THE COMMUNITY ECOLOGICAL MONITORING PROGRAM ANNUAL DATA REPORT 2015

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Executive Summary

This is the ninth 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 very low in all areas in 2015 after the very high cone crops of 2013 and 2014. Ground berries in the forest were moderate to low in 2015 with some variability from site to site. Watson Lake and Faro had very low ground berry counts, and Mayo had low cranberry counts again in 2015. Red-backed voles collapsed to low numbers on all sites in 2015. Snowshoe hares are increasing in all areas except Watson Lake, recovering from their cyclic low of 2010-12. The next hare peak in the Yukon will probably occur in 2016-17. Soapberries were moderate in 2015 at Whitehorse and low at Kluane and 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 numbers appeared to be increasing rapidly during 2015. Marten remained high at Mayo and Kluane. We are investigating whether remote cameras can substitute for snow tracking to census mobile predators and possibly moose and bears in the Kluane region. In a separate study local knowledge interviews were completed at Mayo by Mark O'Donoghue in early 2015 and are summarized briefly here, an important step in bringing local knowledge of trends together with our CEMP data.

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.

Why Monitoring is needed

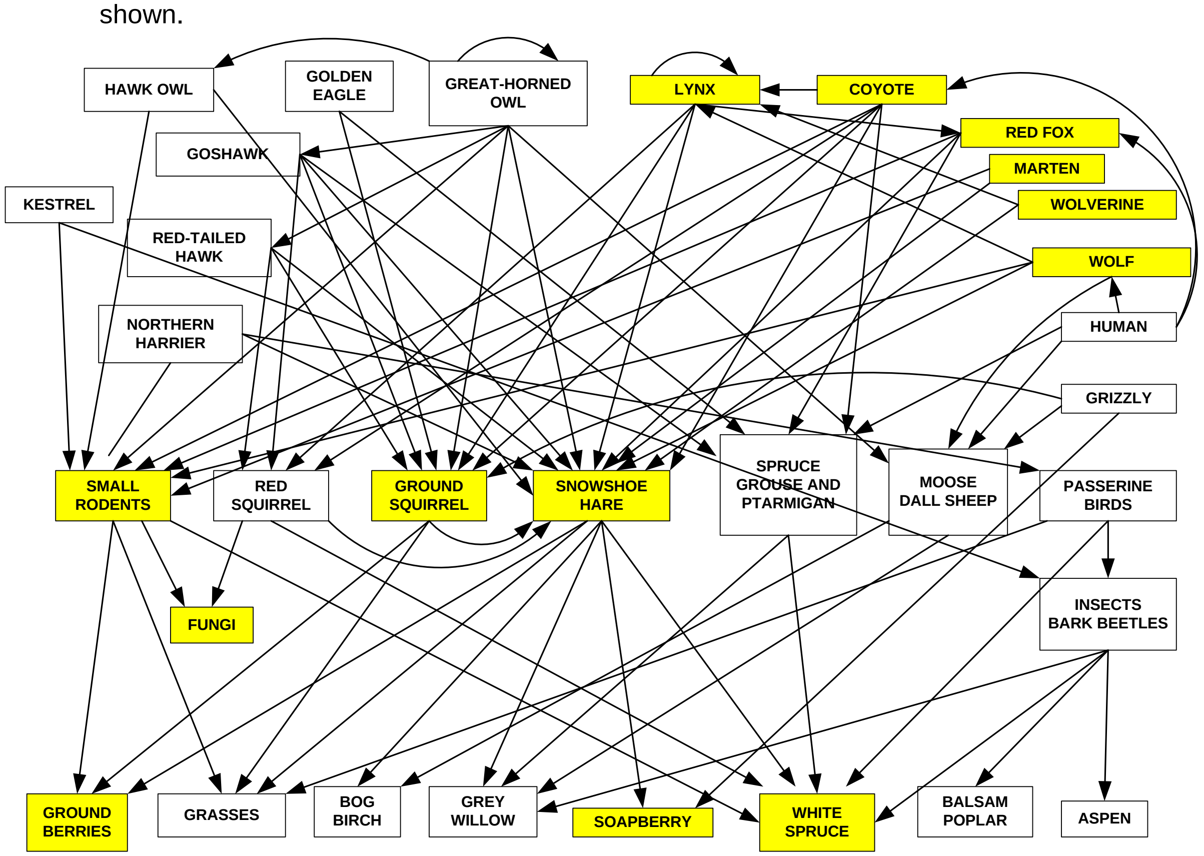
What are the goals of this monitoring program? It is important to keep in mind where we are headed in any monitoring design. The key question we need to be able to answer is ***how will the Yukon's ecosystems respond to climate change*?** The answer to this simple question is not simple. Some parts of 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 species that are being monitored are indicated by shading in Figure 1. 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.



