THE KLOO WETLAND

A RECONNAISSANCE OF ITS ECOLOGICAL DIVERSITY 1988-93

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SUMMARY:

- Five years of field survey were carried out(during the summers of 1988-89 and 92-93) on the 100 sq. km. Kloo Wetland

in South-eastern Yukon,. Both ground and air survey were involved.

- Ground work was on a representative study area (approx. 6.5% of the wetland). The project had a strong public education component; in all, over 70 observers were directly involved. Ground work was regular visits to all the ponds in the study area to describe vegetation, conduct total counts of water bird pairs, and broods. Air survey was of the entire wetland.

- The ponds are mostly thermokarst and oxbow depressions in the flat valley floor isolated from the river channel by raised levees.

- Old growth spruce forest occupies the levees along the river; the wetlands are mostly sedge fens.

- 28 species of water birds were recorded. Spring numbers of ducks averaged just over 2,700 birds (1.4 adults per ha. Water).

- 14 species of water birds produced 500-750 broods (2,200-3,700 young) annually.

- Concentrated use of 4 key water bodies for post-breeding, brood and pre-migration staging was noted.

- 632 bandings suggested that water birds of the area are mostly wintering in the Pacific Flyway.

- The diversity of other wetland species included amphibians, aquatic furbearers, moose, wolves, grizzly bears, mustelids and song birds (total bird list:97 species).

- Recommendations for future conservation of the area's ecological system include protecting the unique hydrology, managing disturbance and protecting the levee old growth forests.

INTRODUCTION:

The Kloo Wetland is an area of approximately 100 sq. km. of just over 340 small to medium sized ponds and lakes associated with the floodplain of the Jarvis River in the South Western Yukon. It includes two larger lakes, Kloo and Sulphur, and is about 30 km NW of the village of Haines Junction, YT. In 1980, an area of 447 sq. km. including the wetland was identified as 'critical' wildlife habitat by map notation for Land Use decision purposes (Yukon Waterfowl Management Plan, 1985, 1990). This designation was based simply on the obvious concentration of waterbodies and the area's known value to wildlife species and to local people.

Wetlands are recognised in the Yukon as supporting a major portion of the territory's biodiversity. Documenting wetland values at Kloo was a first step in developing conservation and management plans for the area. Two major sources for this data base are technical wetland analysis as reported here, and local traditional knowledge of the elders of the Champagne/Aishihik First Nation. This report is mostly the portion contributed by the former from a five-year period of field research (1988-93) although C.A. First Nation elder Frank Joe (deceased) gave valuable assistance with the field logistics and offered good sound advice about the area generally.

The water birds of the area provided a powerful 'focus' of study. They are totally dependant on the functioning of the wetland ecosystem; understanding their relative abundance, productivity and general use of the area gives a good ecosystem-level understanding of the critical features which will have to be protected if the wetland is to continue to function in the future.

Figure 1. The location of the Kloo Wetland in the Jarvis River drainage of the South-western Yukon. The core study area is about 6.5% of the whole 100 sq. km wetland.

OBJECTIVES:

This survey was largely reconnaissance. A good understanding of the area by the original people of the area exists. The focus of this work was to establish a baseline of science-based data to complement that historic local knowledge. Our tasks were to:

a) Develop a basic understanding of why the physical wetland system exists;
b) Describe generally the habitat the system provides,
c) Quantify the populations of waterbirds and other riparian species using the wetland,
d) Describe the use made of the wetland by waterbirds,
e) Suggest conservation criteria for the future planning of the area.

FIELD METHODS:

A field camp was established in the wetland at the approximate centre of a representative concentration of water bodies immediately north of the larger Kloo Lake.

This area became the core study area. It measured 5.0 sq. km. (6.5% of the entire wetland) and contained 37 waterbodies (11% of the water of the wetland). Two to three field workers occupied the camp for periods of one to two weeks at key times of the year over 4 years (1988-89 and 92-93). The ponds were accessible from the channel of the Jarvis River and by foot trails that we established throughout.

The logistic basics of the study were ground surveys and counts supported by canoes, supplemented periodically by a total of about 4 hours of helicopter annually. Regular counts were taken of waterbirds using the study ponds, brood searches were made early and late in the summer and a waterfowl banding station was operational at all times when the camp was occupied. As a matter of course, a running record of bird species and other wildlife was kept and plants were collected, pressed and prepared as permanent specimens. (Other specifics of methods are below in the appropriate sections):

STUDY TEAM, EDUCATIONAL OUTREACH:

A feature of this work was the way it was conducted. A basic study planning team was established at the outset, a series of standardised data sets were agreed upon and then various field teams took the responsibility of conducting the field trips necessary to collect the data. The author provided co-ordination and tried to ensure standardisation of the field procedures. The educational opportunity this strategy provided allowed a broad spectrum of people to visit the site and become familiar with its ecology. Two classes of students from Yukon College visited the site, two groups of the 'Conservation Action Team' and one 'Y2-C2' team visited. All visitors had the opportunity to assist with the field work. In all 70 individuals were directly involved with the research.

Planning team: D. Mossop (Wildlife, Y.T.G./Yukon College)
J. Hawkings (C.W.S. Whitehorse)
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P. Johnston, W. Nixon, D. Green, G. Mowat, M. Mossop, G. Loewen, J. Korn, S. Binette, L. Hume, K Egli, T. Mossop, B. & A. Smith, R. Ricks, Nichole D., G. Baird, R. Henning, R. Rodden(+ 7 C.A.T. and 12 Y2C2 team members), R.Jickling (+ 2x 10 college students) Plus: 'Jayson, Terry, B.M., B.A.H., N.D. and G.M.

