The Changing Ecology of the Old Crow Flats Wetland

YUKON RESEARCH CENTRE
Yukon College

This publication may be obtained from:

Yukon Research Centre, Yukon College
520 College Drive
P.O. Box 2799,
Whitehorse, Yukon
Y1A 5K4
(867) 668-8895
1-800-661-0504
www.yukoncollege.yk.ca/research

Recommended citation:

Mossop, D.H. 2015. The Changing Ecology of the Old Crow Flats. Yukon Research Centre, Yukon College, ms. 25pp.

Printed in Whitehorse, Yukon, 2014 by Arctic Star Printing Inc., 204 Strickland St.

This work grew from concern expressed principally by elders of the Vuntut Gwitchin First Nation, that the wetlands of the Crow Flats upon which generations have depended, are showing distressing changes. The thought was that, remembering several citizens were involved in wetland research about 40 years ago, a new but similar effort could document and perhaps explain those changes. In 2012 the Vuntut Gwitchin government submitted funding proposals for a return to those earlier data sets to discover whether those changes could be substantiated analytically. Three field seasons of that work are now complete.

The Crow Flats Wetland is by far the largest wetland complex in the Yukon. Two major sources for understanding the ecology of natural areas like the flats suitable for producing long term management goals are: technical wetland analysis, and local traditional knowledge of people who grew up on the land.

This report is focussed on trying to combine those two ways of knowing. Principally the idea was to use wetland birds, as 'indicator' species, -- a process that fits well with both traditional knowing and analytical processes of modern Conservation Biology. The Flats was the subject of initial reconnaissance research in the mid 1970's by the author (then in the employ of the Yukon Government) and members of the VGFN. At that time a series of data bases, mostly describing use of the area by wetland and riparian birds, were established. These turn out to be very usable as key ecological indicators of the functioning of the flats. (See Appendix 1 and Yukon Waterfowl Management Plan, 1985, 1990.)

OBJECTIVES of FIELD WORK:
A strong objective of the elders was to make sure the young leaders of the community were directly exposed to the 'Flats' and involved in all the field work there. Student-aged Old Crow citizens, were to make up part of the field crew.

The basic field objective was to mirror as closely as possible the work done in the 1970's. Virtually all work was ground, and water – based, focussed in the area of the flats where that earlier work was conducted.

Far-northern systems are known to be experiencing dramatic, often alarming changes apparently due to global environmental trends. The water birds and all riparian species of the Flats potentially provide a powerful 'focus' for tracking these changes because 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 tracking of the critical features of the area.

Key has been documenting timing of events -- breeding chronology in particular. Species abundance and breeding status are more difficult and are secondary objectives. Observations of plant phenology events and hydrological events have been important habitat components tracked. A running tally of species diversity similar to that collected earlier was also seen as essential.

FIELD METHODS:

The field work was focussed from the Schaeffer Lake cabin at the approximate centre of the Flats where the earlier work was also centered. There were two field sessions annually totalling about a month annually: (approximately June 7-20 and July 4-20.

A 4-person crew on each session cycled eight Old Crow students through the field work. Their assistance and enthusiasm quickly became an essential element.

Study team members:

	June session	July session
2012:	Erin Linklater	Darcie Josie
	David Frost	Chelsea Charlie

In both: The author and Yukon College student Shannon Harvey

2013:	David Frost	Briana Tetlichi
	Tanner (Coyne) Tetlichi	David Frost

In both: The author and Univ. of Victoria student Anne Aubin

2014:	Darcy Josie	Briana Tetlichi
	Wheeler Netro	Ashlyn Frost

In both: The author and Univ. of Victoria student Graeme Poile

The area around base camp at Schaeffer Lake became the core study area for the first half of the study period; intensive survey of a more restrictive area. The second half involved a canoe and portage survey across the southern Flats to the village of Old Crow -- a more extensive coverage.

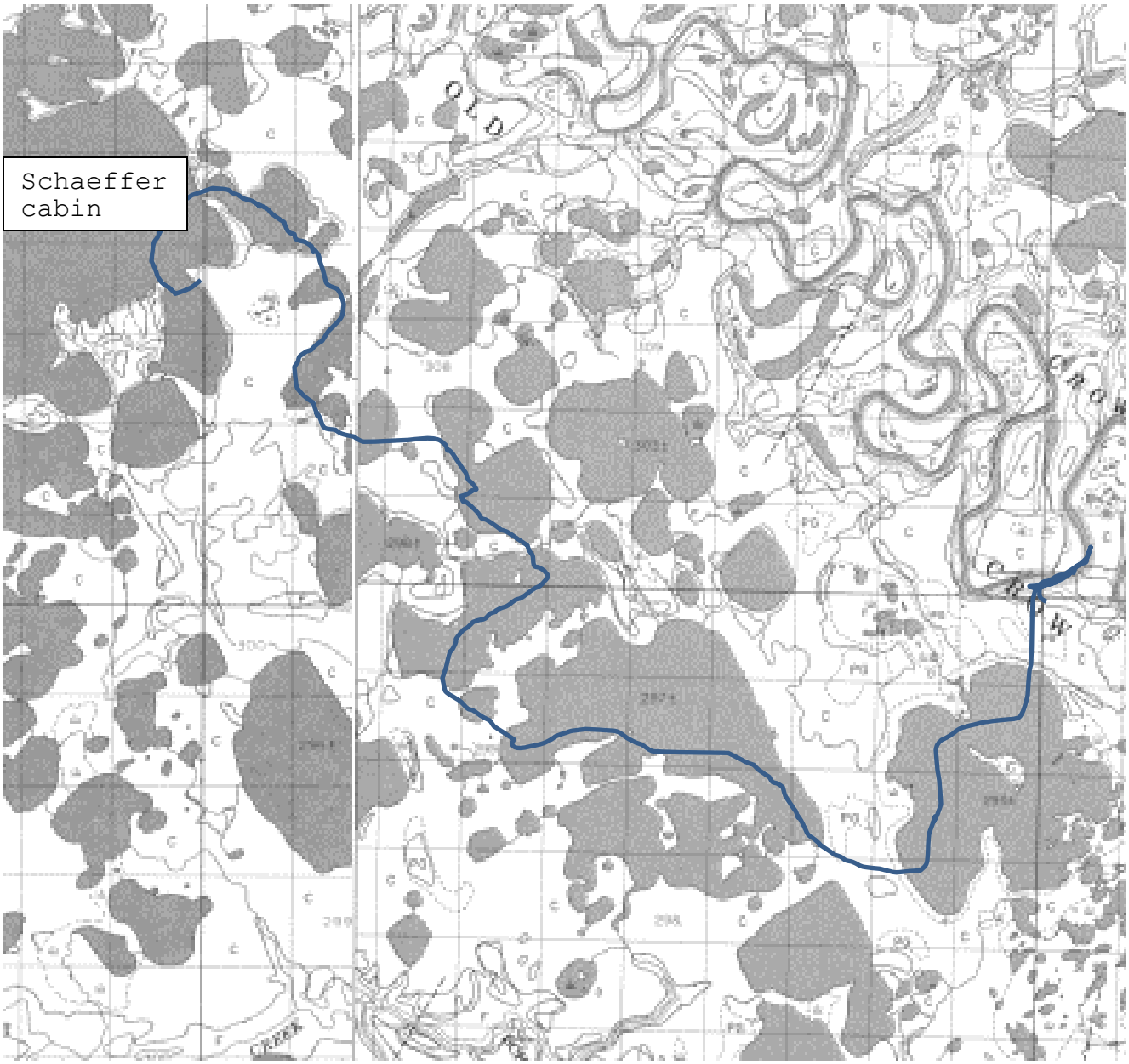
Briana, Ashlyn and Graeme busy repairing the roof of the old Schaeffer Cabin; base camp of the core study area.

By searching for nests and determining the age of young, the exact time of hatch was calculated. This is used to compare the breeding chronology between study periods, roughly 40 years apart.

Extensive survey was by canoe, portaging between lakes, counting all waterbirds, ageing young and recording all species encountered.

