THE COMMUNITY ECOLOGICAL MONITORING PROGRAM ANNUAL REPORT 2008

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Executive Summary

The Community Ecological Monitoring Program (CEMP) arose in 2005 as a regional extension of the Kluane monitoring project to begin a regional assessment of the health of the Yukon boreal forest ecosystem. This is the first report to coordinate the data on white spruce cone crops, ground berry production, small mammal and snowshoe hare populations at Kluane Lake, Mayo, Faro, Watson Lake, and Whitehorse. White spruce cone counts were low to moderate in 2008, following the last high cone year of 2005. As additional data are added in the years to come, the regional patterns of ecosystem changes will become more evident.

Introduction

Since we began work in the Kluane boreal forest 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 will permit us to focus on regional trends in measures of ecosystem health. The Community Ecological Monitoring Program (CEMP) is a partnership between researchers at the Arctic Institute Research Station at Kluane Lake, YTG Environment, the Canadian Wildlife Service and Yukon College. 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.

This monitoring program has several interrelated objectives. First, it provides long-term monitoring data that provides important baseline information on undisturbed forest sites, and this information is of value to many research programs as well as 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

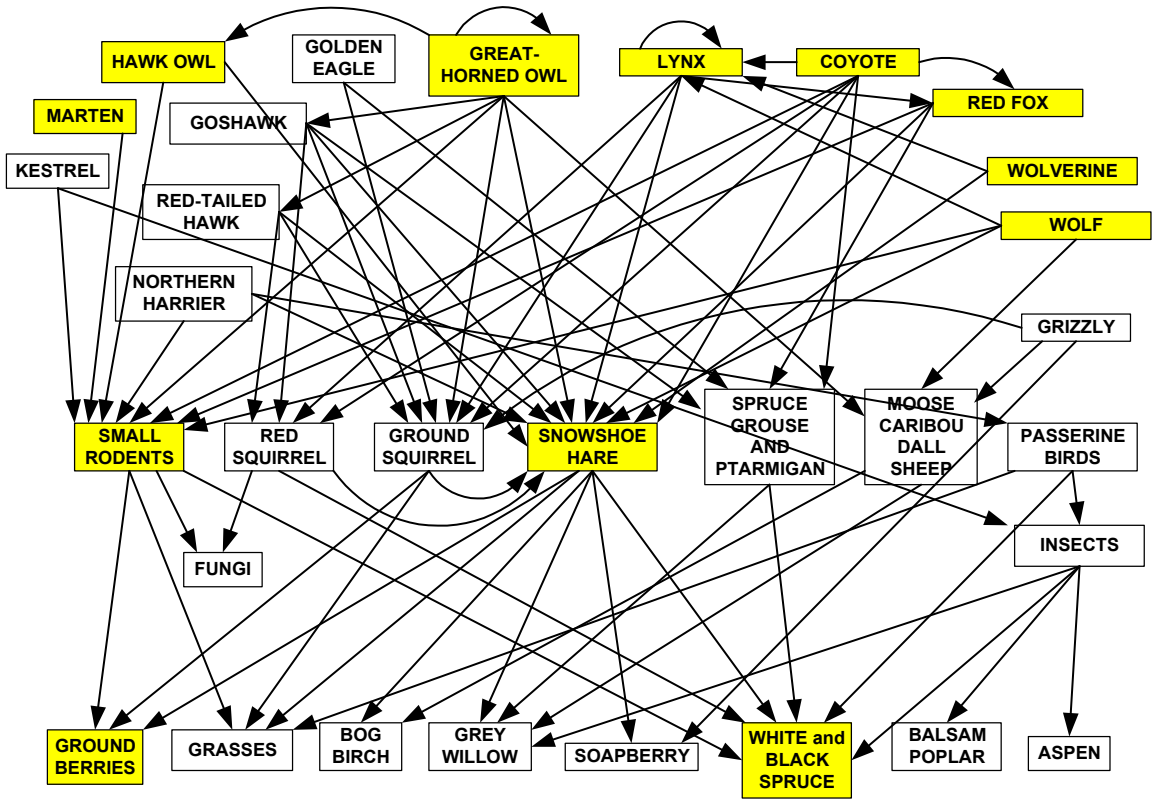
1996 (Krebs, Boutin and Boonstra 2001). However, we still do not understand the longer cycles and processes that drive boreal forest ecosystems on a landscape scale and help to protect its biodiversity. CEMP is helping to document some of those patterns and processes.

An important part of CEMP is the community involvement by way of traditional knowledge. Interviews are carried out each year at Mayo, and community involvement in Dall sheep and arctic ground squirrel censuses at Kluane are part of this work. We will report on this work in subsequent years.

