

# THE COMMUNITY ECOLOGICAL MONITORING PROGRAM ANNUAL DATA REPORT 2014

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## Executive Summary

The Community Ecological Monitoring Program (CEMP) arose in 2005 as an extension of the Kluane monitoring project to begin a regional assessment of the health and change of the Yukon boreal forest ecosystem. This is the eighth annual report to summarize the data on white spruce cone crops, ground berry production, small mammals, snowshoe hares, and carnivore abundance at Kluane Lake, Mayo, Faro, Watson Lake, and Whitehorse. White spruce cone counts were high in all areas in either 2013 or 2014 or both years with some (Faro and Watson Lake) being high in 2013 and Whitehorse and Kluane being high in 2014. Ground berries in the forest were moderate in 2014 with some variability from site to site. Watson Lake and Faro had very low ground berry counts, and Mayo had the lowest cranberry counts recorded in the last 10 years. Red-backed voles remained at high numbers in 2014 at Whitehorse, increased at Mayo and Watson Lake, but declined at Kluane and Faro from the high numbers of 2013. Snowshoe hares are increasing strongly in all areas, recovering from their cyclic low of 2010-2012. The next hare peak in the Yukon will probably occur in 2016. Soapberries were abundant in 2013 at Whitehorse and moderate at Kluane, but very low at Mayo. Snow track counts in winter for mammalian predators were completed at Kluane and Mayo, but very poor snow conditions prevented predator snow tracking at Faro and Watson Lake. At all CEMP sites lynx appear to be starting to increase during 2014. Marten remained at moderate numbers at Mayo and Kluane. In a separate study local knowledge interviews were completed at Mayo by Mark O'Donoghue in early 2014 and are summarized briefly here, an important step in bringing local knowledge of trends together with our CEMP data. As additional data are added in the years to come, the regional patterns of ecosystem changes will become more evident.

## Introduction

Since detailed ecological studies of the Kluane boreal forest began in 1973 we have been monitoring the ecological integrity of the Kluane region, and have over the years improved the monitoring methods being used. In 2005 we were able to expand some of the monitoring protocols to Mayo, Watson Lake, and Whitehorse, and in 2007 we began collecting data at Faro. This has permitted us to focus on regional trends in measures of ecosystem health and change. The Community Ecological Monitoring Program (CEMP) is a partnership between biologists at Environment Yukon, Yukon College, and the Arctic Institute Research Station at Kluane Lake. Additional monitoring in the Yukon is being done by Parks Canada and other research groups but we have not tried to summarize all of this monitoring here. We concentrate here on the CEMP monitoring being carried out in the central and southern Yukon.

There are two approaches ecologists are using to answer the broad question about changes in ecosystem integrity over time. First, sit and count, wait and see. This is the simplest approach to describe the system as it changes and it is useful as a first step. By itself it does not permit any management actions to thwart changes, since, by

the time you see changes, it is often too late to do very much about them. Nevertheless, this approach is important because we carefully document where we were, what is happening now, and where we may be in the future. Second, we can identify key components of the ecosystem that appear to be responding rapidly to climate change and target them for both model building and experimental attack to try to understand the underlying ecosystem complexity. This requires intense multi-year research, carried out by university students, regional biologists, and Parks personnel. This is our approach. We have picked ecosystem variables like ground berry production and spruce cone production that are commonly thought to be under the control of weather, and we are building predictive models that we can test to predict (for example) the abundance of ground berries from temperature and rainfall data in particular months of the previous year. We can then test these models from year to year to see if they are accurate and to change them as needed. By itself this approach will not solve the broad problem of ecosystem change, but it is a start and in combination with the first approach we will gradually improve our understanding of where we are headed with climate change.

This monitoring program has several interrelated objectives. First, it provides long-term monitoring data that provide important baseline information on undisturbed forest sites, and this information is of value to many research programs as well as providing control data for assessing impacts of industrial developments, and for park and forest management in the Kluane region. Second, it constitutes an early warning system of significant changes taking place in the central and southern Yukon boreal forest ecosystem. The early detection of these changes should guide medium to long-term planning and biodiversity management and research. Third, CEMP monitors the long-term processes that drive the boreal forest ecosystem. The Kluane Boreal Forest Ecosystem Project documented important interactions and ecological processes during the ten years of its existence, 1986 to 1996 (Krebs, Boutin and Boonstra 2001). However, we still do not understand the longer cycles and processes that drive boreal forest ecosystems on a landscape scale and help to protect its biodiversity. CEMP is helping to document some of those patterns and processes.

Data from our CEMP monitoring are supplemented by local knowledge gathered in interviews carried out each year at Mayo, and we will report on this work briefly in this report as well.

