to the mapping program are: a five year bird monitoring study started in 1981 at McKinley Bay, Northwest Territories (Scott Brown et al. 1981; Cornish and Allen 1983; Cornish and Dickson 1984); a bird study at King Point, Yukon Territory in 1981 (Dickson 1985); and a bird study at Stokes Point, Yukon Territory in 1983 (Dickson et al. in prep.).

Vegetation studies that provide a useful background for the description of bird habitat in the study region include the work by: Hettinger et al. (1973), Welsh and Rigby (1971) in the northern Yukon Territory; Gill (1971), Reid and Calder (1977), Slaney and Company (1974) on the Mackenzie River delta; and Corns (1974), Hermandez (1973) and Cody (1973) on the Tuktoyaktuk Peninsula. Coastal salt marsh vegetation has been examined at two sites within the present study area by Jeffries (1977). Mapping surveys of general vegetation types have been conducted by the Canadian Forestry Service (1975) in the lower Mackenzie and coastal Beaufort Sea region.

Hulten (1968) and Porsild and Cody (1980) were the main botanical references used to determine vascular plant specimens collected during this study. Douglas et al. (1981) and Cody (1979) were used to define the status of the vascular plant species found.

2.0 METHODS

Bird and habitat observations were made along 30 transects at nine sites along the Beaufort Sea coast between Phillips Bay, Yukon Territory and Russell Inlet on the Tuktoyaktuk Peninsula, Northwest Territories. The location of the nine sites surveyed are shown in Figure 2. Figures 3 to 11 illustrate the location of the transects, transect sections and habitat types encountered at each site.

Transects 1 and 2 at site 1 (Figure 3) and all transects at sites 2, 3 and 4 (figures 4 to 6) were surveyed from the 29 July to 8 August in 1981, whereas Transect 30 at site 1 (Figure 3) and all transects at sites 5 through 9 (Figures 7 to 11) were surveyed from the 21 July to 12 August in 1982. More intensive collections of vascular plant specimens were made during the second year of surveys (1982). The ground census techniques used were similar to those employed by McLaren et al. (1976). Two observers walked the length of the transect, on parallel courses approximately 25 metres apart. The transect covered a strip 55 metres wide, consisting of the area between the observers and the area within 15 metres laterally of each observer.

In most cases, each transect passed through several habitat types. Where this occurred, the transect was divided into sections, with each section corresponding to a particular habitat type. The location of transects and the different habitats encountered during the ground census were plotted on aerial photographs (when large scale photographs were available) or on 1:50 000 scale topographic maps. The position of the observers along the transect was monitored by keeping a count of paces from the transect starting point, using a hand-held counter. The distance in paces along the transect was later converted to metres after calculating the actual transect length from topographic maps.

One observer recorded all birds detected by both observers. For each observation, the species, number of individuals and distance along the transect (paces) were noted. Notes were also made of age, sex and behavior of the birds and of the general habitat type in which the bird was recorded. The location of each bird was designated as either "on transect" (i.e. within the 55 meter transect strip) or "off transect" (i.e. outside the transect strip).

The second observer made detailed notes on the habitat types intercepted by the transect. As each habitat was encountered, the location was plotted and the new habitat was assigned a transect section number. Thus transect sections reflect the changes in habitat types the observers encountered on the transect. Dominant vascular plant species would be noted for each transect section, and their percentage dominance was visually estimated and recorded. Plant specimens were collected for subsequent species verification. Percentage cover of mosses and lichens and total percentage cover of

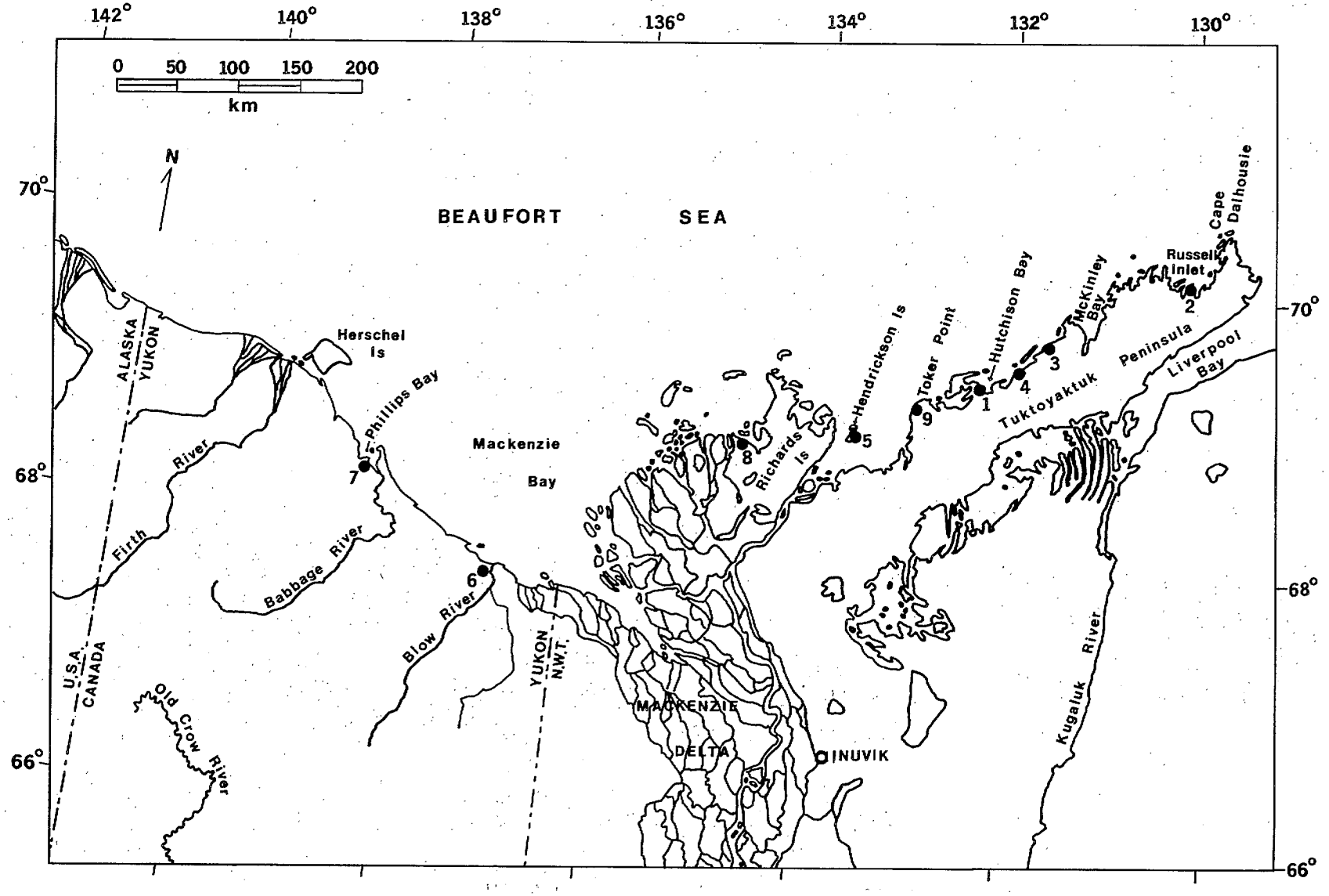

Figure 2. Location of the nine ground survey sites.

CTV-W	-Coastal tundra vegetation with numerous ponds	IML-W	-Inland monocot lowland vegetation with numerous ponds
CTV	-Coastal tundra vegetation	IML	-Inland monocot lowland vegetation
CSV	-Coastal sand vegetation	IMP	-Inland monocot polygons
CTS	-Coastal tundra sparsely vegetated	IMS	-Inland monocot sparsely vegetated
CSS	-Coastal sand sparsely vegetated	IDU	-Inland dwarf shrub-heath upland vegetation
CMO	- Coastal mudflat unvegetated		
T1	Transect	0	Transect section

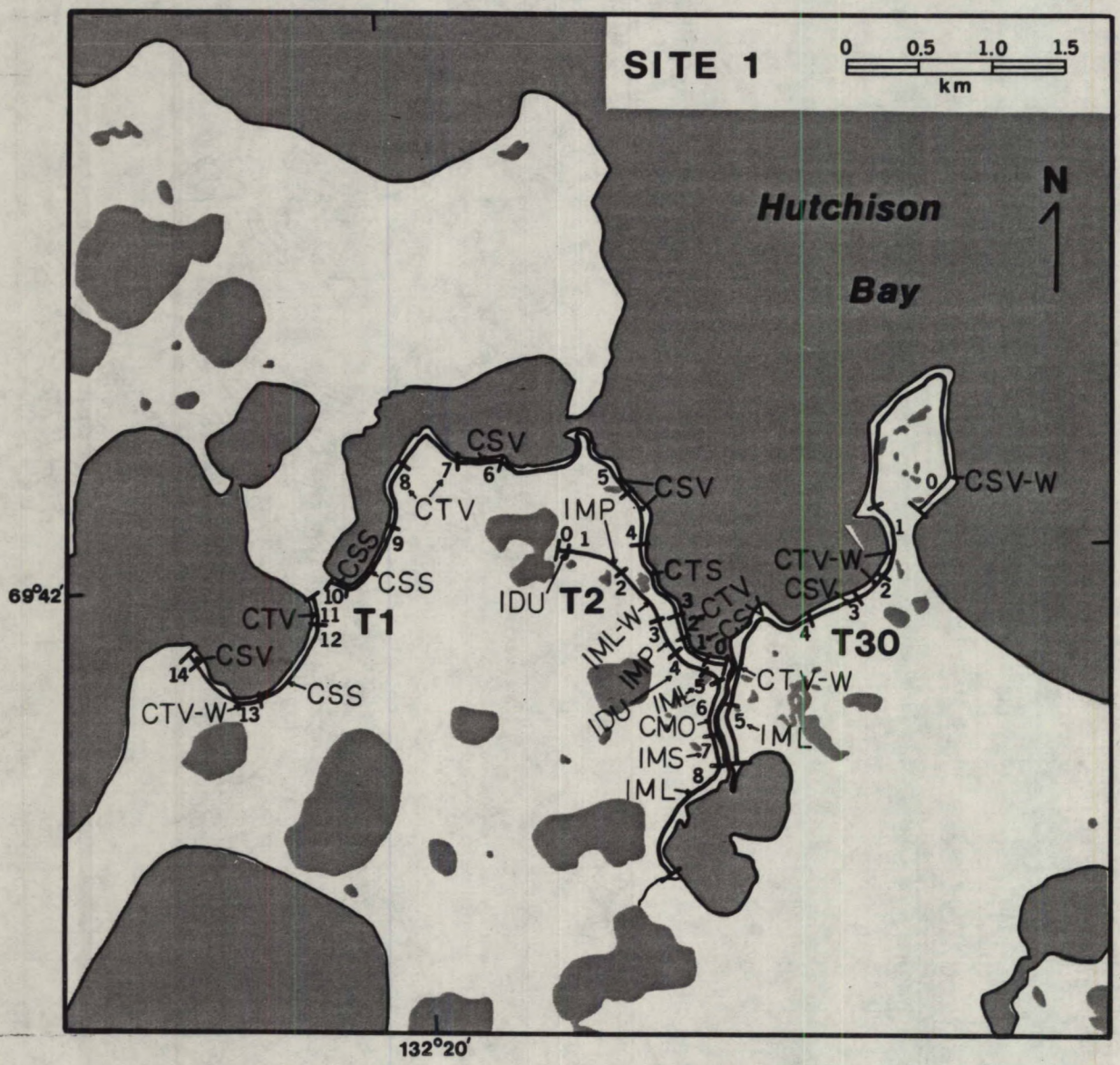

Figure 3. Location of transects, transect sections and habitat types found at site 1 (Hutchison Bay).

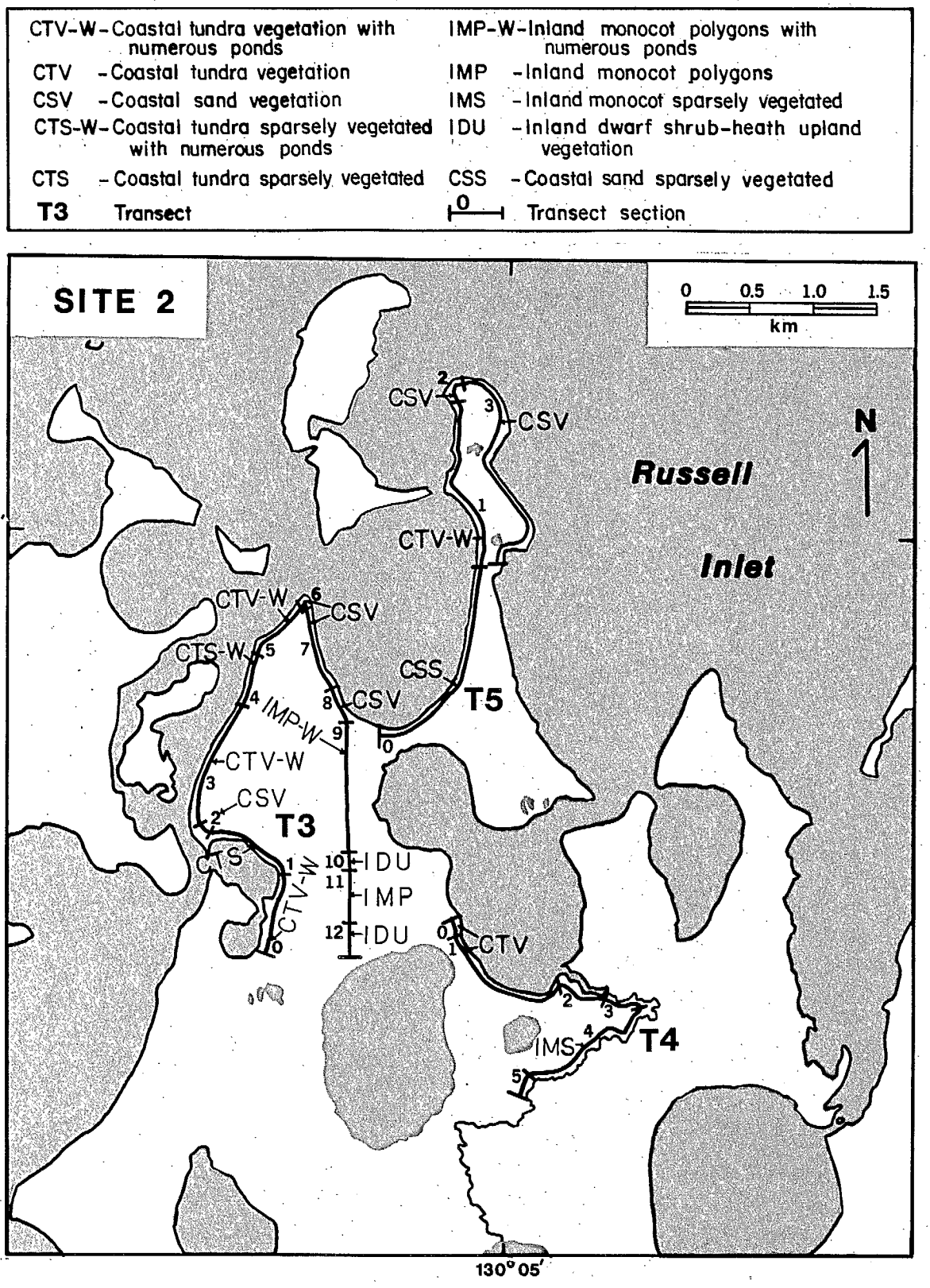

Figure 4. Location of transects, transect sections and habitat types found at site 2 (Russell Inlet).