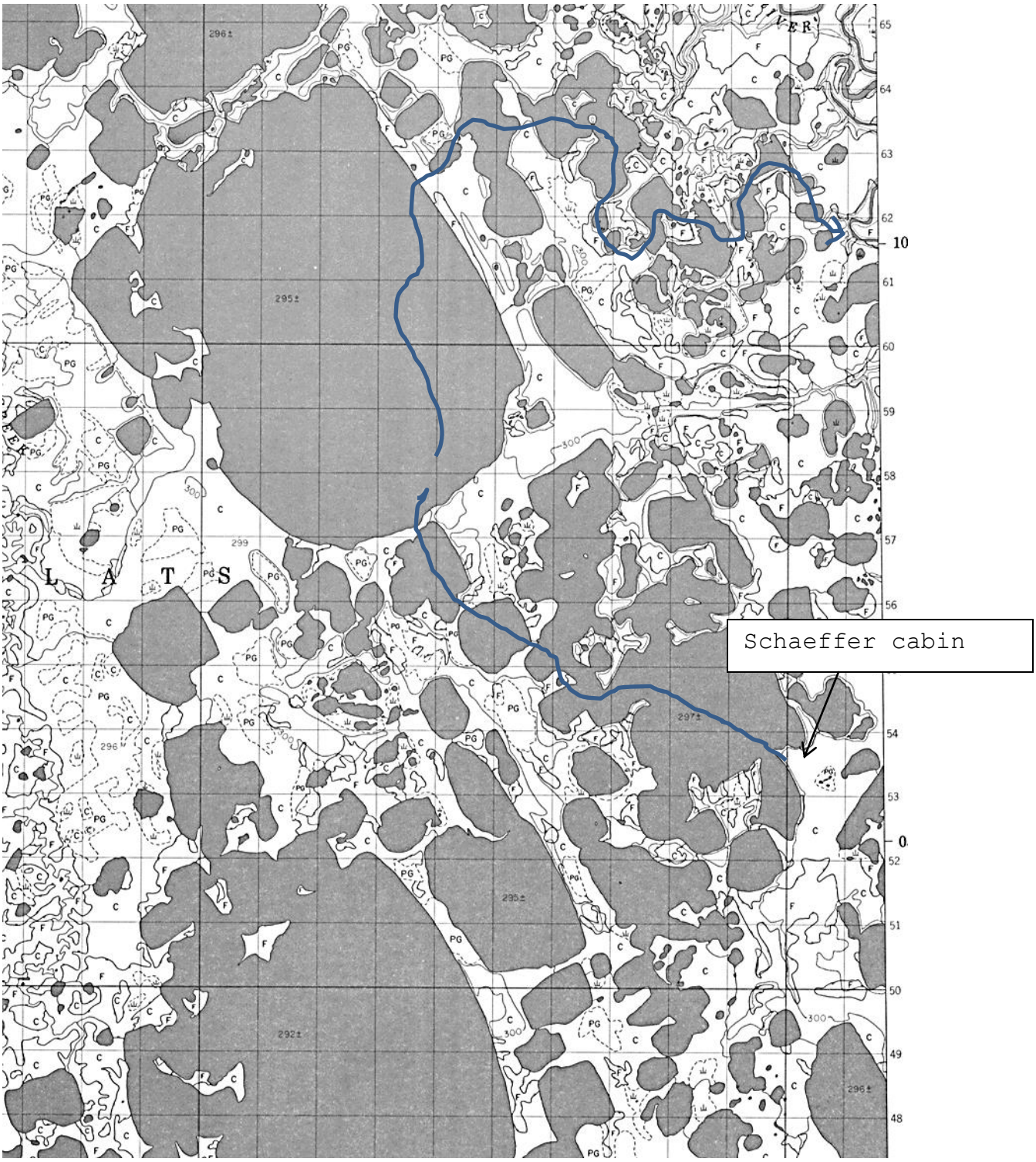
Canoe and portage survey route from Schaeffer Lake to the Old Crow River, July 2013. 11 lakes surveyed.

1 KM l____l



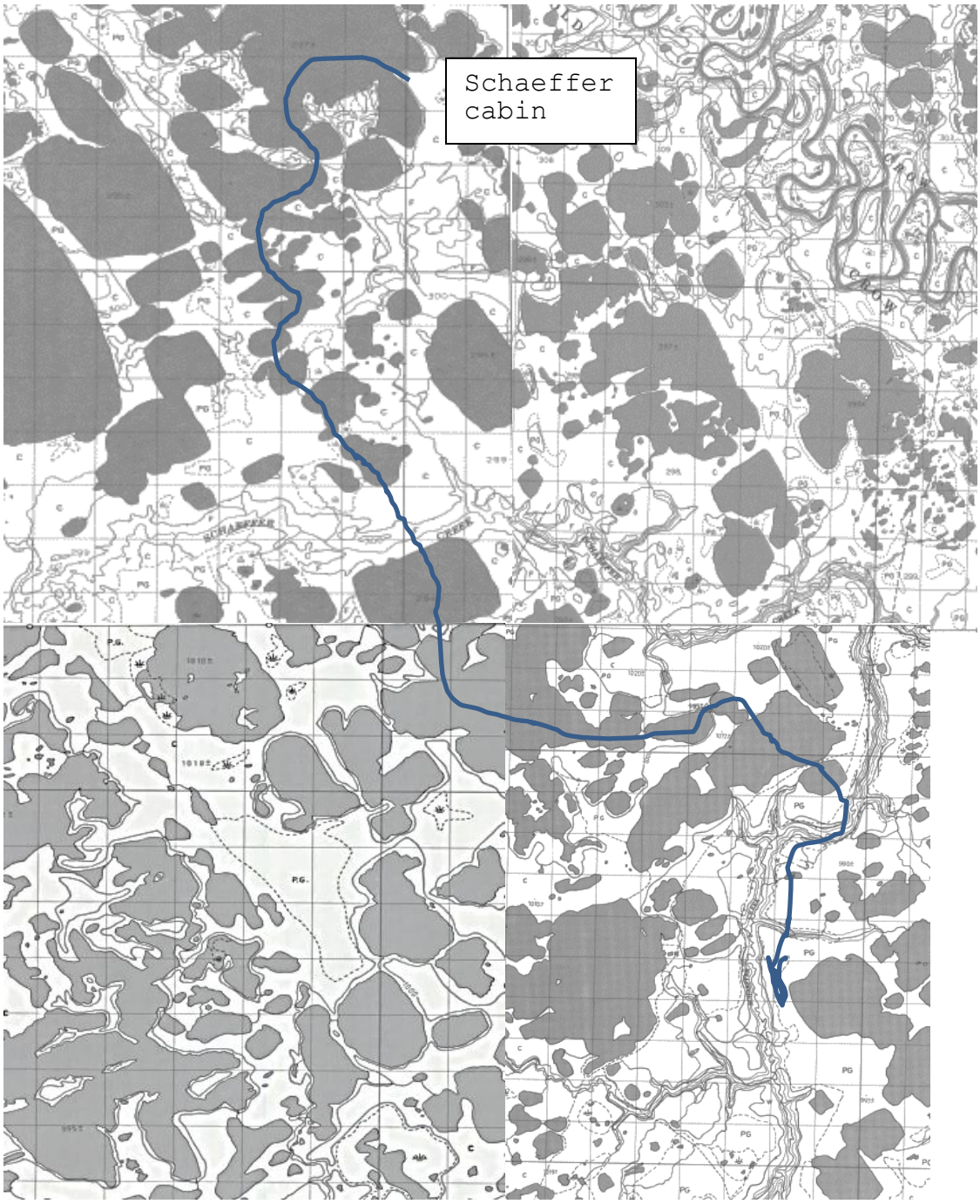
Canoe and portage survey route from Schaeffer Lake to Old Crow River, July 2014. 13 lakes surveyed.

1KM I____I



Canoe and portage survey route, Schaeffer Lake, Drowned Lake, Schaeffer Creek to Old Crow River, June 2012, 13, 14. Eleven lakes surveyed.

1KM I___I



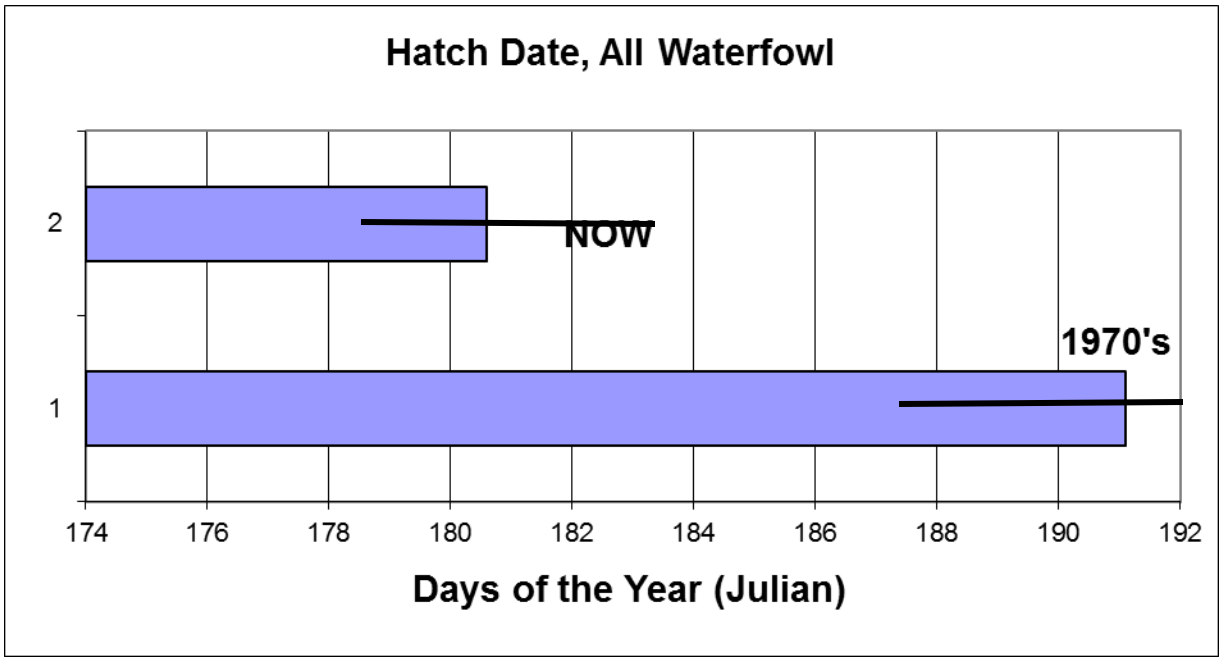
DATA, OBSERVATIONS

a) Focal species:

Waterfowl: The best historic counts and surveys are of the ducks, geese and swans of the Flats. The 1970'S data set contains total counts, breeding pair surveys and a sample of 1,049 breeding records.