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

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. We will add further species to the monitoring program next year. Only the major feeding linkages are shown.



everything, and we have concentrated our efforts on 6 significant indicators. We believe that these indicators constitute a start for obtaining early warning of ecosystem change, evaluating forest management practices and advancing our understanding of the dynamics of boreal ecosystems. The 6 indicators that are being monitored are listed below, and suggestions for additional indicators are given at the

end of this report. The species that are being monitored are indicated by shading in Figure 1.

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 Production.** Measurements: berry production is recorded each year for the major berry producers in the Yukon boreal forests – crowberry, bearberry, red bearberry, toadflax, and cranberry. Rationale: major food supplies for small mammals and birds.
3. **Small Mammal Abundance.** Measurements: population density estimates calculated from live trapping mice and voles twice per year at Kluane and once per summer at other CEMP sites. Rationale: major prey for many predators; these small mammals create a 3-4 year population cycle as well as major irruptions in the area.
4. **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 with a ten-year population cycle.
5. **Predator Abundance**. Measurements: index of relative abundance of coyotes, lynx and other predators from winter track transect is being carried out annually in the Kluane Lake-Sulphur Lake corridor and at Mayo, with plans to extend to other sites. Rationale: an index of major terrestrial predators in the system.
6. **Great Horned Owl Census.** Measurements: annual population density estimate is based on breeding pairs in the Kluane Lake region and will be coordinated with the BC Owl Census for other areas. Rationale: major avian predator 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, 2009, available on the web at http://www.zoology.ubc.ca/~krebs/).

In addition to these 6 protocols, a number of research and management projects are being conducted in the Yukon (e.g. the Breeding Bird Survey, Christmas Bird Counts). 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.

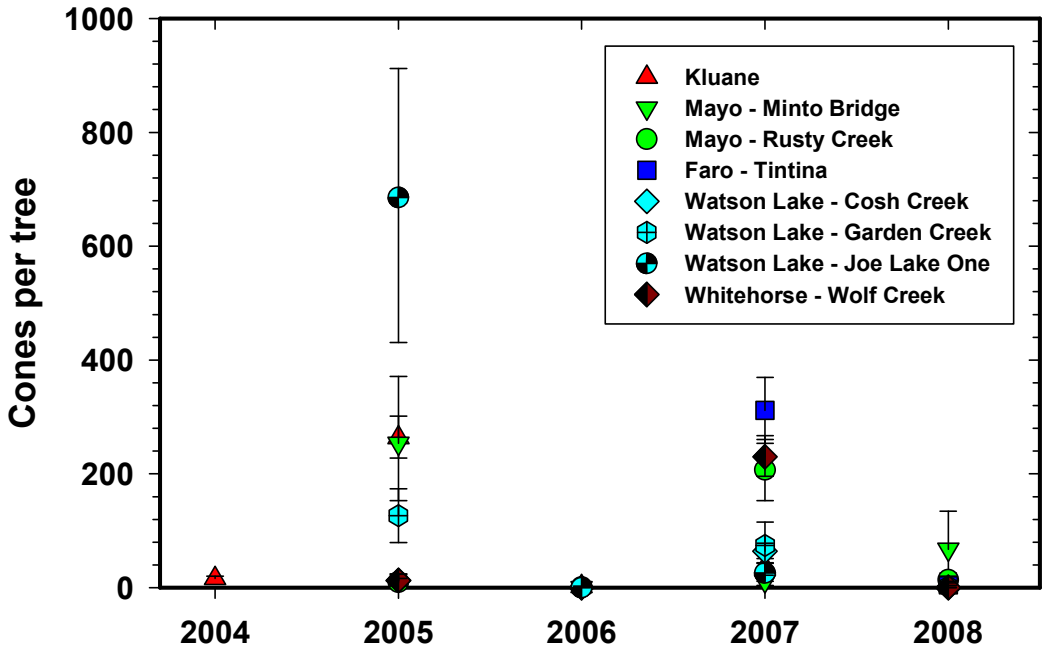
Results and Discussion

For the purpose of this Annual Report, we would like to discuss some of the findings from 5 of the protocols. We maintain on the web site http://www.zoology.ubc.ca/~krebs/ a detailed EXCEL file (*monitor.xls*) that has all the summarized data from 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 2008.