## **Why Monitoring is needed**

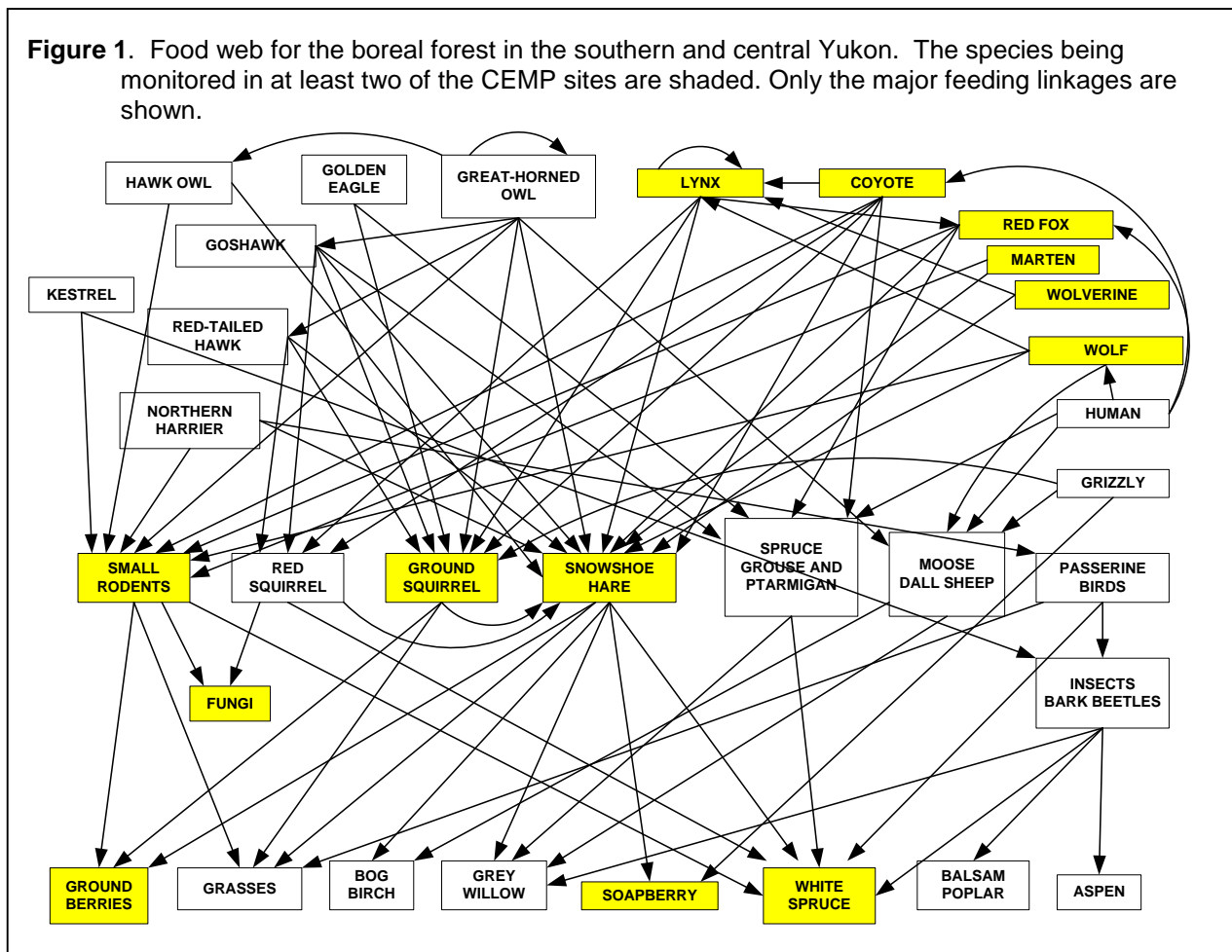
What are the goals of this monitoring program? It is important to keep in mind where we are headed in any monitoring design. The key question we need to be able to answer is *how will the Yukon's ecosystems respond to climate change?* The answer to this simple question is not simple. Some parts of our Yukon ecosystems like spruce cone crops are directly dependent on climatic variables like temperature and rainfall. Others, for example snowshoe hares, depend immediately on the abundance and hunting success of predators like lynx, so the question then becomes will climate change affect lynx hunting success and if so how?

The key to these approaches is to have a comprehensive monitoring program in place that gathers data year after year. We cannot start and stop monitoring programs for a few years any more than we can stop and start reporting on the stock market for a few years. The need is thus for a commitment in funding and in people to carry these goals forward. This is what we have begun in the CEMP program and we summarize here what we have so far achieved.

### Protocols Monitored and Cooperating Research Programs

Figure 1 shows the food web of the southern and central Yukon boreal forest region. If we wish to monitor ecological integrity, we need to measure key components in each of the levels of this food web. However, we cannot monitor everything, and we have concentrated our efforts on 7 significant indicators. We believe that these indicators constitute a start for obtaining early warning of ecosystem change, establishing baseline data on the natural range of variation of key ecosystem components, evaluating forest management practices, and advancing our understanding of the dynamics of boreal ecosystems. The 7 indicators (counting the mammalian predators as one indicator) that are being monitored are listed below. The species that are being monitored are indicated by shading in Figure 1. Note that we do not have the funding to monitor large mammals like bears, moose, caribou, and Dall sheep, and these large mammals are monitored by other programs in Environment Yukon and by First Nations.

**Figure 1.** Food web for the boreal forest in the southern and central Yukon. The species being monitored in at least two of the CEMP sites are shaded. Only the major feeding linkages are shown.



A brief description of what we measure in each protocol and why we measure it is given below:

1. **White Spruce Cone Production.** Measurements: annual rates of cone production are documented. Rationale: major food for red squirrels, passerine birds, and mice.
2. **Ground Berry and Soapberry Production.** Measurements: berry production is recorded each year for the major berry producers in the Yukon boreal forests – crowberry, bearberry, red bearberry, toadflax, cranberry, and soapberry. Rationale: major food supplies for small mammals, bears and birds.
3. **Mushroom Production:** Measurements: standing crop of mushrooms is recorded in early August each year as an index of mushroom fruiting. Rationale: important food for red squirrels and other mammals, highly variable in production from year to year.
4. **Small Mammal Abundance.** Measurements: population density estimates calculated from live trapping mice and voles twice per year at Kluane and Whitehorse, and once per summer at other CEMP sites. Rationale: major prey for many predators (weasel, marten, raptors); these small mammals create a 3-4 year population cycle as well as major irruptions in the area.
5. **Arctic Ground Squirrel Abundance:** Measurements: population density estimates from live trapping once or twice per year at Kluane. Ground squirrels do not occur in forested areas at the other CEMP sites, and are most common in alpine areas that we do not sample. Rationale: major prey item for many predators.
6. **Snowshoe Hare Abundance.** Measurements: population density estimates calculated from live trapping hares twice per year at Kluane and by counting fecal pellets once per year at all CEMP sites. Rationale: the keystone species of the boreal forest throughout Canada with a 9-10 year population cycle.
7. **Predator Abundance.** Measurements: index of relative abundance of coyotes, lynx, marten, and other predators from winter track transect is being carried out annually in the Kluane Lake area and in the Mayo, Whitehorse, Watson Lake and Faro areas. Rationale: an index of major terrestrial predators in the system.

We have prepared a separate handbook of the details of the monitoring protocols for each of the species groups listed above (CEMP Monitoring, 2013, available on the web at <http://www.zoology.ubc.ca/~krebs/kluane.html>).

In addition to these 7 protocols, a number of research and management projects are being conducted in the Yukon (e.g. the Breeding Bird Survey, Christmas Bird Counts, Owl Surveys). Through cooperation and partnerships, these projects contribute important additional information that is valuable for long-term monitoring in the Yukon.

Two general questions underlie this monitoring program. First, is there synchrony among sites in these indicators? Regional synchrony can be achieved by ecological indicators responding to weather variation that has a widespread regional signature, or by large-scale dispersal of animals like lynx and coyotes. Second, are there regional patterns of variation in the density or productivity of indicators? For example, snowshoe hares may be on average more abundant in some areas than they are in others. In turn, all these regional similarities or differences need to be explained ecologically.