Figure 2. Youth from a Conservation Action Team some of the 70 individuals that assisted with the field work.

PHYSIOGRAPHY, POND FORMATION:

The Kloo Wetland complex is in the Shakwak Valley at the junction between the Yukon Plateau of the interior Yukon, and the Coastal Mountains. It is located just east of the 'Kluane Hills' and south of the Ruby Ranges of the Plateau Mountains. It lies within the 'Ruby Ranges' ecoregion (Oswald & Senyk, 1977). The Alaska Highway traverses the Shakwak valley along its southern border; the Kloo wetlands lie north of the Highway corridor.

Its substrate surface material forms a relatively flat to rolling bench thought to be composed primarily of glacial drift, tills and stratified tills,(Kindle 1953). Ridges in the drift have created what relief there is between depressions in the Pleistocene overburden. The area lies at about 1000m a.s.l. which places it higher than most other major Yukon interior wetlands.

A large portion of the area was the site of glacially impounded water during Pleistocene ice sheet advances; Kloo and Sulphur lakes are the remnants. The entire area up to about the 1050m mark was underwater and silt strata are now a feature at the base of this former lake.

Drainage of the area is via the Alsek River through the Jarvis river. The Jarvis, a small relict stream, occupies the flatter area of lacustrine deposit from the former lake and has altered a portion of the valley by meandering across its floor (Kindle, 1953). It has thrown up levees along its length which isolate a large area from the stream flow and trap water well above the stream level for much of the year. Only in unusual flood years does the levee system overtop 'recharging' the wetlands behind.

The waterbodies in this substrate have apparently formed in a number of ways. Thermokarst ice lens melt and stream channel oxbows in the flatter floodplain have created the densest complex of ponds. In this area of about 23 sq. km., 209 ponds have formed. This area includes the flats around Kloo Lake itself and stretches roughly 14 km north (upstream) along the Jarvis river from its delta on Kloo Lake. Another 39 ponds have formed apparently in depressions in the till overburden. These ponds tend to average slightly larger than the floodplain ponds; the largest is Sulphur Lake and is about 3 km in length.

There is evidence of active thermokarst occurring on many of the ponds in the study area. Most ponds average less than 2 meters in depth but often have a far deeper hole usually near one shore where the shoreline is often actively slumping into the lake.

Several ponds have dead trees still standing literally throughout, suggesting a recent collapse of the substrate.

The region lies completely in the rain shadow of the St. Alias Mountains, the highest on the continent. The wetland area receives only about 190 mm of precipitation a year (Oswald and Senyk, 1977). Water in this general area is a valuable commodity. The fact that the area is a wetland at all speaks to its uniqueness. These are relatively cool ponds with very low evaporation, formed and held in place primarily by ice and ice phenomenon. Situated as it is on one of the Yukon's most important migration corridors (Yukon Waterfowl Mgmt Plan, 1990), this little assemblage of stable ponds has great significance in the local and regional ecology.

Figure 3. Most of the wetland basins of the Kloo wetland are sedge Fens, usually natural thermokarst depressions in the flat glacial valley now occupied by the 'relict' Jarvis River. The spruce forest in the background occupies the raised levees of the stream.

VEGETATION:

The local vegetation is typical dry spruce boreal forest. On dryer sites within the wetland, in particular along the raised stream levees, white spruce dominates. This forest is clearly true 'old growth' that has been protected from renewal processes for an exceedingly long time. It has been the subject of a companion study looking at its importance in providing nesting cavities for larger hole-nesting birds like certain ducks and small owls (Mossop, 1997 – Appendix 3). In lower wetter sites open stands of black spruce occur. Willows are the dominant shrub. Near waterbodies willows form dense stands which can attain a height of over 5 meters.

The wetlands are basically sedge and *Equisetum* marshes and fens. Two small stands of Bulrush (*Scirpus validus*) were found but by far the dominant emergents are Sedges (principally *Carex aquatilus and rostrata)*. Floating sedge mats are a feature of most ponds with *Equisetum* occupying the deeper water sections of the mat. It is common for the outer mats to be invaded by bladderwort (*Utricularia vulgaris)* which indicates a slow decomposition cycle.

The aquatic community in the ponds of the study area varies considerably. On average the waterbodies support one of the densest stands of rooted aquatic plants of any Yukon wetland studied to date. Dense stands of pondweed (*Potomogeton richardsonii, P. vaginatus, P. filifomis, P.praelongus)* literally fill most waterbodies. The exceptions are areas where active thermokarst is occurring. Variations did occur however; one pond was unique in that the pond beyond the sedge emergents was literally plant-free. The reason is not clear. Burr reed (*Sparganium spp*) and water milfoil (*Myriophyllum sibericum*) were not common but did occur in scattered stands in some ponds.

WATERBIRD POPULATIONS:

Survey Techniques: The principal field procedure was total counts of waterbirds taken from the ground and from the air on a pond-by-pond basis. All the ponds on the core study area (11% of the water area of the wetland) were visited at least three times a year on the ground. The first count was in mid June to survey the breeding population, the second in early July to count early broods and the last in early August to count late broods. Brood counts were conducted by a minimum of two observers walking the shoreline in opposite direction to ensure all broods were seen. The air survey was done only during the early spring as a breeding pair count. The air count was an attempt to count a much larger sample of the wetland (80% of the water area).

Analysis of these data used the birds per hectare of water as the ratio estimator to extrapolate the counts and to calculate variation. Stratification was done by 3 size classes of waterbody, -- 'big' (those above 100 ha), 'medium' (those between 100ha and 10ha) and 'small' (those below 10 ha) were analysed separately, variance pooled.