(a) White Spruce Cone Production

White spruce 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 1986, and Figure 2 shows the variation in cone counts over the CEMP sampling sites since 2005. The 2005 cone crop was moderate, but the 2006 cone crop was nearly a complete failure at Kluane, Mayo, Watson Lake, and Whitehorse. If years of high cone production are driven by weather variables, we should soon be able to correlate our weather data with

Figure 2. White spruce cone counts on CEMP sites for 2004 to 2008. Green cones are counted from the top 3 m of a tagged set of trees each August. Only the cones visible from one side of the tree are counted, so this is an index of cone production, not an absolute measure. There was a complete cone failure in 2004 at Kluane and in 2006 at all sites. The 2008 count was low on all areas.



these cone production events. There is a suggestion of a 5-year cycle in cone crops in the Kluane area, but this cyclic interval is so variable it does not allow for prediction of when the next large cone crop should be expected.

What is surprising about Figure 2 is that all the 4 regional counts show the same pattern of high and low years. Further data are required to quantify this regional synchrony in cone crops. Cone counts are highly variable, as Figure 2 shows and different sites within a region can be quite variable. Some of this variability will be reduced when we can achieve larger sample sizes. We recommend counting cones on about 100 trees at each site, but some sites have fewer samples in some years. Because of this variability in cone production, it will take a series of poor years for us to conclude that cone production is failing. 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*). For each of these species green berries are counted in late July or early August before the berries are harvested by bears, mice, and chipmunks. Figure 3 shows the data we have accumulated on three of the species of ground berries since 2005.

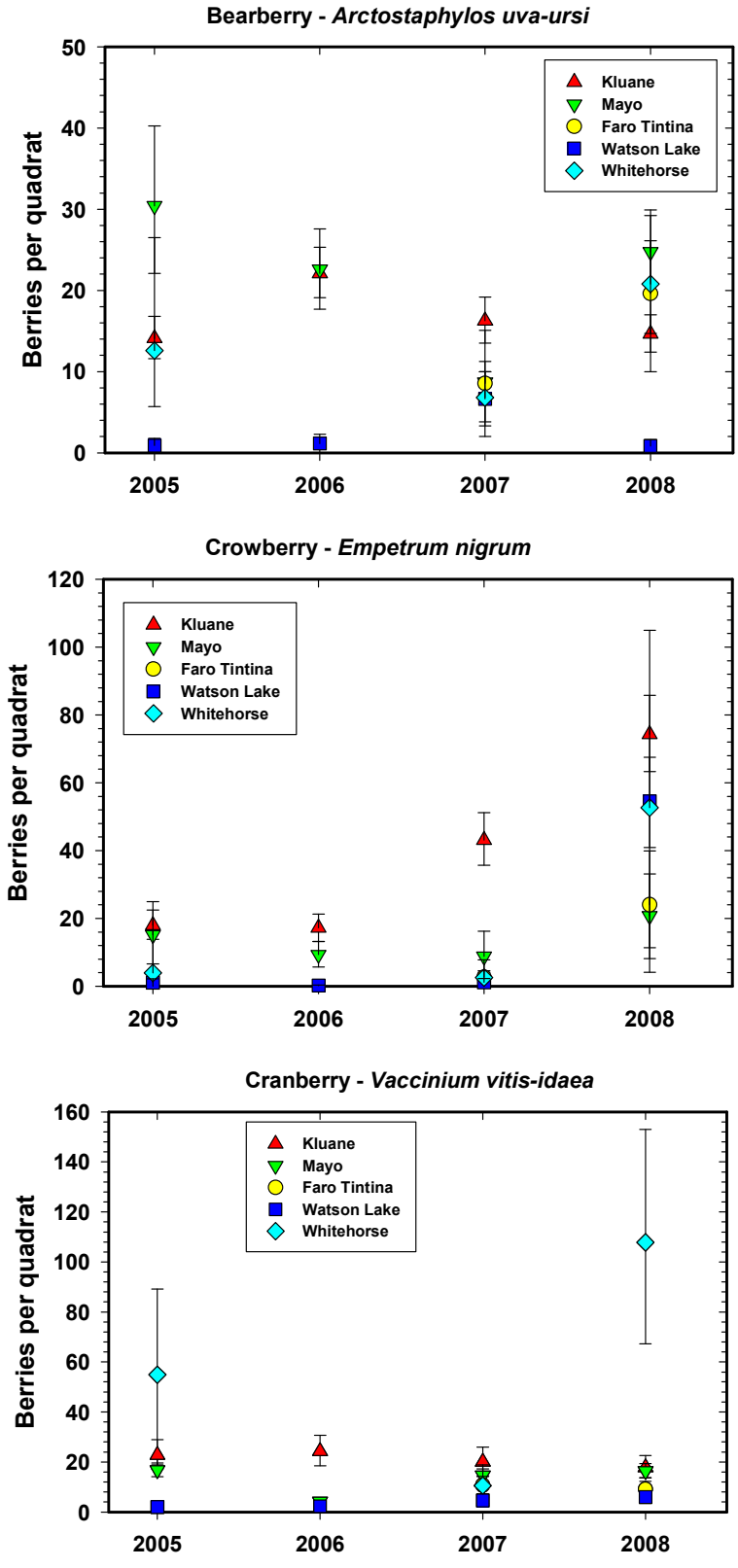
Bearberry counts are highly variable among the four monitoring areas. In particular Watson Lake sites have very few bearberries for all these years, approximately one-tenth the numbers of Kluane, Mayo, Faro, and Whitehorse. There is some general agreement of year to year variation among the four sites with abundant bearberries but the variation is large enough to require more data to see a clear pattern.