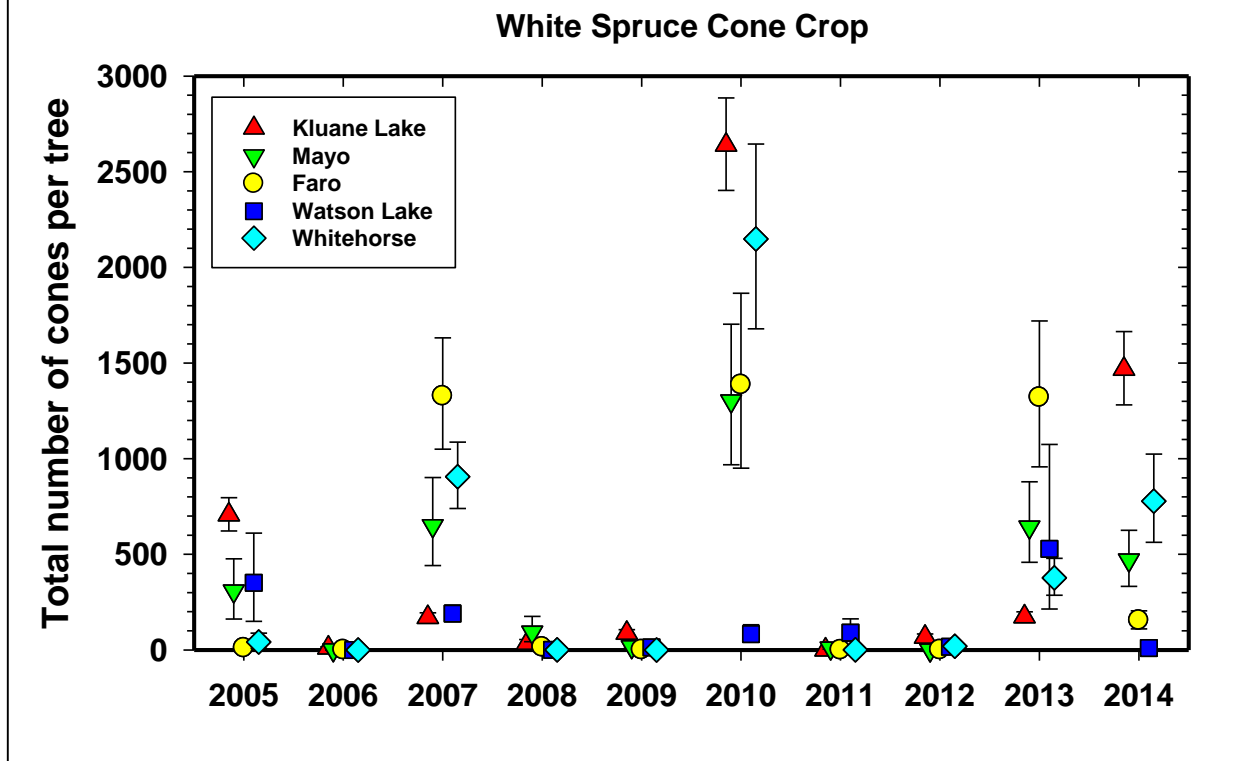
## Results and Discussion

For the purpose of this Annual Report, we would like to discuss some of the findings from 7 of the protocols. We maintain on the web site <http://www.zoology.ubc.ca/~krebs/kluane.html> a detailed EXCEL file (*monitor.xlsx*) that has all the summarized data from all our monitoring efforts at Kluane since 1973. As indicated in Table 1, many of the protocols have been developed for CEMP only since 2004 and thus regional comparisons within CEMP are limited to the years 2005 to 2014. In the figures that follow we report means and 95 % confidence limits unless indicated otherwise.

### (a) White Spruce Cone Production

White spruce trees produce a variable number of cones each year, and at irregular intervals very large crops are produced in many years. We have been counting cones on spruce in the Kluane area since 1987, and Figure 2 shows the cone counts over the CEMP sampling sites since 2005. The 2005 and 2007 cone crops were moderate, but the 2006, 2008, 2009, 2011, and 2012 cone crops were nearly a complete failure at Kluane, Mayo, Watson Lake, Faro, and Whitehorse. Cone counts in 2013 were rising on all sites with Faro the highest, and 2013 was peak cone production for Faro and Watson Lake. Cone production was even higher in 2014 at Kluane Lake and Whitehorse and remained moderately high at Mayo. The pattern of two high years in a row at Mayo was produced by the unusual situation in which one set

**Figure 2.** Average white spruce cone counts on CEMP sites for 2005 to 2014. Green cones are counted from the top 3 m of a tagged set of trees each August. These index counts are converted to total cones per tree by the LaMontagne conversion (LaMontagne et al. 2007). There was a complete cone failure in 2006, 2008, 2009, 2011 and 2012 at all sites. The 2010 count was the largest we have seen during the last 25 years.



of individual trees were at peak cone production in 2013 and another set of trees the following year, masking the average cone count for these two years. If years of high cone production are driven by weather variables, we should soon be able to correlate our weather data with these cone production events. There is a suggestion of a cycle in cone crops in the CEMP areas, but this cyclic interval is variable so more data are needed and so far our data do not allow for prediction of when the next large cone crop should be expected. We have data on cone crops at Kluane Lake since 1987 and we have developed a statistical model to predict cone crops in the Kluane region from summer temperature and rainfall of the previous 2 years (Krebs et al. 2012). In 2015 we will check this statistical model with further data, and develop comparable models for the other sites.

What is surprising about Figure 2 is that all the 5 regional counts show a similar pattern of high and low years, and there were very high crops in summer 2010 at all sites except Watson Lake. Peak cones were more variable in 2013 and 2014 among the 5 sites and this might be due to local weather variation. The suggestion from this is that the regional climate of the southern and central Yukon may coordinate years of high and low cone counts. Further data are required to quantify the regional synchrony in cone crops. Cone counts are highly variable, as Figure 2 shows, and different sites within a region can be quite variable. Because of this variability in cone production, it will take a series of several poor years (> 7) in a row for us to conclude that cone production is falling due to some external factor such as climate change. Red squirrels and seed-eating birds might provide a more responsive index of detrimental cone crop changes.