Species Diversity:

Twenty-eight species of waterbirds were recorded on the wetland over the years of study(1 loon, 2 grebe, 18 duck, 2 swan, 1 goose, 3 gull species and American coot). This diversity is as high as any wetland that has been looked at systematically in the Yukon to date. The McQuesten Wetland in the central Yukon supported 24 species and the Needlerock Wetland supported 25 (Mossop, 1991, Sinnott & Mossop, 1998), the Horseshoe Slough wetland showed a waterbird diversity similar to the Kloo (Sinnott and Mossop, 2001). The dominant species were Lesser Scaup, and American Wigeon, accounting for 50% of all observations. A group of four species (Mallard, Northern Pintail, American green-winged teal and Bufflehead) accounted for most of the remaining. Together they accounted for over 30% of the total. Eight of the species were quite rare; combined, they were seen less than 0.1% of observations.

Table 1. Relative abundance of waterbirds from all survey counts 1988-93, Kloo Wetland, Yukon.

Species		Percent in Count
Lesser scaup		31.0(%)
American wigeon		19.7
Mallard		9.8
N.Pintail		8.8
A.Green-winged teal		7.2
Bufflehead		6.5
N.Shoveler		4.7
Ring-necked duck		3.7
Barrow's goldeneye		2.7
Surf scoter		1.5
Gull(s)	Arctic tern	
	Mew gull	
	Herring gull	1.3
Red-necked grebe		0.8
Canvasback		0.7
Blue-winged teal		0.7
Pacific loon		0.3
Horned grebe		0.2
Trumpeter swan		0.1
White-winged scoter		0.1
American coot		<0.1
Tundra swan		<0.1
Long-tailed duck		<0.1
Redhead		<0.1
Ruddy duck		<0.1

The relative abundance of the key waterbird species fluctuated in the early days of the open water season but by late July had settled into the proportions suggested by the pooled data. In early spring, Lesser scaup far outnumbered all ducks on the area but by July American wigeon began to overtake them, matching them in abundance through the rest of the year. These numbers suggest a large transient spring population of scaup staging on the area and perhaps a slow build up of wigeon as they arrive from their spring migration (Figure 4).

Figure 4. Change in relative abundance of key duck species on the Kloo wetland during the ice-free period; data from 1988.

Breeding Numbers:

Air surveys were planned to make estimates of spring abundance. Very early counts (which net mostly dabbling species) and diving species from later counts, were combined to give an assessment of the breeding population.

For the 4 years of counts, an average total population of about 2,700 adults was made up principally of diving and sea ducks (about 1,600) followed by dabblers (about 1,000). Over the years of study a slight decline in total spring numbers is suggested but this is not significant (p=90%), (Figure 3). Our counts of breeding pairs suggests that far fewer than half the adults we counted were actually breeding although there is no way to judge the accuracy of that conclusion. An average of 5 adult Trumpeter swans occurred on the wetland annually. Two pairs were found nesting in the core study area although in no year did both pairs produce young.

Figure 5. Estimates of total spring numbers of waterbirds on the Kloo Wetland, 1988-92

The average spring density at the Kloo wetland was comparable-to-slightly-lower than other key wetlands studied to date. Overall density was about 1.4 adults per hectare of water. The duck species density was about 1.3 adults per hectare. (The Needlerock and McQuesten Wetlands in the central Yukon support 2-4 adults per ha.; the Peel Plateau wetland in the Northern Yukon supported 0.4). Comparing the wetland area in general (including land between ponds) density was 27 adults per sq. km. compared to 8-20 at the above mentioned wetlands (Mossop, 1991, Sinnott & Mossop, 1998).

Table 3. Total spring population estimates of waterbirds on the Kloo Wetland, 1988-92

	1987	1988	1989	1992	AVERAGE
DIVING DUCKS AND SEA DUCKS:	972	2065	1490	1326	**1464**
DABBLING DUCKS:	1640	649	1049	994	**1083**
SWANS:	10	15	35	10	**15**
OTHER WATERBIRDS:	315	126	40	150	**158**
TOTAL WATERBIRDS:	**2,937**	**2,855**	**2,614**	**2,480**	**2,720**

Variation between years:

Figure 5 shows the change in count recorded over the period of study for some of key waterfowl species on the wetland. It is interesting that by far the majority of variability was in the number of unpaired adults. This suggests that the wetland may be providing habitat for non-breeding adults displaced from breeding habitat elsewhere -- a common finding in Yukon and other northern wetlands. Our count reliability was borderline for suggesting real changes in abundance that were less than 20% (at 90% c.l.) and there is no evidence of a significant change in the breeding population over the course of the study.

Table 4. Estimated adult spring population of individual waterbird Species on the Kloo Wetland 1988-92 from air counts.

Divers/Seaducks	**1987**	**1988**	**1989**	**1992**	**Average**
Canvasback	8	0	120	18	37
Scaup (spp)	752	1563	798	970	1021
Ring-necked duck	32	0	45	66	36

Scoter (spp)	9	109	21	75	54
Barrow's goldeneye	69	172	96	105	111
Bufflehead	103	220	408	92	205
Dabbling ducks					
Mallard	300	148	114	315	220
A.Green-winged teal	160	60	169	217	152
Blue-winged teal	20	3	0	43	17
American Wigeon	725	129	420	210	371
Northern Shoveler	375	100	183	100	190
Northern Pintail	60	208	162	207	159
Geese/Swans					
Trumpeter Swan	5	40	7	15	16
Other Waterbirds					
Loon (spp)	9	27	24	9	17
Gull (spp)	294	68	78	87	112
Grebe (sp)	9	32	18	54	32
Merganser (sp)	3	0	0	0	1

Figure 6a. The variation in the numbers of key duck species on the Kloo wetland over the years of study 1988-92.