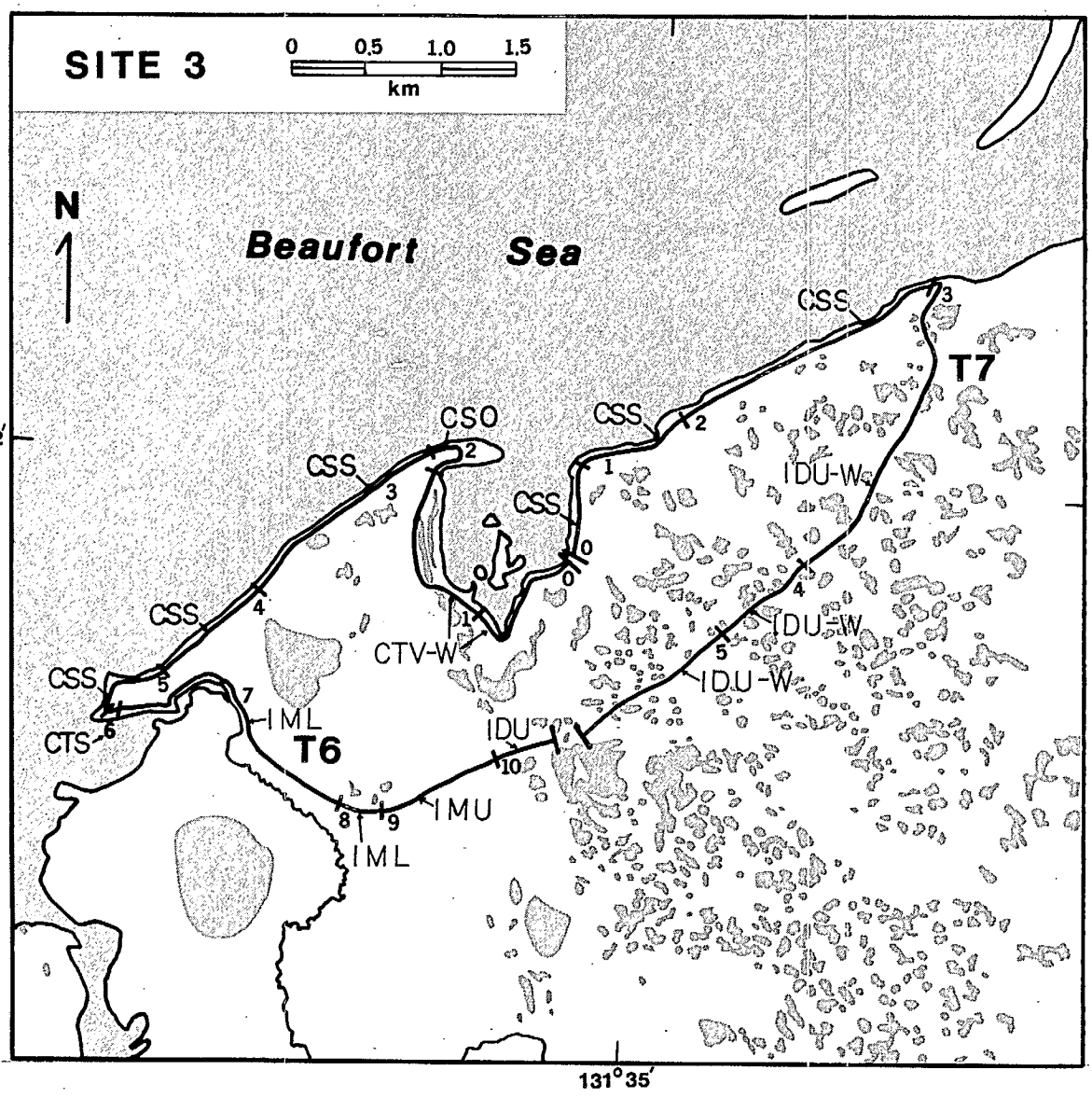

Figure 5. Location of transects, transect sections and habitat types found at site 3 (West of McKinley Bay).

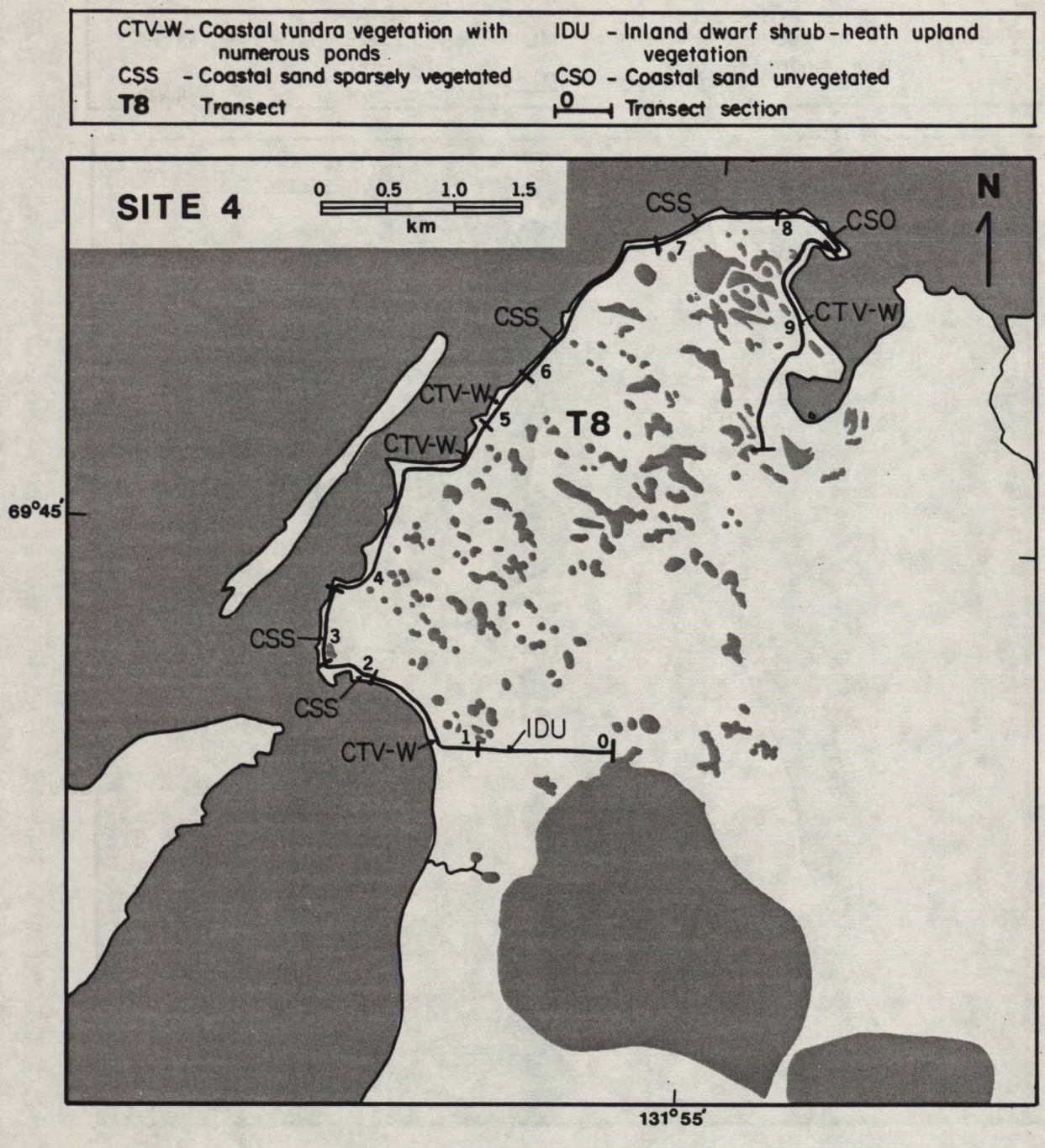

Figure 6. Location of transects, transect sections and habitat types found at site 4 (east of Hutchison Bay).

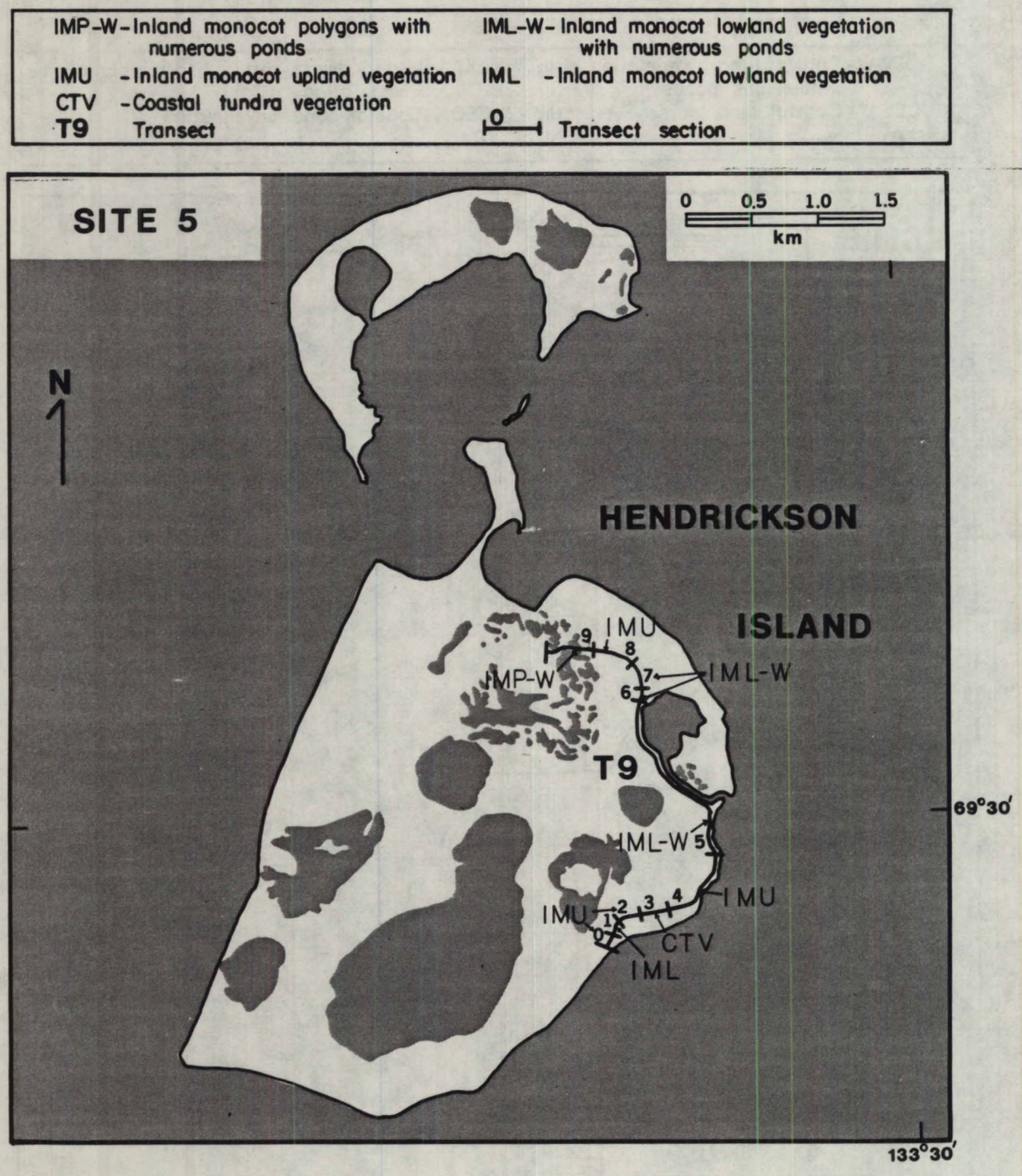

Figure 7. Location of transects, transect sections and habitat types found at site 5 (Hendrickson Island).

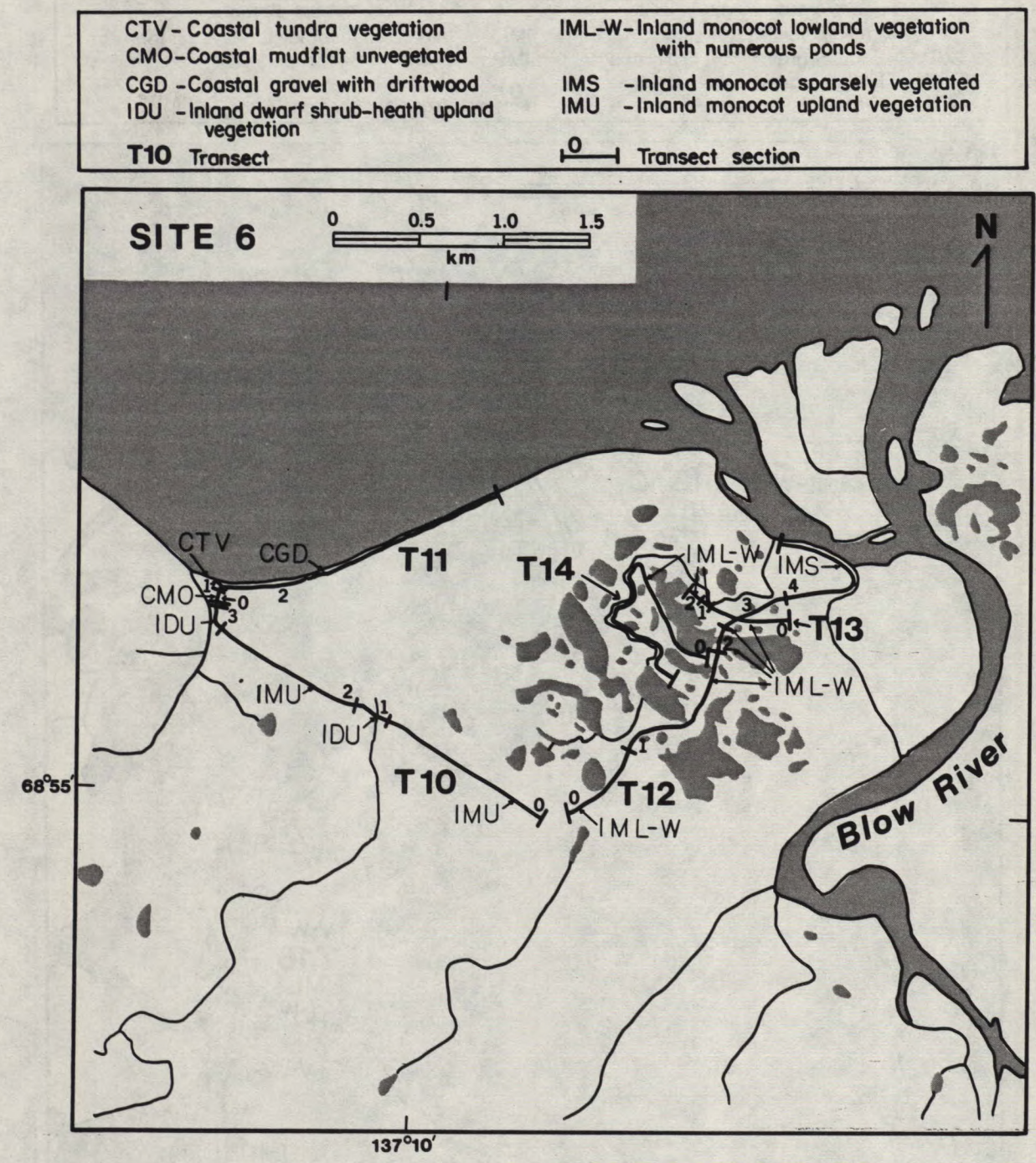

Figure 8. Location of transects, transect sections and habitat types found at site 6 (Blow River).

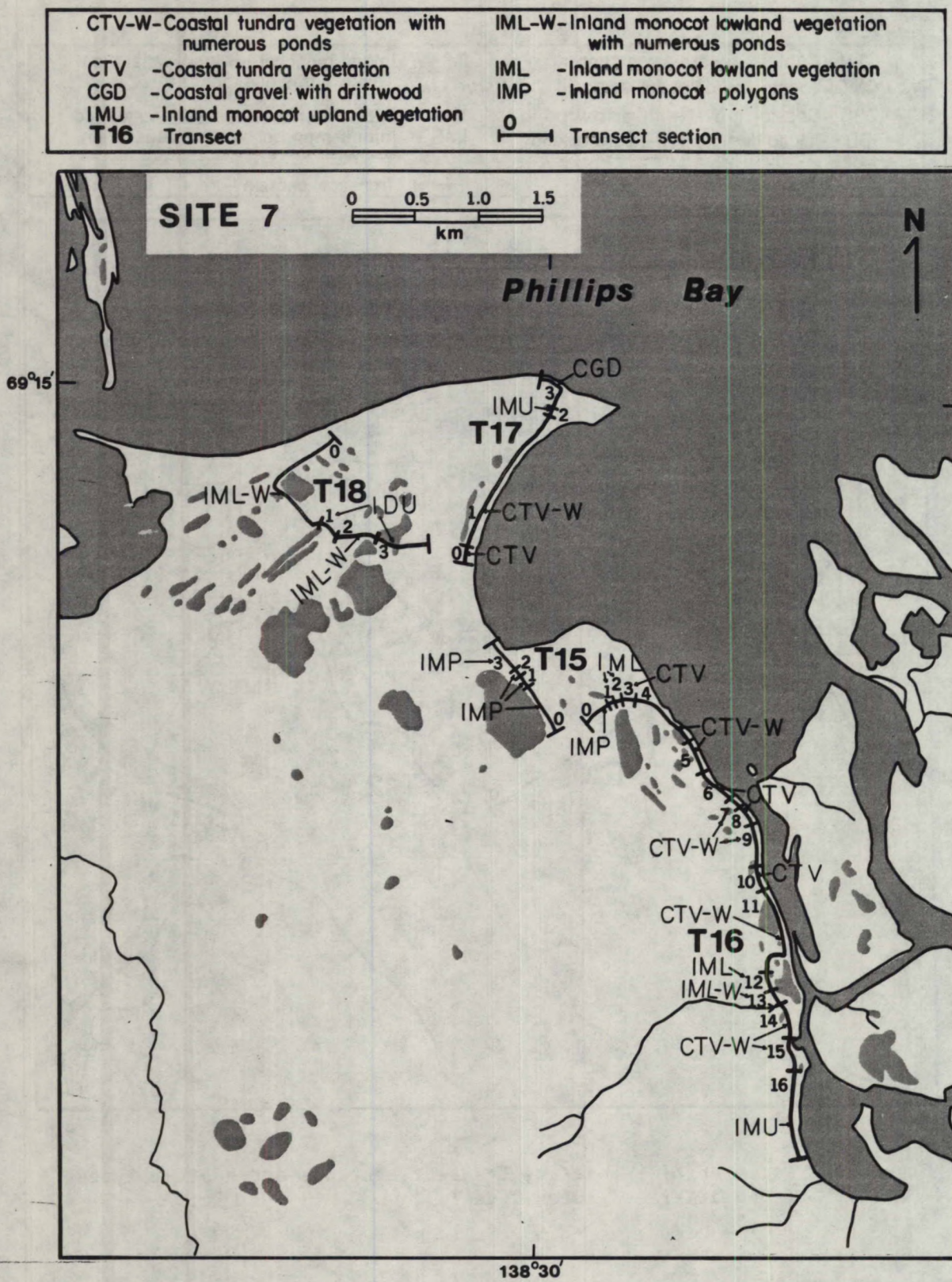

Figure 9. Location of transects, transect sections and habitat types found at site 7 (Phillips Bay).