### **(b) Ground Berry Production**

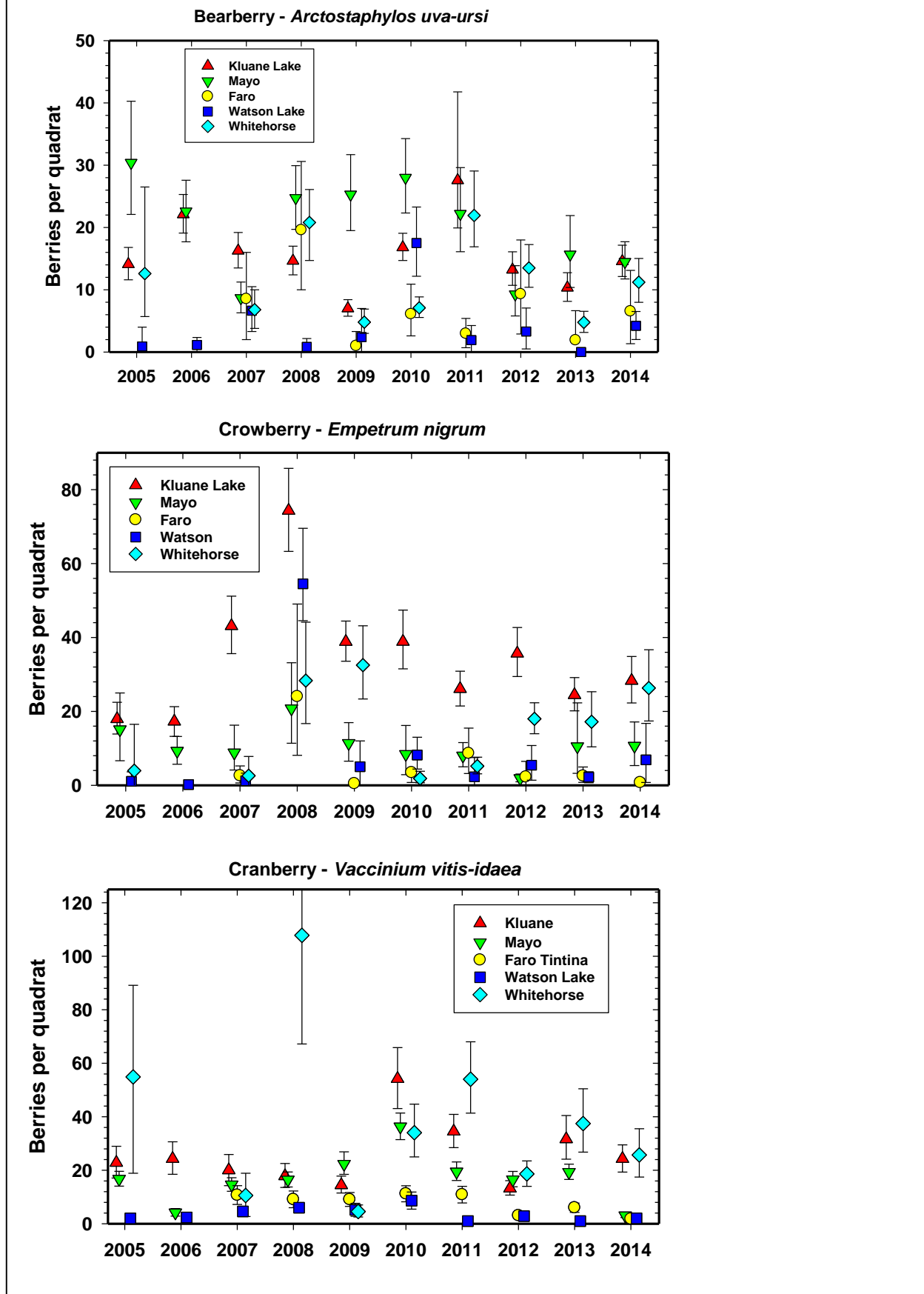
Five species of ground berries are counted in permanent quadrats each year. The major berry-producing plants are bearberry (*Arctostaphylos uva-ursi*), red bearberry (*A. rubra*), crowberry (*Empetrum nigrum*), toadflax (*Geocaulon lividum*), and cranberry (*Vaccinium vitis-idaea*). Figure 3 shows the data we have accumulated on three of the species of ground berries since 2005.

Bearberry counts are highly variable among the five monitoring areas. In particular Watson Lake sites had very few bearberries in all these years. Mayo had consistently high counts of bearberries from 2005 to 2011 (which could account for the stability of small rodent numbers) but in the last 2 years Mayo counts of bearberries have been lower but still relatively high compared to other sites. There was considerable variation in bearberry numbers between sites and years in 2010 and 2011, but less among sites in 2012 and 2013. The variation is large enough to require more data to see if there is a clear pattern or if local processes (e.g. at Mayo) determine berry production in this species. At the present time it looks like local processes determine bearberry crops.

Crowberry counts show a clearer pattern of agreement among most of the sites with a high production year only in 2008 and lower counts in the last 6 years. The average production of crowberries at Kluane is 2-3 times that of each of the other 4 sites for these ten years of data. Crowberry counts on all sites except Kluane and Whitehorse were very low in 2014. Crowberry counts at Mayo appear to be more constant than those at other CEMP sites.

Cranberry counts show yet a different pattern with low to very low production at all sites in 2012 and increasing counts in 2013 in Whitehorse and Kluane. In 2013 Faro and Watson Lake had very few cranberries, while Mayo was nearly the same in 2012 and 2013 but collapsed to near zero in 2014. There has been no repeat of the 2008

**Figure 3.** Average berry counts for 3 species of ground berries at CEMP sites from 2005 to 2014. Quadrat size is 40 by 40 cm. Error bars are 95% confidence intervals.



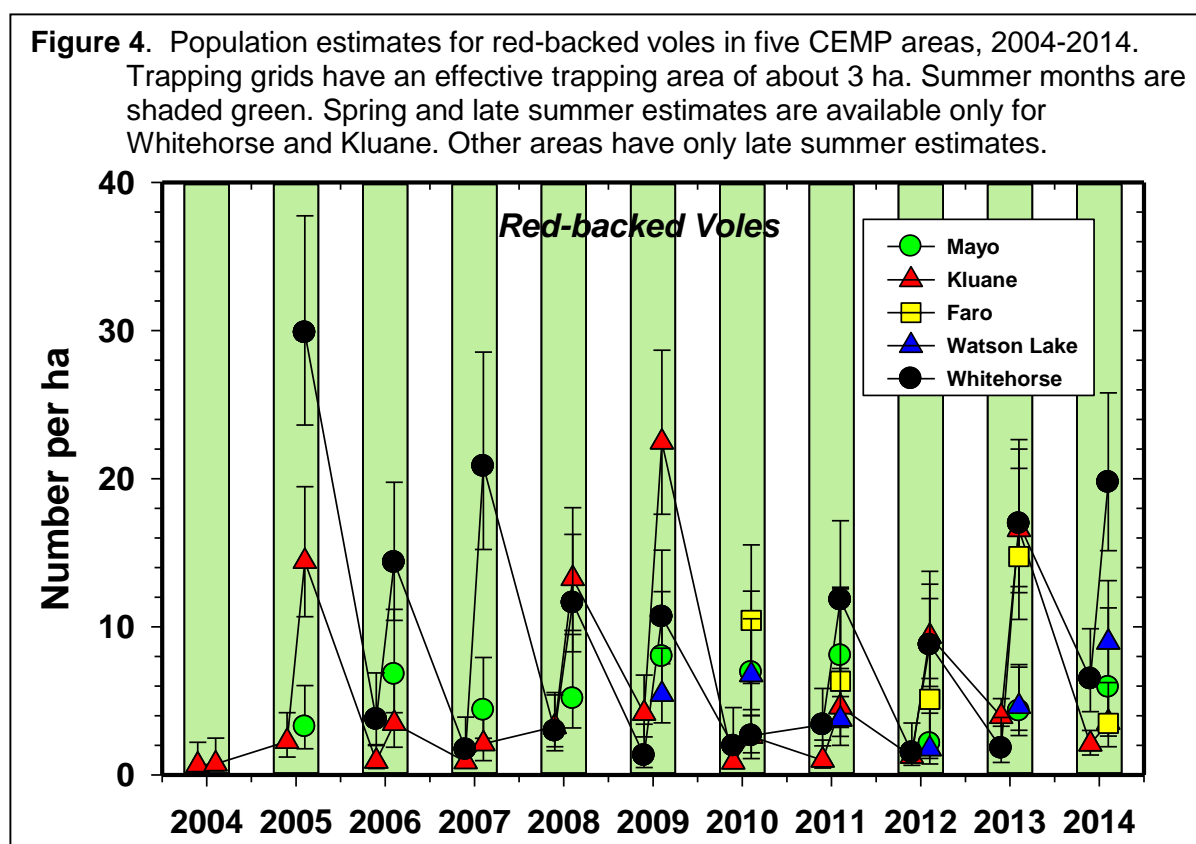
high cranberry counts in Whitehorse, and moderate counts were found only at Whitehorse and Kluane in 2014. There seems to be no clear general regional pattern to these berry counts.