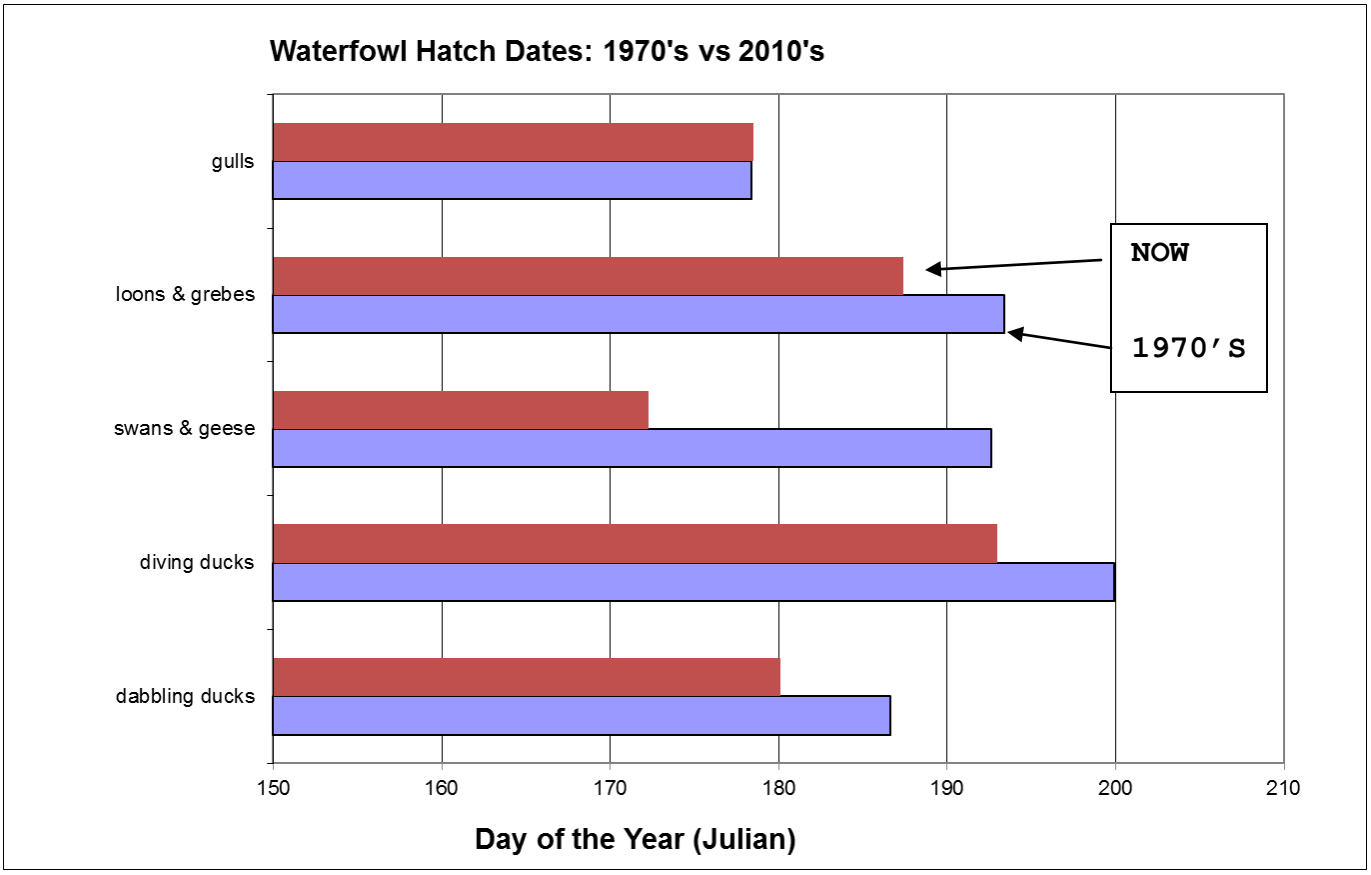
In 2012-14, ground counts of nesting habitat and extensive brood counts produced a sample of 150 breeding records that could be compared to earlier data. Total counts of breeding pairs produced relatively small sample sizes but some initial comparisons can also be made.

Combining all waterfowl species it is clear that a significant change in timing of breeding has happened over the last 40 years: on average these birds are breeding about 10 days to two weeks earlier. (Interestingly this held even in 2013 -- in spite of that spring being obviously relatively late.)



Sub-dividing the waterfowl by groups of species, it is starting to become clearer which groups are mostly responsible.

Swans and geese in particular are apparently breeding over two weeks earlier. These and the duck species, (mostly the dabbling ducks (American Wigeon, Mallard, Green-winged teal) seem to be responsible for most of the observation of advanced breeding. Other water birds (gulls, loons and grebes) have not significantly shown a change. Some may even be breeding slightly later:



Tundra Swans on the Flats are breeding up to two weeks earlier than 40 years ago.

Some of the most revealing observations are of the **relative abundance** of water birds on the Flats. Comparing counts from the 1970's the major changes in the ranking of species encountered on the flats:

Frequency: When lists of bird species are made some species show up almost every time, others rarely, giving a measure of the changing diversity over time. The old data set has a series of152 counts taken from the ground, the present work produced 32. A few clear differences in the diversity of water birds are evident:

Long-tailed ducks seen 95% of the time in the 1970's are only seen about 28% of the time now. Greater Scaup have virtually disappeared from the species list (from 56% of observations in the 1970's) Likewise the Red-throated loon is seen about half as often now.

Never recorded and now apparently appearing for the first time on the Flats are the Common Merganser, Gadwall and Harlequin duck all seen now about 6% of the time. We saw no evidence of 8 species now that were seen in the 1970's but their numbers were never really significant.

PERCENT OF COUNTS IN WHICH WATERBIRD SPECIES WERE RECORDED

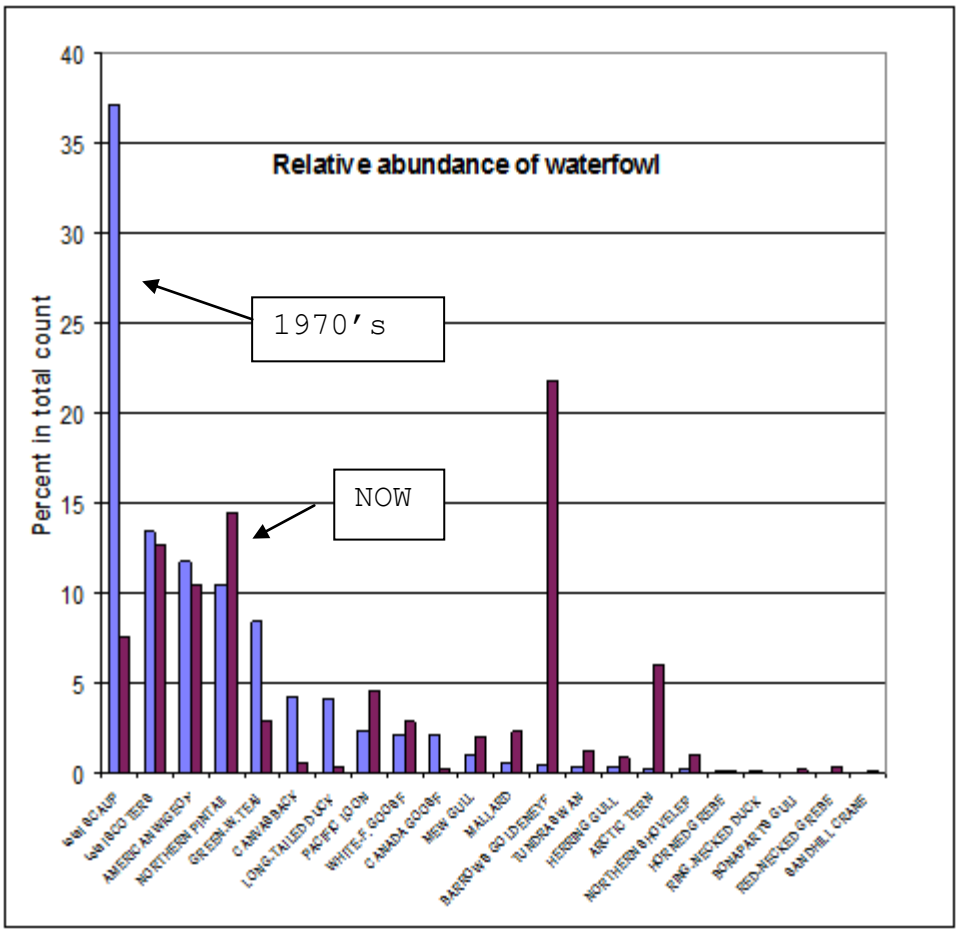
1975-7			**2012- 14**
Counts	(152)	(32)	
98.03	HERRING GULL	AMERICAN WIGEON	81.25
96.71	PACIFIC LOON	LESSER SCAUP	78.13
96.05	AMERICAN WIGEON	MALLARD	71.88
95.39	LONG-TAILED DUCK	PACIFIC LOON	68.75
95.39	WHITE-WINGED SCOTER	WHITE-WINGED SCOTER	65.63
89.47	MEW GULL	GR. WHITE-FR. GOOSE	62.50
86.84	BONAPART'S GULL	HERRING GULL	62.50
86.84	NORTHERN PINTAIL	TUNDRA SWAN	62.50
83.55	SURF SCOTER	MEW GULL	53.13
75.66	MALLARD	NORTHERN PINTAIL	53.13
75.66	GREEN-W.TEAL	NORTHERN SHOVELER	46.88
75.00	LESSER SCAUP	SURF SCOTER	46.88
72.37	TUNDRA SWAN	BARROW'S GOLDENEYE	43.75
61.84	ARCTIC TERN	GREEN-W.TEAL	43.75
55.92	GREATER SCAUP	BONAPART'S GULL	43.75
48.68	RED-NECKED GREBE	CANVASBACK	28.13
47.37	NORTHERN SHOVELER	CANADA GOOSE	28.13
39.47	BARROW'S GOLDENEYE	LONG-TAILED DUCK	28.13
31.58	RED-THROATED LOON	RED-NECKED GREBE	21.88
26.32	CANVASBACK	RED-THROATED LOON	18.75
25.66	HORNED GREBE	COMMON LOON	18.75
25.66	GR. WHITE-FR. GOOSE	HORNED GREBE	12.50
25.00	COMMON LOON	SANDHILL CRANE	12.50
18.42	COMMON GOLDENEYE	ARCTIC TERN	9.38
13.16	CANADA GOOSE	RED-BR. MERGANSER	6.25
11.18	PARASITIC JAEGER	COMMON MERGANSER	6.25
6.58	LONG-TAILED JAEGER	HARLEQUIN DUCK	6.25
3.95	SANDHILL CRANE	GADWALL	6.25
3.29	RED-BR. MERGANSER	RING-NECKED DUCK	3.13
2.63	GLAUCUS GULL	GLAUCUS GULL	3.13
1.32	RING-NECKED DUCK	SNOW GOOSE	0.00
1.32	SNOW GOOSE	PARASITIC JAEGER	0.00
0.66	GARGANY	GREATER SCAUP	0.00
0.66	BUFFLEHEAD	COMMON GOLDENEYE	0.00
0.66	BRANT	BUFFLEHEAD	0.00
0.00	COMMON MERGANSER	BRANT	0.00
0.00	GADWALL	GARGANY	0.00
0.00	HARLEQUIN DUCK	LONG-TAILED JAEGER	0.00