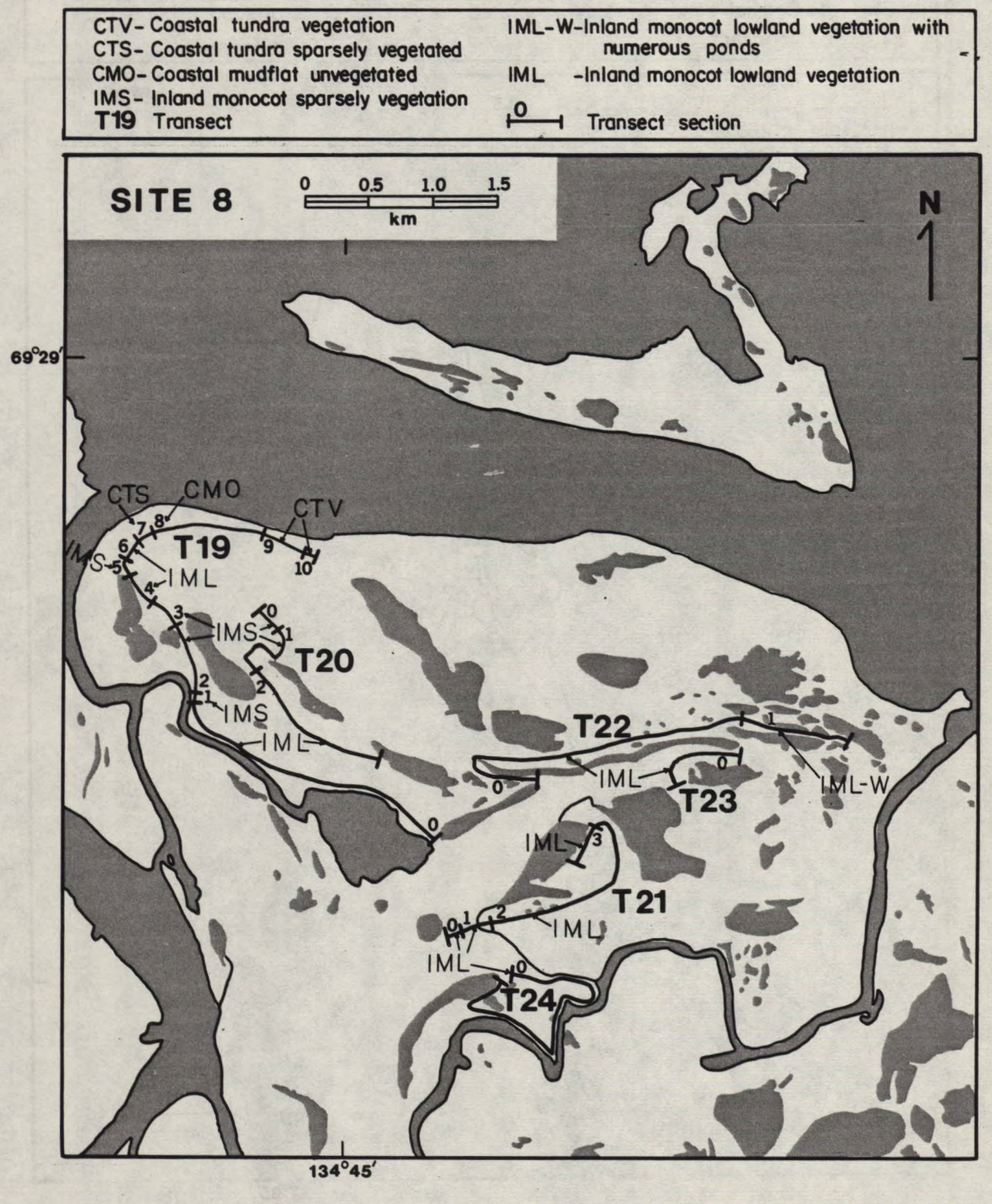

Figure 10. Location of transects, transect sections and habitat types found at site 8 (Mackenzie Delta).

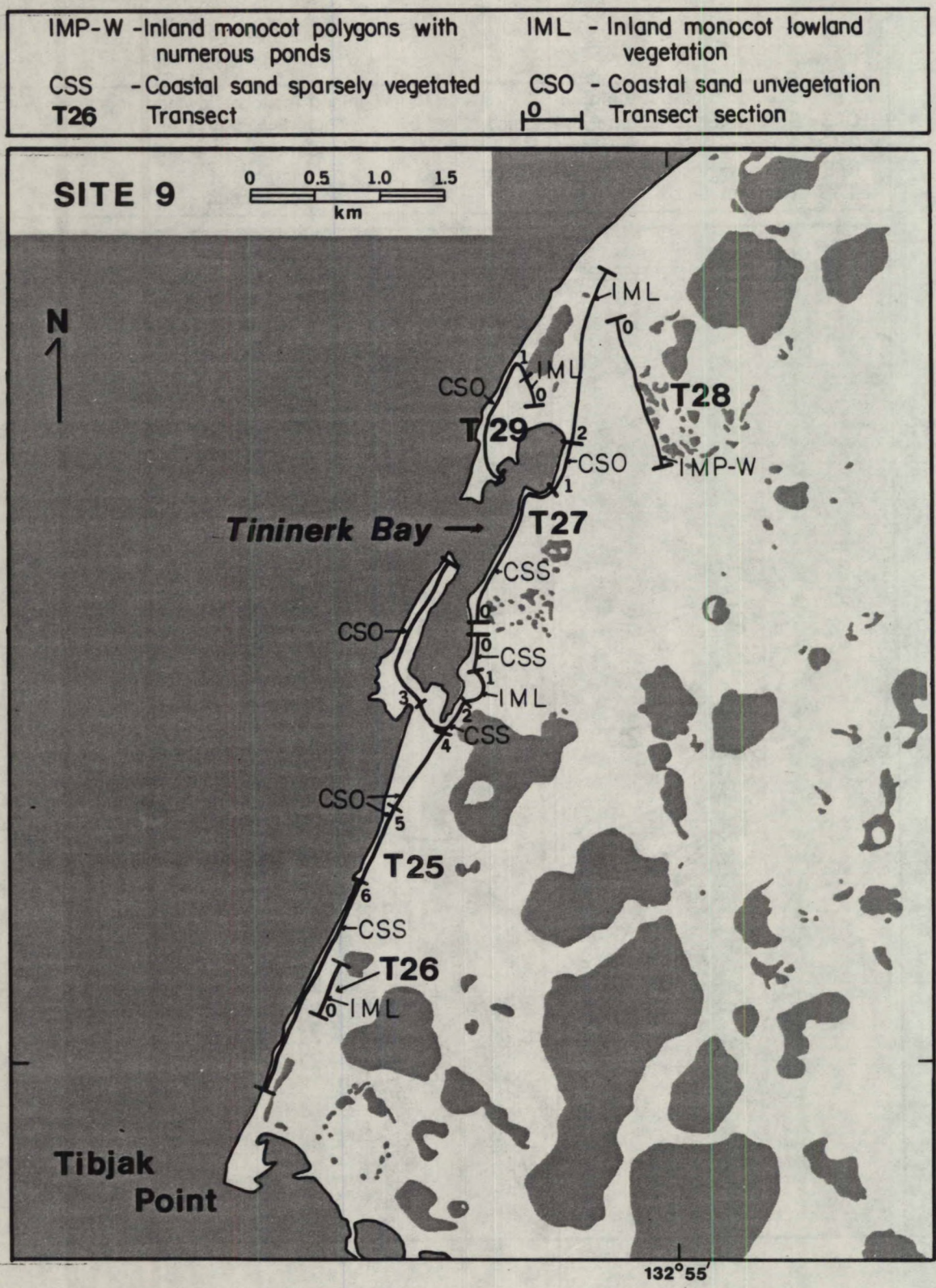

Figure 11. Location of transects, transect sections and habitat types found at site 9 (Toker Point). (Note: Toker Point is located approximately 5.0 km northeast of Tininerk Bay).

the vegetation were also visually estimated for each transect section. In addition, records of moisture regime, macro- and micro-relief, substrate type, presence of ponds and streams, and other notable features were included in the description of each transect section.

Initially, the bird data were compiled to reflect how many individual birds of a given species were found in a given transect section. Subsequent analysis lumped data from similar transect sections (similar in terms of species composition, dominance, % cover, etc.), thus enabling a description of bird-habitat relationships to be developed.

Bird observations were compiled in the following sequence: by transect section; by transect; and by region (i.e. the Yukon Coast, the Mackenzie Delta and the Tuktoyaktuk Peninsula). Table 1 identifies the sites and transects found within each of the three regions.

Table 1. List of sites and transects within each of the three regions along the Beaufort Sea coast.

Region	Site	Transects
Yukon Coast	7 (Phillips Bay)	15, 16, 17, 18
	6 (Blow River)	10, 11, 12, 13, 14
Mackenzie Delta	8 (Mackenzie Delta)	19, 20, 21, 22, 23, 24
	5 (Hendrickson Island)	9
Tuktoyaktuk Peninsula	9 (Toker Point)	25, 26, 27, 28, 29
	1 (Hutchison Bay)	1, 2, 30
	4 (East of Hutchison Bay)	8
	3 (West of McKinley Bay)	6, 7
	2 (Russell Inlet)	3, 4, 5

The biases inherent to the ground transect method have been discussed by McLaren and Alliston (1981) and by Richardson and Gollop (1974). The most important bias is the difference in detectability between bird species. This may affect the estimates of relative species abundance within habitats, but should not seriously affect comparisons of species abundance between habitats.

Other factors may also affect the results of ground transects, including the season and time of day that surveys are conducted, weather conditions and variation in observers skills. These effects were minimized, where possible, in the present study. Tidal phase may be an additional factor to consider on coastal transects, although Cornish and Allen (1983) found no consistent trends in diving duck distribution relative to the tides at McKinley Bay on the Tuktoyaktuk Peninsula, Northwest Territories.

3.0 RESULTS

The results will first deal with the abundance and geographic distribution of the major species or species groups of birds encountered during the survey period (section 3.1). This is followed by a habitat analysis (section 3.2) which includes a presentation of the habitat classification system used (section 3.2.1); vascular plant species composition of habitats (section 3.2.2); and finally the habitat preferences of major bird species and species groups (section 3.2.3).

3.1 Abundance and geographic distribution of birds

3.1.1 Bird numbers on and off transect

Total bird counts by species for each site have been compiled in Table 2. Subsequently, the total bird counts by species for the sites within each of the three regions were combined to give the results presented in Table 3. A list of the common and scientific names of the birds recorded during the study is provided in Appendix A. The nomenclature follows the recent revisions of the American Ornithologist's Union (1982).

The greatest number of bird sightings were made at site 8 on the Mackenzie Delta, where 1488 birds were recorded. This number represents a total of all birds recorded both on and off transect (Table 2). This total includes 504 tundra swans, which was by far the largest concentration of swans observed during the study; the second largest concentration of tundra swans was 13 individuals recorded at site 1 (Hutchison Bay, Table 2). Site 8 also harboured the largest number of white-fronted geese (93 recorded off transect) and was the only site where Canada geese were recorded (one flock of 120, off transect, Table 2).

Including both on and off transect sightings, a total of 448 brant were noted at sites 1 to 4 on the Tuktoyaktuk Peninsula (Tables 2 and 3). In contrast, no brant was observed at the sites from Toker Point westward to the Alaskan border (Table 2).

Northern pintail was the most abundant duck species recorded in each of the three regions (Table 3), and accounted for 59% of the on transect duck sightings. Large numbers of American wigeon (a total of 245 individuals on and off transect) and red-breasted mergansers (120 individuals off transect) were also recorded during the study, at site 4, east of Hutchison Bay (Table 2).

Sandhill cranes were scarce, except at site 8 on the Mackenzie Delta, where a total of 29 were recorded on and off transect (Table 2). Small numbers of sandhill cranes were observed at the following

Table 2. Birds observed on and off transect at each site.

	Yukon Coast Region				Mackenzie Delta Region				Tuktoyaktuk Peninsula Region									
	Phillips Bay (Site 7)		Blow River (Site 6)		Mackenzie Delta (Site 8)		Hendrickson Island (Site 5)		Toker Point (Site 9)		Hutchison Bay (Site 1)		East of Hutchison Bay (Site 4)		West of Mckinley Bay (Site 3)		Russell Inlet (Site 2)	
Bird Species	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off
Arctic Loon	2	17		1		31		1	3	8		1		11		14		3
Red-throated Loon		7	2	4		2		4	3	3		10			5	9		4
Unidentified Loon		8				4				4	2	8		8		11		2
Tundra Swan	4	6		6	2	502		3			1	12				2	3	4
Greater White-fronted Goose		53				93						43		3		65	8	23
Canada Goose						120												
Brant											95	2	15	95	1	101	7	132
Unidentified Goose						25								95		15		
Mallard						2					1	6		2		1		6
Northern Pintail	10	39	70	34	46	129	7	4	27	15	150	47	111	97	31	181	6	53
Green-winged Teal											2		7	1	5	2		1
American Wigeon						19					25		170	75	1	14		22
Greater/Lesser Scaup			1								25							
Common Eider	4												6					
Oldsquaw	20	3				14	1	11		2	27	23				2		78
White-winged Scoter		2		5						2								8
Unidentified Scoter																		35
Red-breasted Merganser	3										12	15		120	2	14		15
Unidentified Duck						85		23		23		118	5	102		113		253
Rough-legged Hawk												1						
Peregrine Falcon						1						1	1					
Snowy Owl		2		2			1			2								1
Rock Ptarmigan													7		4			
Sandhill Crane		4			2	27		4					2	2				4
Semipalmated Plover			6	3									2					
Lesser Golden Plover	7	5	4			9		7		1	2							
Black-bellied Plover					5	8					4	4			2		15	3
Unidentified Plover		1				10		5				1						
Lesser Yellowlegs	10	1				1			5						5			
Ruddy Turnstone																	1	
Sanderling			2						3							4	35	

Table 2. Continued.

	Yukon Coast Region				Mackenzie Delta Region				Tuktoyaktuk Peninsula Region									
	Phillips Bay (Site 7)		Blow River (Site 6)		Mackenzie Delta (Site 8)		Hendrickson Island (Site 5)		Toker Point (Site 9)		Hutchison Bay (Site 1)		East of Hutchison Bay (Site 4)		West of Mckinley Bay (Site 3)		Russell Inlet (Site 2)	
	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off	on	off
Semipalmated/Baird's Sandpiper	63	37	24	5	14	4	63	140	27		21	12	9	27	45	2	18	
White-rumped Sandpiper	1	7																
Pectoral Sandpiper	28	39	109	54	6	7	54	68	3	1	24	3		62	3	8	6	
Dunlin							1	1									17	1
Long-billed Dowitcher		2					6	4										
Stilt Sandpiper							3	2				6		7		26		
Buff-breasted Sandpiper											1							
Red Phalarope							1		3									
Red-necked Phalarope	28	8	10	3	73	16	9	10	15	3	4	2			9			
Shorebird spp.	27	37	3	42		67	2	126				158	1	1	5	39	1	9
Parasitic Jaeger				3		11		1	1		5	3		2		4		1
Long-tailed Jaeger		2															1	
Unidentified Jaeger												2						
Glaucous Gull	1	6	4	71	2	31		51	60	36	3	31	1	37	3	24	3	
Arctic Tern		18		5	2	14		7		15	2	13	3	15		17		2
Common Raven				14		1						1				1		
Yellow Warbler						1												
Hoary Redpoll									1									
Common Redpoll			4															
Unidentified Redpoll			7	4		8		1				1						
Savannah Sparrow	16		14		5	7	3		8		2							
American Tree Sparrow						2												
Fox Sparrow			1			2												
Unidentified Sparrow	2	2	3		4	4			6									
Lapland Longspur	198	23	166	41	62	3	9	1	55	1	31		16	5	110	25	29	
Smith's Longspur	2		1						1		2							
Snow Bunting	2												3		3			
Unidentified Passerine			2			5					3				17			
Total	428	329	433	297	223	1265	160	474	221	116	450	524	360	760	260	685	149	661
Metres of Transect	9344		9683		16 250		3632		12 006		14 530		9969		17 984		14 374	

Table 3. Number of birds observed in each of three regions surveyed on the Beaufort Sea coast in mid-summer of 1981 and 1982.