We have analyzed the climatic controls of ground berry production in the Kluane region from data gathered over 1994 to 2008 resulting in equations relating berry production to climate (Krebs et al. 2009). Each species of ground berry in the Kluane area responded to different signals of temperature and rainfall, and there was no general climate pattern to which all the species of ground berries responded. Future data will permit us to evaluate whether these predictive climatic equations that seem to operate well in the Kluane area also apply to the other CEMP sites. Our working hypothesis is that ground berries respond to regional weather patterns but that individual berry species require a different suite of weather variables (monthly temperatures, monthly rainfall) from the current and previous years in order to produce a large berry crop.

### (c) Small Rodent Numbers

The most common rodent on all of the CEMP sites is the red-backed vole (*Myodes = Clethrionomys rutilus*), and we have estimated the abundance of this species by live trapping, marking, and releasing individuals. Live trapping at Kluane and Whitehorse is done in spring and late summer, and at Mayo, Faro, and Watson Lake only in late summer. Figure 4 shows the changes in red-backed vole numbers for the period 2004 to 2012.

Red-backed voles at Kluane have fluctuated in 3-4 year cycles for the past 25 years and this pattern is shown in Figure 4 with peak years of 2005, 2009, and 2013. But Mayo populations have been nearly stable from 2005 to 2011, dropping to a low point in 2012. Whitehorse populations were extremely high in the late summer of 2005 and again in late summer 2007, moderately abundant in 2008 and 2009, at low ebb in





2010, and rising again in the last 3 years. The pattern to date does not suggest any clear synchrony in fluctuations of red-backed vole numbers in the southern and central Yukon. Further data are needed to determine if this asynchrony continues in red-backed vole populations at the different CEMP sites in subsequent years.

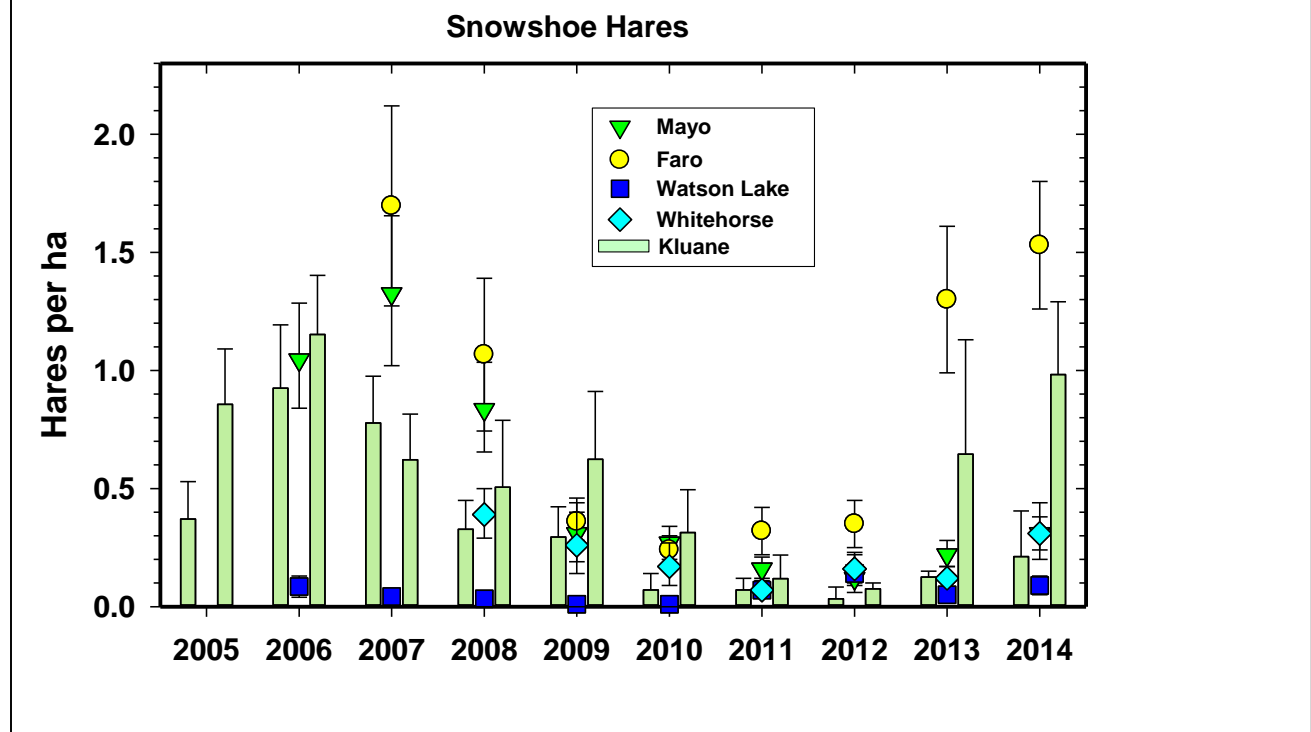
The only other small mammal that is common to many of the CEMP sites is the deer mouse, *Peromyscus maniculatus*. At present the number of captures of this rodent species is too low on most of the sites to discuss any common patterns of population change. Deer mice remained between 1-3 per ha on all sites from 2005 to 2014, and in general tend to be stable in numbers from year to year.