Abundance: The 'frequency' at which species are observed doesn't always reflect their abundance on the habitat. Interestingly, most species observed, at least among the water birds, were seen at about thre same rates as in the 1970's, even though it seemed apparent that their numbers seem to have changed.

From the old data set there are 51 counts of abundance that are comparable with the 31 counts taken in the current work.

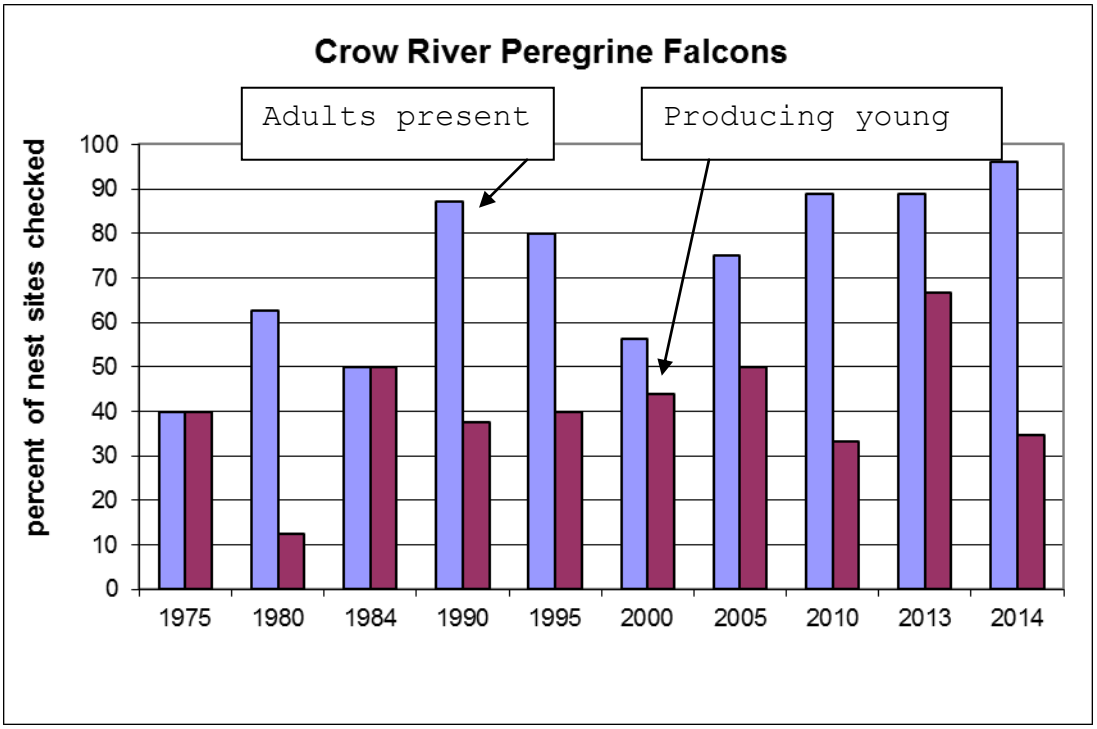
By this measure, Scaup species have declined from almost 40% of all waterfowl on the flats to just about 7%. Others that have declined significantly but to a lesser extent are Green-winged teal, Canvasback and Long-tailed duck. Apparently increasing in relative abundance are: Barrow's goldeneye, Pacific loon, White-fronted goose, Mallard, Northern Shoveler, and Arctic tern.

Several have stayed unchanged, among them Scoters that interestingly, are the most important duck harvested locally.



b) Birds of Prey: The best historic data among the birds of prey track the performance of the Peregrine Falcon that breed along the Crow River. Peregrine falcons are an excellent indicator species because they are very dependant on water birds. Bald Eagle, and Osprey also use the flats but our current field work doesn't survey their numbers adequately. We surveyed the Peregrine falcons of the Crow River from the water in both 2013 and 2014. Occupancy and productivity data from a minimum of 10 nesting pairs was the objective.

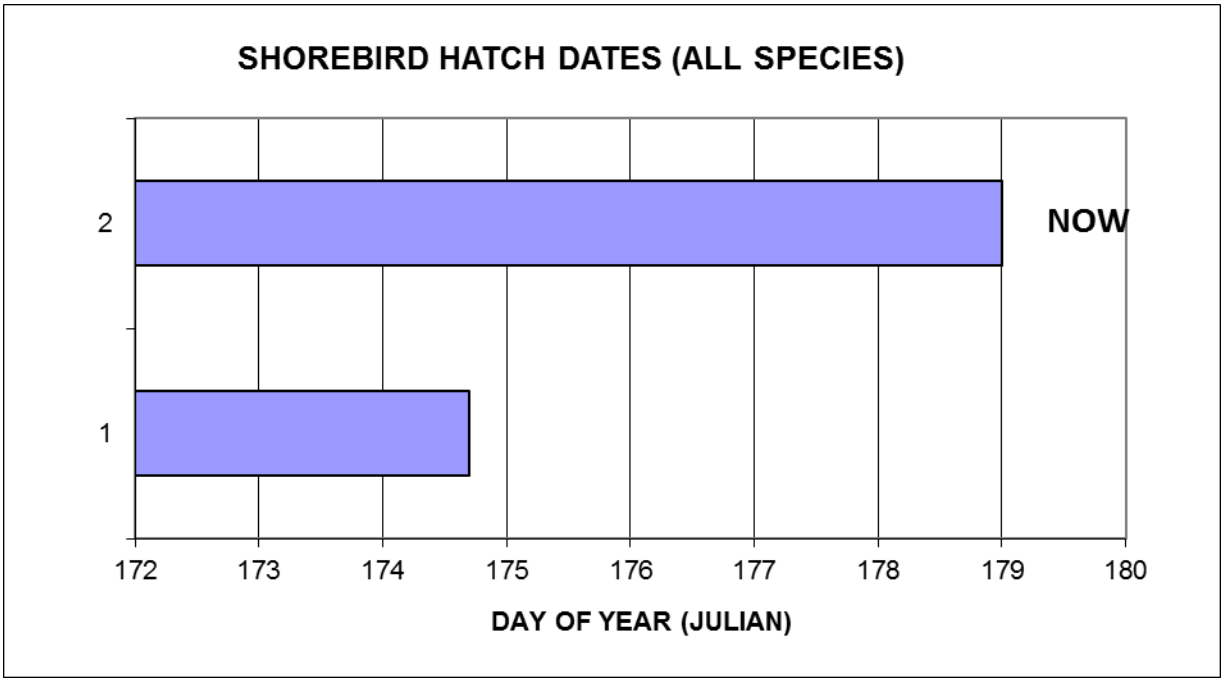
Over the last few decades the Peregrine has been showing a decided slump in its production of young. An average of 60% of pairs have been producing no young (Mossop, 2010). Interestingly in our 2013 survey the situation was totally reversed: over 60% of pairs were observed producing young. This could be a very important finding of our study as changing weather in early spring has been implemented as a suggested reason for poor falcon breeding. The spring of 2013 was very cold and late which more accurately mirrors the historic weather regime for the region. In 2014 the weather in spring again became unusually warm and production of young Peregrines again fell.