Figure 6b (key duck number variation between years continued)

Poduction of young:

Ground counts at the core study area were used to estimate brood production on the wetland. Early counts in late June were combined with later counts in late July to net early and late species. Broods, because of their age that were likely recounts were eliminated. Extrapolation to the larger wetland was by the number of broods per hectare of water area. (The study area water area is about 11% of the whole wetland water area).

In two years (1988 and 1989) our counts were complete enough to allow an estimate of the wetlands productivity. A running total of brood sizes showed no significant difference between Years so all the years of data were pooled to produce the mean brood sizes in estimated total duckling production:

Table 5. Mean brood sizes, Kloo wetland 1988-92

Species	(n)	mean
Mallard	20	7.3
A. Green-winged teal	13	6.5
A. Wigeon	29	7.1
N. Pintail	20	6.0
Lesser scaup	40	7.3
Canvasback	2	5.0
Ring-necked duck	10	9.5
Barrow's goldeneye	13	4.9
Bufflehead	14	6.0
Scoter (sp)	5	10.0

The proportion of the spring population that were later found to have produced broods (about 40%) is consistent with the proportion counted in spring that were found in pairs. It also ranks with other wetlands in the Yukon (30-50% - McQuesten wetland, 15% - Horseshoe wetland, 24% - Needlerock wetland). Duckling production changed significantly between years. This was apparently diven principally by the proportion of divers -- mostly Lesser scaup -- that bred in that particular year.

Moult/Brood Concentrations, Migration Staging:
In 1988 and 89 we carried out air counts late enough into the year to monitor the changing distribution of waterfowl over the wetland. By mid August over half the water birds on the area were found on a group of four water bodies. The four were the larger ponds of the wetland and included Sulphur Lake, the two largest lakes in our core study area (#'s 63 and 85) and the largest lake in the northern section of the wetland (lake #53). (Kloo lake itself was not apparently a site of late summer staging with the exception that Trumpeter swans seemed to prefer it as their staging site: 12 adults Aug 15, 1988.) Sulphur Lake was by far the dominant lake in this group. Between 450 and 700

Table 6. Estimated total brood production Kloo wetland 1988-89, from ground counts extrapolated to the entire wetland by water surface area.

Species	Total broods		Total young	
	1988	1989	1988	1989
Dabbling ducks				
Mallard	73	55	531	398
A.Green-winged teal	18	18	118	118
Am. Wigeon	46	91	323	646
N. Pintail	55	9	327	55
Totals:	**192**	**173**	**1299**	**1217**
Diving/Sea ducks				
Lesser scaup	18	145	133	1062
Canvasback	2	1	90	46
Ring-necked duck	0	9	0	86
Barrow's goldeneye	72	64	356	312
Bufflehead	55	118	327	709

Scoter (sp)	0	27	0	273
Totals:	**147**	**364**	**906**	**2488**
Trumpeter swan	9	9	36	36
Horned grebe	46	64		
Red-necked grebe	9	18		
Gull (spp)	91	109		
All species:	**508**	**746**	**2,243**	**3,740**

Lesser Scaup and between 30-100 scoter(sp) and goldeneye(sp) were moulting on the lake annually along with between 100 and 200 dabbling ducks. Lake 63 was next where about 100 Lesser Scaup(sp) and goldeneye(sp) moulted. These key lakes clearly play an important role in the functioning of the wetland and will be integral to future conservation planning for the area.

Figure 7. Locations of the four key late summer brood, moult and pre migrational concentration waterbodies, Kloo wetland

Banding studies, wintering flyways:

Two bait traps were in operation on two of the ‘key’ water bodies (#63 and #85) whenever a field crew was on the study area. A total of 346 trap-days were logged over the years of study. In that time just over 800 captures (of 12 species) were made.

Recaptures and band returns from other locations create a picture of the staging and wintering patterns of the waterbirds of the wetland. In the case of the Kloo Wetland about 23% of captures were of birds we had already captured earlier suggesting the area is likely providing for birds that are resident for an extended period. Both local breeders and transients are using the area for staging habitat for pre-migration feeding.

Table 7. Capture results from the Kloo Wetland, 1988-89 and 1992-93 with recaptures at the same location

	Total Captures	**Recaptures**
Mallard	454	133
Northern Pintail	121	49
American Wigeon	21	2
American Green Winged Teal	29	1
Blue-winged teal	3	
Shoveler	3	
Lesser Scaup	78	3
Canvasback	34	4
Ring-necked Duck	16	1
Redhead	1	
Bufflehead	35	1
Barrow’s goldeneye	17	2

	828	196(23.6%)

Returns of bands from remote locations gives an indication of the migration patterns and the flyways in which these waterbirds winter. Some indication of harvest pressure is also possible but mostly these returns give a valuable picture of the size of the continental ecosystem of which the Kloo wetland is part. We bandied a total of 632 individuals. Of those 14 (2.2%) have been recovered elsewhere. As is common for waterfowl in the southern half of the territory, (Mossop 1990), most returns were from the Pacific flyway states although a scattering across at least as far east as Louisana occurred.

Table 8. Band returns from waterfowl captured at the Kloo Wetland

	Location band recovered
Mallard	Clark Count, Washington
	Escalon, California
	Tofield, Alberta
	Sumas, Wanshington
	Sorel, Quebec
	Victoria, B.C.
	Lacey, Washington
N. Pintail	Farragut Bay, (Alaksa panhandle)
Am.Wigeon	Vancouver, B.C.
Am. Green-winged teal	Ameron, Louisana
Canvasback	New Port, Oregon
Lesser Scaup	Minnesota
	Sumas, Washington
Ring-necked duck	Hemet, California

USE BY OTHER SPECIES:

Song bird diversity:
Records of song birds were systematically collected by a) keeping new lists of species encountered on every field trip (normally weekly) and b) by recording birds encountered at single points along with standardised waterfowl counts.