#### (d) Snowshoe Hare Numbers

The snowshoe hare is a keystone species in much of the boreal forest because it is the prey of so many predators (see Figure 1). Snowshoe hares fluctuate in 9-10 year cycles throughout the boreal zone. At Kluane we have estimated the abundance of snowshoe hares by live trapping, marking, and releasing individuals. We developed a simple census method for hares by the use of fecal pellet counts carried out once a year in summer (Krebs et al. 2001) and this technique has been used at all the CEMP sites for comparative data. Figure 5 shows the changes in hare numbers since 2005 at the CEMP sites.

Two points stand out in Figure 5. First, Watson Lake sites had almost no snowshoe hares in any of the eight years for which we have data. There is clear natural history information for Watson Lake that the hare cycle exists and that hares are

**Figure 5.** Population density estimates for snowshoe hares in CEMP areas, 2005-2014. Mark-recapture data from Kluane are given as histogram bars, and estimates from fecal pellet counts at CEMP sites are given as points (95% confidence limits). Note that the data from fecal pellet counts integrate hare density over the previous year.



increasing rapidly in that area, so the problem is that the current hare monitoring sites are in poor hare habitat and need to be repositioned. Second, all other CEMP sites are following the Kluane hare cycle closely, with peak populations in 2006-7 and declining populations in 2008, 2009, and 2010. The hare population at Kluane showed a strong increase over the summer of 2009, but this increase was trimmed back to low numbers by the spring of 2010, and the same pattern occurred in 2011 and 2012. Faro hare numbers increased rapidly in the summer of 2013 and continued to increase in 2014. Slower rates of growth at Mayo and Whitehorse occurred in 2014. The increase phase of the hare cycle has begun strongly and if these trends continue we could have a super-peak in 2015-2016.

Regional synchrony is well established in snowshoe hares in much of the Yukon, but as we get more regional details we find that not all areas in western Canada and Alaska tend to be in phase. We have summarized the hare data from the Yukon, Alaska, northern BC and the NWT in Krebs et al. (2013, 2014). This analysis of regional synchrony strongly suggests a travelling wave of hare peaks that moves from northern BC into the Yukon and then north and west into Alaska. We are interested to determine if this travelling wave will be seen in the coming hare peak in 2015-2018, and our colleagues in Alaska and the NWT are gathering hare data comparable to ours to answer this question.

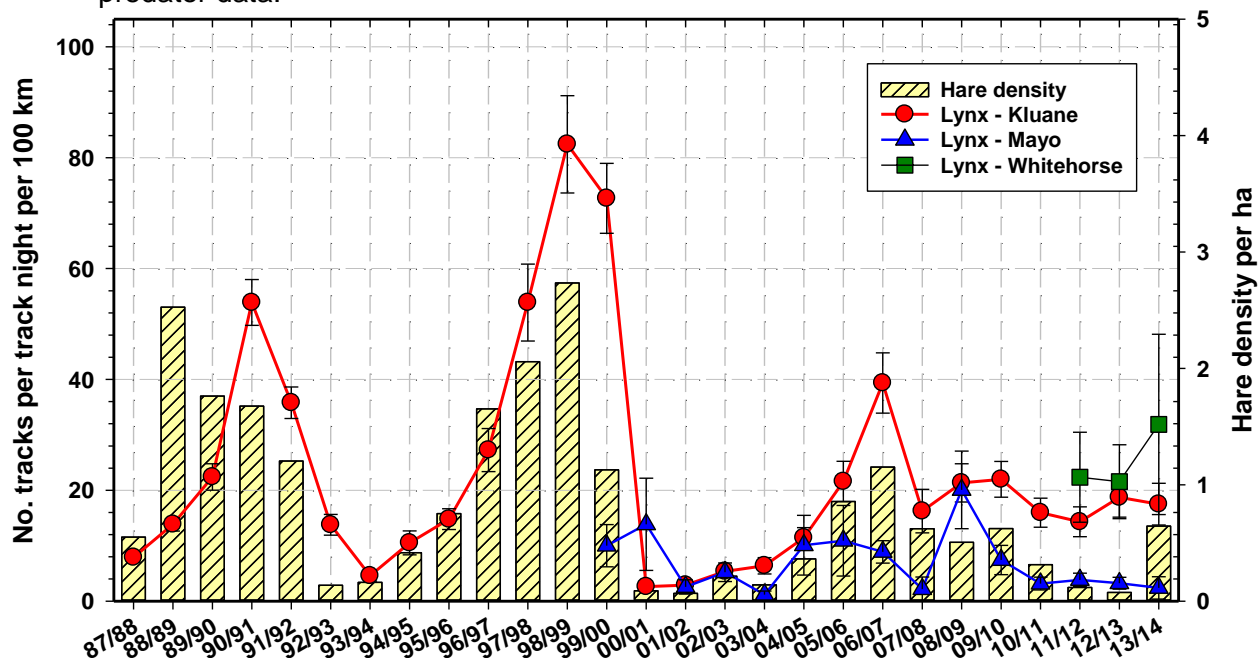
The significance of these regional differences in the hare cycle lies in the movements of predators like lynx and great-horned owls from one high hare area to adjacent ones that are low or starting to recover. The most promising explanation for regional synchrony involves predator movements, and depending on the geometry of the highs, such movements could produce a travelling wave of density changes.

### **(e) Lynx Abundance**

We have been following lynx abundance in the Kluane region since 1987 by means of winter snow track counts along established routes. We expanded this predator tracking to Mayo in 1999 and to Whitehorse, Faro, and Watson Lake in 2009. We count lynx tracks crossing snowmobile routes after fresh snowfalls each winter, depending on wind conditions. On average about 300 km are tracked each winter at Kluane and about 125 km at Mayo. But during the last 2 years snow conditions in winter have limited our ability to use snow tracking for predator counts.

Figure 6 shows the changes in abundance of lynx in Mayo, Kluane and Whitehorse as measured by snow tracks. Because our winter snow tracking cannot be done in identical habitats in all areas, we do not expect the absolute number of tracks to directly indicate lynx density but only trends in density. Three points are quite striking in this graph. First, the last lynx peak at Kluane in 2006-07 was the lowest we have seen, coincidental with the lowest hare peak we have seen at Kluane. Second, lynx at Mayo appear to be out of phase with lynx at Kluane by a delay of 1-2 years. Third, lynx abundance during the low of the hare cycle at Kluane during the last 6 years is higher than we have seen in a hare low previously. There are more lynx in the Kluane area (and at Whitehorse) during the last several years than could ever be supported on the existing hare population. These lynx must be transients headed for starvation or have been able to switch to alternate prey like red squirrels. We do not know which of these scenarios is correct but we suspect that they are feeding mainly on red squirrels. O'Donoghue et al. (1997) showed that radio-collared lynx moved up to 830 km from their home range once the hare cycle collapsed.