	Yukon Coast Sites 6 and 7		Mackenzie Delta Sites 5 and 8		Tuktoyaktuk Peninsula Sites 1,2,3,4,9		Total All Sites	
Bird Species	on	off	on	off	on	off	on	off
Arctic Loon	2	18		32	3	37	5	87
Red-throated Loon	2	11		6	8	26	10	43
Unidentified Loon		8		4	2	33	2	45
Tundra Swan	4	12	2	505	4	18	10	535
Greater White-fronted Goose		53		93	8	134	8	280
Canada Goose				120				120
Brant					118	330	118	330
Unidentified Goose				25		110		135
Mallard				2	1	15	1	17
Northern Pintail	80	73	53	133	325	393	458	599
Green-winged Teal					14	4	14	4
American Wigeon				19	196	111	196	130
Greater/Lesser Scaup	1				25		26	
Common Eider	4					6	4	6
Oldsquaw	20	3	1	25	27	105	48	133
White-winger Scoter		7				10		17
Unidentified Scoter						35		35
Red-breasted Merganser	3				14	164	17	164
Unidentified Duck				108	5	609	5	717
Rough-legged Hawk						1		1
Peregrine Falcon				1	1	1	1	2
Snowy Owl		4	1			3	1	7
Rock Ptarmigan					11		11	
Sandhill Crane		4	2	31	2	6	4	41
Semipalmated Plover	6	3			2		8	3
Lesser Golden Plover	11	5		16	2	1	13	22
Black-bellied Plover			5	8	21	7	26	15
Unidentified Plover		1		15		1		17
Lesser Yellowlegs	10	1		1	10		20	2
Ruddy Turnstone					1		1	
Sanderling	2				38	4	40	4
Semipalmated/Baird's	87	42	77	144	120	41	284	227
White-rumped Sandpiper	1	7					1	7
Pectoral Sandpiper	137	93	60	75	36	74	233	242
Dunlin			1	1	17	1	18	2
Long-billed Dowitcher		2	6	4			6	6
Stilt Sandpiper			3	2	39		42	2
Buff-breasted Sandpiper					1		1	
Red Phalarope			1		3		4	
Red-necked Phalarope	38	11	82	26	28	5	148	42
Shorebird spp	30	79	2	193	7	207	39	479
Parasitic Jaeger		3		12	6	10	6	25
Long-tailed Jaeger		2				1		3
Jaeger spp.						2		2
Glaucous Gull	5	77	2	82	70	128	77	287
Arctic Tern		23	2	21	5	62	7	106
Common Raven		14		1		2		17
Yellow Warbler				1				1
Hoary Redpoll					1		1	
Common Redpoll	4						4	
Redpoll spp.	7	4		9		1	7	14
Savannah Sparrow	30		8	7	10		48	7
Northern Tree Sparrow				2				2
Fox Sparrow	1			2			1	2
Sparrow spp.	5	2	4	4	6		15	6
Lapland Longspur	364	64	71	4	241	31	676	99
Smith's Longspur	3				3		6	
Snow Bunting	2				6		8	
Unidentified Passerine	2			5	3	17	5	22
Metres of Transect	19 027		19 882		68 863		107 772	

sites: four individuals at Russell Inlet (site 2); four individuals east of Hutchison Bay (site 4); four individuals on Hendrickson Island (site 5); and four individuals at Phillips Bay (site 7).

Loons, gulls, terns and jaegers were observed at each of the nine sites (Table 2), but most of the sightings were off transect. Glaucous gulls were relatively abundant, particularly at Toker Point (site 9), where a total of 96 were recorded.

Single sightings of peregrine falcons were made at Hutchison Bay (site 1), east of Hutchison Bay (site 4) and on the Mackenzie River delta (site 8), and one rough-legged hawk was recorded at Hutchison Bay. Snowy owls were observed in each of the three regions (Table 2 and 3).

The most abundant of the 16 species of shorebirds recorded were semipalmated sandpipers, pectoral sandpipers and red-necked phalaropes (Table 3). Together these species comprised 75% of the on transect sightings of shorebirds. Large numbers of shorebirds totalling 1070 individuals were also recorded off transect during the study, particularly at Hendrickson Island (site 5), where 363 shorebirds were sighted off transect (Table 2).

The lapland longspur was the most abundant of all bird species recorded, comprising 88% of the passerine birds sighted, and 25% of all birds seen on transect (Table 2). Savannah sparrows, comprising 6% of the passerines sighted, were most abundant at the Yukon sites (6 and 7) but were absent from the three eastern sites (2 to 4) on the Tuktoyaktuk Peninsula (Table 2).

3.1.2 Bird densities

The density index of each bird species was calculated for each region, using the on transect data only (Table 4). Since coastal habitats tend to be linear, the density index is presented as birds per kilometre.

Table 4 indicates that lapland longspur densities were much higher along the Yukon coast (19.1 birds/km) than in the other two regions, where densities of less than 4.0 birds/km were recorded. The Yukon coast also harboured the highest densities of pectoral sandpipers (7.2 birds/km) and semipalmated sandpipers (4.6 birds/km). In contrast, the density of red-necked phalaropes was highest (4.1 birds/km) in the Mackenzie Delta region (Table 4). Table 4 shows that pintail were abundant in all three regions, although the densities of most other duck species were highest on the Tuktoyaktuk Peninsula.

Bird species were also grouped into categories (e.g. geese, ducks, shorebirds) to give an overall view of bird abundance on a regional and site specific basis. Density indices of bird species groups are presented, by site, in Table 5 and by region in Table 6.

Table 4. Density indices (birds/km) of bird species in each of three regions surveyed on the Beaufort Sea coast in mid-summer of 1981 and 1982 (based on "on transect" data only).

	Density (birds/km)			
Bird Species	Yukon Coast Sites 6 and 7	Mackenzie Delta Sites 5 and 8	Tuktoyaktuk Peninsula Sites 1,2,3,4,9	All Sites
Arctic Loon	0.11		0.04	0.05
Red-throated Loon			0.12	0.09
Unidentified Loon			0.03	0.02
Tundra Swan	0.21	0.10	0.06	0.09
Greater White-fronted Goose			0.12	0.07
Brant			1.71	1.09
Mallard			0.01	0.01
Northern Pintail	4.20	2.67	4.72	4.25
Green-winged Teal			0.20	0.12
American Wigeon			2.85	1.82
Lesser Scaup	0.05			0.01
Unidentified Scaup			0.36	0.23
Common Eider	0.21			0.04
Oldsquaw	1.05	0.05	0.39	0.45
Red-breasted Merganser	0.16		0.20	0.15
Unidentified Duck			0.07	0.05
Peregrine Falcon			0.01	0.01
Snowy Owl		0.05		0.01
Rock Ptarmigan			0.16	0.10
Sandhill Crane		0.10	0.03	0.04
Semipalmated Plover	0.32		0.03	0.07
Lesser Golden Plover	0.58		0.03	0.12
Black-bellied Plover		0.25	0.30	0.24
Lesser Yellowlegs	0.53		0.15	0.19
Ruddy Turnstone			0.01	0.01
Sanderling	0.11		0.55	0.37
Semipalmated/Baird's Sandpiper	4.57	3.87	1.74	2.64
White-rumped Sandpiper	0.05			0.01
Pectoral Sandpiper	7.20	3.02	0.52	2.16
Dunlin		0.05	0.25	0.17
Long-billed Dowitcher		0.30		0.06
Stilt Sandpiper		0.15	0.57	0.39
Buff-breasted Sandpiper			0.01	0.01
Red Phalarope		0.05	0.04	0.04
Red-necked Phalarope	2.00	4.12	0.41	1.37
Unidentified Shorebird	1.58	0.10	0.10	0.36
Parasitic Jaeger			0.09	0.06
Glaucous Gull	0.26	0.10	1.02	0.71
Arctic Tern		0.10	0.07	0.06
Hoary Redpoll			0.01	0.01
Common Redpoll	0.21			0.04
Unidentified Redpoll	0.37			0.06
Savannah Sparrow	1.58	0.40	0.15	0.45
Fox Sparrow	0.05			0.01
Unidentified Sparrow	0.26	0.20	0.09	0.14
Lapland Longspur	19.13	3.57	3.50	6.27
Smith's Longspur	0.16		0.04	0.06
Snow Bunting	0.11		0.09	0.07
Unidentified Passerine	0.11		0.04	0.05
Total	45.25	19.26	20.91	24.90
Metres of Transect	19 027	19 882	68 863	107 772

Table 5. Density indices (birds/km) of bird species groups at each site surveyed on the Beaufort Sea coast in mid-summer of 1981 and 1982 (based on "on transect" data only).

	Density (birds/km)								
	YUKON COAST REGION		MACKENZIE DELTA REGION		TUKTOYAKTUK PENINSULA REGION				
Species Group	Phillips Bay Site 7	Blow River Site 6	Mackenzie Delta Site 8	Hendrickson Island Site 5	Toker Point Site 9	Hutchison Bay Site 1	Hutchison Bay Site 4	McKinley Bay Site 3	Russell Inlet Site 2
Loons	0.2	0.2			0.5	0.1		0.3	
Swans	0.4		0.1			0.1			0.2
Geese						6.6	1.5	0.1	1.0
Ducks	4.0	7.5	2.8	2.2	2.2	16.9	29.3	2.3	0.4
Ptarmigan							0.7	0.2	
Cranes			0.1				0.2		
Jaegers					0.1	0.3			
Gulls	0.1	0.4	0.1		5.0	0.2	0.1	0.2	0.2
Terns			0.1			0.1	0.3		
Raptors				0.3			0.1		
Shorebirds	17.6	16.8	6.0	38.3	4.7	4.3	1.9	5.7	6.1
Passerines	23.5	20.9	4.4	3.3	5.9	2.6	1.9	6.8	1.9
Total	45.8	45.8	13.6	44.1	18.4	31.4	36.0	15.6	9.7
Distance Surveyed (metres)	9344	9683	16 250	3632	12 006	14 530	9969	17 984	14 374

Table 6. Density indices (birds/km) of bird species groups in each of three regions surveyed on the Beaufort Sea coast in mid-summer of 1981 and 1982 (based on "on transect" data only).

	Density (birds/km)			
Species Group	Yukon Coast Sites 6 and 7	Mackenzie Delta Sites 5 and 8	Tuktoyaktuk Peninsula Sites 1,2,3,4,9	All Sites
Loons	0.2		0.2	0.2
Swans	0.2	0.1	0.1	0.1
Geese			1.8	1.2
Ducks	5.7	2.7	8.8	7.1
Ptarmigan			0.2	0.1
Cranes		0.1	+	+
Jaegers			0.1	0.1
Gulls	0.3	0.1	1.0	0.7
Terns		0.1	0.1	0.1
Raptors		0.1	+	+
Shorebirds	16.9	11.9	4.7	8.2
Passerines	22.0	4.2	3.9	7.2
Total	46.3	19.3	20.9	24.9
Metres of Transect	19 027	19 882	68 863	107 772

+ Less than 0.05 birds/km but greater than 0.00 birds/km.

On a regional basis, the Tuktoyaktuk Peninsula yielded the highest duck density (8.8 ducks/km), while the Mackenzie Delta had the lowest density (2.7 ducks/km, Table 6). Duck densities were particularly high at sites 1 (Hutchison Bay) and 4 (east of Hutchison Bay), where densities of 16.9 and 29.3 ducks/km, respectively, were recorded (Table 5).

Hendrickson Island (site 5) had a much greater density of shorebirds (38.3 birds/km) than any other site (Table 5). The Yukon Coast region had a moderately high shorebird density (16.9 birds/km), while the Tuktoyaktuk Peninsula had a relatively low density (4.7 birds/km, Table 6).

Passerine bird densities were by far the highest in the Yukon coast region, where 22 birds/km were recorded. In comparison, the Mackenzie Delta and Tuktoyaktuk Peninsula regions had very low passerine densities of 4.2 and 3.9 birds/km respectively (Table 6).

The densities of the other species groups were generally very low. Gull and loon densities were highest (5.0 and 0.5 birds/km respectively) at Toker Point (site 9). Goose densities were highest (6.6 birds/km) at Hutchison Bay (site 1) (Table 5).

3.2 Habitat analysis

3.2.1 Classification of habitats

In classifying the habitats, only general features of the vegetation were used and plant species composition was estimated visually. Including ponded habitats, a total of 18 habitat types were recognized. The habitat type of each transect section is indicated in Figures 3 to 11. A key to the habitat classification used is given in Table 7.

3.2.2 Plant species composition of habitats

Approximately 130 species (including subspecies) of vascular plants were recorded. The plant species recorded in each habitat are shown in Appendix B, and the plants which were dominant or frequent are indicated. Appendix C gives species list of the plants recorded at each site, with the sites arranged in order from west to east. The plant specimens collected are housed in either one of the following two herbaria located in Ottawa, Ontario: the herbarium of the National Museums of Natural Sciences, National Museums of Canada (CAN); or the herbarium of the Biosystematics Research Institute, Agriculture Canada (DAO).

Table 7. Key to the classification of habitat types identified in the study.

1. Habitat situated along beach of sea coast.....2
   2. Humus or mud beach.....3
      3. Vegetation cover 60% or more.....
      .....Coastal Tundra Vegetation (CTV)
      3. Vegetation cover less than 60%.....4
         4. Vegetation cover 15 to 55%.....
         .....Coastal Tundra Sparsely Vegetated (CTS)
         4. Vegetation cover 10% or less.....
         .....Coastal Mudflat Unvegetated (CMD)
   2. Sand or gravel beach.....5
      5. Sand beach.....6
         6. Vegetation cover 60% or more..Coastal Sand Vegetation (CSV)
         6. Vegetation cover less than 60%.....7
            7. Vegetation cover 15 to 55%.....
            .....Coastal Sand Sparsely Vegetated (CSS)
            7. Vegetation cover 10% or less.....
            .....Coastal Sand Unvegetated (CSD)
      5. Gravel beach with driftwood.....
      .....Coastal Gravel With Driftwood (CGD)
1. Habitat situated inland from beach.....8
   8. Monocots dominant.....9
      9. Vegetation cover 60% or more.....10
         10. Polygons absent.....11
            11. Upland vegetation (dry to mesic).....
            .....Inland Monocot Upland Vegetation (IMU)
            11. Lowland vegetation (wet to wet-mesic).....
            .....Inland Monocot Lowland Vegetation (IML)
         10. Polygons present.....Inland Monocot Polygons (IMP)
      9. Vegetation cover 15 to 55%.....
      .....Inland Monocot Sparsely Vegetated (IMS)
   8. Dwarf shrub and heath dominant.....
   .....Inland Dwarf Shrub-Heath Upland Vegetation (IDU)

Note: The habitat categories identified above can also have numerous ponds present. In such cases the designation "-W" would be added to the type designation. For example; Coastal Mudflat Unvegetated With Numerous Ponds (CMD-W).

Several species had widespread distribution, and were present or dominant in a variety of lowland habitats. These include the sedges Carex aquatalis, C. rariflora, C. saxatilis and C. subspathacea, and the grasses Dupontia fisheri, Elymus arenarius and Puccinellia spp. On sparsely vegetated sand coasts, lyme grass (Elymus arenarius) was the most frequently recorded species. Dwarf willows (Salix spp.) were also common in lowland habitat, notably Salix arctica, S. fuscescens and S. ovalifolia.

Upland monocot habitats were usually dominated by tussock forming cotton grasses (mostly Eriophorum vaginatum) or by lyme grass (Elymus arenarius). In upland dwarf shrub-heath habitats, dwarf birch (Betula glandulosa), willow (Salix glauca), Labrador tea (Ledum palustre) and crowberry (Empetrum nigrum) were most abundant.