The number of lists and points at which a species was recorded gives a measure of the 'commonness' of the species over the habitat in general. Thirty-one of these lists or counts were taken. In all 97 species were recorded. Eighteen of the 97 were observed only once; 52 could be considered 'common' species on the wetland-- recorded in over 20% of lists. (See Appendix 2.)

Raptors:

The raptors are powerful top-of-the-foodchain indicator species for assessing the complexity and general productivity of an ecosystem. The Kloo Wetland ranks relatively high in both categories as compared to other wetlands studied to date. Bald eagles nested on the area and Gyrfalcons were seen hunting the area. American kestrels and Merlin were fairly common summer residents and breeders. A pair of Great-horned owls with fledged young were encountered regularly and Boreal owls were heard calling in early spring. Eleven species of birds of prey were using the area, reflecting an area of concentrated prey and relatively high biodiversity.

Table 10. Raptor sightings on the Kloo wetland 1987-90.

Raptor Species	**Breeding evidence**
American Kestrel	Several breeding records (nest boxes), adults and young seen Regularly.
Merlin	A pair were heard and seen tending flying young on several occasions in 1988
Peregrine Falcon	One adult was observed in late July, 1987, hunting waterfowl at lake number 63: (in July this adult seemed to be tending and defending young nearby)

Gyrfalcon	Two juveniles were seen many times in the late summer of 1989 hunting waterbirds near the field camp
Bald Eagle	Four breeding pairs with nests in larger riparian spruce: Two pairs raised young to fledging in 1988 but none did in the subsequent years of study
Northern Harrier	No breeding records. Several adults observed hunting throughout the summer, probably tending nests nearby.
Northern Goshawk	No breeding records, one adult observed .
Sharp-shinned hawk	No breeding records, a single adult was seen
Great-horned owl	A family with flying young were encountered regularly in the woods of the lower Jarvis in 1989.
Boreal owl	One nest box was occupied, 2 eggs in 1989. Adults were heard singing on several occasions. Apparently a good breeding population in the riparian woods
N. hawk-owl	A fledged juvenile with attending adult was near camp in 1989 for several days

Aquatic mammals:
Both **muskrats** and **beaver** occur on the wetland, but during our study were relatively uncommon. Muskrat were observed only twice during pond counts although in early spring of 1987 “many” pushups were noted on ponds still frozen. A feature noted was the construction of true ‘lodges’ in at least 2 of the waterbodies. (Most Yukon muskrat populations use ‘bank dens’ and do not seem to build lodges in the middle of marshes.)

Moose:
Virtually every pond visited showed moose sign. Females with calves were observed on several occasions suggesting the wetland and notably its raised stream levies may be important calving habitat. Moose feeding on aquatic vegetation was seen on several occasions. During air surveys (12) a total of 15 adult moose were observed 4 of 8 females had calves (but calves are often difficult to observe during water bird counts.) We made no attempt to estimate total numbers on the wetland.

Carivores:
Mustelids: Both **mink** and **short-tailed weasel** were recorded on the area. **Black bears** were a fairly common visitor to the area. Local people have recorded grizzy infrequently in the area

however we encountered grizzly and evidence of **grizzly** almost every field trip. A grizzly regularly visited out field camp during our absences and did various damage annually.

Wolves were heard on one occasion in 1998; tracks were only infrequently found on river bars. At least one moose carcass was observed that was probably a wolf kill. No adults were observed .

Amphibians:
Wood frogs were the only amphibian present on the wetland. They were recorded regularly but relatively rarely during pond counts.

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APPENDICES

APPENDIX 1:

SYNTHESIS, CONSERVATION RECOMMENDATIONS:

HABITAT PROTECTION AREA

A) Protection
Based on natural values of this area, its positioning and its heritage value to local people, the area should be considered a prime candidate for protection under the Yukon Wildlife Act as a "Habitat Pretection area"

The key features we can identify to date responsible for the continuation of this wetland ecosystem are the unique hydrologic regime, the disturbance free areas of the wetland habitat, and the unique levee forests.

B) Hydrology:
This wetland lies in a very dry region of the Yukon (in the rain shadow of the St. Elias mountains. Its water regime is critical. Permafrost and the silt substrates are thought to be responsible for holding the water basins intact. Undoubtedly the protecting vegetative cover will be critical for maintaining these substrates. The flow and periodic flooding of the Jarvis River and its tributaries will be key to preserve.

The levee system and old growth forest along the banks of the active channel of the Jarvis basically hold the wetland basins from draining. The flat glacial valley itself is wet mostly because of the impeded drainage caused by the stream levee system. Depressions in the flat substrate apparently mostly as a result of termokarst, are recharged by periodic flooding.

C) Access:
Serious thought will have to be given to the amount and type of human access that is appropriate for the area. Traditionally boat access has been the most common. A horse trail around the west border of the upper wetland complex has been used in the past. There is road access to both Sulphur and Kloo lakes which will clearly lead to future desire by some for further vehicle Access. Given the nature of the water bodies of the area this could be a very destructive process.:

D) Old Growth forest:
The uniqueness of the forest occupying the stream levees of the area are obviously a critical feature that could easily be lost. These very old trees, protected from renewal by the wetland provide habitat for a number of cavity nesting birds and other organisms. Once these trees are either cut or destroyed they would not be replaced in their current form for a very long time.