Peregrine falcons seemed to breed better in 2013 than in the last many years -- correlated with a very cold spring season 2013

Shorebirds: From the 1970's data there are about 42 breeding records. In 2012 thru 2014 we recorded only 4 nesting records. This alone is significant; clearly it suggests a catastrophic decline in these important species. Nine species observed in the 1970' were not seen in the present study at all.

Initial analysis suggests a change in timing to perhaps a later hatch, but sample sizes are far too small in the current study for definitive conclusions:



The abundance of shorebirds on the Flats is reflected best in the number of times species showed up in count lists. Almost all shorebird species showed apparent declines in abundance since the 1970's. Most alarming are those species that seem to have disappeared completely:

Percent of species lists that recorded shorebirds

1975-77		2012-14
86.84	LESSER YELLOWLEGS	62.50
81.58	LEAST SANDPIPER	25.00
69.08	RED-NECKED PHALAROPE	12.50
51.97	WILSON'S SNIPE	31.25
9.21	SEMIPAL. SANDPIPER	0.00
8.55	LON-BILLED DOWITCHER	0.00
7.89	PECTORAL SANDPIPER	0.00
7.24	GOLDEN PLOVER	0.00
5.92	SPOTTED SANDPIPER	21.88
1.97	WHIMBREL	0.00
1.97	BLACK-B. PLOVER	0.00
1.32	RED PHALAROPE	0.00
1.32	SOLITARY SANDPIPER	3.13
1.32	HUDSONIAN GODWIT	0.00
0.66	UPLAND SANDPIPER	3.13
0.00	SEMIPALMATED PLOVER	6.25

Gulls: There are 85 nesting records in the data base from the 1970's; in the current work there are 45.

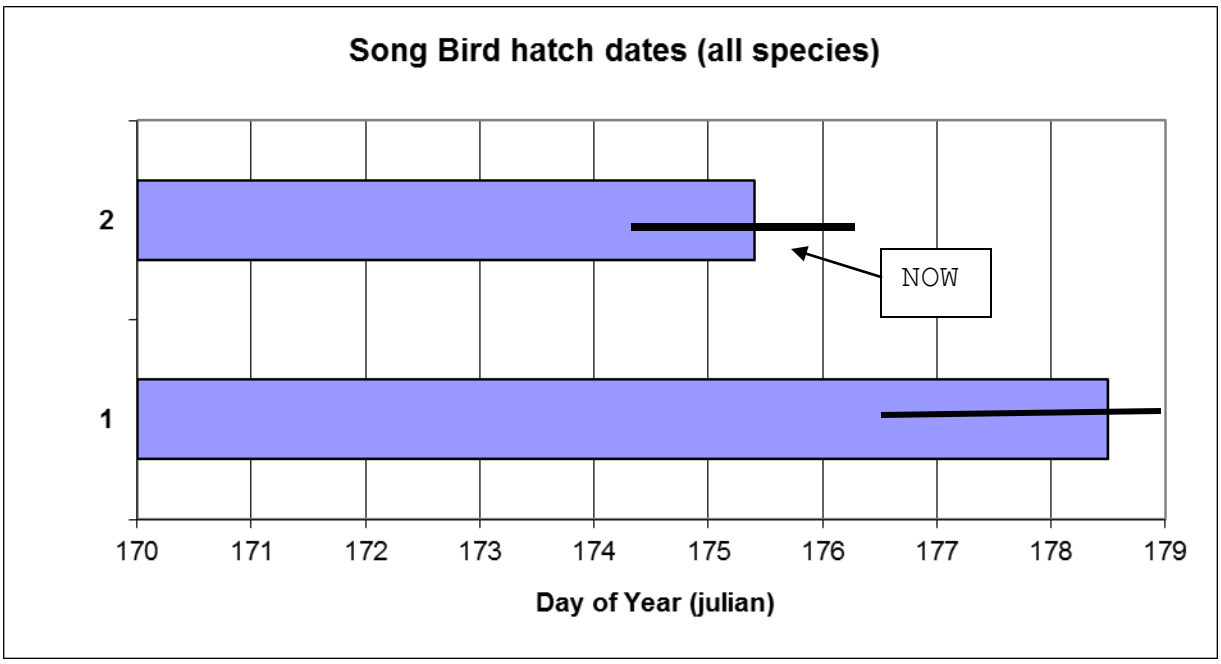
Some observations suggest that Herring gull in particular may be a species that has increased in abundance on the Flats. One nesting colony seems to have increased by about 25% and it will be important to continue to track this possible trend. Herring gulls are known to be very effective predators of young water birds and are apparently being artificially benefited by humans in winter. (Wintering at garbage dumps is thought to be giving these birds a huge advantage.)

Interestingly in 2013-14 the one nesting colony surveyed had been apparently visited by a bear, all remaining nests seemed to be later re-nests and many of the adults had simply abandoned the site. It will be interesting to track its progress in the future. (Nest timing is meaningless in 2014.) There is no significant difference in hatch date between the 1970's and now.

Herring gull nest at Drowned lake nesting colony, OCF, June 18, 2013. Incomplete clutch after earlier depredation, apparently by a bear.

Riparian land birds: The historic data set for song birds has a sample of 122 nests that provide an excellent view of basic nesting ecology on the Flats.

In 2012 and 13 we conducted a running count of species diversity, mapped the nesting pairs in the core area at the Schaeffer lake camp survey plot and accounted for a sample of 37 nest sites observed. Lumping all species, Initial analysis in 2012 suggested a significant change in nesting chronology toward an EARLIER hatch date. However in 2013 an obviously later nesting time (probably due to the unusual spring weather that year) put the nesting time back almost the same as it was in the earlier years. In 2014 timing again advanced. Overall these birds seem to be breeding about 5-6 days earlier but the difference is not significant statistically.



Land Bird Species diversity: Historically, a running record of all bird species encountered was maintained. In the current study, a similar log was kept. (Appendix 2 details the relative abundance of all species of birds encountered in the 2012-13-14 field seasons.)

Noting how often species were encountered, there are only insignificant differences between the early data set and the present study. A couple of possible exceptions are birds like the Golden-crowned sparrow which were not recorded at all in the current work. As well there is some indication that birds like the Rusty Blackbird have declined --(known to have declined elsewhere) but was still recorded in 80% of counts.

Land bird diversity: percent of time species appeared in counts: most common species in 1970's at top:

1970's		2012-14
100.00	RUSTY BLACKBIRD	81.25
90.79	NORTHERN WATERTHRUSH	90.63
88.16	AM. TREE SPARROW	65.63
86.18	GRAY-CHEEKED THRUSH	71.88
79.61	FOX SPARROW	81.25
76.32	COMMON RAVEN	62.50
76.32	YELLOW WARBLER	78.13
73.03	AMERICAN ROBIN	93.75
72.37	WILLOW PTARMIGAN	12.50
71.71	BLACKPOLL WARBLER	59.38
55.92	GOLDEN-CRND SPARROW	0.00
44.08	SAVANNAH SPARROW	53.13
40.79	GRAY JAY	46.88
36.18	COMMON REDPOLL	59.38
31.58	WHITE-CRND SPARROW	78.13
20.39	TREE SWALLOW	3.13
8.55	SMITH'S LONGSPUR	6.25
5.92	CLIFF SWALLOW	3.13
3.95	LAPLAND LONGSPUR	0.00
3.29	N.FLICKER	6.25
3.29	BOREAL CHICKADEE	9.38
2.63	BELTED KINGFISHER	6.25
2.63	PINE GROSBEAK	9.38
2.63	AMERICAN PIPIT	0.00
2.63	VARIED THRUSH	6.25
1.97	YEL-RUMPED WARBLER	56.25
1.32	ROCK PTARMIGAN	0.00
1.32	SAY'S PHOEBE	0.00
1.32	ALDER FLYCATCHER	3.13
1.32	WHITE-W. CROSSBILL	3.13
1.32	PINE SISKIN	0.00
1.32	DARK-EYED JUNCO	21.88
1.32	SWAINSON'S THRUSH	18.75
0.66	HORNED LARK	0.00
0.66	LINCOLN'S SPARROW	9.38
0.66	BANK SWALLOW	18.75
0.66	TOWNSEND'S SOLITAIRE	0.00
0.00	BOHEMIAN WAXWING	25.00
0.00	NORTHERN SHRIKE	6.25
0.00	ORANGE CRND WARLER	6.25
0.00	WILSON WARBLER	9.38
0.00	GRAY HEADED CHICKADEE	3.13
0.00	RUBY-CRND KINGLET	25.00
0.00	HERMIT THRUSH	3.13

c) Vegetation phenology: (Historic data exists on 8 key species.) The same species were followed in 2012-14:

Plant first bloom and full bloom observations (Julien days)

	1970′		2012-14	
	First Bloom	Full Bloom	First Bloom	Full Bloom
Labrador tea	**172±1.4**	**178±0.7**	**164±2.1**	**170 -**
Andromeda	**164 -**	**175 -**	**160 -**	**164 -**
Dw. Birch	**164 -**	**170 -**	**162±2.8**	**164+1.4**
Cotton grass	**--**	**171±4.2**	**--**	**163±3.5**
Leather leaf	**--**	**--**	**162±2.8**	**--**
Colt's foot	**173 -**	**182 -**	**162±2.8**	**164 -**
Cloud berry	**164 -**	**170 -**	**160 -**	**167±4.2**
Water sedge	**170 -**	**175±0.7**	**165±2.1**	**--**

There appears at least a strong suggestion that vegetation events are trending about 5-7 days earlier than in the early data. However no clear conclusions are possible with these data, it will take several more years to confirm and unfortunately the old data often only have one observation. We also know 2013 was an obviously late spring that will probably be affecting results.

