LONG-TERM STUDIES OF WILLOW PTARMIGAN IN THE YUKON TERRITORY: ARE THEY SHOWING COLLAPSE OF 10-YEAR CYCLE ?

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D. Mossop
Northern Research Institute
Yukon College

Abstract:
From the late 1950's to the present, two to seven study plots across the Yukon have been variously searched annually for territorial ptarmigan. These data are held in a long-term data base maintained at Yukon College through the Northern Research Institute. Willow Ptarmigan (*Lagopus lagopus*) are the focus although Rock (*L. muta)* and White-tailed Ptarmigan (*L. leucurus*) observations are also logged incidentally. Monitoring has supported studies of winter survival strategies, tests of population change theory, reproductive strategy and interrelations with other members of the tundra community as a keystone species. Stable, regular cycles in abundance in broad 10-year synchrony across the Territory have been demonstrated. Beginning in 2000, monitoring surveys have been suggesting the regular cycling of abundance may have been disrupted. The potential consequence to the tundra ecosystem and possible climate change connections are potentially disastrous.

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--grouse as keystone species
--focus on health of northern communities
--grouse species across the landscape
--long term monitoring
--focus on willow ptarmigan and shrub tundra system
--study populations
--spawning research questions from data base
--cyclic phenomenon and recent anomaly
--community link (gyrfalcon top of food chain)
--evidence of breeding strategy disruption??

Grouse as Keystone species:
Perhaps the most important contribution the new synthesis discipline of Conservation Biology has made to our thinking has been to have us back off from single species analysis and to reassemble the natural communities within which these species live. Grouse with their rather huge research literature have become potentially one of the most powerful tools in helping this along. Grouse clearly rank in this conceptualizing as "keystone" species providing in the northern systems a vital 'portal' between the tropic levels of the plant kingdom and the animal. In particular during winter when they often literally provide the only prey for some species on the tundra their fluctuations are essential pieces to many reproductive strategies and their loss would be disastrous

Northern systems under siege:
As most of us are aware, northern systems are emerging as some of the most "in harms way" as human caused global changes to the environment occur. Living things here have built up sometimes amazing survival strategy to deal with what appears to us as a harsh land. As in all strategy these anatomical and behavioral adaptations are built around predictability. When predictability wavers we can expect to see strategy fail. Northern people are becoming abundantly aware of these failures piling up.

We could quote numerous examples of apparent 'failure' in what appear as wonderful strategy. (One: A trumpeter swan nesting on a Yukon Wetland probably for dozens of generations has a nest now annually devastated by wolverine…: though no fault of the species involved. Whereas water defended the nest site for generations; now the wetland for some reason has dried.)

Grouse species across the landscape:
Grouse, one of the three exclusively "northern" families of birds have done a wonderful job of dividing up and conquering northern ecosystems. In the Pacific Northwest here, 7-8 (depending how you count) species of grouse pursue specialization in their own

habitats. Bob Weeden (1958) was one of the first to start recognizing and analyzing the three tundra grouse doing so; now we recognize literally the whole landscape occupied:

Our understanding of the ecology of these species varies greatly, their ranges are understood only rudimentarily: Yukon's recent "Birds of Yukon" project tried to assemble sightings but of course is out of date the minute it was published:

White-tailed ptarmigan: Occupy the open desolate highest alpine tundras

Rock ptarmigan: Appear to be "high" and mesic shrubless tundra specialists

Willow ptarmigan: Are shrub tundra specialists.

Dusky and Sooty grouse: Subalpine fir community specialists

Spruce grouse: The massive Boreal Forest

Ruffed grouse: Riparian mostly mixed and deciduous forest

Sharp-tailed grouse: Outwash plains and open bog habitats

The numbers of these across the land basically reflects the abundance of their habitats: Harvest records show the spruce grouse (and its boreal forest home) dominating. In the tundra systems willow ptarmigan are clearly the dominant force.