**Figure 6.** Snow tracking abundance estimates for Canada lynx at Kluane, Mayo, and Whitehorse, 1987 to 2013. Hare data are from Kluane in the autumn preceding the winter predator data.



We do not have any snow tracking data from Faro or Watson Lake for winter 2013-2014 because of a shortage of snow. Because this may become a more serious problem in future years, we began in autumn 2014 to install a set of trail cameras in the Kluane area to take automatic photos from October to January of animals moving along game trails and paths. We will determine in spring 2015 if this use of game cameras can potentially replace snow tracking in winter to obtain an index of predator abundance.

Lynx appear to be increasing on all areas as the hare cycle is returning in late 2014, and we need more quantitative data to evaluate their rate of increase as hare abundance increases.

#### **(g) Brief Notes on Other Monitoring Measurements**

Soapberries are a favourite food of grizzly bears, and are being counted at Kluane, Mayo, and Whitehorse. We place a high priority on counting soapberries in all sites but there are few soapberries on some of our sites which make this a challenge. In 2014 soapberries were at very low abundance at Mayo but were abundant on bushes at Whitehorse and moderately abundant at Kluane.

Red squirrel numbers have been studied extensively at Kluane for years by Stan Boutin's group, and we are evaluating the possibility of using midden counts or call counts as indices on the other CEMP sites. In general red squirrel numbers are relatively stable in the boreal forest and may need to be censused only every few years.

Coyotes and lynx follow the hare cycle closely. Marten and weasels have become much more abundant since 2000 at Kluane and may be affecting the dynamics of the hare cycle. More information is being gathered from the other CEMP monitoring sites on predator numbers by means of snow tracking or camera trapping and this will give us regional patterns in the coming years.

Bird surveys in the Yukon are being done by other groups, but we would like to coordinate owl survey counts with the BC Owl Survey in future years to get coverage at all CEMP sites. Other bird surveys would be desirable to put in place to obtain a better picture of regional trends for the southern Yukon. Natural history observations suggest increasing grouse populations at many of the CEMP sites in 2014.

There is general interest among Yukon and Alaskan biologists to implement a program of regional monitoring of the major mammal and bird predators of the boreal forest. It would require a large investment of time and money to analyze this large-scale monitoring of movements of major predators.

Our goal in this monitoring program is to develop statistical methods of estimating the abundance and productivity of our seven indicators of ecosystem health for the Yukon boreal forest. We expect all of these to change as the climate alters, and we need to be able to predict how climatic variables do or do not affect our indicators. There are three ways to determine the impact of climate change – to observe what happens (the passive approach), to monitor changes and try to explain them ecologically, and to develop and use models which include climatic variables to predict what will happen (our active approach). Long-term data sets are essential to this endeavour and we learn as we go along from year to year.

#### ***(h) Local Knowledge Interviews***

We summarize here a complementary set of data from Mark O'Donoghue gathered under another YTG program that involves local knowledge interviews in Mayo. Unfortunately these local knowledge data are not systematically obtained from other sites within the CEMP monitoring region. Mark O'Donoghue has summarized the data from these local knowledge interviews (O'Donoghue 2015). The strength of the local knowledge interviews is that they give insight into many environmental changes that we best monitor by local knowledge and on the impacts of these changes on rural people. They also place the results we find from our technical monitoring in the larger context of the whole regional landscape. Many examples are illustrated in the Mayo report – changes in the abundance of wolves, wolverine, moose and deer, as well as changes in the availability of fish and berries for the local population. Changes in winter ice conditions in relation to climate change can be evaluated, as well as general human impacts on wildlife. The summary taken from the Mayo document from interviews in February and March 2014 about conditions in the previous year illustrates the additional information that can be obtained by local knowledge interviews about a variety of topics of interest:

Most people interviewed noted that spring was late in coming in 2013 with generally cooler temperatures. There was some snowfall in late winter and more freezing rain than usual, but conditions were generally drier later in the spring. Unlike most previous years when conditions were windier than usual, most people noted average winds this spring. Most people interviewed noted that summer 2013 was a fairly warm, dry summer with an average amount of wind and periodic storms with a variable amount of lightning depending on location. There was lots of smoke in the air in the southern part of the Mayo area because of the large Ethel Lake fire. Fall 2013 was fairly warm with few snowfalls and average winds. People interviewed were mixed in their responses about the amount of rain compared to other years. Conditions were very icy in late October.

Weather in the Mayo region during the winter of 2013-14 was quite varied. November was fairly cold but overall the winter was warmer, especially in January, and

temperatures never fell into the -50s. Snowfalls were about average overall, with more falling later in the winter and there were a couple of days of freezing rain in January. Winds were mostly average compared to other years. Most people interviewed found that weather made it harder for them to get out on the land this past winter or they had no weather-related problems. The late and incomplete freeze-up rivers and lakes made it hard for trappers to get out on their lines early in the season and for safe river travel later in the winter. Lots of overflow also made travel by snowmobile more difficult.

Mining exploration and associated aircraft activity continued to decline this year from the boom that's occurred during much of the past decade, although activities remained high in some areas. The use of ATVs and sport hunting generally increased. Most people interviewed noted less highway tourism than usual for the sixth year in a row. Use of ATVs and sport hunting caused the biggest concerns about their effects on wildlife and subsistence activities of all the activities considered. Most people interviewed thought that there were cumulative effects of all human activities on wildlife in the Mayo area.

People interviewed noted about the same number or more spruce cones in 2013 compared to other years. The infestation of leafminers in aspen trees continued to affect most trees in 2013, but it seemed less severe than at its peak in 2008. Most people interviewed noted at least a few more trees dying. The infestation varied considerably in intensity depending on location. Most people interviewed saw fewer or the same number of mushrooms compared to other years in 2013. Generally, more mushrooms grow in wet years, and the summer of 2013 was quite dry.

Cranberries and blueberries are consistently the most frequently picked berries but a wide variety of others including raspberries, strawberries, black and red currants, high-bush cranberries, cloudberries, soapberries, blackberries (crowberries), bearberries, bog cranberries, dewberries, Saskatoon berries, and juniper berries are also picked. A quarter of the people interviewed who picked berries in 2013 did not meet their berry needs, mostly because of a short blueberry season caused by warm summer temperatures.