Strong observational evidence suggests that riparian shrubs and spruce seem to have been 'released', and now are in accelerated growth, standing significantly higher than historically. This observation, supported by local people on the land would suggest the growing season is advancing significantly.

d) Physical environment: (Historical data collection from the research campsite included water temperature and water level changes over the summer period. A summer weather station was also operational. Recorded were: twice daily temperatures, maximum and minimum, precipitation and notes on cloud cover.)

Weather data: In 2012 and 13 during the two, 1-week periods at the Schaeffer site, the same standard weather data were taken. No clear conclusion about change is possible with the current data.

Hydrological observations: Observations of the level of water in key water bodies on the Flats strongly suggests

that many seem overcharged with water as compared to the historic levels.

In particular Schaeffer Lake (and others such as Drowned Lake are obviously holding significantly more water than historically. From a strictly observational point of view, the shoreline emergent vegetation, so important to staging and feeding water birds is virtually all flooded. The shrub and treed shorelines are obviously eroding and collapsing. Potentially more disturbing, significant drainage channels are building that should lead to catastrophic drainage in the near future.

In 2014 a series of water samples were taken from all lakes visited during our extensive canoe survey. The results of analysis of those samples and one from the 1970's are in Appendix 3.

FOCUS FOR ONGOING FIELD PROGRAM:

Clearly these initial years have suggested interesting ecological changes occurring on the Flats. The value of historic data in quantifying those changes is obvious. However, in all cases these initial years have produced only minimal sample sizes for drawing sound conclusions.

- Planning must be toward continuing this work and focussing on duplicating the best of those data sets. Timing of events, -- in particular breeding chronology of the various groups of bird species is a key focus. Plant phenology should probably be given more emphasis than in 2012-13.
- Waterfowl breeding data is one of the most powerful indicators of wetland ecosystem integrity. Pair counts and brood counts are standard in waterfowl management procedures and give a good method for comparing across time as well as between wetlands elsewhere. It will be important standardize those counts, targeting lakes that were best monitored in the historic field work. (Schaeffer Lake, D.Lord lake and Drowned Lake are key.)
- Simple species diversity data may be the best and easiest data set to maintain. Song bird diversity, in particular at the Schaeffer Camp, was a strong data set historically and should continue to be a focus.

MISSING SPECIES, SPECIES AT RISK: Building on the 2012 findings, one of the alarming observations was the almost complete disappearance of some of the common species historically. In particular, Greater Scaup, Long-tailed duck, Surf Scoter, and all the shorebirds have apparently declined significantly. Other species may also be found declining as the work continues.

- This has to lead to an increased focus on species becoming at 'risk'. It is known that some species in the area (notably

Peregrine falcon) have in the past been 'in harms way' and almost extirpated completely.

- It is hard to know how to respond to species disappearance except to increase vigilance where those identified as declining are concerned. In continuing it will be important to revisit sites where it was known historically that, for example, long-tailed ducks and Greater Scaup were nesting. One of the best data sets of any bird is that for the Peregrine falcon. The Old Crow river breeding population, dependant as it undoubtedly, is on the water birds of the Flats, is an obvious key indicator species. A greater emphasis on its breeding ecology will be an easy addition to the project. A general focussing on others known at risk: Rusty blackbird, Short-eared owl.

VEGEGATION CHANGES: A startling observation (supported locally) was the apparent 'release' of shrubs and stunted spruce.

- Recover and locate on the ground, historic photographs of shoreline vegetation
- Make companion photos and measurement
- Record growth (ring and stem) growth

Schaeffer cabin in the 1970's, shrub tundra, basically treeless

Same site, 2012

PHYSIOGRAPHY, POND DYNAMICS, HYDROLOGY: In 2012-13 it has become relatively clear that water level in many key lakes in the central flats are higher than historically. Why this may be the case and what the consequences will be is undoubtedly of major importance to the ecology of the area.

- Engage hydrological expertise in the project
- Design and implement monitoring protocols

COMMUNITY BASED MONITORING AND BASIC HABITAT MANAGEMENT: The importance of long term monitoring and care for ecological processes is central to the conclusions from work like this project. People on the land with clear, analytical protocols for tracking changes are in the best position to create the data sets necessary.

- In consultation, design clear, simple protocols for local people to track key focal indicators. In all cases of the focal species and processes the project identifies as key, thought must go into creating those protocols.
- Data bases need to be designed and maintained as a matter of course in the VGFN government processes.
- Co-ordination and cooperation with ecological monitoring already underway in the Parks Canada is essential
- A good practical, on-going addition to the field work on the Flats could be developing a process of dealing with debris and other garbage accumulating on the land. Earlier occupancy of field camps by a variety of 'external' visitors as well as local people, has left a fair amount of non-degradable debris.

A good practical learning and management addition to the field work can be the developing of a process for dealing with debris accumulating on the land.

Grizzlies on the Old Crow Flats are a major feature. (Interestingly, local observations seem to suggest that since the 1970's they have learned to visit and destroy campsites, often acting aggressively toward field workers.)

APPENDIX 1:

DATA SETS COLLECTED IN THE 1970'S
FOCAL SPECIES & Physical Env. For possible use in comparison from D. Mossop files

Useable data sets exist for:
Focal species:

a) Birds of Prey: D. Mossop (published in several reports, some published papers, 1974, to present)
best data:
Peregrine Falcon
Bald Eagle
Osprey

b) Gulls and shorebirds: (some reports 1974-77) and unpubl data
Herring gull
Mew gull

c) Riparian song birds:
Basic community structure at center of Flats (1975-76)

d) Waterfowl:
1974-76: (published in report form)
Plus: US Fish and Wildlife Service annual surveys (published in report form),

e) Mammals:
Moose: 1974-78 Some fairly good counts that could be used to compare with recent counts to identify trend:

Caribou: 1976: Important documentation of calving on the flats by the Porcupine herd. (report form)

Physical environment:

Hydrology: 1975: Russell and D.Mossop (published)
1974-77 Water level and water temperature data set: Unpubl. data

Weather: 1975-78 Summer weather station: unpubl data

Plant phenology: 1975-7 unpublished notes on time of blooming for several species

APPENDIX 2: .

RELATIVE ABUNDANCE OF BIRD SPECIES, OLD CROW FLATS WETLAND COMPARING 1970'S TO 2010'S

1975-77				2012-14		
TOTAL COUNTED 152	% OF TOTAL SEEN	% OF COUNTS WHERE SEEEN		TOTAL COUNTED	% OF TOTAL SEEN	% OF COUNTS WHERE SEEN
74	1.53	48.68	RED-NECKED GREBE	17	0.19	21.88
39	0.81	25.66	HORNED GREBE	6	0.07	12.50
38	0.78	25.00	COMMON LOON	7	0.08	18.75
147	3.04	96.71	PACIFIC LOON	164	1.80	68.75
48	0.99	31.58	RED-THROATED LOON	11	0.12	18.75
17	0.35	11.18	PARASITIC JAEGER	0	0.00	0.00
10	0.21	6.58	LONG-TAILEE JAEGER	114	1.25	62.50
149	3.08	98.03	HERRING GULL	3	0.03	6.25
136	2.81	89.47	MEW GULL	187	2.05	53.13
132	2.73	86.84	BONAPART'S GULL	47	0.52	43.75
94	1.94	61.84	ARCTIC TERN	7	0.08	9.38
4	0.08	2.63	GLAUCUS GULL	1	0.01	3.13
0	0.00	0.00	COMMON MERGANSER	5	0.05	6.25
5	0.10	3.29	RED-BR. MERGANSER	7	0.08	6.25
115	2.38	75.66	MALLARD	181	1.99	71.88
0	0.00	0.00	GADWALL	2	0.02	6.25
146	3.02	96.05	AMERICAN WIGEON	872	9.58	81.25
115	2.38	75.66	GREEN-W.TEAL	64	0.70	43.75
1	0.02	0.66	GARGANY	0	0.00	0.00
72	1.49	47.37	NORTHERN SHOVELER	119	1.31	46.88
132	2.73	86.84	NORTHERN PINTAIL	181	1.99	53.13
0	0.00	0.00	REDHEAD	0	0.00	0.00
40	0.83	26.32	CANVASBACK	215	2.36	28.13
85	1.76	55.92	GREATER SCAUP	0	0.00	0.00
114	2.35	75.00	LESSER SCAUP	551	6.05	78.13
2	0.04	1.32	RING-NECKED DUCK	4	0.04	3.13
28	0.58	18.42	COMMON GOLDENEYE	0	0.00	0.00
60	1.24	39.47	BARROW'S GOLDENEYE	1895	20.81	43.75
1	0.02	0.66	BUFFLEHEAD	0	0.00	0.00
145	3.00	95.39	LONG-TAILED DUCK	25	0.27	28.13
0	0.00	0.00	HARLEQUIN DUCK	2	0.02	6.25
145	3.00	95.39	WHITE-WINGED SCOTER	656	7.20	65.63
127	2.62	83.55	SURF SCOTER	63	0.69	46.88
2	0.04	1.32	SNOW GOOSE	0	0.00	0.00
39	0.81	25.66	GR. WHITE-FR. GOOSE	725	7.96	62.50