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

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.

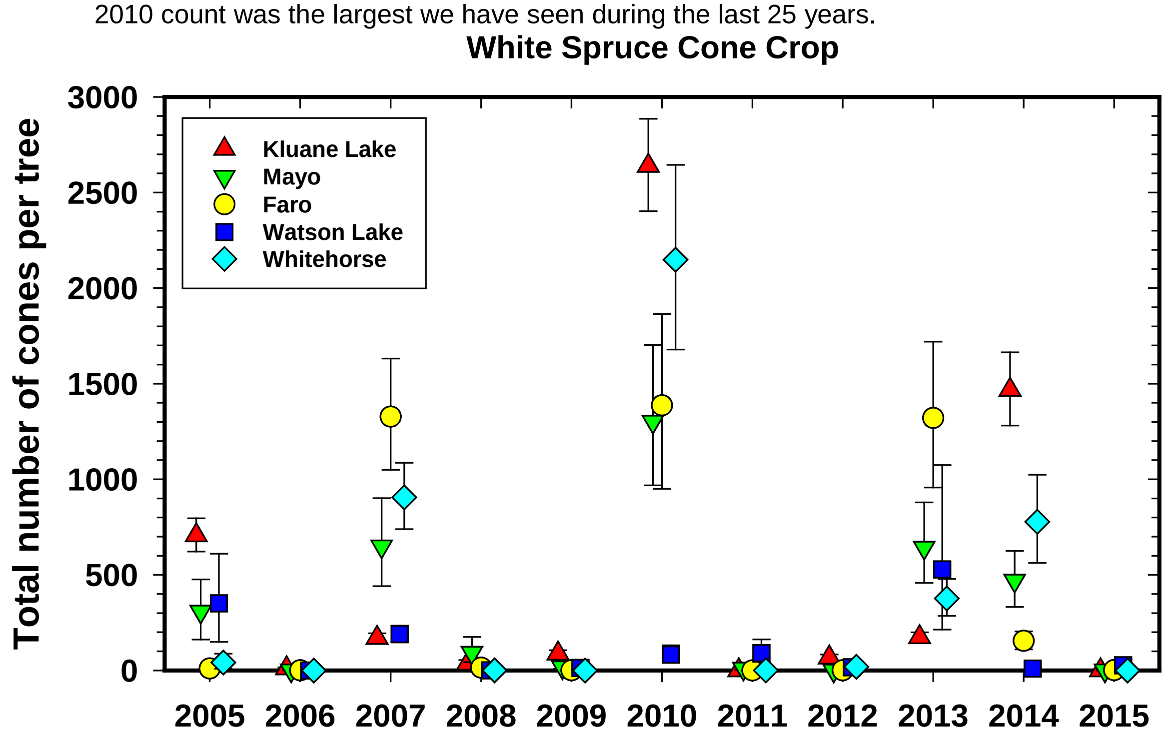
Results and Discussion

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. 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 mast 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, 2012, and 2015 cone crops were nearly a complete failure at all our study sites. Cone counts reached a peak in 2013 and 2014 on