Crowberry counts show a clearer pattern of agreement among all the sites with a high production year only in 2008 and very low counts in the other 3 years. The average production of crowberries at Kluane is 2-3 times that of each of the other 4 sites for these four years of data.

Cranberry counts show yet a different pattern with very low production at Watson Lake sites, low but relatively constant production at Kluane, Mayo and Faro, and high counts only at the Whitehorse sites in 2005 and 2008.

We have recently analyzed the climatic controls of ground berry production in the Kluane region from data gathered over 1994 to 2008 (Krebs et al. 2009). Each species of ground berry in the Kluane area responded to different climatic 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.

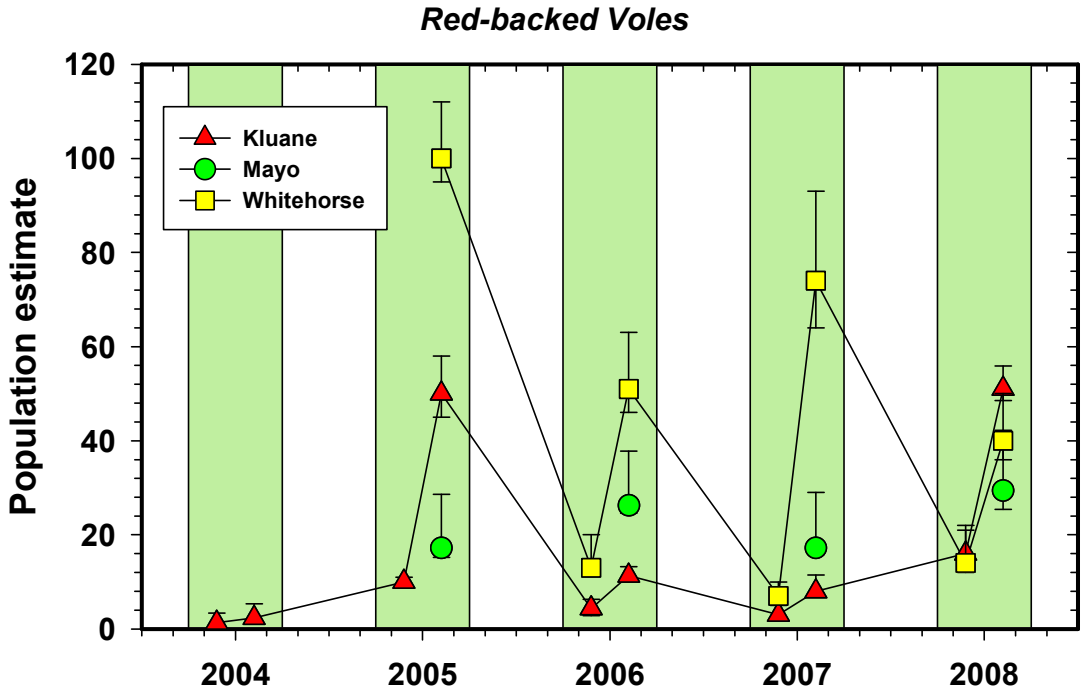
Figure 3. Average berry counts for 3 species of ground berries at CEMP sites from 2005 to 2008.



(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 only in late summer. Data are not yet available for Watson Lake or Faro. Figure 4 shows the changes in red-backed vole numbers for the period 2005 to 2008.

Figure 4. Population estimates for red-backed voles in three CEMP areas, 2005-2008. Trapping grids have an effective trapping area of about 2.81 ha. Summer months are shaded.



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 and 2008. But Mayo populations have been nearly stable from 2005 to 2008, and Whitehorse populations were extremely high in the late summer of 2005 and again in late summer 2007 and 2008. We do not yet have data from Watson Lake.