3.2.3 Bird habitat preferences

The densities of bird species groups in each of the 18 habitat types are indicated in Table 8. The habitats have also been grouped into four categories (Ponded Lowland Habitat, Lowland Habitats with Few Ponds, Sparsely Vegetated Lowland Habitats, Upland Habitats), as shown in Table 8 and the densities of bird species in each of these groups is presented in Table 9.

The ponded lowland habitats all had relatively high bird densities, averaging 54.1 birds/km (Table 8) and the greatest species richness (Table 9). Coastal vegetated habitats with numerous ponds (Coastal Sand Vegetation With Ponds and Coastal Tundra Vegetation with Ponds) harboured the highest densities of ducks (35.2 and 24.2 birds/km, respectively) (Table 8), both pintail and wigeon being the most common. Pintail densities were 2.64 birds/km on sand coasts and 6.92 birds/km on humus coasts while the density of wigeon was 7.53 birds/km on humus coasts (Table 10).

These habitats also harboured the highest densities of geese (35.7 and 2.6 birds/km, respectively) (Table 8). Brant were especially abundant with 2.18 and 1.82 birds/km on sand coasts and humus coasts respectively (Table 10).

Shorebird densities were also highest in ponded lowlands (Table 8), averaging 20.4 birds/km. Semipalmated/Bairds and pectoral sandpipers were the most common with densities of 7.09 and 6.69 birds/km on ponded lowland habitats respectively (Table 9). However, shorebirds, particularly pectoral sandpipers, red-necked phalarope and to a lesser extent semipalmated/Baird's sandpipers favoured the inland habitats (Table 10). Inland Monocot Polygons with Numerous Ponds and Inland Monocot Uplands with Numerous Pond, had shorebird densities of 38.9 and 31.0 birds/km, respectively (Table 8).

Lowland habitats with few ponds had lower densities of birds, averaging 14.2 birds/km. As indicated in Table 8, the density of

geese, ducks, shorebirds and passerines were considerably lower in this habitat group compared to ponded habitats.

Sparsely vegetated lowland habitats were generally the lowest in total bird density, averaging 7.7 birds/km (Table 8). This was particularly true of Coastal Tundra Sparsely Vegetated and Inland Monocot Sparsely Vegetated habitats which had total bird densities of 1.8 and 2.2 birds/km, respectively. Coastal Sand Unvegetated Habitat harboured a relatively high glaucous gull density (4.7 gulls/km), but other birds were scarce in this habitat. The transect length represented by Coastal Mudflat Unvegetated was low, with only 1128 m, but the results suggest moderate shorebird (semipalmated/Baird's sandpiper being the most abundant) and duck (pintail being the most abundant) densities in this habitat, each with 6.2 birds/km. Coastal Gravel Beach with Driftwood harboured the highest passerine density (12.1 birds/km) (mainly Lapland Longspurs) of the sparsely vegetated habitats (Tables 8 and 10) .

The upland habitats were variable in bird density, and averaged 20.7 birds/km (Table 8). Monocot dominated uplands (Inland Monocot Uplands) had a very high passerine density of 38.5 birds/km, compared to dwarf shrub-heath dominated uplands (Inland Dwarf Shrub-Heath Upland Vegetation and Inland Dwarf Shrub-Heath Upland Vegetation With Numerous Ponds), where passerine densities were less than 5.0 birds/km. Lapland longspurs showed a definite preference for upland habitat, whereas savannah sparrows were about equally abundant in all four habitat categories (Table 9).

Several species groups were recorded infrequently on transect, and the numbers observed are not adequate for detailed habitat analysis. Only 15 loons were recorded on the transects. Low densities of tundra swans, sandhill cranes and arctic terns were recorded, all in well-vegetated lowland habitats. Rock ptarmigan were noted only in Inland Dwarf Shrub-Heath Upland Vegetation and in Coastal Sand Sparsely Vegetated Habitat. Only two raptors, one peregrine falcon and one snowy owl, were observed on transect (Tables 3 and 8).

Table 8. Density indices (birds/km) of bird species groups in each of eighteen habitat types and in four grouped habitat types surveyed along the Beaufort Sea coast in mid-summer of 1981 and 1982.

Habitat Type	Distance Surveyed (metres)	Density (Birds/km)* Loons	Swans	Geese	Ducks	Ptarmigan	Cranes	Jaegers	Gulls	Terns	Raptors	Shorebirds	Passerines	Total
Ponded Lowland Habitats:														
Coastal Tundra Vegetation - Ponded.	18 285	0.2	0.2	2.6	24.2		0.1	0.1	0.3	0.3		14.4	10.6	52.8
Coastal Tundra Sparsely Vegetated - Ponded.	417											12.0	16.8	33.6
Coastal Sand Vegetation - Ponded	1959			35.7	35.2							6.1	4.6	81.7
Inland Monocot Lowland Vegetation - Ponded.	8776	0.2			9.6			0.1			0.1	31.0	10.5	51.4
Inland Monocot Polygons - Ponded.	2568	2.3		2.3	4.3			0.4				38.9	7.0	55.3
Total	32 005	0.3	0.1	3.8	18.9		0.1	0.1	0.2	0.2	+	20.4	10.0	54.1
Lowland Habitats with few Ponds:														
Coastal Tundra Vegetation	4401	0.2			1.1			0.2				5.2	2.5	9.3
Coastal Sand Vegetation	6274		0.5	0.3	1.0			0.2	0.3			5.9	4.8	12.9
Inland Monocot Lowland Vegetation	18 701		0.1		4.9		0.1			0.1		5.0	6.5	16.7
Inland Monocot Polygons	2191		0.5									1.4	5.0	6.8
Total	31 567	+	0.2	0.1	3.2		0.1	0.1	0.1	0.1		5.0	5.5	14.2

Table 8. Continued.

Habitat Type	Distance Surveyed (metres)	Density (Birds/km)*												
		Loons	Swans	Geese	Ducks	Ptarmigan	Cranes	Jaegers	Gulls	Terns	Raptors	Shorebirds	Passerines	Total
Sparsely Vegetated Lowland Habitats:														
Coastal Tundra Sparsely Vegetated	1651											1.8		1.8
Coastal Sand Sparsely Vegetated	16 531				2.0	0.2			2.2			1.9	2.0	8.4
Coastal Sand Unvegetated	5549			0.2	0.5				4.7			0.4		5.8
Coastal Mudflat Unvegetated	1128				6.2			1.8	1.8			6.2	0.9	16.8
Coastal Gravel with Driftwood	2235								1.3			4.0	12.1	17.4
Inland Monocot Sparsely Vegetated	4113											2.0		2.2
Total	31 207			+	1.4	0.1		0.1	2.2			2.0	2.0	7.7
Upland Habitats:														
Inland Monocot Upland Vegetation	4990				1.0							0.8	38.5	40.3
Inland Dwarf Shrub-Heath Upland Vegetation	3453				0.9	2.0			0.3		0.3	0.9	4.6	9.0
Inland Dwarf Shrub-Heath Upland Vegetation - Ponded.	4527	1.1			3.3							1.3	2.2	8.0
Total	12 970	0.4			1.8	0.5			0.1		0.1	1.0	16.8	20.7

* Based on "on transect" data only.
+ Present in less than 0.1 but greater than 0.0 birds/km densities.

Table 9. Density indices (birds/km) of bird species in each of four grouped habitat types surveyed on the Beaufort Sea coast in mid-summer of 1981 and 1982.

	Density (birds/km)*			
	Lowland Habitats			Upland Habitats
Bird Species	Numerous Ponds	Few Ponds	Sparsely Vegetated	
Arctic Loon	0.12	0.03		
Red-throated Loon	0.16			0.39
Unidentified Loon	0.06			
Tundra Swan	0.12	0.19		
Greater White-fronted Goose	0.19	0.06		
Brant	3.66		0.03	
Mallard	0.03			
Northern Pintail	9.81	3.20	0.96	1.00
Green-winged Teal	0.16		0.13	0.39
American Wigeon	6.09			0.08
Unidentified Scaup	0.81			
Common Eider				0.31
Oldsquaw	1.34	0.03	0.13	
Red-breasted Merganser	0.47		0.06	
Unidentified Duck	0.22		0.10	
Peregrine Falcon				0.08
Snowy Owl	0.03			
Rock Ptarmigan			0.13	0.54
Semipalmated Plover		0.03	0.22	
Lesser Golden Plover	0.41			
Black-bellied Plover	0.50	0.03	0.22	0.15
Lesser Yellowlegs	0.47		0.16	
Ruddy Turnstone		0.03		
Sanderling	0.37	0.73	0.16	
Semipalmated/Baird's Sandpiper	7.09	1.17	0.51	0.15
White-rumped Sandpiper	0.03			
Pectoral Sandpiper	6.69	0.51		0.23
Dunlin	0.56			
Long-billed Dowitcher	0.16			0.08
Stilt Sandpiper	0.91	0.03	0.35	0.08
Buff-breasted Sandpiper	0.03			
Red Phalarope	0.12			
Red-necked Phalarope	1.94	2.31	0.29	0.31
Unidentified Shorebird	1.09	0.13	0.06	
Parasitic Jaeger	0.06	0.06	0.06	
Glaucous Gull	0.19	0.06	2.18	0.08
Arctic Tern	0.16	0.06		
Hoary Redpoll		0.03		
Common Redpoll				0.31
Unidentified Redpoll	0.03		0.10	0.23
Savannah Sparrow	0.47	0.51	0.35	0.39
Fox Sparrow	0.03			
Unidentified Sparrow	0.12	0.29	0.06	
Lapland Longspur	9.03	4.59	1.22	15.88
Smith's Longspur	0.16		0.03	
Snow Bunting	0.12		0.13	
Unidentified Passerine		0.06	0.06	
Total	54.09	14.22	7.72	20.66

*Based on "on transect" data only.

Table 10. Density indices (birds/km) of bird species in sand coast, humus coast and inland habitat types surveyed on the Beaufort Sea coast in mid-summer of 1981 and 1982.

Bird Species	Density (birds/km)** * Sand Coast	+ Humus Coast	All Coastal Habitats	All Inland Habitats
Arctic Loon		0.08	0.03	0.06
Red-throated Loon				0.20
Unidentified Loon		0.08	0.03	
Tundra Swan	0.09	0.15	0.12	0.06
Greater White-fronted Goose	0.06		0.03	0.12
Brant	2.18	1.82	2.02	
Mallard		0.04	0.02	
Northern Pintail	2.64	6.92	4.54	3.91
Green-winged Teal	0.12	0.19	0.15	0.10
American Wigeon		7.53	3.34	0.02
Unidentified Scaup		0.97	0.43	0.02
Common Eider				0.08
Oldsquaw		1.78	0.79	0.04
Red-breasted Merganser	0.40	0.04	0.24	0.06
Unidentified Duck	0.22	0.08	0.17	
Peregrine Falcon				0.02
Snowy Owl				0.02
Rock Ptarmigan	0.12		0.07	0.14
Sandhill Crane		0.08	0.03	0.04
Semipalmated Plover	0.22	0.04	0.14	
Lesser Golden Plover		0.35	0.15	0.08
Black-bellied Plover	0.03	0.89	0.41	0.04
Lesser Yellowlegs	0.15	0.31	0.22	0.14
Ruddy Turnstone	0.03		0.02	
Sanderling	0.86	0.46	0.68	
Semipalmated/Baird's Sandpiper	0.71	4.29	2.29	3.00
White-rumped Sandpiper		0.04	0.02	
Pectoral Sandpiper	0.15	1.74	0.86	3.71
Dunlin		0.66	0.29	0.02
Long-billed Dowitcher				0.12
Stilt Sandpiper	0.34	0.81	0.55	0.20
Buff-breasted Sandpiper		0.04	0.02	
Red Phalarope				0.08
Red-necked Phalarope	0.31	1.00	0.61	2.27
Unidentified Shorebird	0.03	1.00	0.46	0.28
Parasitic Jaeger	0.03	0.15	0.09	0.02
Glaucous Gull	2.09	0.31	1.30	0.02
Arctic Tern		0.19	0.09	0.04
Hoary Redpoll				0.02
Common Redpoll				0.08
Unidentified Redpoll	0.09		0.05	0.08
Savannah Sparrow	0.40	0.15	0.29	0.61
Fox Sparrow				0.02
Unidentified Sparrow	0.06		0.01	0.26
Lapland Longspur	2.15	7.84	4.67	8.21
Smith's Longspur	0.09	0.08	0.09	0.02
Snow Bunting	0.12	0.12	0.12	0.02
Unidentified Passerine	0.12		0.07	
Total	13.86	40.22	25.53	24.27
Distance Surveyed (m)	32 548	25 882	58 430	49 319

** Based on "on transect" data only.

* Also includes Coastal Gravel with Driftwood Habitats.

\+ Also includes Coastal Mudflats Unvegetated Habitats.

4.0 DISCUSSION

4.1 Factors Affecting Bird Habitat Utilization

4.1.1 Ponds and lakes

The abundance of ponds and lakes was a major factor governing bird distribution in lowland habitats. In the present study, waterfowl were approximately six times more numerous and shorebirds were four times more numerous in ponded lowlands compared to lowlands with few ponds (Table 8).

The importance of this habitat factor is supported by McLaren et al. (1977), who quantified the abundance and extent of waterbodies during ground transects in the Rasmussen Lowlands, Keewatin District, Northwest Territories, and found a significant positive correlation between percentage cover of waterbodies and the densities of shorebirds and waterfowl.

Inland Monocot Polygons With Numerous Ponds harbours the highest shorebird density (38.9 birds/km) in the study area (Table 8). This habitat was distinctly evident on topographic maps (1:50 000 scale), appearing as a somewhat circular pattern of numerous small ponds. It was encountered twice on the transects: on Hendrickson Island, site 5, transect 9 (Figure 7) and at Toker Point, site 9, transect 28 (Figure 11). The presence of ponds in the other habitat types was also usually discernible from 1:50 000 scale topographic maps. In some cases, however, the ponds were very small, and visible only on large scale aerial photographs or during the ground census.

4.1.2 Percentage cover of the vegetation

Vegetation cover also appears to strongly influence bird abundance. In general, sparsely vegetated habitats had very low densities of birds compared to vegetated habitats (Table 8). Possible exceptions to this general trend are Coastal Mudflats Unvegetated and Coastal Gravel With Driftwood habitats, both of which harboured moderate bird densities of about 17 birds/km (Table 8). This factor is difficult to quantify on coastal transects, for at low tide, large areas of unvegetated mud or sand flats are exposed that would not be accessable during high tide.

4.1.3 Coastal habitat types

Coastal habitats are of particular importance in the present study, since they would be most vulnerable to the effects of an offshore oil spill. Tables 10 and 11 summarize the bird densities in two categories of coastal habitat types: a) sand coast habitats (including one gravel coast habitat) comprised of Coastal Sand Vegetation with Ponds, Coastal Sand Vegetation, Coastal Sand Sparsely Vegetated, Coastal Sand Unvegetated and Coastal Gravel With Driftwood; and

b) humus coast habitats (including one mudflat habitat), comprised of Coastal Tundra Vegetated With Numerous Ponds, Coastal Tundra Sparsely Vegetated With Numerous Ponds, Coastal Tundra Sparsely Vegetated, Coastal Tundra Vegetation and Coastal Mudflat Unvegetated. Bird densities of inland habitats are also shown for comparison. The densities are given by bird species in Table 10 and by bird species group in Table 11.

Table 11. Density indices (birds/km) of bird species groups in sand coast, humus coast and inland habitat types surveyed on the Beaufort Sea coast in mid-summer of 1981 and 1982.

	Density (birds/km)*			
Species Group	* Sand Coast	$ Humus Coast	All Coastal Habitats	All Inland Habitats
Loons		0.2	0.1	0.3
Swans	0.1	0.2	0.1	0.1
Geese	2.2	1.8	2.1	0.1
Ducks	3.4	17.5	9.7	4.2
Ptarmigan	0.1		0.1	0.1
Cranes		0.1	+	+
Jaegers	+	0.2	0.1	+
Gulls	2.1	0.3	1.3	+
Terns		0.2	0.1	+
Raptors				+
Shorebirds	2.8	11.6	6.7	10.0
Passerines	3.0	8.2	5.3	9.3
Totals	13.9	40.2	25.5	24.3
Distance Surveyed (m)	32 548	25 882	58 430	49 319

+ Less than 0.05 but greater than 0.00 birds/km.
* Also includes one Coastal Gravel with Driftwood Habitat.
$ Also includes one Coastal Mudflats Unvegetated Habitat.
# Based on "on transect" data only.