Long-term monitoring:
Tracking the fortunes of populations in the face of global changes has given huge meaning to the wisdom of long-term monitoring. Bob Weeden again, was one of the grouse pioneers in the Yukon/Alaska region beginning back in the1950's almost instinctively to recognize this value. Some his original data sets now span almost 50 years.(Taylor, 2008). Religiously some of us (often in the face of official opposition) have gone forth annually, building these data bases and adding new ones. (Its been a delight to watch 'officialdom' suddenly realize this mundane tracking of species fortunes is so important that they now want us to think it was all their idea – and by the way "give us all your data".)

One of the longest-term efforts tracking the status of a northern species involves the Willow Ptarmigan (Lagopus lagopus) in the far northern Canadian Pacific Northwest. I picked up Weeden's work on the Chilkat pass, began tracking population parameters in 1970 and have continued through the present year. Yukon College students and I have added three additional widely spaced reference areas since that time allowing a broad view of the dynamics of the species from northern B.C. to the Yukon North Slope.

Collecting the data:The study populations are spaced widely across ecoregions of the territory. From the extreme south in Coast Range at the Chilkat Pass; the eastern

extremes in the Selwyn Mountains; mid-Yukon on the North Fork pass of the Ogilvie Mountains; above the arctic circle on the Old Crow Flats and finally the far north on the North Slope. The longest, best data sets are from the Chilkat Pass, the Ogilvie Mountains and to a lesser extent, the North Slope.

All are addressed by total search for territorial adults in spring. All but the North Slope populations have permanent areas which are searched from the ground normally on skis or snowshoes. A dog is used principally to make sure all pair members are found (ie females). The North slope and Old Crow Flats populations are surveyed with aircraft flying low level transect just after the snow disappears when visibility is highest.

Spawning research questions:
The major initial reason for this data base was to create a back drop for understanding research questions about the natural history and population ecology of the species.

a) Winter survival strategy was the first unknown. The result was a pretty good understanding of the roles of snow roosting, flocking behavior, feeding strategies, and daily timing of events culminating in the basic conclusion that winter is one of ptarmigan's best times of year; they gain weight all winter (Mossop 1970, 1988).
b) As the obvious 10-year cycle of abundance became clear, understanding what was driving numbers to decline at the top of the cycles led to research into events in late winter/early spring in the social system directly linked to a catastrophic decline in productivity (Mossop, 1988).
c) Following up on this work in cooperation with Tom Bergerud we were able to address questions about reproductive strategy, principally suggesting pretty clear hypothesis of the reasons for differing degrees of monogamy in the species of tundra grouse (Bergerud & Mossop 1884).
d) Harvest analysis and its effect on grouse (principally willow ptarmigan and sharp-tailed grouse, which early were intuitively recognized as vulnerable due to their winter strategy of forming flocks), led to some sobering results. (Yukon incidentally has one of the more sophisticated harvest tracking process, assigning harvest to small sub units across the territory.) Basically we were able to show that the harvest of these species are 'driven' not by their own densities but by the density and availability of Spruce Grouse. We are set up for catastrophic over harvest. (Mossop, 1994)

More recently questions of the role of willow ptarmigan in the tundra community have become the focus. In cooperation with Norm Barichello a grad student from UBC we were able to conduct companion field studies with ptarmigan as a keystone prey and a top predator. We begin putting together what has become a pretty comprehensive picture of the interrelationships between gyrfalcon dynamics and willow ptarmigan (Barichello). And most recently the data base principally the North Slope portion has become an integral part of a major ecosystem modeling effort in the current International Polar Year research initiative (WOLVES, 2007).

Recent cyclic anomaly:
The cyclic nature of grouse populations across the territory has been remarkable. Not only have the data bases been showing classic 10-year predictable cycles but synchrony across the entire territory and across the various species has been the norm. (graphs: harvest of species, etc).

Then in more recent times changes have become apparent. The first thing noted was that in the Coast Range population in particular, a general decline seemed to be happening (graph) driven apparently by a steady 3-decade decline in the amplitude of peak population numbers (graph). I first interpreted as possible over-harvest, but the next cycles seem to be revealing a more deep-seated change.

The best way to characterize the recent results is that the population peak seems to have disappeared and that fluctuations from year to year have become random without trend. (graphs). In both annually monitored populations the same kind of collapse of the 'cycle' seems apparent (graphs).