Figure 2. Average white spruce cone counts on CEMP sites for 2005 to 2015. 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. 2005). There was a complete cone failure in 2006, 2008, 2009, 2011, 2012 and 2015 at all sites. The 2010 count was the largest we have seen during the last 25 years.



all sites. The summer of 2013 was peak cone production for Faro and Watson Lake, and cone production was even higher in 2014 at Kluane Lake and Whitehorse. The recent pattern of two high years in a row at Mayo was produced by the unusual situation in which one set 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 1986 and since then peak spruce cone crops have occurred at 7, 5, 7, 5, and 4 year intervals, and we are wondering if the interval between peak cone crops is becoming shorter. We are currently updating our statistical model to predict cone crops in the Kluane region from summer temperature of the previous 2 years (Krebs et al. in prep.). In all Yukon sites mid-summer temperatures seem to be the key variable of interest, and the best predictors of high cone crops are temperatures in the previous two summers.

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. Watson Lake in particular seems to not have as large cone crops as the other areas. All sites were near zero in 2015 and we should expect some recovery in 2016. Red squirrels and seed-eating birds might provide a more responsive index of detrimental cone crop changes.

(b) Ground Berry Production

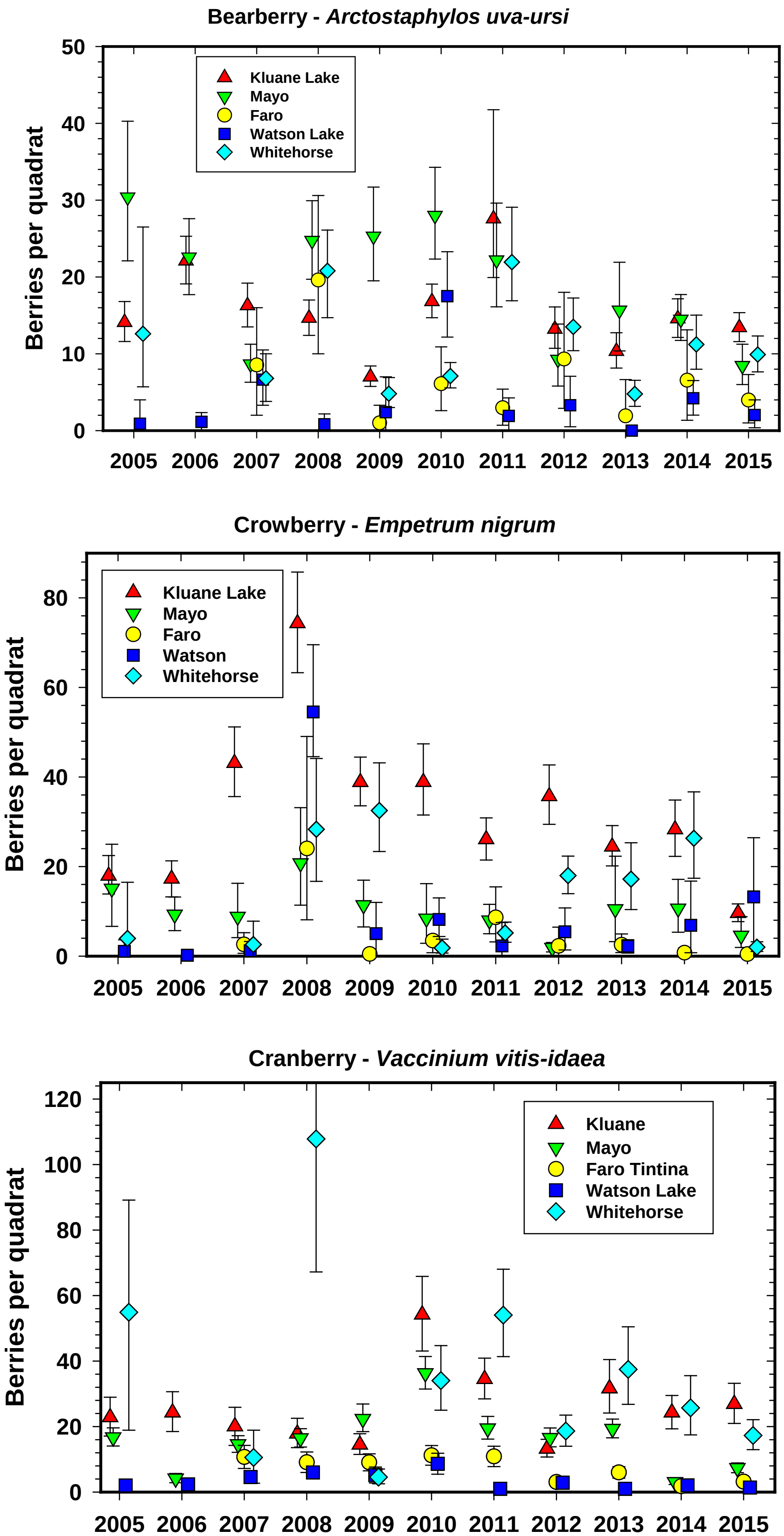
Five species of ground berries are counted in permanent quadrats each year. The major berry-producing plants are bearberry (*Arctostaphylos uva-ursi*), red bearberry (*A. rubra*), crowberry (*Empetrum nigrum*), toadflax (*Geocaulon lividum*), and cranberry (*Vaccinium vitis-idaea*). We use permanent quadrats for our counts because in any particular area it is possible for some small patches of berries to be abundant when the general landscape has few berries overall. 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. The variation is large enough to require more data to see if the suggestion that bearberry crops in general have been declining since 2011 indicates the start of a long-term trend.