The results in Table 10 and 11 indicate that humus coasts receive a much heavier bird use than sand coasts. However, this is merely a reflection of the level of vegetation each of these coastal types possess. Table 8 indicates that of the transect sections (habitat types) representing humus coastlines, 22 686 metres were well vegetated and 3196 metres were unvegetated to sparsely vegetated. Of the transect sections representing sand coastlines, Table 8 indicates that 8233 metres were well vegetated and 24 315 metres were unvegetated to sparsely vegetated. Thus, sand coast transect sections were 75% unvegetated to sparsely vegetated and 25% vegetated while humus coasts transect sections were 12% unvegetated to sparsely

vegetated and 88% vegetated. Thus, the data also indicated that vegetated coastal habitats are more heavily used by birds than unvegetated coastal habitats.

Total bird density on humus coasts (40.2 birds/km) was about three times higher than on sand coasts (13.9 birds/km, Table 11). This trend was constant for ducks and passerines. Shorebird densities were also highest on humus coasts (Table 11), but there was considerable variation in habitat preference by species. The densities of semipalmated and Baird's sandpipers, pectoral sandpipers, red-necked phalaropes, dunlins and stilt sandpipers were higher on humus coasts; but several of the uncommon species, such as sanderlings, semipalmated plovers and ruddy turnstones apparently preferred sand coasts (Table 10).

Glaucous gulls showed a distinct preference for sand coastal habitats (Table 10), particularly unvegetated and sparsely vegetated sand beaches (Coastal Sand Unvegetated and Coastal Sand Sparsely Vegetated, Table 8). The number of observations of loons, geese, cranes, raptors, jaegers and terns were insufficient to determine relative habitat preferences of these birds for sand or humus coasts. The inland habitats surveyed supported a density of total birds (24.3 birds/km) that was similar to the density in coastal habitats (25.5 birds/km, Table 11). Ducks and geese, notably brant, American wigeon, scaup spp., red-breasted Merganser, and oldsquaw, were recorded at much higher densities in coastal habitats (Tables 10 and 11). In contrast, the densities of shorebirds and passerines, particularly pectoral sandpipers, red-necked phalaropes and lapland longspurs, were greatest inland (Tables 10 and 11).

4.1.4 Moisture

The moisture regime of habitats is reflected by their classification as either "lowland" or "upland". Lowland habitats were generally wet or wet mesic.

Passerines were the dominant bird group in upland habitats, and one species, the lapland longspur, accounted for 77% of all birds sighted (Tables 8 and 9). Lowland habitats harbour much more diverse bird communities, with higher densities of waterfowl and shorebirds (Table 8).

4.1.5 Plant species composition

General vegetation type and total percentage cover of the vegetation were important habitat features, but there was no discernible evidence that vascular plant species composition *per se* affects bird species composition and abundance. For example, both sections 1 and 2 of Transect 20, at site 8 on the Mackenzie River delta, were dominated by the sedge (*Carex aquatilis*) and the grass (*Dupontia fisheri*), but bird densities within these two transect sections were dramatically different. In section 1, which was 704 m in length,

only two red-necked phalaropes were recorded, giving a total bird density of 2.8 birds/km; while in Section 2, which was 1292 m in length, 53 red-necked phalaropes, 6 other shorebirds, 33 pintail and two passerines, yielding a much higher total bird density of 72.8 birds/km. In this instance, the difference was related to the percentage cover of the vegetation (50-60% in section 1; 100% in section 2) rather than plant species composition. A multi-variate analysis of bird habitat relationships by McLaren et al. (1976) in the Keewatin District, Northwest Territories resulted in similar conclusions.

4.1.6 Vascular Plants of Restricted Range

The following notable vascular plants which have a restricted range within the Northwest Territories (Cody 1979) were collected during this study. On Hendrickson Island (site 5): the daisy (Chrysanthemum arcticum); the grasses (Arctagrostis latifolia ssp. nahanniensis and Calamagrostis deschampsioides); the primrose (Primula borealis); the cinqfoils (Potentilla egedii and P. rubricaulis); and the willow (Salix ovalifolia var. arctolitoralis) were collected. On the Mackenzie River delta (site 8), the grass (Puccinellia agrostoidea) and the willow (Salix ovalifolia var. arctolitoralis) were collected. Thrift (Armeria maritima) was collected at Toker Point (site 9).

The following plants collected during the study in the Yukon have a rare status (Douglas et al. 1981): the sedges (Carex glareosa ssp. glareosa var. amphigena and C. rariflora), and the willows (Salix fuscescens and S. ovalifolia var. arctolitoralis), collected at both the Blow River and Phillips Bay (sites 6 and 7); the seabeach sandwort (Honckenya peploides) and the saxifrage (Saxifraga foliosa), collected at Blow River (site 6); and the sedge (Carex chordorrhiza) and the willow (Salix ovalifolia var. ovalifolia), collected at Phillips Bay (site 7). Waterwort (Elatine triandra), collected at the Blow River (site 6), represents a new record for the Yukon Territory. This is the most northerly known record for this species in North America (Cody 1980). The location of this record, relative to the previously known distribution of Elatine triandra is shown in Figure 12. There are a number of possibilities which could explain how this apparent disjunct occurred: 1) the species is very inconspicuous and therefore has simply been overlooked; 2) the seeds were eaten by waterfowl, geese or swans and transported to the area; or 3) the plant was introduced by man. The latter option seems the most unlikely considering the present and past lack of activity in the area which would be associated with other known site locations of this species.

The collection numbers and habitat types for all of the above species are indicated in Appendices B and C.

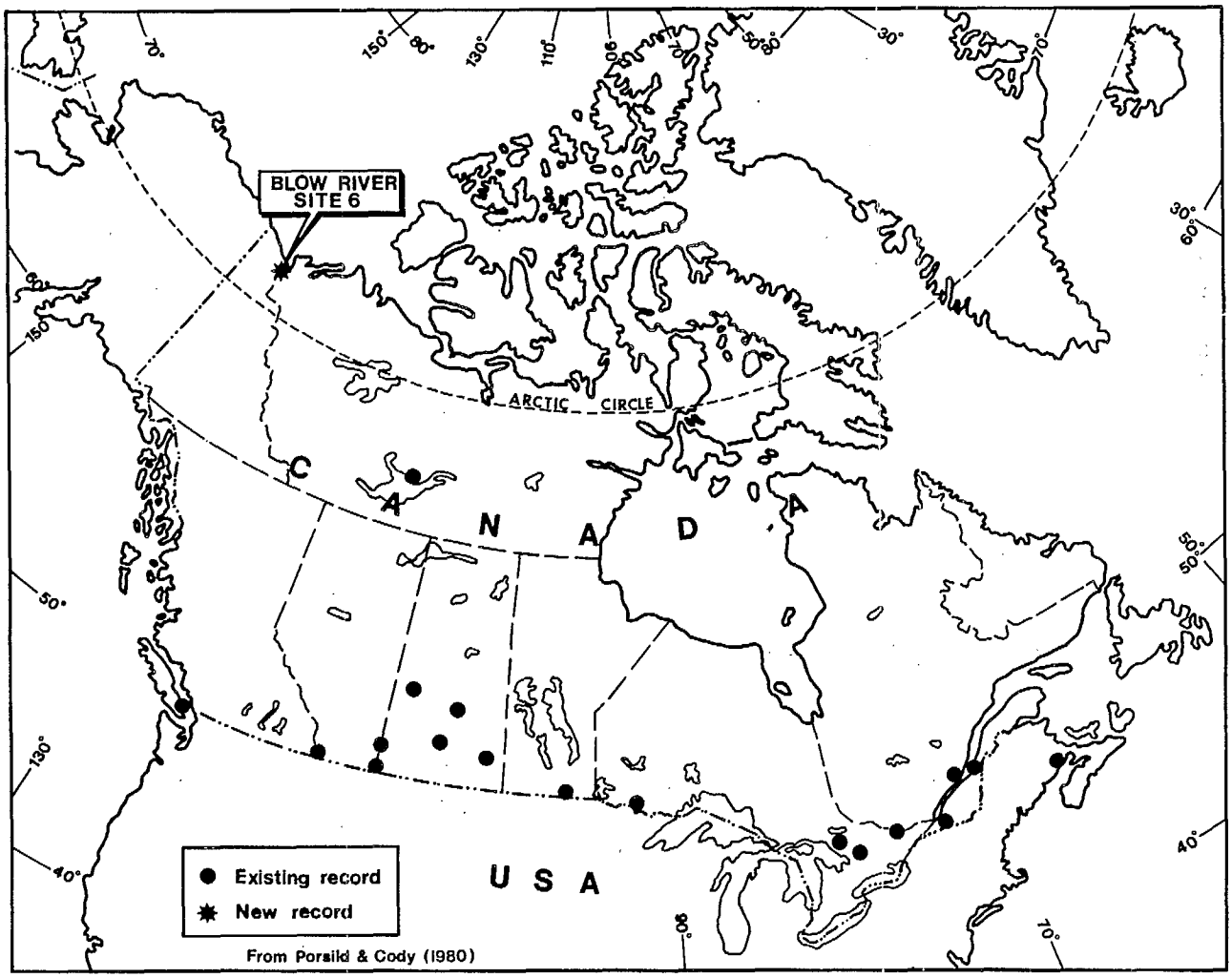

Figure 12. Location of Elatine triandra collected during the present study in relation to other Canadian records.

4.2 Bird distribution and abundance

4.2.1 Swans

Tundra swans were recorded infrequently on transect, but more than 500 were observed off transect on the outer Mackenzie River delta, at site 8, in monocot lowland habitats (Inland Monocot Lowland Vegetation and Inland Monocot Lowland Vegetation With Numerous Ponds) (Table 2). Site 8 falls within one of the areas designated as important to birds by Barry and Barry (1982), and this area is known to harbour a breeding population of approximately 300 swans and 500 to 1000 non-breeding swans. The location of site 8 is also within the portion of the outer Mackenzie River delta that has been mapped by Slaney and Co. (1974) as receiving a high degree of use by nesting and moulting swans.

Although few swans were recorded during the ground surveys on the Tuktoyaktuk Peninsula and on the Yukon coast (Table 3), substantial numbers have been reported at specific locations within these regions. An estimated 150 nesting swans and several hundred non breeding swans utilize the coastal marshes of Shoalwater Bay, Y.T. (T. Barry, pers. observ. 1958-1982; cited in Dickson et al. 1983) and up to 79 swans were recorded by Scott-Brown et al. (1981) in a lagoon system south of McKinley Bay on the Tuktoyaktuk Peninsula.

The present study provides little data on the habitat preferences of swans, but other studies have indicated the importance of large ponds and lakes to swans (Derksen et al. 1981). On the Mackenzie River delta, breeding and moulting swans use upland lakes as well as ponded lowland tundra and river channels (Slaney and Co. 1974).

4.2.2 Geese

Geese preferred well-vegetated lowland habitats with numerous ponds (Coastal Sand Vegetation With Numerous Ponds, Coastal Tundra Vegetation With Numerous Ponds and Inland Monocot Polygons With Numerous Ponds) (Table 8), although the data are limited, because geese were encountered infrequently on the transects.

The white-fronted goose is the most abundant nesting goose species along the Beaufort Sea coast (Koski 1981). Substantial concentrations of this species were sighted in each of the three regions, totalling 588 individuals, although the majority of these were non-breeders. Since only eight of the white-fronted geese were on transect, the habitat preference cannot be determined from the analysis presented in Table 9 and 10. However, an examination of the off transect data suggests a preference of this species for monocot dominated habitats, both upland and lowland, where lakes, ponds or streams are present. Major off transect observations included: 53 white-fronted geese of which 30 were young on the bank of a lake in Inland Monocot Uplands at Phillips Bay (site 7); 55 adults on a lake in Inland Monocot Lowland Vegetation With Numerous Ponds on the Mackenzie River delta

(site 8); and 50 adults near a river in Inland Monocot Lowland Vegetation at McKinley Bay (site 3). Additional information is provided by Slaney et al. (1974), who report that the white-fronted goose is non-colonial, and in the Mackenzie Delta region, often breeds in upland habitats that are adjacent to sedge lowlands and river channels.

Brant were observed mainly in well-vegetated sand or tundra coast habitats with numerous ponds (Tables 9 and 10). This observation is consistent with the results of Searing et al. (1975), who noted that brant were "notably rare" on freshwater lakes situated inland from the Beaufort Sea coast. In the present study, brant were recorded only on the Tuktoyaktuk Peninsula, at the four sites east of Toker Point (Table 2, Figure 2). Despite the absence of brant sightings in the western portion of the study area it should be noted that brant breed near the coast throughout the Beaufort Sea coast region (Koski and Tull 1981). Small numbers of brant nest at scattered locations on barrier islands in Mackenzie Bay and on the outer Mackenzie River delta (Barry and Barry 1982; Slaney and Co. 1974). Vegetated flats and lagoons in the Herschel Island area of the Yukon coast are used by an estimated 26 000 brant in early September (Barry and Barry 1982).

Canada geese occur in low numbers in the Mackenzie River delta and along the Beaufort Sea coast (Koski and Tull, 1981). Slaney and Co. (1974) reported that the summer population of Canada geese in their study area, which encompassed most of the outer Mackenzie River delta, "probably did not exceed 150 individuals". Hence, the record of 120 Canada geese off transect at site 8 (Mackenzie Delta) in the present study may be significant.

Snow geese are abundant in the region (Koski and Tull, 1981) but have a very localized nesting distribution, which accounts for their absence from the transects on the present study. A group of four islands south of Kendall Island on the outer Mackenzie River delta supports a breeding population of up to 8000 Snow Geese (Barry and Barry 1982).

4.2.3 Ducks

The habitats most heavily utilized by ducks were ponded lowlands along the coast (Coastal Sand Vegetation With Numerous Ponds and Coastal Tundra Vegetation With Numerous Ponds), but ponded habitats inland (Inland Monocot Lowlands With Numerous Ponds, Inland Monocot Polygons With Numerous Ponds and Inland Dwarf Shrub-Heath Upland Vegetation With Numerous Ponds), unponded lowlands (Inland Monocot Lowlands) and Coastal Mudflats Unvegetated also harboured low to moderate densities of ducks (Table 8). Ducks were most abundant on the Tuktoyaktuk Peninsula (Tables 3 and 4).

Four species of dabbling ducks (northern pintail, American wigeon, green-winged teal and mallard), and at least five species of diving ducks (oldsquaw, common eider, scaup spp., white-winged scoter and red-breasted merganser) were recorded. Dabbling ducks, particularly the northern pintail, were abundant at all nine sites surveyed (Table 2) and outnumbered diving ducks in each of the three regions. A total of 1419 dabbling ducks, which includes 1057 northern pintail, were recorded on and off transect during the study, whereas only 450 diving ducks were sighted (Table 3).

In contrast, Searing et al. (1971) commented on the "low numbers of dabbling ducks" in the Beaufort Sea region, and stated that Pintail are "generally restricted to the eastern portion of the Beaufort Sea to the Mackenzie Delta." Other studies indicate that diving ducks, particularly, oldsquaw, scaup spp, and scoter spp., are relatively more numerous than dabblers throughout the Beaufort Sea coast region (Gollop and Richardson 1974; Gollop and Davis 1974; Slaney and Co. 1974; Cornish and Allen 1983; Karasiuk and Boothroyd 1982; Scott-Brown et al. 1981). Diving ducks are typically concentrated in bays off-shore (Scott-Brown et al. 1981) or on upland lakes (Slaney and Co. 1974), and this may account for the relatively low numbers observed in the present study, since all of the transects were in terrestrial habitats within 2.0 kilometres of the coast.

On 25 July 1982, a lesser scaup nest with four eggs was observed near the Blow River (Site 6, Transect 12, Section 1), in an Inland Monocot Lowland Vegetation With Numerous Ponds habitat, (Figure 8). This represents a northern extension of the known breeding range of this species in the northern Yukon, as indicated by Bellrose (1980). Scaup broods have been previously recorded near the Yukon arctic coast between the Blow and Firth rivers (Salter et al. 1980; Gollop and Davis 1974), but they were not identified to species (i.e. greater and lesser scaup).

4.2.4 Shorebirds

Shorebirds were recorded in all 18 habitat types, but ponded lowland habitats harboured the highest densities, particularly those situated inland (Inland Monocot Polygons With Numerous Ponds and Inland Monocot Lowland Vegetation With Numerous Ponds) (Table 8). A total of 16 species of shorebirds were observed (Table 3) and all of these have been previously recorded for the Mackenzie River delta (Slaney et al. 1974).

In the present study, pectoral and semipalmated sandpipers were the most abundant shorebird species. Both showed a strong preference for lowland habitats with numerous ponds. In ponded lowland habitats, the pectoral sandpiper density was about 13 times higher, and the semipalmated sandpiper density was approximately six times higher, than in unponded habitats. Similar habitat preferences have been reported by McLaren et al. (1977) for pectoral sandpipers in the Rasmussen lowlands (Keewatin District, Northwest Territories), where

over 50% of the sightings were made within 25 yards (23 m) of a waterbody. However, McLaren et al. (1977) found no evidence that semipalmated sandpipers prefer habitats close to lakes or ponds.