20	0.41	13.16	CANADA GOOSE	78	0.86	28.13
1	0.02	0.66	BRANT	0	0.00	0.00
110	2.27	72.37	TUNDRA SWAN	95	1.04	62.50
2	0.04	1.32	RED PHALAROPE	0	0.00	0.00
105	2.17	69.08	RED-NECKED PHALAROPE	12	0.13	12.50
79	1.63	51.97	WILSON'S SNIPE	19	0.21	31.25
13	0.27	8.55	LON-BILLED DOWITCHER	0	0.00	0.00
12	0.25	7.89	PECTORAL SANDPIPER	0	0.00	0.00
124	2.56	81.58	LEAST SANDPIPER	21	0.23	25.00
14	0.29	9.21	SEMIPAL. SANDPIPER	0	0.00	0.00
2	0.04	1.32	SOLITARY SANDPIPER	1	0.01	3.13
132	2.73	86.84	LESSER YELLOWLEGS	57	0.63	62.50
1	0.02	0.66	UPLAND SANDPIPER	1	0.01	3.13
9	0.19	5.92	SPOTTED SANDPIPER	219	2.41	21.88
2	0.04	1.32	HUDSONIAN GODWIT	0	0.00	0.00
3	0.06	1.97	WHIMBREL	0	0.00	0.00
3	0.06	1.97	BLACK-B. PLOVER	0	0.00	0.00
11	0.23	7.24	GOLDEN PLOVER	0	0.00	0.00
0	0.00	0.00	KILLDEER	3	0.03	6.25
0	0.00	0.00	SEMIPALMATED PLOVER	0	0.00	0.00
0	0.00	0.00	RUDDY TURNSTONE	3	0.03	9.38
31	0.64	20.39	NORTHERN HARRIER	2	0.02	6.25
3	0.06	1.97	SHARP-SH. HAWK	0	0.00	0.00
0	0.00	0.00	COOPER'S HAWK	0	0.00	0.00
2	0.04	1.32	GOSHAWK	0	0.00	0.00
0	0.00	0.00	NORTHERN GOSHAWK	0	0.00	0.00
0	0.00	0.00	RED-TAILED HAWK	10	0.11	15.63
1	0.02	0.66	HARLAN'S HAWK	0	0.00	0.00
0	0.00	0.00	SWAINSON'S HAWK	0	0.00	0.00
4	0.08	2.63	ROUGH-LEGGED HAWK	1	0.01	3.13
4	0.08	2.63	GOLDEN EAGLE	12	0.13	21.88
13	0.27	8.55	BALD EAGLE	0	0.00	0.00
2	0.04	1.32	GYRFALCON	55	0.60	21.88
11	0.23	7.24	PEREGRINE FALCON	5	0.05	6.25
2	0.04	1.32	MERLIN	1	0.01	3.13
4	0.08	2.63	AMERICAN KESTREL	4	0.04	12.50
9	0.19	5.92	OSPREY	7	0.08	12.50
5	0.10	3.29	SANDHILL CRANE	7	0.08	12.50
9	0.19	5.92	SHORT-EARED OWL	7	0.08	12.50
0	0.00	0.00	GREAT GRAY OWL	1	0.01	0.00
0	0.00	0.00	BOREAL OWL	0	0.00	0.00
1	0.02	0.66	GREAT HORNED OWL	4	0.04	9.38
0	0.00	0.00	SNOWY OWL	0	0.00	0.00
0	0.00	0.00	NORTHERN HAWK-OWL	0	0.00	0.00

0	0.00	0.00	SPRUCE GROUSE	0	0.00	0.00
0	0.00	0.00	RUFFED GROUSE	0	0.00	0.00
110	2.27	72.37	WILLOW PTARMIGAN	6	0.07	12.50
2	0.04	1.32	ROCK PTARMIGAN	0	0.00	0.00
4	0.08	2.63	BELTED KINGFISHER	3	0.03	6.25
0	0.00	0.00	DOWNY WOODPECKER	0	0.00	0.00
0	0.00	0.00	BLACK-B. WOODPECKER	1	0.01	0.00
0	0.00	0.00	THREE-TOED WODPECKER	0	0.00	0.00
0	0.00	0.00	YL-BELLIED SAPSUCKER	0	0.00	0.00
5	0.10	3.29	N.FLICKER	4	0.04	6.25
0		0.00				
2	0.04	1.32	SAY'S PHOEBE	0	0.00	0.00
0	0.00	0.00	OL.-SIDED FLYCATCHER	0	0.00	0.00
2	0.04	1.32	ALDER FLYCATCHER	1	0.01	3.13
0		0.00				
1	0.02	0.66	HORNED LARK	0	0.00	0.00
0	0.00	0.00	BLACK-B. MAGPIE	0	0.00	0.00
62	1.28	40.79	GRAY JAY	59	0.65	46.88
116	2.40	76.32	COMMON RAVEN	89	0.98	62.50
0		0.00				
152	3.14	100.00	RUSTY BLACKBIRD	154	1.69	81.25
0		0.00				
4	0.08	2.63	PINE GROSBEAK	4	0.04	9.38
2	0.04	1.32	WHITE-W. CROSSBILL	5	0.05	3.13
0	0.00	0.00	G.C.ROSY-FINCH	0	0.00	0.00
0	0.00	0.00	HOARY REDPOLL	0	0.00	0.00
55	1.14	36.18	COMMON REDPOLL	127	1.39	59.38
2	0.04	1.32	PINE SISKIN	0	0.00	0.00
0	0.00	0.00	SNOW BUNTING	0	0.00	0.00
6	0.12	3.95	LAPLAND LONGSPUR	0	0.00	0.00
13	0.27	8.55	SMITH'S LONGSPUR	2	0.02	6.25
67	1.38	44.08	SAVANNAH SPARROW	46	0.51	53.13
48	0.99	31.58	WHITE-CRND SPARROW	119	1.31	78.13
85	1.76	55.92	GOLDEN-CRND SPARROW	0	0.00	0.00
134	2.77	88.16	AM. TREE SPARROW	126	1.38	65.63
0	0.00	0.00	CHIPPING SPARROW	0	0.00	0.00
2	0.04	1.32	DARK-EYED JUNCO	25	0.27	21.88
1	0.02	0.66	LINCOLN'S SPARROW	4	0.04	9.38
121	2.50	79.61	FOX SPARROW	184	2.02	81.25
0		0.00				
9	0.19	5.92	CLIFF SWALLOW	2	0.02	3.13
31	0.64	20.39	TREE SWALLOW	1	0.01	3.13
0	0.00	0.00	VIOLET-GREEN SWALLOW	0	0.00	0.00
1	0.02	0.66	BANK SWALLOW	409	4.49	18.75
0		0.00				

0	0.00	0.00	BOHEMIAN WAXWING	21	0.23	25.00
16		10.53				
0	0.00	0.00	NORTHERN SHRIKE	6	0.07	6.25
0		0.00				
0	0.00	0.00	WARBLING VIREO	0	0.00	0.00
0	0.00	0.00	ORANGE CRND WARLER	4	0.04	6.25
116	2.40	76.32	YELLOW WARBLER	169	1.86	78.13
3	0.06	1.97	YEL-RUMPED WARBLER	79	0.87	56.25
109	2.25	71.71	BLACKPOLL WARBLER	73	0.80	59.38
138	2.85	90.79	NORTHERN WATERTHRUSH	200	2.20	90.63
0	0.00	0.00	COMMON YELLOWTHROAT	0	0.00	0.00
0	0.00	0.00	WILSON WARBLER	6	0.07	9.38
0		0.00				
4	0.08	2.63	AMERICAN PIPIT	0	0.00	0.00
0	0.00	0.00	AMERICAN DIPPER	0	0.00	0.00
0	0.00	0.00	BLACK C. CHICKADEE	0	0.00	0.00
0	0.00	0.00	GRAY HEADED CHICKADEE	1	0.01	3.13
5	0.10	3.29	BOREAL CHICKADEE	7	0.08	9.38
0	0.00	0.00	RUBY-CRND KINGLET	10	0.11	25.00
0		0.00				
1	0.02	0.66	TOWNSEND'S SOLITAIRE	0	0.00	0.00
131	2.71	86.18	GRAY-CHEEKED THRUSH	145	1.59	71.88
2	0.04	1.32	SWAINSON'S THRUSH	22	0.24	18.75
0	0.00	0.00	HERMIT THRUSH	1	0.01	3.13
111	2.29	73.03	AMERICAN ROBIN	206	2.26	93.75
4	0.08	2.63	VARIED THRUSH	3	0.03	6.25
0	0.00	0.00	NORTHERN WHEATEAR	0	0.00	0.00
4841				9105		

APPENDIX 3:

Summary of water isotope sample results collected from Old Crow Flats, July 2014

Prepared by Dr. Bronwyn Benkert, Yukon Research Centre

Water samples were collected from a suite of 11 lakes in the northwest portion of the Old Crow Flats (OCF) on July 9, 2014 Water samples were collected from just below the surface of the lake in 30 mL HDPE bottles and were capped tightly. Samples were analyzed for isotopic compositions of oxygen and hydrogen (reported as $\delta^{18}O$ and $\delta^{2}H$) by the University of Waterloo Environmental Isotope Laboratory. Results are expressed as δ-values, expressing deviations per mil (‰) from the widely used Vienna Standard Mean Ocean Water (VSMOW) standard, and are normalized to Standard Light Antarctic Precipitation. Analytical uncertainties are ±0.2‰ for $\delta^{18}O$ and ±2.0‰ for $\delta^{2}H$. Results are presented in .