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 7 years with a suggested continuing decrease in production in recent years all over the southern Yukon. Crowberry counts on all sites except perhaps Watson Lake were very low in 2015.

Cranberry counts show yet a different pattern with low to very low production at all sites in 2012 and higher counts from 2013 to 2015 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 and 2015. There has been no

Figure 3. Average berry counts for 3 species of ground berries at CEMP sites from 2005 to 2015. Quadrat size is 40 by 40 cm. Error bars are 95% confidence intervals.



repeat of the 2008 high cranberry counts in Whitehorse, and moderate counts were found only at Whitehorse and Kluane in 2014 and 2015. There seems to be no clear general regional pattern to these berry counts.

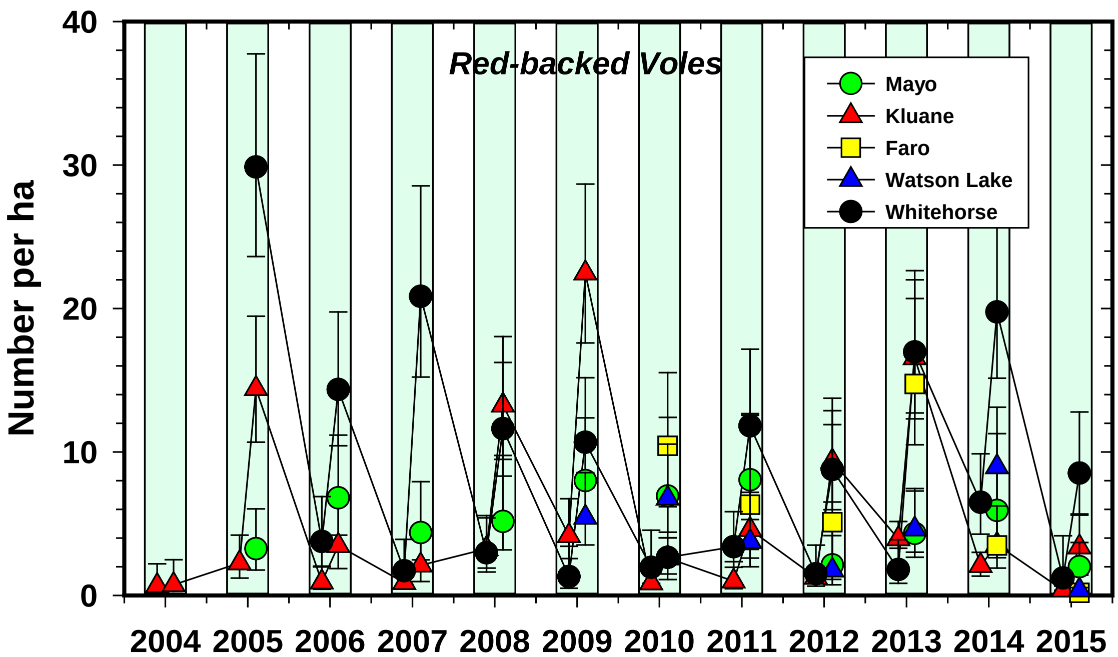
We have analyzed the climatic controls of ground berry production in the Kluane region from data gathered over 1994 to 2008 resulting in equations relating berry production to climate (Krebs et al. 2009). Each species of ground berry in the Kluane area responded to different signals of temperature and rainfall, and there was no general climate pattern to which all the species of ground berries responded. 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 2015. All populations were low in 2015, with most failing to rise above 5 per ha.