Red-necked phalaropes, also recorded at high densities in the present study, exhibited no apparent preference for ponded habitats (Table 9). However, standing water was usually present in the unponded habitats where phalaropes were observed. Distinct ponds or lakes may not be necessary as habitat for red-necked phalaropes, but the presence of standing water appears to be important.

4.2.5 Passerines

The lapland longspur was the most abundant species recorded, accounting for 88% of all passerines detected on transect, and 25% of all birds observed. Similar results were obtained by Koski (1975) during ground surveys of the Yukon and Alaska north slopes, where lapland longspurs comprised 25 to 33% of birds sighted. As indicated by the results of the present study, as well as those found by Koski (1975) in the northern Yukon, and by McLaren et al. (1976) in the Keewatin District, Northwest Territories, lapland longspurs utilize a wide variety of habitats, but are most numerous in dry upland habitats dominated by monocots.

Bird communities along the Beaufort Sea coast appear to have less passerine diversity than in areas further south. Slaney and Co. (1974) estimated that savannah sparrows and American tree sparrows were more numerous than lapland longspurs in their study region on the Mackenzie River delta, and that yellow warblers and redpolls were abundant. In contrast, savannah sparrows were relatively uncommon in the present study, comprising only 6% of the passerines sighted on-transect; redpolls comprised less than 2%; and American tree sparrows and yellow warblers were recorded off transect only, with only two and one individuals of each species observed respectively (Table 3). Tall shrubs were very uncommon near the Beaufort Sea coast, and this likely accounts for the reduced diversity noted in the present study compared to more inland areas of the Mackenzie Delta, where tall shrubs are more abundant and passerine diversity is higher.

4.2.6 Other birds

Bird species groups other than waterfowl, shorebirds and passerines were not observed with sufficient frequency to permit reliable indications as to habitat preferences. However, the data suggest that loons preferred ponded habitats, both upland and lowland, and that glaucous gulls preferred sparsely vegetated sand beaches (Table 8). Colonies of glaucous gulls and arctic terns nest on offshore spits and islands along the Beaufort Sea coast (Koski and Tull 1981). It is on these nesting areas that the impact of an oil spill would likely be greatest in certain seasons.

5.0 SUMMARY AND CONCLUSIONS

Ground transects conducted during the present study provide an insight into the general distribution, species composition and habitat preferences of birds in the coastal Beaufort Sea region during mid-summer (late July and early August).

Ponded lowland habitats that are well-vegetated, and located between the Beaufort Sea coast and the storm tide line, should receive the highest priority for cleanup in the event of an oil spill. These habitats harboured high densities of waterfowl and shorebirds, and moderate passerine densities. Specifically, waterfowl favoured ponded coastal tundra or well-vegetated sand coasts with ponds; shorebirds preferred ponded tundra situated inland, and to a lesser extent, ponded coastal tundra. Complexes of numerous ponds associated with low-centered polygons should be protected from oil spills as they have been found to harbour unusually rich shorebird communities.

Well-vegetated lowland habitats lacking numerous ponds harboured lower densities of waterfowl, shorebirds and passerines. However, at least one species, the red-necked phalarope, made heavy use of such habitats if standing water was present. Unponded well-vegetated lowlands below the storm tide line, would have a moderate impact on birds, if fouled by oil. This would be less critical than if similar ponded well-vegetated lowlands habitats were oiled.

Sparsely vegetated habitats, particularly wide sand beaches with little or no vegetation, received limited use by birds, and supported very low densities of waterfowl, shorebirds and passerines. Certain uncommon shorebird species, however, showed a preference for sand beaches, including semipalmated plovers, ruddy turnstones, and sanderlings. Gulls were observed most frequently on unvegetated sand beaches; however in the event of an oil spill, it would probably be more critical to protect the nesting sites of gulls, and other colonially nesting seabirds, on a site specific basis.

Upland habitats, and other habitats protected from inundation by cliffs, banks, or gradual elevation gradients, would be least susceptible to the impacts of oil spilled off shore.

The habitat preferences determined from the present study are based on mid-summer observations, and it should be noted that the importance of coastal habitats to birds, and hence the habitats sensitivity, is subject to considerable seasonal variation during the period when open water is present in the Beaufort Sea. The seasonally changeable habitat requirements of birds during staging, breeding and moulting should therefore be taken into account when priority areas for cleanup after an oil spill are designated. For example; several shorebird species are known to exhibit seasonal variation in habitat utilization, and use coastal habitats more intensively after breeding in late summer (Connors et al. 1979). The sensitivity of shorebird populations to the impact of an oil spill is therefore likely to vary considerably depending on the time of year.

Of the nine sites surveyed, six were found to receive a particularly heavy use by birds. Phillips Bay (site 7) and the Blow River (site 6) in the Yukon Territory harboured relatively high densities of shorebirds (notably pectoral sandpipers and semipalmated sandpipers) and passerines (mostly lapland longspurs). The Mackenzie Delta (site 8) was a particularly rich area for tundra swans, sandhill cranes, red-necked phalaropes and white-fronted geese, and was the only site where Canada geese were recorded. Hendrickson Island (site 5) harboured a higher shorebird density than any other site, of which semipalmated sandpipers and pectoral sandpipers were the most abundant of the nine species found there. Two sites in the Hutchison Bay area of the Tuktoyaktuk Peninsula (sites 1 and 4) supported very high densities of ducks and geese, particularly pintail and brant. American wigeon and red-breasted mergansers were also abundant at site 4.

A limitation of the study was that the transects were sampled over a two-year period. Most of the transects on the Tuktoyaktuk Peninsula were surveyed in 1981, whereas the transects on the Mackenzie Delta and the Yukon Coast were surveyed in 1982. Bird populations often fluctuate considerably from one year to the next in arctic regions, and hence it has been difficult to separate regional differences in bird abundance from differences in relative abundance between the two years.

Birds that have an aggregated distribution pose difficulties for sampling by the ground transect method if they are encountered very infrequently on transects. This was particularly true of most geese and diving ducks in the present study. In such cases, aerial surveys supplemented by ground truthing would be a more appropriate means of determining habitat preferences.

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APPENDIX A. Common and scientific names of birds observed on ground surveys along the Beaufort Sea coast in mid-summer of 1981 and 1982.

APPENDIX A. Common and scientific names of birds observed on ground surveys along the Beaufort Sea coast in mid-summer of 1981 and 1982.

*Common name	*Scientific Name
Red-throated Loon	Gavia stellata (Pontoppidan)
Arctic Loon	G. arctica (Linnaeus)
Tundra Swan (Whistling Swan)	Cygnus columbianus (Ord)
Greater white-fronted goose	Anser albifrons (Scopoli)
Brant	Branta bernicla (Linnaeus)
Canada Goose	B. canadensis (Linnaeus)
Green-winged Teal	Anas crecca Linnaeus
Mallard	A. platyrhynchos Linnaeus
Northern Pintail	A. acuta Linnaeus
American Wigeon	A. americana Gmelin.
Greater Scaup	Aythya marila (Linnaeus)
Lesser Scaup	A. affinis (Eyton)
Common Eider	Somateria mollissima (Linnaeus)
Oldsquaw	Clangula hyemalis (Linnaeus)
White-winged Scoter	Melanitta fusca (Linnaeus)
Red-breasted Merganser	Mergus serrator (Linnaeus)
Rough-legged Hawk	Buteo lagopus (Pontoppidan)
Peregrine Falcon	Falco peregrinus Tunstall
Rock Ptarmigan	Lagopus mutus (Montin)
Sandhill Crane	Grus canadensis (Linnaeus)
Black-bellied Plover	Pluvialis squaturola (Linnaeus)
Lesser Golden Plover (American Golden Plover)	P. dominica (Muller)
Semipalmated Plover	Charadrius semipalmatus Bonaparte
Lesser Yellowlegs	Tringa flavipes (Gmelin)
Ruddy Turnstone	Arenaria interpres (Linnaeus)
Sanderling	Calidrius alba (Pallas)
Semipalmated Sandpiper	C. pusilla (Linnaeus)
White-rumped Sandpiper	C. fuscicollis (Vieillot)
Baird's Sandpiper	C. bairdii (Coues)
Pectoral Sandpiper	C. melanotus (Vieillot)
Dunlin	C.alpinus (Linnaeus)
Stilt Sandpiper	C. himantopus (Bonaparte)
Buff-breated Sandpiper	Tryngites subruficollis (Vieillot)
Long-billed Dowitcher	Limnodromus scolopaceus (Say)
Red-necked Phalarope (Northern Phalarope)	Phalaropus lobatus (Linnaeus)
Red Phalarope	P. fulicaria (Linnaeus)
Parasitic Jaeger	Stercorarius parasiticus (Linnaeus)
Long-tailed Jaeger	S. longicaudus Vieillot
Glaucous Gull	Larus hyperboreus Gunnerus
Arctic Tern	Sterna paradisea Pontoppidan
Snowy Owl	Nyctea scandiaca (Linnaeus)
Common Raven	Corvus corax Linnaeus
Yellow Warbler	Dendroica petechia (Linnaeus)
Common Redpoll	Carduelis flammea (Linnaeus)
Hoary Redpoll	C. hornemanni (Holboll)
American Tree Sparrow (Northern Tree Sparrow)	Spizella arborea (Wilson)
Savannah Sparrow	Passerculus sandwichensis (Gremlin)
Fox Sparrow	Passerella iliaca (Merrem)
Lapland Longspur	Calcarius lapponicus (Linnaeus)
Smith's Longspur	C. pictus (Swainson)
Snow Bunting	Plectrophenax nivalis (Linnaeus)

* Nomenclature From American Ornithologist's Union (1982).

APPENDIX B: Plant species recorded in each of 18 habitat types surveyed along the Beaufort Sea coast in mid-summer of 1981 and 1982.

Key to Habitat Abbreviations used in Appendix B.

CTV-W = Coastal Tundra Vegetation with Numerous Ponds
CTS-W = Coastal Tundra Sparsely Vegetated with Numerous Ponds
CSV-W = Coastal Tundra Sand Vegetation with Numerous Ponds
IML-W = Inland Monocot Lowland Vegetation with Numerous Ponds
IMP-W = Inland Monocot Polygons with Numerous Ponds
CTV = Coastal Tundra Vegetation
CSV = Coastal Sand Vegetation
IML = Inland Monocot Lowland Vegetation
IMP = Inland Monocot Polygons
CTS = Coastal Tundra Sparsely Vegetated
CSS = Coastal Sand Sparsely Vegetated
CSO = Coastal Sand Unvegetated
CMO = Coastal Mudflat Unvegetated
CGD = Coastal Gravel with Driftwood
IMS = Inland Monocot Sparsely Vegetated
IMU = Inland Monocot Upland Vegetation
IDU = Inland Dwarf Shrub-Heath Upland Vegetation
IDU-W = Inland Dwarf Shrub-Heath Upland Vegetation with Numerous Ponds

Appendix B. Plant species recorded in each of 18 habitat types surveyed along the Beaufort Sea in mid-summer of 1981 and 1982 (on transect data).

Habitat Type	CTVW	CTSW	CSVW	IML W	IMP W	CTV	CSV	IML	IMP	CTS	CSS	CSO	CMO	CGD	IMS	IMU	IDU	IDW
Number of transect sections in habitat type	22	1	1	16	3	14	13	24	8	4	18	7	3	2	9	9	10	3
BETULACEAE																		
Alnus crispa ssp. crispa																	+	
Betula glandulosa				x	x				+		+					#	#	+
CARYOPHYLLACEAE																		
Honckenya peploides ssp. peploides											x			x				
Melandrium affine					x													
Melandrium apetalum ssp. arcticum	+			x	x	x		x										
Minuartia arctica									x									
Minuartia obtusifolia																	x	
Stellaria spp.						x												
Stellaria humifusa					x													
Stellaria longipes					x													
Stellaria montantha				x				x						x		x		
COMPOSITAE																		
Achillea millefolium														x				
Artemisia tilesii ssp. elatior														x				
Chrysanthemum arcticum ssp. polare	+			x		+		x										
Petasites spp.				x														
Petasites frigidus																x		
Saussurea angustifolia																x		
Senecio atropurpureus ssp. frigidus																x		
Senecio fuscatus																x		
Taraxacum spp.					x													
Taraxacum lacerum											x							
CRASSULACEAE																		
Sedum rosea ssp. integrifolium	#				x	+		+			x			x	+			
CRUCIFERAE																		
Cardamine pratensis ssp. angustifolia									x									
Cochlearia officinalis spp. arctica						#												

Appendix B. Continued.

Habitat Type	CTVW	CTSW	CSVW	IMLW	IMPW	CTV	CSV	IML	IMP	CTS	CSS	CSO	CMO	CGD	IMS	IMU	IDU	IDW
Number of transect sections in habitat type	22	1	1	16	3	14	13	24	8	4	18	7	3	2	9	9	10	3
CYPERACEAE																		
Carex spp.											+		x					
Carex amblyorhyncha	x													x				
Carex aquatilis	D+			#	x	+		D#	D+					+	D+			
Carex atrofusca					x			x								x		
Carex bigelowii																x		
Carex chordorrhiza									x									
Carex glareosa ssp. *glareosa* var. *amphigena*	+			D#		x										x		
Carex holostoma					x													
Carex livida var. *grayana*									x									
Carex maritima								x										
Carex rariflora	D+			+	D+	x		#								x		
Carex rotundata	x																	
Carex saxatilis	D+			D#		D+												
Carex subspathacea	D#		x	+		D+		D			D+							
Eriophorum spp.					+	+	x		x		+			x				x
Eriophorum angustifolium ssp. *subarcticum*	x			+				#								+	+	
Eriophorum russeolum								+	+									
Eriophorum scheuzeri	x																	
Eriophorum vaginatum				+					+							D#	+	
ELATINACEAE																		
Elatine triandra var. *brachysperma*				x														
EMPETRACEAE																		
Empetrum nigrum ssp. *hermaphroditicum*		x			+	x	x	+				x					#	# +
EQUISETACEAE																		
Equisetum spp.											x					x		
Equisetum variegatum ssp. *variegatum*					x				+									

Appendix B. Continued.

Habitat Type	CTVW	CTSW	CSVW	IMLW	IMPW	CTV	CSV	IML	IMP	CTS	CSS	CSO	CMO	CGD	IMS	IMU	IDU	IDW
Number of transect sections in habitat type	22	1	1	16	3	14	13	24	8	4	18	7	3	2	9	9	10	3
ERICACEAE																		
Arctostaphylus rubra																x	x	
Cassiope tetragona ssp. tetragona							x											
Chaemadaphne calyculata									x									
Ledum palustre ssp. decumbens					x		x				x					#	#	+
Vaccinium spp.					x		x									+	#	+
GENTIANACEAE																		
Gentiana propinqua ssp. arctophila								x										
GRAMINEAE																		
Alopecurus alpinus							x									x		
Arctagrostis latifolia									x							x		
Arctagrostis latifolia ssp. latifolia					x													
Arctagrostis latifolia ssp. nahanniensis				x	x									x				
Arctophila fulva						+							x					
Calamagrostis deschampsioides	x					x										x		
Calamagrostis stricta								#			x				+			
Deschampsia caespitosa	x					+		x		x			x		#			
Dupontia fisheri	+			*	x	+		D*						x	+	x		
Elymus arenarius	*	x	Dx	D#	+	D#	D#	D#		x	D#	+		+	D#	D+		
Festuca rubra ssp. richardsonii				x				x			x							
Dupontia fisheri	+			*	x	+		D*						x	+	x		
Elymus arenarius	*	x	Dx	D#	+	D#	D#	D#		x	D#	+		+	D#	D+		
Festuca rubra ssp. richardsonii				x				x			x							
Hierchloe alpina						x			+							x	x	
Poa arctica	x					x												
Poa arctica ssp. longiculmis																	x	
Poa arctica ssp. williamsii														x		x		
Poa glauca (P. palustris complex)				x			x											
Poa cf. lanta							x	x										
Poa pratensis								+						+		x		
Puccinellia spp.	D+	Dx	x	D+		D#	+	D+		D+	+	x			D+			
Puccinellia agrostoidea	x					+				x					D#			
Puccinellia andersonii	x										x							

Appendix B. Continued.