D) Monitoring:
Based on the surveys of the ecological functioning of the wetland, a series of long term monitoring field protocols can be devised to give a picture of the status of the area. Management planning will have to clearly define those processes.

APPENDIX 2: . Annotated List of Bird species, Kloo Wetland, June-August 1988-92.

Species	**% counts where observed (n=31)**	**Comments**
LOONS		
Common loon	30(%)	Local on the larger lakes, 3-4 pairs in the area
Pacific loon	6.7	Uncommon breeder (see waterbird analysis)
GREBES		
Red-necked grebe	43.3	Common breeder (see waterbird analysis)
Horned grebe	76.7	Common breeder (see waterbird analysis)
GEESE/SWANS		
Canada goose	3.3	Uncommon .. one flock in spring 1989
Trumpeter swan	26.7	Local breeder, 4-5 pairs and several nonbreeders
DABBLING DUCKS		
Mallard	100	Common breeder (see waterbird analysis)
Gadwall	3.3	Rare-group of 4, 1989
American wigeon	100	Common breeder (see waterbird analysis)
A. Green-winged teal	93.3	Common breeder (see water bird analysis)
Blue-winged teal	23.3	Uncommon breeder (see waterbird analysis)
Northern shoveler	83.3	Common summer resident
Northern pintail	83.3	Common breeder (see waterbird analysis)
DIVING AND SEA DUCKS		
Lesser scaup	100	Common breeder (see waterbird analysis)
Greater scaup	--	One observation

Ring-necked duck	36.7	Common breeder (see waterbird analysis)
Barrow's goldeneye	93.3	Common breeder(see waterbird analysis)
Common goldeneye	-	Rare (1-2 observations)
Bufflehead	96.7	Uncommon (see waterbird analysis)
Oldsquaw	3.3	Rare (1-5 observations)
White-winged scoter	10.0	Uncommon breeder (see waterbird analysis)
Surf scoter	16.7	Uncommon breeder (see waterbird analysis)
Ruddy duck	--	One observation
RAPTORS		
Northern goshawk	3.3	one observation
Northern harrier	33.3	fairly common, no nests found
(Harlan's) Red-tailed hawk	23.3	raising young on edges of area every year
Bald eagle	20.0	4 active nests on wetland,
American kestrel	40.0	fairly common, many breeding records
Merlin	6.7	fledged young being fed near camp
Gryfalcon	6.7	2 fledged young hunting wetland 89
Rough-legged hawk	--	1 observation in fall,
GROUSE		
Spruce grouse	16.7	Fairly common in spruce forest between lakes on the wetland; broods were observed on 2 occasions.
SHOREBIRDS		
Red phalarope	--	One observation
Red-necked phalarope	56.7	Seen primarily in small flocks on the larger lakes, presumably in migration
Common snipe	46.7	Fairly common, one nest
Least sandpiper	3.3	Uncommon, no breeding record
Lesser yellowlegs	67.7	Very common breeder, recorded at most waterbodies many pairs with young recorded
Solitary sandpiper	46.7	Common breeder, several pairs with small young recorded
Spotted sandpiper	33.3	Fairly common breeder along the river and beaches of the larger lake
Long-billed dowitcher	6.7	Uncommon, no sign of breeding
Semipalmated plover	10.	Localised pairs defending were observed on less than 5 occasions
GULLS		
Herring gull	10.0	A few pairs were seen over the large lake occasionally

Mew gull	36.7	A common breeder in the larger sedge mats of the wetland, nests and young observed
Bonapart's gull	53.3	A common breeder in groups scattered throughout The wetland
Arctic tern	36.7	Common summer resident, one nesting colony
OWLS		
Short-eared owl	3.3	Uncommon on the wetland, no breeding record
Boreal owl	6.7	Heard singing regularly, one breeding record
Northern hawk-owl	6.7	Few observations, fledged immature plus adult
Great-horned owl	6.7	Young calling near camp in 1989
Belted Kingfisher	30.0	Fairly common along river
WOODPECKERS		
Three-toed woodpecker	26.7	Common,
Northern flicker	56.7	Very common, feeding young, several nests
FLYCATCHERS		
Say's phoebe	6.7	Uncommon
Olive-sided flycatcher	46.7	Singing males heard less than 10 times
Western wood peewee	10	Fairly common in riparian stands throughout the wetland
Alder flycatcher	16.7	Fairly common singing in riparian shrub zone near the larger lakes
SWALLOWS		
Tree swallow	36.7	Common, feeding young on 2 occasions; most observations were of feeding adults
Cliff swallow	3.3	one observation
Violet-green swallow	20.0	Fairly common
Bank swallow	3.3	one observation
JAYS		
Gray jay	100	Very common; dispersed throughout; family groups observed on many occasions
Common raven	6.7	Unommon in small group(s),
Black-billed magpie	63.3	Common, feeding fledged young near camp all years
Steller's jay	--	One observation
TITMICE		
Boreal chickadee	70.0	Locally common near riparian forest stands
Black capped chickadee	26.7	
Mountain chickadee	6.7	