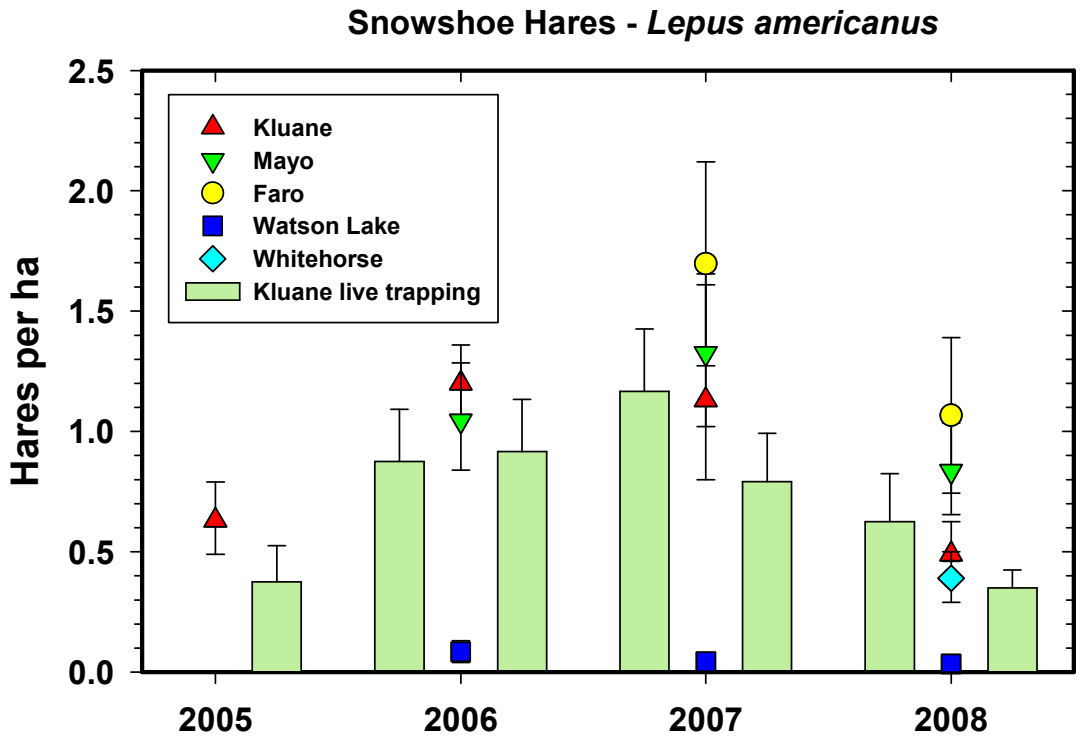
Further data are needed to determine if there a similar pattern of population change in red-backed voles at the different CEMP sites in subsequent years.

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 are too few on most of the sites to discuss any common patterns of population change.

(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 early 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 2004 at the CEMP sites.

Figure 5. Population density estimates for snowshoe hares in CEMP areas, 2005-2008. Mark-recapture data from Kluane are given as histogram bars, and estimates from fecal pellet counts are given as points.



Two points stand out in Figure 5. First, Watson Lake sites had almost no snowshoe hares in any of the four years. Second, all other CEMP sites are following the Kluane hare cycle closely, with peak populations in 2007 and declining populations in 2008. Regional synchrony is well established in snowshoe hares, but not all areas in western Canada and Alaska are in phase. For example, in 2008 Old Crow Flats had high hare populations while CEMP areas were already in decline, and there are reports of high hare populations in the Copper River area of Alaska from 2008 (E. Hofer, pers. comm.).

(e) Brief Notes on Other Monitoring Measurements and Future Needs

We are in the process of coordinating the monitoring at each of the five CEMP sites. Mushroom production is being estimated at Kluane and Whitehorse and we hope to expand coverage to all CEMP sites in 2009. Soapberries are a favorite food of grizzly bears, and are being counted at Kluane and we will evaluate the feasibility of expanding these counts to the other four CEMP areas in 2009. Red squirrel numbers have been studied extensively at Kluane for years by Stan Boutin's group, and we are evaluating the possibility of using call counts and midden counts as indices on the other CEMP sites in 2009. Snow track counts in winter for large predators are being done at Kluane and Mayo, and we hope to have them operational at all CEMP sites in 2009-2010. 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.

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 4 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 two questions:

(1) How much correlation is there between the Kluane Lake sites and other sites at Mayo, Faro, Watson Lake, and Whitehorse?

(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?

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.

Acknowledgements

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