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

Figure 4. Population estimates for red-backed voles in five CEMP areas, 2004-2015. Trapping grids have an effective trapping area of about 3 ha. Summer months are shaded green. Spring and late summer estimates are available only for Whitehorse and Kluane. Other areas have only late summer estimates.



from 2010 to 2013, and rising to a peak in 2014. The pattern to date does not suggest any close synchrony in fluctuations of red-backed vole numbers in the southern and central Yukon.

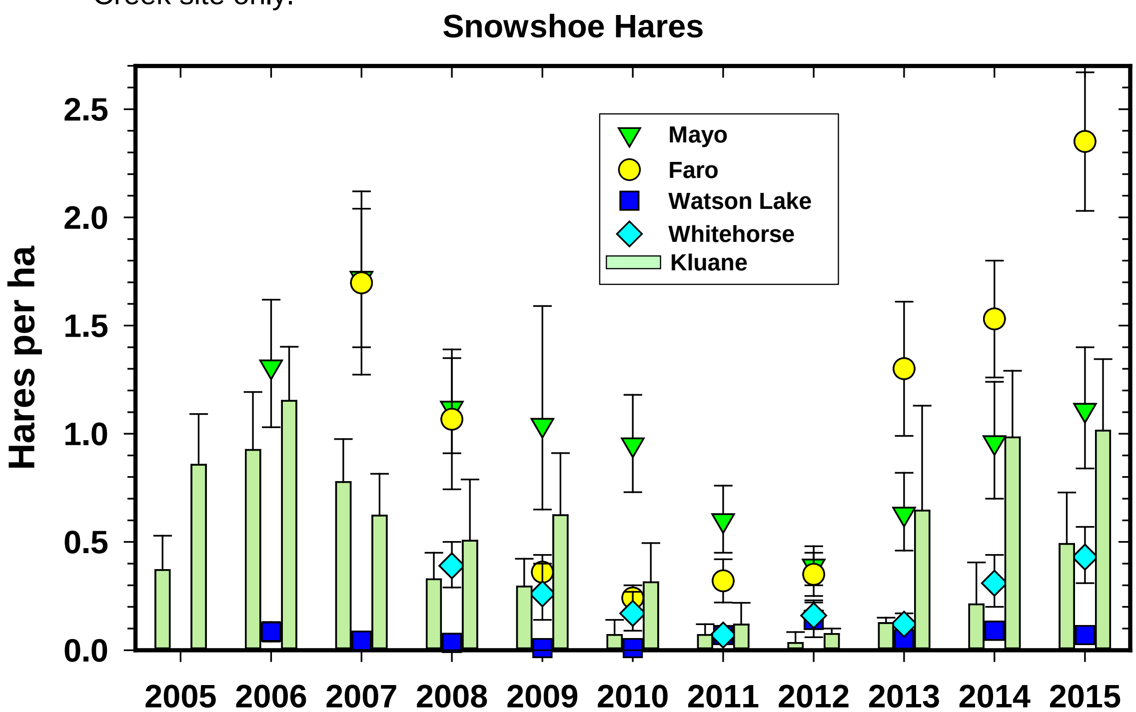
The only other small mammal that is common to many of the CEMP sites is the deer mouse, *Peromyscus maniculatus*. At present the number of captures of this rodent species is too low on most of the sites to discuss any common patterns of population change. Deer mice remained between 1-3 per ha on all sites from 2005 to 2015, 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 nine 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, 2005-2015. 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. Mayo data from Rusty Creek site only.