Red-breasted nuthatch	--	one observation
THRUSHES		
Hermit thrush	3.3	Heard singing on 2 occasions
Swainson's thrush	33.3	Fairly common in riparian stands
American robin	60.0	Common breeder
Varied thrush	3.3	
Golden-crnd kinglet	6.7	
Ruby-crnd kinglet	36.7	farily common in riparian stands
Bohemian waxwing	53.3	Fairly common throughout; all observations were of groups
Northern shrike	--	one observation
WARBLERS		
Orange crowned warbler	17.0	
Yellow warbler	10.0	
Yellow-rumped warbler	57.0	Common breeder
Blackpoll warbler	53.3	Singing males heard on less than 10 occasions
Northern waterthrush	20.0	Locally common in sedge marshes
Common yellowthroat	53.3	
Wilson's warbler	10.0	
BLACKBIRDS		
Red-winged blackbird	70.0	Locally common, breeding in sedge marshes
Rusty blackbird	63.3	Common throughout the wetland
FINCHES ETC		
Pine grosbeak	--	Heard singing on one occasion
White-winged crossbill	3.3	Flocks observed on less than 5 occasions
Common redpoll	13.3	Fairly common summer resident, no breeding record
Pine siskin	--	One observation
SPARROWS		
Savannah sparrow	40.0	Common breeder near sedge meadows, nests found young being fed
White-crowned sparrow	43.3	Common breeder throughout the wetland, nests, yn observed
Am tree sparrow	56.7	
Chipping sparrow	26.7	
Dark-eyed junco	56.7	Common breeder, family groups observed regularly
Fox sparrow	56.7	

Lincoln’s sparrow	26.7	Fairly common, singing males heard regularly

APPENDIX 3:

OLD GROWTH REFUGIA IN THE YUKON BOREAL FOREST AND CAVITY NESTING BIRDS – 1999-2000 INTERIM REPORT

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INTRODUCTION, BACKGROUND

This work is exploratory research into the availability of very old trees in the Yukon boreal forest community required for providing nesting sites for boreal owls (*Aegolius funereus*) and other larger cavity-nesting birds. I have hypothesized that the slow growing nature of northern boreal forest trees combined with the natural renewal cycle which sees the forest burn down about every 200 years, should make the large, decadent tree bolls necessary, a very rare event (Mossop, 1997, 1998).

In spite of this, larger cavity nesters are fairly common. Research into the way in which the boreal forest community clearly must be providing these nest sites, is seen as basic to understanding how true 'old-growth' can be a natural feature of this forest system.

One hypothetical ecological 'rare event' that I have suggested may be responsible is wetland-protected riparian forest "refugia" along glacial relict streams of the central and southern Yukon (Mossop, op cit.). My purpose is to test this idea as an example of a "keystone event" (Power et al 1996). Understanding how it occurs and planning for its continuation in the face of increasing human demands on the boreal forest will likely be essential to conserving biodiversity in the Yukon's boreal forest. The 1998 summer field season started started experimental work with artificial cavities and began testing the idea that these small forest sites were indeed true old growth.

SUMMARY OF 1999-2000 FIELD SEASONS

There were two phases to the work a) In 1998 an analysis of the forest at one selected site (Kloo wetland), and b) In 1099-2000 a continuation of forest analysis and a forest owl population census.

Site analysis: (See 1998 interim report): Two field trips were taken to the study area. The area lies upstream of Kloo lake on the Jarvis River drainage and has been the subject of several years of basic ecosystem research. The riparian woodland of the area is dry white spruce occupying small sites along the levees of the Jarvis River. The wetlands of the area lie immediately behind the forest community.

2.1.1 Field Methods: The key data collection method on the forest sites, was 'nearest-neighbor' measurements of the tree component of the forest community.

A visual description was first taken of the community detailing the ground, shrub and canopy. Nearest-neighbor measures started at a tree chosen randomly. Series of 10 nearest-neighbor trees were measured. Distance to its neighbour, circumference at 1 m , and a ranking of the health of the tree (alive, obviously injured, dead, or deformed, degree of leaning or supported etc. were recorded at each individual. A sample of trees were bored with a standard increment borer. This method was found inadequate due to the large percentage of trees with punky or missing centers; a sample of tree bolls were cut through to obtain a series of known age trees.

2.2: Owl and other cavity nester - population analysis: This portion was an attempt to devise a simplified methodology for monitoring boreal owl density and relative abundance on various habitats. A method using nest boxes to demonstrate cavity abundance was continued from earlier years.

2.2.1: Field Methods: A series of nest boxes was used as in other years to gain insight into the availability of cavities and the nesting abundance of larger cavity nesters (See 1998 interim report).

A listening transect was established across the Kloo lake study area as well as one other comparison area though not to be 'old growth'. In early April the route was covered on foot at night and all calling owls were recorded in each location.

3.0 PRELIMINARY RESULTS

3.1: Kloo Wetland forest stands:

Known age sample: I now have direct ages from a sample of 23 trees across the Kloo wetland study area. A variety of tree sizes were selected and all were taken from trees, which could be accurately bored with an increment borer or were found wind-thrown.

The relationship between circumference and age was found to be highly variable. Simple circumference measurements are proving the most valuable and useful forest "structure" parameter (Table 1)

Table 1. Known-aged trees and their circumference at 1 meter above ground level. The Kloo Wetland forest plot, 1998-2000.

Tree number	Stand number	circumference	Age
1.	1	47 cm	160
2.	1	72 cm	250
3.	1	97 cm	340
4.	2	52 cm	145

5.	2	90 cm	260
6.	2	95 cm	179
7.	3	48 cm	165
8.	3	75 cm	200
9.	3	78 cm	280
10	3	53 cm	205
11	3	22 cm	62
12	2	15 cm	25
13	1	35 cm	102
14	4	34 cm	99
15	4	50	145
16	4	95	180
17	4	70	200
18	5	53	200
19	5	92	280
20	5	85	145
21	5	40	100
22	5	85	205
23	5	74	85