Discussion: Tundra Community implications:
Clearly it is important to view all of the changes we see in the north against the background of a warming, less predictable climate.

Survival strategies clearly have to be built around predictability in the system. One of the more observable predictable features of life in the northern ecosystems is the cyclic nature of the medium sized vertebrates like hares and grouse along with their predators. It makes intuitive sense that strategy to deal with this periodic 'rush' of nutrient followed by virtual disappearance would be a vital part of the life history of many species. Everything the discipline of Conservation Biology is teaching would say that when a key-stone resource or species falters, the system is going to be in some jeopardy.

The cooperative work Norm Barichello and I have conducted with willow ptarmigan and gyrfalcons provides some insight. Gyrfalcons , top predator in the tundra system are largely non-migratory and totally dependant on ptarmigan in late winter when literally there is no other source of prey. This idea is borne out by comparisons of ptarmigan and gyrfalcon annual data (graphs)

Norm was further able to describe as a mechanism, an almost eerily close association between ptarmigan population performance and gyrfalcon breeding. Seemingly this is driven by social behavior of gyrfalcons around the breeding cycle which involves the male using prey in courting. The correlation between the proportion of yearling ptarmigan present in late winter and the reproductive output of gyrfalcons was almost perfect. This hypothesis supported by good observational data suggests that the gyrfalcon's performance will be an almost perfect focal species as an indicator of the health of the tundra ecosystem.

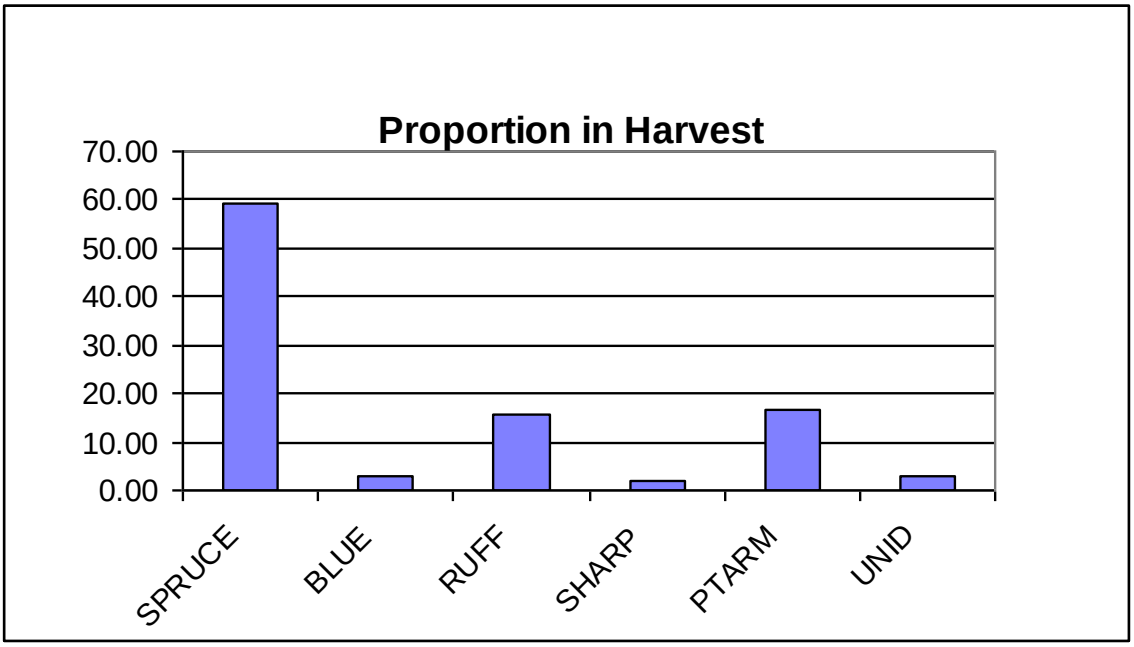
Over the same period during which ptarmigan performance has become less predictable there have been apparently profound changes in gyrfalcon breeding ecology. Firstly there is some suggestion (especially obvious on the North Slope - graph) that the numbers of adults attending nest sites has been declining. This of course is the ultimate indication of problems.