Four fish species—Chinook salmon, grayling, lake trout, and pike—are consistently the species most harvested in the Mayo area, but there has been a noticeable decline in the percentage of people fishing for salmon since 2009. In the last three years, more people have also been fishing for burbot (ling cod). Salmon are the main subsistence species for First Nations people, harvested using nets. The other species are harvested by angling and ice fishing. In 2013-14, four of the fourteen people interviewed who fished did not meet their fish needs, and said that low numbers of other fish and lack of time to go fishing were the reasons they came up short. The percentage of people interviewed who have not been able to meet their fish needs has generally increased over the ten years of these interviews but was better in 2013-2014 than the previous year.

Moose are an important source of food for people in Mayo. Most people interviewed thought 2013 was an average to poor year for moose calving based on what they saw during the summer. Most hunters saw fewer moose and fewer bulls than usual in fall 2013, and the percentage of hunters seeing fewer animals has been increasing during the past ten years. We saw the highest percentage of hunters unable to meet their needs for moose in 2013 as well. Most moose harvested were in good shape. Low numbers of moose in the area, high numbers of other hunters, and high

wolf numbers were listed as the main factors affecting numbers of moose seen. Most people noted that the timing of this year's rut was later than usual. Bulls seen were average sized to smaller than usual, as has been the case in the previous nine years. People interviewed saw relatively few to an average number of calves in the fall compared to what they usually see.

For the past four years, most people interviewed noted that they had seen more or the same numbers of spruce and ruffed grouse in the last year compared to other years. Most people saw the same number or fewer ptarmigan. As in most years, people interviewed gave variable responses about the number of ducks and geese they saw in 2013, depending on where they spent their time on the land. Most thought that numbers of ducks and geese had stayed the same. Numbers of swans stayed the same or increased, consistent with the trend we've seen the past few years. Numbers of cranes seen were variable, depending on location.

Numbers of kestrels are declining throughout North America. Most people interviewed saw few or some kestrels in 2013 and most felt that there were about the same number of birds compared to other years.

Numbers of rusty blackbirds have declined by about 85% since the mid-1960s in North America. Most people interviewed saw few blackbirds in 2013, but some people saw some or lots, especially people spending time along the rivers. Most people saw about the same number or fewer as in previous years. These birds are most frequently seen in the spring and fall when they are grouped up for migration. We also asked people interviewed about the numbers and trends in numbers of common bird species—chickadees and gray jays—so that we have a baseline to compare their trends with those of the species of concern. People interviewed consistently saw some or lots of chickadees and gray jays in all years and mostly indicated they saw about the same numbers from year to year.

Most people interviewed saw lots of mice and voles and saw about the same number as the year before. This is the third year in a row of abundant mice and voles in the area. Most people interviewed reported seeing lots of red squirrels in 2013-14, and more or the same number as the year before. Red squirrels seem to have responded favourably to the good cone crop in 2013.

Numbers of hares have started to increase again in the region during the last 3 years, although there are localised spots where there are still very few or no animals. The last cyclical peak in hare numbers was around 2006. Most people interviewed saw few or some muskrats in 2013-2014, and reported about the same number of muskrats as in the previous year. People interviewed saw variable numbers of beavers in 2013-2014. As in other years, Talbot Creek and several others were identified as being blocked for fish movements by beaver dams. Most people interviewed reported that they had seen lots of and more porcupines in 2013-14, maintaining the high numbers we have seen since 2004.

Most people interviewed saw some marten in 2013-2014, and numbers were about the same as in the previous year. Numbers of marten have been fairly good in most areas for the past three years. Relatively few people interviewed saw mink during the past year but those that did saw a variable number. Most people interviewed said there were some or few otters during the past year, and this has been the case in each year of these interviews. Most people interviewed said there were few or some

wolverines during the past year and most thought numbers had stayed about the same compared to the year before that. There were some local hotspots of activity though. Most people interviewed said there were some or lots of weasels and that they had seen about the same number or more as in the previous year. Weasel numbers mostly respond to numbers of mice and voles which have been good in the Mayo area for the past three years. Most people interviewed saw some lynx, and their numbers seem to be starting to increase in some places in response to rising numbers of hares. However, the increase in hare numbers is slow and numbers of lynx remain low or have declined in some other local areas. People interviewed saw some or lots of foxes in 2013-2014, and most thought numbers had stayed the same or increased compared to the previous year. This may be a positive response of foxes to good numbers of mice and voles. Most foxes are seen around the communities. Relatively few coyotes are seen in most years in the Mayo area. People interviewed gave variable responses as to how many coyotes they had seen in 2013-2014 and how those numbers compared to the previous year. Most people interviewed said there were lots of wolves, and thought numbers had increased or stayed the same since the previous year.

This year, seven of the people interviewed trapped. Most trappers had a fairly good year because mid-winter temperatures were warmer than usual, making it easier to get out, but some had difficulty getting access to their lines early in the season because of the late freeze-up. Fur prices were generally good and some trappers found good numbers of animals—marten numbers were good in some areas and lynx numbers were low but starting to increase. The price of gas remained high and made it harder for trappers to afford their activities on the land.

These local knowledge interviews can help to provide the larger picture of changes in Yukon's ecosystems as the climate continues to warm and thus complement the data we are gathering in the CEMP program.

## Conclusion

In this report we have presented a few of the time series of monitoring results that we have obtained from the CEMP program since it was begun in 2005. With only 10 years of data, our conclusions to date must be tentative, but we have a firm foundation for coordinating these regional data sets. We need to proceed to answer three questions:

1. How much correlation is there between the Kluane Lake sites and other sites at Mayo, Faro, Watson Lake, and Whitehorse? We have seen that, for example, bearberry production (Figure 3) can vary greatly between sites, yet snowshoe hare numbers (Figure 5) are highly correlated among sites.
2. How much correlation is there between climatic measurements and biological measurements? For example, can we develop a predictive equation for cone crops from temperature and precipitation data that will apply across all CEMP sites?
3. How can we get a better index of changes in predator populations in a time when snowfall and winter conditions have become so variable? Can we utilize remote camera trapping (Meek et al. 2014) as one way of spreading our sampling and overcoming weather changes?

The database management system for CEMP is well set up, and we have developed a

good group of workers with skills to make the needed measurements. With the data we have gathered and will continue to gather, we can begin to address the important management issues for the southern and central Yukon and to provide a detailed assessment of how climate change is affecting biodiversity in the boreal forest ecosystem in this part of the Yukon. In connection with local knowledge interviews a broad picture of how the environment is changing will emerge from these efforts.

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