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 2014 and continued to increase in 2015. Mayo hares (Rusty Creek site) have increased in close correlation to those at Kluane Lake but with a peak density one year later in 2007. Slower rates of growth at Whitehorse occurred in 2014 and 2015. The increase phase of the hare cycle has been similar to the 2006-7 peak in Whitehorse and Mayo, and if these trends continue we could have a low hare peak in 2016-17 in all areas except for a higher peak at Faro.

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 one year later and then moves north in the Yukon with a further one year delay and west into Alaska to peak 2 years later than BC. As far as we can determine, this travelling wave is occurring in the current hare peak in 2016-2017, and our colleagues in Alaska and the NWT are gathering hare data comparable to ours to answer this question.

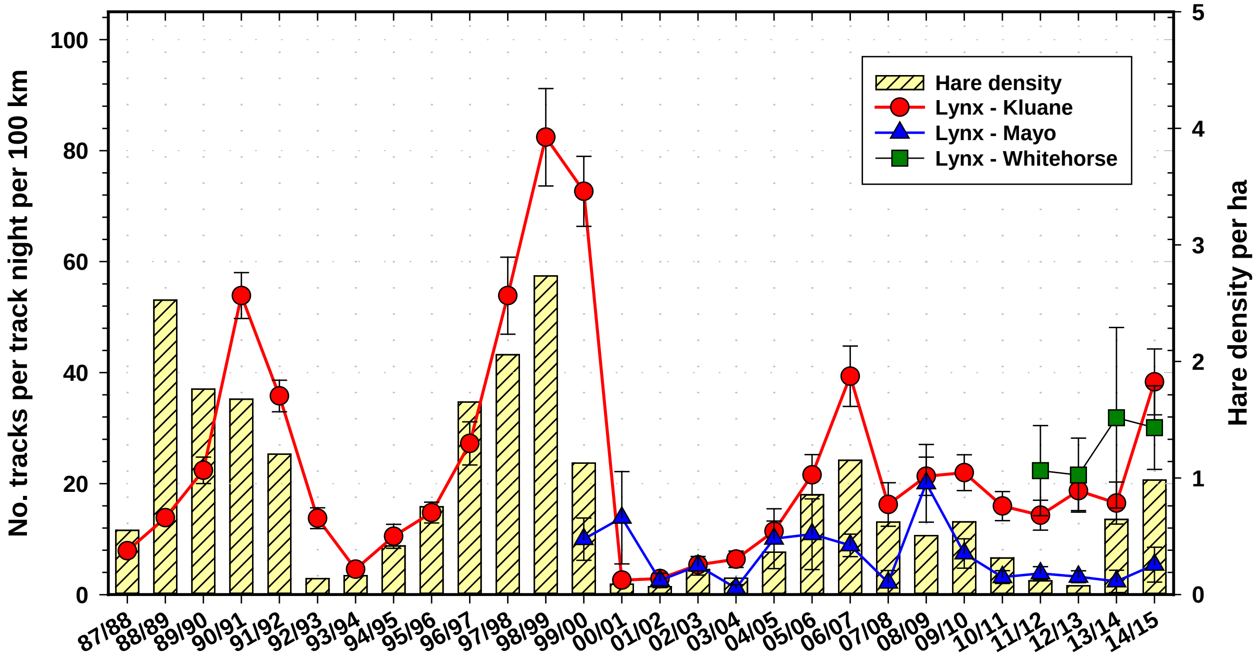
The significance of these regional differences in the hare cycle lies in the movements of predators like lynx and great-horned owls from one high hare area to adjacent ones that are low or starting to recover. The most promising explanation for regional synchrony involves predator movements, and depending 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 (unlikely) or have been able to switch to alternate prey like red squirrels (more likely). We suspect that lynx have been feeding mainly on red squirrels from 2008 to 2013. O'Donoghue et al. (1998) showed that lynx fed extensively on red squirrels in the low phase of the hare