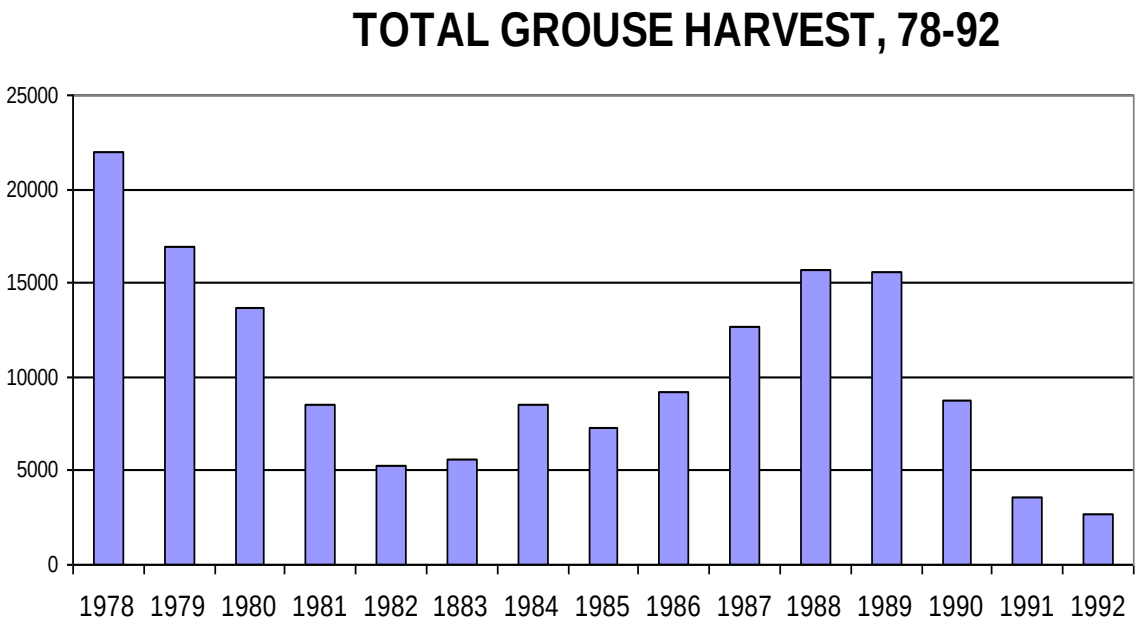
Associated is an obvious change in the timing of gyrfalcon breeding effort. It makes intuitive sense that these arctic nesting birds should track the timing of events as a priority and time breeding to be both as early as possible and associated with the best prey availability at key times in the breeding cycle. As ptarmigan performance becomes less predictable one would expect it to become less possible to track accurately. In the first few years of the anomalies associated with clear indications of a warming northern

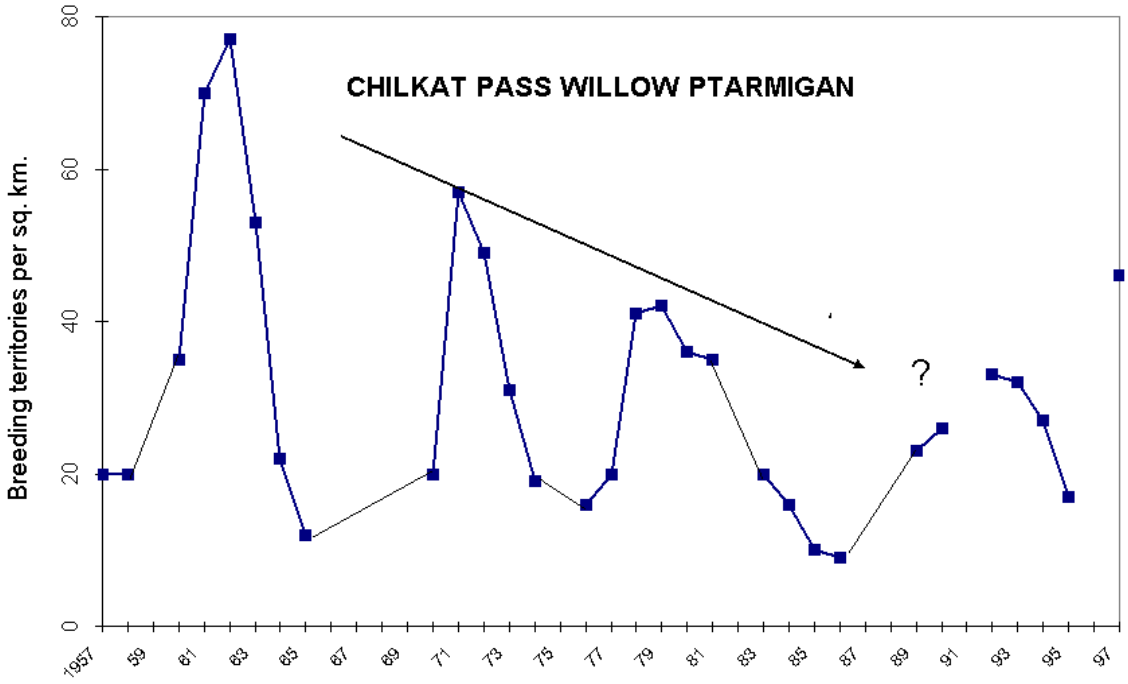
climate, what appeared to be happening was a perfectly expected shift toward earlier breeding in gyrfalcons (graph).