Habitat Type	CTVW	CTSW	CSVW	IMLW	IMPW	CTVW	CSVW	IMLW	IMPW	CTSS	CSSO	CSMO	CGDW	IMSW	IMUW	IDUW	IDUW
Number of transect sections in habitat type	22	1	1	16	3	14	13	24	8	4	18	7	3	2	9	9	10	3
Puccinellia arctica								+										
Puccinellia langeana	x																	
Puccinellia phryganodes	D+					Dx	Dx	Dx		Dx	D+				Dx			
Puccinellia vaginata	D+			D+	Dx	Dx												
Trisetum spicatum														x				
HALORAGACEAE																		
Hippuris sp.	+			#		+	x	+										
Hippuris vulgaris					x													
JUNCACEAE																		
Juncus arcticus ssp. *alaskanus*								+							+			
Juncus castaneus	x																	
Luzula spp.				x		x										x	x	
Luzula confusa					x				x									
Luzula wahlenbergii ssp. *piperi*				x														
Luzula wahlenbergii ssp. *wahlenbergii*								+	x									
JUNCAGINACEAE																		
Triglochin maritimum															x			
LEGUMINOSAE																		
Astragalus alpinus											x							
Astragulus umbellatus														x				
Hedysarum alpinum ssp. *americanum*								x							x			
Lathyrus japonicus var. *aleuticus*	x			x							x			x				
Lupinus arcticus																x		
Oxytropis spp.	x																	
LILIACEAE																		
Allium schoenoprasum var. *sibiricum*																	x	

Appendix B. Continued.

Habitat Type	CTVW	CTSW	CSVW	IMLW	IMPW	CTVV	CSVV	IMLL	IMPP	CTSS	CSSS	CSSO	CMOO	CGDD	IMSS	IMUU	IDUU	IDUW
Number of transect sections in habitat type	22	1	1	16	3	14	13	24	8	4	18	7	3	2	9	9	10	3
ONAGRACEAE																		
Epilobium angustifolium ssp. angustifolium																x		
Epilobium latifolium																	x	
Epilobium palustre								x	x									
PLUMBAGINACEAE																		
Armeria maritima ssp. arctica								x										
POLEMONIACEAE																		
Polemonium acutiflorum														x		x		
POLYGONACEAE																		
Polygonum spp.					x												x	
Polygonum bistorta																x		
Polygonum viviparum								+	x									
Rumex spp.	+					x												
POTAMOGETONACEAE																		
Potamogeton filiformis				x														
PRIMULACEAE																		
Primula borealis						x												
Primula stricta				x														
Pyrola grandiflora									x							x	x	
RANUNCULACEAE																		
Aconitum delphinifolium ssp. paradoxicum																x		
Caltha palustris ssp. arctica									x									
Ranunculus spp.						+		+										
Ranunculus cymbalaria	x																	
Ranunculus gmelinii ssp. gmelinii									x									

Appendix B. Continued.

Habitat Type	CTVW	CTSW	CSVW	IML W	IMP W	CTV	CSV	IML	IMP	CTS	CSS	CSO	CMO	CGD	IMS	IMU	IDU	IDU W
Number of transect sections in habitat type	22	1	1	16	3	14	13	24	8	4	18	7	3	2	9	9	10	3
RANUNCULACEAE																		
Ranunculus hyperboreus ssp. hyperboreus				x														
ROSACEAE																		
Dryas integrifolia ssp. integrifolia						x		x	x			+						+
Potentilla egedii ssp. egedii				#		x		x										
Potentilla palustris									x									
Potentilla rubricaulis				x	x													
Rubus spp.					x				+							#	+	
Spiraea spp.																	x	
SALICACEAE																		
Salix spp.							x			+	+							
Salix arctica	+			+	x	x		+			+			x	+	x		
Salix fuscescens				#	+	+		+	+							+		
Salix glauca					x											+	+	
Salix ovalifolia var. arctolitoralis	+			#	x	x		#								x		
Salix ovalifolia var. ovalifolia	+			+		x		#							D+			
Salix phlebophylla																	x	
Salix planifolia ssp. pulchra var. pulchra									+							x		
SAXIFRAGACEAE																		
Parnassia palustris ssp. neogaea								x							x			
Saxifraga spp.						x					x							
Saxifraga cernua	x								x									
Saxifraga foliosa var. foliosa				x														
Saxifraga hirculus								#								x		
Saxifraga punctata ssp. porsildiana																x		
Saxifraga tricuspidata																	x	
SCROPHULARIACEAE																		
Castilleja sp.																	x	
Castilleja elegans																x		

Appendix B. Continued.

Habitat Type	CTVW	CTSW	CSVW	IMLW	IMPW	CTV	CSV	IML	IMP	CTS	CSS	CSO	CMO	CGD	IMS	IMU	IDU	IDW
Number of transect sections in habitat type	22	1	1	16	3	14	13	24	8	4	18	7	3	2	9	9	10	3
SCROPHULARIACEAE																		
Castilleja pallida ssp. caudata														x		x		
Lagotis glauca ssp. minor															x			
Pedicularis spp.						+												
Pedicularis capitata																x		
Pedicularis kanei ssp. kanei	x				x			#								+		
Pedicularis labradorica																x		
Pedicularis sudetica				+	x			#									x	
Pedicularis sudetica ssp. interior	x																	
VALERIANACEAE																		
Valeriana capitata																x		

x Recorded in one transect section only.
+ Recorded in 2 to 4 transect sections.
# Recorded in 5 to 9 transect sections.
* Recorded in 10 or more transect sections.

Appendix C. Plant species recorded in each of 3 regions surveyed along the Beaufort Sea coast in mid-summer of 1981 and 1982.

Key to sites used in Appendix C.

1. Hutchison Bay
2. Russell Inlet
3. West of McKinley Bay
4. East of Hutchison Bay
5. Hendrickson Island
6. Blow River
7. Phillips Bay
8. Mackenzie River Delta
9. Toker Point

Appendix C. Plant species recorded in each of 3 regions (includes off transect data).

	Yukon Coast Region		Mackenzie Delta Region		Tuktoyaktuk Peninsula Region				
Site	7	6	8	5	9	1	4	3	2
BETULACEAE									
Alnus crispa ssp. crispa		x							
Betula sp.		x		x		x	x	x	x
Betula glandulosa	5252								
Betula nana ssp. exilis								c	
CARYOPHYLLACEAE									
Honckenya peploides ssp. peploides		5275			5434				
Melandrium affine					5448				
Melandrium apetalum ssp. arcticum	5356		5418	5221					
Minuartia arctica	5340								
Minuartia obtusifolia		5264							
Stellaria sp.	x								
Stellaria edwardsii			5429		5463				
Stellaria humifusa					5443			c	
Stellaria longipes					5435				
Stellaria montantha		5286		5207					
COMPOSITAE									
Achillea millefolium		5281							
Arnica alpina					5466				
Artemisia tilesii ssp. elatior		5277							
Chrysanthemum arcticum ssp. polare	(x)			5197	(x)				
Petasites sp.	x								
Petasites frigidus	5374								
Petasites sagittatus									
Saussurea angustifolia			5248	5212					
Senecio atropurpureus ssp. frigidus	5377		5232	5209				c	
Senecio congestus	x								
Senecio fuscatus		5260							
Senecio lugens			5423						
Taraxacum sp.				x					
Taraxacum lacerum					5433				
Tripleurospermum phaeocephalum			5243						

Appendix C. Continued.

	Yukon Coast Region		Mackenzie Delta Region		Tuktoyaktuk Peninsula Region				
Site	7	6	8	5	9	1	4	3	2
CRASSULACEAE									
Sedum rosea ssp. integrifolium	x	5278	x		x		x		
CRUCIFERAE									
Cardamine hyperborea	5383		5234						
Cardamine pratensis ssp. angustifolia	5327		5247						
Cochlearia officinalis ssp. arctica		5302						h	
Descurainea sophioides									
Draba cf. stenoloba	5372								
Parrya nudicaulis ssp. septentrionalis	5382								
CYPERACEAE									
Carex sp.						x	x	x	x
Carex amblyorrhyncha	5387	5287							
Carex aquatilis			x						
Carex aquatilis ssp. aquatilis	5393	5282			5438	*		c	
Carex atrofusca	(x)				5441				
Carex bigelowii		5256	5246					c	
Carex chordorrhiza	5332								
Carex glareosa ssp. glareosa var. amphigena	5360	5303		5205					
Carex holostoma					5447				
Carex cf. livida var. grayana						(x)			
Carex maritima			5420						
Carex rariflora	5351	5293	x	5204	5454			c	
Carex rotundata								(*)	
Carex saxatilis	5353	5301							
Carex subspathacea				5196		(x)	*	*c	*
Eriophorum sp.						x	x	x	x
Eriophorum angustifolium	x				x			h	
Eriophorum angustifolium ssp. subarcticum			5245	5216					
Eriophorum russeolum var. albidum	5347					*			
Eriophorum scheuzeri	5388								
Eriophorum vaginatum	5336	5255		5215				c	
Kobresia myosuroides					5456				

Appendix C. Continued.

	Yukon Coast Region		Mackenzie Delta Region		Tuktoyaktuk Peninsula Region				
Site	7	6	8	5	9	1	4	3	2
ELATINACEAE									
Elatine triandra var. brachysperma		5311							
EMPETRACEAE									
Empetrum nigrum ssp. hermaphroditicum	x	x		x	x	x	x	xc	x
EQUISETACEAE									
Equisetum sp.	x		x		x				
Equisetum arvense									
Equisetum scirpoides		5238							
E. variegatum ssp. variagatum	5375		x						
ERICACEAE									
Arctostaphylos rubra	(x)	x						c	
Cassiope tetragona ssp. tetragona			5428		x	x		c	
Chaemaedaphne calyculata	x								
Ledum palustre ssp. decumbens	x	x		5213	x	x	x	c	
Vaccinium sp.					x	x	x	x	
V. uliginosum cf. ssp. alpinum	5262						c		
V. vitis-idaea ssp. minus	5379		5427		5450			c	
GENTIANACEAE									
Gentiana propinqua ssp. arctophila	5390		5419						
GRAMINEAE									
Agropyron violaceum					5464				
Alopecurus alpinus				5203					*
Arctagrostis latifolia	5335	5258							
A. latifolia ssp. latifolia					5445			c	
A. latifolia ssp. nahanniensis				5219					

Appendix C. Continued.

	Yukon Coast Region		Mackenzie Delta Region		Tuktoyaktuk Peninsula Region				
Site	7	6	8	5	9	1	4	3	2
Arctophila fulva	5369	5272							
Calamagrostis deschampsioides	5367			5200		*			
C. stricta			5402		5437				
Deschampsia caespitosa	5363		5414						
Dupontia fisheri	5346		5401		x			c	
D. fisheri ssp. fisheri	5366								
D. fisheri ssp. psilosantha		5295		5218					
Elymus arenarius	x	x	x	5194	x	x	x	x,h	x
Festuca auriculata		5319							
F. brachyphylla			5241						
F. rubra ssp. richardsonii		5299	5421		5436				
Hierchloe alpina	5333	5268		5225					
Poa sp.									x
P. arctica	5355	5318						h	
P. arctica ssp. caespitans		5325							
P. arctica ssp. longiculmis	5398								
P. arctica ssp. williamsii	5284		5211						
P. glauca (=P. palustris complex)		5310							(*)
P. interior (=P. palustris complex)		5269							
P. lanata			(x)						(*)
P. palustris (complex)		5285							
P. pratensis	x		(x)						
P pratensis ssp. subcoerulea (Introduced)					5446				
Puccinellia sp.						x	x	x	x
P. agrostoidea			5412					(*)	
P. andersonii						(x)	(*)		
P. arctica					5439	(*)			
P. borealis			5240						
P. langeana							(*)		
P. phryganodes		5307				*	(x)	(x)	*
P. cf. vaginata	5364				5442			c	
Trisetum spicatum	5394								
HALORAGACEAE									
Hippuris sp.	x	x	x		x	x			
H. tetraphylla						*			
H. vulgaris				5230					
Myriophyllum spicatum	5326								

Appendix C. Continued.

	Yukon Coast Region		Mackenzie Delta Region		Tuktoyaktuk Peninsula Region				
Site	7	6	8	5	9	1	4	3	2
JUNCACEAE									
Juncus sp.					x				
J. arcticus ssp. *alaskanus*			5408						
Juncus castaneus	5389								
Luzula confusa	5334	5315			5449				
L. wahlenbergii	5348								
L. wahlenbergii ssp. *piperi*	5291								
L. wahlenbergii ssp. *wahlenbergii*	5337								
JUNCAGINACEAE									
Triglochin maritimum			5413						
LEGUMINOSAE									
Astragalus alpinus					5435				
A. cf. umbellatus		5288							
Hedysarum alpinum ssp. *americanum*				5415		5462			
Lathyrus japonicus var. *aleuticus*	x	5279			(x)				
Lupinus arcticus	5381								
Oxytropis sp.		x							
Oxytropis maydelliana					5461				
LILIACEAE									
Allium schoenoprasum var. *sibiricum*	(x)								
Tofieldia coccinea			5426						
ONAGRACEAE									
Epilobium angustifolium ssp. *angustifolium*		5271							
Epilobium latifolium		5270							
Epilobium palustre	5468								
ORCHIDACEAE									
Platanthera obtusata		5235							

Appendix C. Continued.

	Yukon Coast Region		Mackenzie Delta Region		Tuktoyaktuk Peninsula Region				
Site	7	6	8	5	9	1	4	3	2
OROBANCHACEAE									
Boschniakia rossica		5425							
PAPAVERACEAE									
Papaver cf. *macounii*					(5465)				
PLUMBAGINACEAE									
Armeria maritima ssp. *arctica*					5440				
POLEMONIACEAE									
Polemonium acutiflorum	5392	5283							
POLYGONACEAE									
Polygonum sp.					x				
P. bistorta		5253						c	
P. viviparum	5352		5231					c	
Rumex sp.		x							
R. arcticus		5274							
POTAMOGETONACEAE									
Potamogeton filiformis		5308							
PRIMULACEAE									
Androsace chamaejasme ssp. *lehmanniana*					5467				
Dodecathon frigidum	5400								
Primula borealis				5208					
Primula stricta				5222					
PYROLACEAE									
Pyrola grandiflora	5329		5233					c	
P. secunda ssp. *secunda*			5430						

Appendix C. Continued.

	Yukon Coast Region		Mackenzie Delta Region		Tuktoyaktuk Peninsula Region				
Site	7	6	8	5	9	1	4	3	2
RANUNCULACEAE									
Aconitum delphinifolium ssp. paradoxicum	5259								
Anemone parviflora					5460				
Caltha palustris ssp. arctica	5338								
Ranunculus sp.		x		x					
R. cymbalaria	5370								
R. gmelinii ssp. gmelinii	5339								
R. hyperboreus ssp. hyperboreus				5217					
R. lapponicus			5312						
R. pygmaeus	5373								
ROSACEAE									
Dryas integrifolia ssp. integrifolia			5236		5459	x		c	x
Potentilla egedii ssp. egedii	x			5198					
P. egedii ssp. egedii var. groenlandicum	5298		5220						
P. palustris	x								
P. rubricaulis				5223					
Rubus sp.	x	x	x			x	x	x	x
R. chamaemorus				5210				c	
R. stellatus								*	
Spiraea sp.			(x)						
SALICACEAE									
Salix sp.						x	x	x	x
S. alaxensis ssp. alaxensis			5417						
S. arctica	5361	5280	5403	5195	5431		x		
S. fuscescens	5330	5273		5214	5453				
Salix glauca			5454	5249		5451			c
S. glauca var. acutiflora				5202					
S. ovalifolia var. arctolitoralis		5362	5304	5406	5201				
S. ovalifolia var. ovalifolia	5359		5409						
S. phlebophylla		5266							
S. planifolia ssp. pulchra var. pulchra	5331			5224				c	
S. reticulata	5399							c	

Appendix C. Continued.

	Yukon Coast Region		Mackenzie Delta Region		Tuktoyaktuk Peninsula Region				
Site	7	6	8	5	9	1	4	3	2
SAXIFRAGACEAE									
Parnassia palustris ssp. neogaea						5416			
Saxifraga sp.							x		
S. cernua	5328								
S. foliosa var. foliosa		5292							
S. hirculus	5391		5404						
S. punctata ssp. porsildiana		5251							
S. rivularis	5371								
S. tricuspidata		5265							
SCROPHULARIACEAE									
Castilleja elegans			5199						
C. pallida ssp. caudata	5384	5289							
Lagotis glauca ssp. minor			5378						
Pedicularis sp.						x			
P. capitata	5385							c	
P. kanei ssp. kanei	5341	5257	5407	5226					
P. labradorica		5263							
P. sudetica	5267		5227						
P. sudetica ssp. interior	5376		5405						
VALERIANACEAE									
Valeriana capitata		5261							

Specimen collection number is given if plant was collected.
* Specimen collected by D.L. Dickson (Allen) in 1981.
x Denotes species recorded but not collected.
(x) Denotes uncertainty in identification
c Denotes species recorded by Corns (1974) near Atkinson Point, Tuktoyaktuk Peninsula.
h Denotes species recorded by Hernandez (1973) near Atkinson Point, Tuktoyaktuk Peninsula.

13035595

QL
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.N6
H64
1986
c.1

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