Figure 6. Snow tracking abundance estimates for Canada lynx at Kluane, Mayo, and Whitehorse, 1987 to 2015. Hare data are from Kluane in the autumn preceding the winter predator data.



cycle, and the data suggest that this prey switching was very strong during the low phase from 2008 to 2013, which allowed lynx to maintain a relatively high density during low phase.

We do not have any snow tracking data from Faro or Watson Lake for winter 2014-2015 because of a shortage of snow. Because this may become a more serious problem in future years, we began in autumn 2015 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 2016 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 in numbers on all areas as the hare cycle is returning in late 2014 and 2015, 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 makes this a challenge. In 2015 soapberries were at very low abundance at Kluane Lake and at Mayo but were moderately high on bushes at Whitehorse.

Red squirrel numbers have been studied extensively at Kluane for years by Stan Boutin's group. In general red squirrel numbers are relatively stable in the boreal forest but they have increased at Kluane in the last 2 years in response to good spruce cone crops.

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 2015.

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, to monitor changes and try to explain them ecologically, and to develop and use models which include climatic variables to predict what will happen. 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. Mark O’Donoghue has summarized the 2015 data from these interviews (O’Donoghue 2016). The strength of 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 2015 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.

After 2013’s very late spring, most people interviewed noted that spring 2014 was more of a typical spring with average to warmer temperatures than usual. There was some snowfall and freezing rain in late winter, 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. The weather was quite mixed during the summer of 2014—there were quite a few rainy days but also some clear skies, and while most people interviewed noted average to warmer temperatures overall, there was also a frost in late July. There were an average number of storms and windy conditions, with less lightning. Few forest fires led to less smoke in the air. Fall 2014 was fairly warm with few snowfalls and average winds. September was quite variable with cool weather at first and then warming again by mid-month. Most people interviewed noted a less to average amount of rainfall compared to other years. Conditions were very icy in late October.

With the exceptions of a short cold snap in November and a 2-week cold snap in the first half of February, the winter of 2014-15 was quite warm. There was little snowfall before January and some freezing rain and drizzle. Winds were mostly average compared to other years. Most people interviewed found that weather either caused no problems or made it harder for them to get out on the land this past winter. The lack of snow and late freeze-up of 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. Most people interviewed noted that the timing of spring break-up of ice on the Stewart River and lakes was early to average timing this year, reflecting the warm spring temperatures. Water levels in rivers and creeks varied over the summer with rainfall but were generally average to low. Rivers and lakes froze back up later than usual, and rivers more slowly compared to other years, because of the late fall. Ice was average to smoother on the Stewart River this winter. There was not much overflow compared to the last few winters in most areas.

Mining exploration and associated aircraft activity continued to decline this year from the boom that's occurred during much of the past decade. While most people interviewed thought snowmobile use had stayed the same or declined, the use of ATVs and sport hunting generally increased. Most people interviewed noted a continuing trend of declining levels of highway tourism. Use of ATVs, sport hunting, and sport fishing 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 2014 compared to other years. The infestation of leafminers in aspen trees continued to affect most trees in 2014, but it seemed more severe than during the previous few years. Most people interviewed noted fewer trees dying though. The infestation varied considerably in intensity depending on location. People interviewed saw a variable number of mushrooms compared to other years in 2014. Generally, more mushrooms grow in wet years, and the summer of 2014 had a mix of sun and rain.