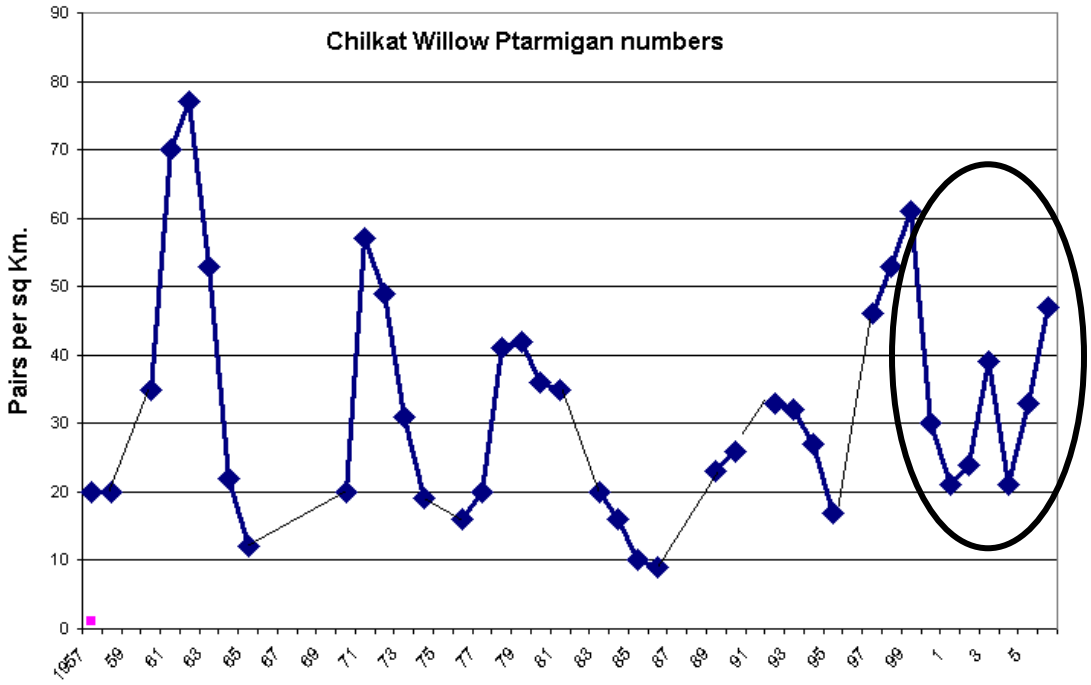
More recently a more striking and troubling observation has been a trend toward the exact opposite. Gyrfalcons are now breeding almost three weeks LATER than they did originally (graph). Breeding late as is generally known is not a good strategy. Everything about gyrfalcon natural history has emphasized early breeding.