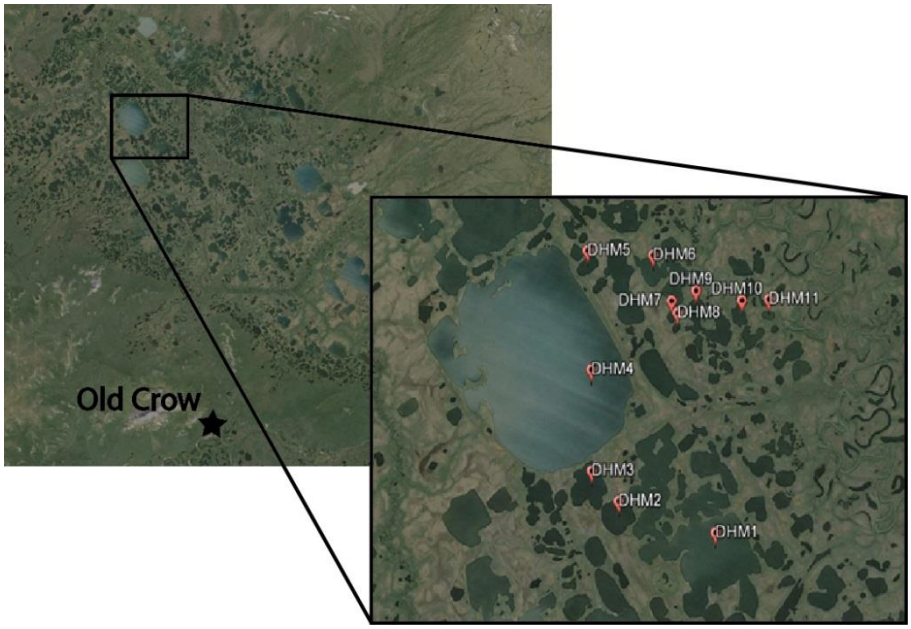


Figure 1. *Water isotope sampling sites from July 9, 2014 sampling campaign in the Old Crow Flats. Imagery: Google Earth.*

Table 1. Results of water samples collected from shallow OCF lakes on July 9, 2014.

Sample	Latitude	Longitude	δ18O result	δ2H result
DHM1	68.1034	-140.0758	-13.6	-131
DHM2	68.1122	-140.1619	-13.4	-130
DHM3	68.1208	-140.1861	-13.9	-131
DHM4	68.1501	-140.1874	-13.9	-130
DHM5	68.1844	-140.1915	-13.8	-131
DHM6	68.1833	-140.1333	-14.4	-134
DHM7	68.1702	-140.1165	-13.7	-135
DHM8	68.1667	-140.1111	-15.6	-144
DHM9	68.1732	-140.0948	-13.6	-132
DHM10	68.1705	-140.0539	-14.1	-135
DHM11	68.1709	-140.0299	-12.8	-128

Results are plotted on an isotopic framework reflecting atmospheric and climatological conditions for the Old Crow Flats, as presented by Turner et al. (2010). Framework parameters are defined in the caption.

Sample results plot closely along the LEL, supporting its suitability for the region, and are approaching isotopic and hydrological steady state. This indicates that proportionally, the ratio of inflow-to-evaporation is approaching 1, although at the time of sampling, all lakes were still more strongly influenced by inflow than evaporation.

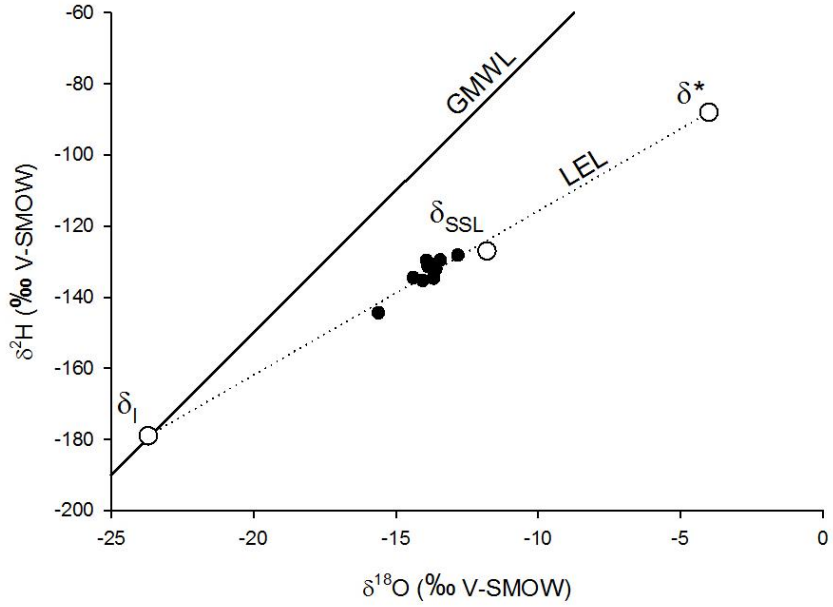


Figure 2. *Isotopic framework for the Old Crow Flats, with July 9, 2014 samples superimposed as closed circles. On the framework, GMWL = Global Meteoric Water Line (representing the isotopic composition of precipitation globally), LEL = Local Evaporation Line (representing the expected isotopic evolution of a water body undergoing evaporation), δ_I = isotopic composition of average annual precipitation for the*

region; δ_{SSL} = isotopic composition of a lake at isotopic and hydrologic steady state, and δ^* = limiting isotopic composition of a lake just before complete desiccation. Framework parameters are based on values published by Turner et al. (2010).

Previous work by Turner et al. (2010) on a suite of OCF lakes identified the two key input sources to lakes as snow and rain, with the isotopic composition of snow plotting along the more depleted end of the GMWL (i.e., more depleted than δ_I), while the composition of rain was more enriched than δ_I but still plotted closely to the GMWL. As a result, it is possible to infer that samples plotting above the LEL are predominantly influenced by rainfall, while samples that plot below the LEL are more strongly influenced by snowmelt. The distinction between snowmelt and rainfall-dominated lakes is most distinct in the early season. By July, when the samples shown were collected, the influence of snowmelt is largely overridden by the influence of evaporation and precipitation. However, some lakes continue to plot slightly above the LEL. This is consistent with results presented by Turner et al. (2010), which posit that the area of the OCF from which these samples were collected is largely dominated by rainfall.

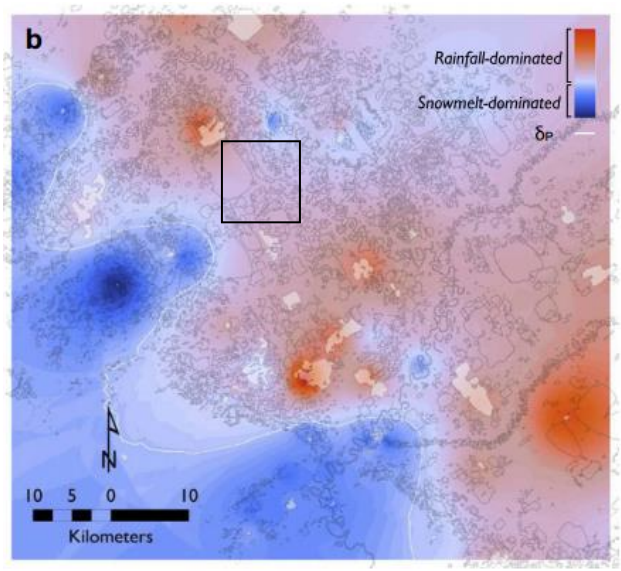


Figure 3. *Weighted interpolation map illustrating spatial distribution of δ_I values for the OCF, and inferring snowmelt vs. rainfall dominance. Reproduced from Turner et al. (2010). Black box outlines July 2014 sampling area.*

Continued collection of water samples from OCF lakes for water isotope tracer analysis is recommended, to monitor hydrological change spatially and over time in the OCF.

Literature:

1975. Mossop, D.H. Waterfowl research on the Old Crow Flats and wildlife inventories in The Northern Yukon, 1975. Y.T. game Branch ms.

1976. -------Waterfowl population status and breeding ecology on the Old Crow Flats, Y.T. Yukon game branch ms.

1977. -------Waterfowl population status and breeding ecology on the Old Crow Flats, Y.T. Yukon dept Ren. Res. Ms

1978. -------Romote sensing for waterfowl nesting and nesting habitat Old Crow Flats, Yukon Territory, Canada. (D. Russel sen a) Pecora 4 conference Sioux Falls

1982. -----The recovery of an interior peregrine falcon population in the northern Yukon Territory. In:Proceedings of a symposium and workshop: Raptor management and biology in Alaska and Western Canada: W.N.Ladd and P.F. Schempf eds: 234- (R. Hayes sr. aut)

2010. ------2010 population status of the peregrine falcon in the Yukon Territory. Northern Res. Inst ms, Yukon College 12 pp + append.

2013. ------The changing ecology of the Crow Flats Wetland (The birds are telling us things). Year two. Vuntut Gwitchin Govt, Yukon Res.Ctr. ms 22pp