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, juniper berries, and rose hips are also picked. Four of ten people interviewed who picked berries in 2014 did not meet their berry needs, mostly because of a very poor year for cranberries in most local areas.

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 2014, the First Nation asked that nobody harvest salmon because of low numbers. Salmon are the main subsistence species for First Nations people, harvested using nets. The other species are harvested by angling and ice fishing. In 2014-15, most of the people interviewed who fished did not meet their fish needs, and said that low numbers of salmon 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 eleven years of these interviews.

Moose are an important source of food for people in Mayo. Most people interviewed thought 2014 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 2014, and the percentage of hunters seeing fewer animals has been increasing during the past eleven years. We saw the highest percentage of hunters unable to meet their needs for moose in 2014 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, continuing a trend towards later ruts that hunters feel are related to warmer than usual falls. Bulls seen were average sized to smaller than usual, as has been the case in the previous ten years. People interviewed saw relatively few to an average number of calves in the fall compared to what they usually see.

Most people interviewed noted that they had seen more spruce grouse and about the same numbers of ruffed grouse in the last year compared to other years. People saw variable numbers of ptarmigan. As in most years, people interviewed gave variable responses about the number of ducks and geese they saw in 2014, depending on where they spent their time on the land. Most thought that numbers of ducks and geese had stayed the same or declined. More people than usual noticed few swans in 2014, suggesting that the increasing trend we've seen during much of the past decade has stopped. 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 2014 and most felt that there were fewer or about the same number of birds compared to other years, although more were noted in farm areas.

Numbers of rusty blackbirds have declined by about 85% since the mid-1960s in North America. Most people interviewed saw few or some blackbirds in 2014; people spending time along the rivers tended to see more. Most people saw fewer or about the same number 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 more or about the same number as the year before. This is the fourth year in a row of abundant mice and voles in the area. Most people interviewed reported seeing lots of red squirrels in 2014-15, and the same number as the year before. Red squirrels seem to have responded favourably to the good cone crops in 2013 and 2014.

Numbers of hares being seen have been generally increasing in the region during the last 4 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. People interviewed saw a variable number of muskrats in 2014-2015, and no consistent trend in numbers was noted. People interviewed saw variable numbers of beavers in 2014-2015. 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 or the same number of porcupines in 2014-15, maintaining the high numbers we have seen since 2004.

People interviewed were mixed in their observations about marten in 2014-2015, depending on where they looked. Numbers of marten were fairly good in most areas during the previous three years, but more people noticed few marten this past year. 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 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 four years. Most people interviewed saw some or lots of lynx, and their numbers are increasing in most places in response to rising numbers of hares. However, the increase in hare numbers is slow and numbers of lynx remain fairly low in some local areas. Most people interviewed saw some or few foxes in 2014-2015, and most thought numbers had stayed the same or decreased compared to the previous year. Most foxes are seen around the communities. Relatively few coyotes are seen in most years in the Mayo area. Most people interviewed saw few coyotes in 2014-2015 and fewer or the same number compared to the previous year. Most people interviewed said there were lots of wolves, and thought numbers had increased since the previous year.

This year, eight 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. Animal numbers, especially lynx, were good on most lines, but fur prices were fairly low. The price of gas was lower but still high enough that it made it hard for some 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. Benefits would accrue if this type of community monitoring could be expanded to other sites within First Nations' areas.

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 11 years of data, our conclusions to date must be tentative, but we have a firm foundation for coordinating these regional data sets. The boreal forest ecosystem is a boom-bust ecosystem with all the major components showing strong fluctuations in abundance. Determining the associations between these fluctuating components of the ecosystem is underway, and in the same way that we have needed a long time series of weather data to recognize climate change, achieving an understanding of this northern ecosystem will require long-term ecological data.

We need to proceed in the short term 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 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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