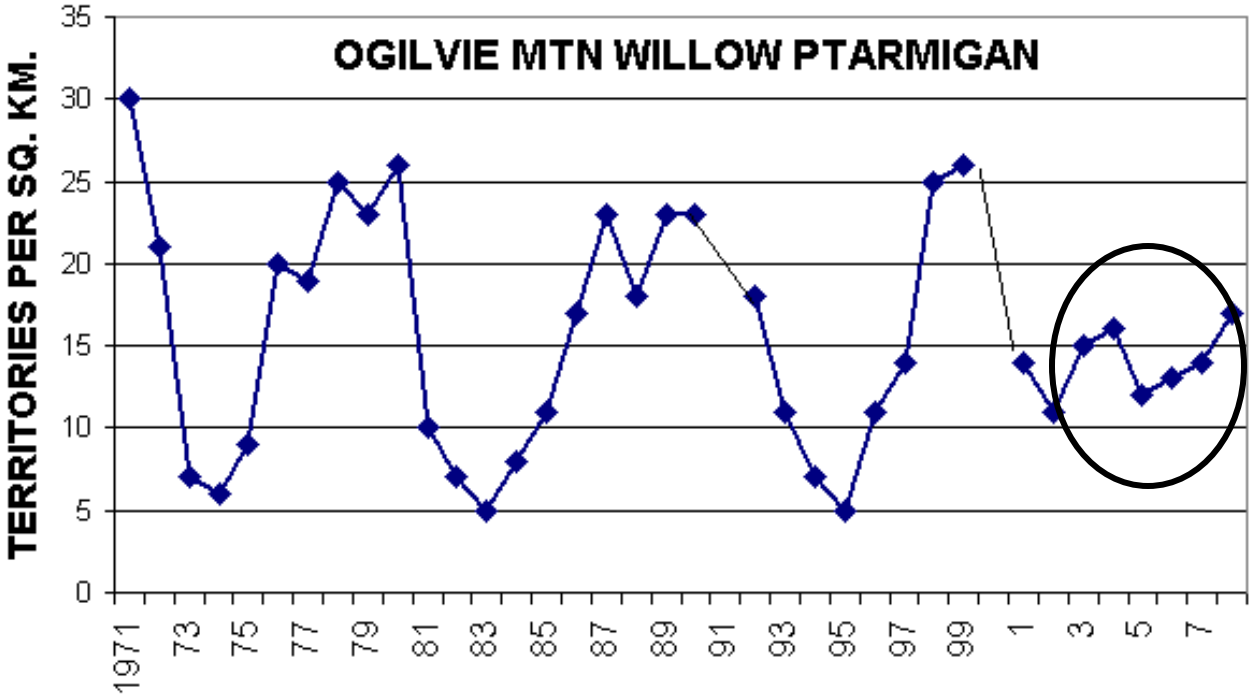
What this points most squarely at, is the vital importance of the key stone species and its predictable populations. More specifically it is very likely that the 10-year peak 'rushes' of protein are absolutely essential parts of this predictability. For instance, all our modeling of gyrfalcon number suggests that the young produced in the peak ptarmigan years may be vital to maintaining a sustainable population over the long term. If we are losing one of the most obvious features of the northern systems and if this is happening as a consequence of climate change this just might develop as one of our most tragic complications caused by that human-caused universal catastrophe.


Proportion in Harvest
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
SPRUCE
BLUE
RUFF
SHARP
PTARM
UNID


TOTAL GROUSE HARVEST, 78-92
25000
20000
15000
10000
5000
0
1978
1979
1980
1981
1982
1883
1984
1985
1986
1987
1988
1989
1990
1991
1992


CHILKAT PASS WILLOW PTARMIGAN
Breeding territories per sq. km.
0
20
40
60
80
1957
59
61
63
65
67
69
71
73
75
77
79
81
83
85
87
89
91
93
95
97
?


Chilkat Willow Ptarmigan numbers
Pairs per sq Km.
90
80
70
60
50
40
30
20
10
0
1957
59
61
63
65
67
69
71
73
75
77
79
81
83
85
87
89
91
93
95
97
99
1
3
5


OGILVIE MTN WILLOW PTARMIGAN
TERRITORIES PER SQ. KM.
35
30
25
20
15
10
5
0
1971
73
75
77
79
81
83
85
87
89
91
93
95
97
99
1
3
5
7