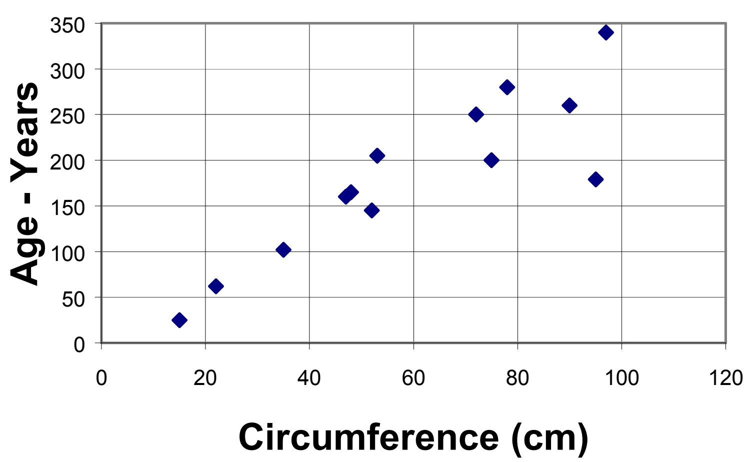

Figure 1. The relationship between known-aged trees and circumference, Kloo Old Growth site, 1998.

b) Forest structure measurements: I now have to measured sample of approximately 280 individual trees from the 'old growth' sites using the nearest-neighbor sampling method. (See 1998 interim report)

The measures suggest a highly diverse structure to the stand. There was no evidence of even spacing. Inter-tree distance averaged about 120 cm but varied widely. Tree boll sizes likewise showed a wide degree of variation. (Standard deviation from the means in both cases almost equaled the means obtained.) Differences between stands could not be identified and therefore all the data were pooled:

e) Tree condition ratings were mostly a measure of the speed at which theses stands were producing decadent trees suitable for larger cavity formation. Significantly, (but not surprisingly), a relatively large percentage of the trees in these stands were obviously "decadent" or already dead (Figure 5). The ages at which trees were dying in the stand averaged about 120 years, a minimum age for producing large cavity sites (Figure 6). Clearly the small percentage of trees that lived beyond the mean age of death become the "key" resource of interest in this work.

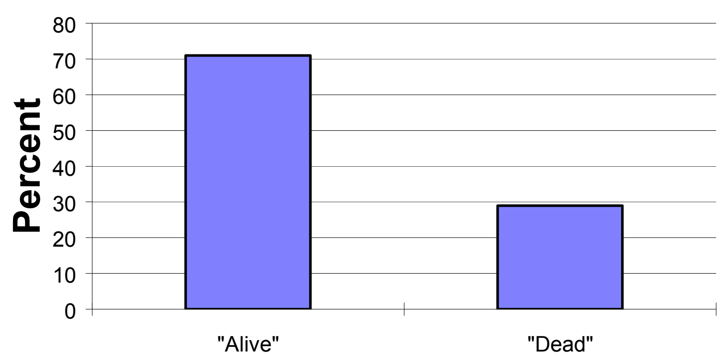

Figure 2. The proportion of dead and dying trees in the Kloo Old Growth.

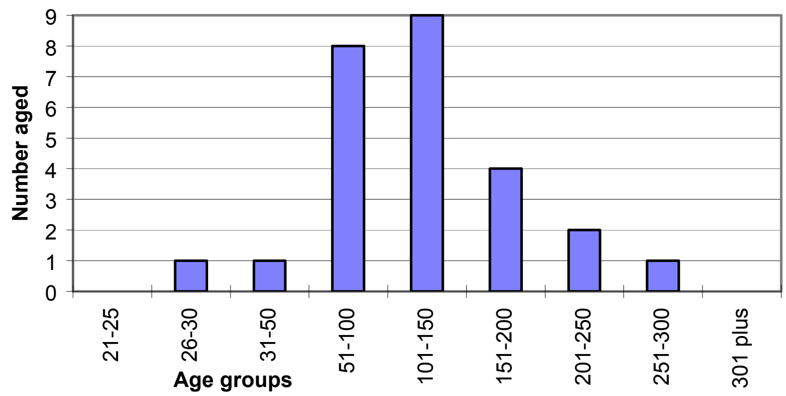

Figure 3. Age at death of trees in the Kloo Old Growth.

f) Owl counts: Nest box occupancy continues to be less than successful in giving a picture of large cavity nesting birds. This part of the study will likely evolve into an index of relative cavity availability in various habitats.

The process of estimating numbers with listening transect counts was more profitable. Good numbers were recorded although good keen ears will be required to make this methodology work consistently.

4.0 CONCLUSIONS, PLANS FOR FUTURE:

The principal objective of the 1999 and 2000 years was to add to the sample size of measured trees and to devise methodology for continuing monitoring the indicator species: large hole-nesters. Findings relate to the nature of the wetland-protected sites like the Kloo “old growth” stands. It is clear that these sites display a very complex structure with a wide variation in spacing and age of individual trees. There is no evidence of a ‘renewal’ process such as wild fire having ever having hit the sites. This finding along with the high proportion of old or dead trees in the stands is consistent with the idea that these sites are providing an inordinate amount of opportunity for larger cavities to form.

The nest box experiment is proving less easy to relate to the original hypothesis. Longer series of data are available for these boxes; they will continue to provide occupancy rate data in the future and it is most likely the long term analysis of these rates will be far easier to interpret. Monitoring the indicator species like boreal owls and other larger hole-nesters will require some additional though and planning although the methods tested obviously hold promise.

The plan for the continuation of this work is to find a student interested in carrying it on and developing it. The findings could have very wide application in the management of the boreal system in the future and it would be best to see a more concentrated effort by a dedicated research team. The results to date suggest a 'keystone process'; predicting where it can be expected, methods for remotely identifying it and understanding the intricacies of how it functions will be focus of work for some years.

5.0 ACKNOWLEDGMENTS

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