

Yukon Ecological Monitoring PROTOCOLS



(2016 edition)

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Background - The Community Ecological Monitoring Project

In 1973 ecologists from the University of British Columbia began working on the small mammals of the Kluane area. In 1986 a group of nine ecologists from the University of British Columbia, the University of Alberta, and the University of Toronto collaborated to expand the research with support from the Natural Sciences and Engineering Research Council of Canada. This new study was called the "Kluane Boreal Forest Ecosystem Project" and continued until 1996. The focus of the Kluane Boreal Forest Ecosystem Project was to understand the community structure of the vertebrates that live in the boreal forest around Kluane Lake in the southwestern Yukon. The key focus of all this research for the past 37 years has been the snowshoe hare, which undergoes 9-10 year cycles throughout the boreal forest of Canada. The snowshoe hare is a keystone herbivore in this system, and has potential impacts on other species either through competition for food through its browsing on plants or through predators that eat hares as well as other prey species (Figure 1). In the early 1990s the spruce bark beetle began to outbreak in the Kluane area, killing mature spruce trees in a patchy manner throughout the Shikwuk Trench. This major disturbance to the ecosystem is only slowly working its effects on other species in the food chain, and is one of the centers of attention for the project that developed starting in 1996 – the "Kluane Ecological Monitoring Project".

The Kluane Ecological Monitoring Project (KEMP) attempts to census the major plants and animals in the boreal forests of Kluane in order to provide a long term baseline of ecosystem change. Our working hypothesis is that the boreal forest community is never in equilibrium because of disturbances caused by fire and bark beetle outbreaks, and we need long-term data to follow these changes. Major climatic change is predicted to occur in the coming decades, and we need information on how the biological systems of the Canadian north are responding to climatic fluctuations. Because of the extensive background of information from the Kluane Project of 1986-96, we can build a monitoring project of international importance in this region.

The KEMP project has evolved since 1999 into a partnership between the University of British Columbia, University of Alberta, University of Toronto, Yukon College, Parks Canada, Yukon Department of Environment and the Canadian Wildlife Service. From 2004 to 2008 we received funding from

the Northern Ecosystem Initiative of Environment Canada and we are grateful for their support. The EJLB Foundation of Toronto supported our monitoring efforts from 2004 to 2009. The focus has now broadened geographically to several areas of the southern Yukon and the project is now called the “Community Ecological Monitoring Project” (CEMP) with the major support now from the Yukon Department of the Environment. In 2008 we reduced the number of protocols used to monitor the system.

Protocols - We include here a brief description of the protocols for the monitoring procedures of this project. Most of these procedures are based on similar methods evolved over the earlier studies at Kluane. We would appreciate feedback on how to improve these methods, what more might be included and how the descriptions could be improved. All data are stored in MS ACCESS databases. For each type of data collected, the database includes data sheets which can be printed and taken into the field, data entry forms, as well as appropriate summary statistics and reports.

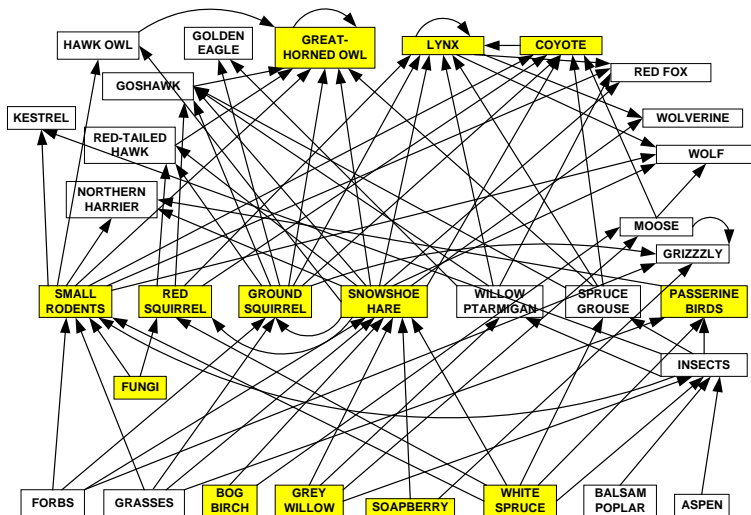


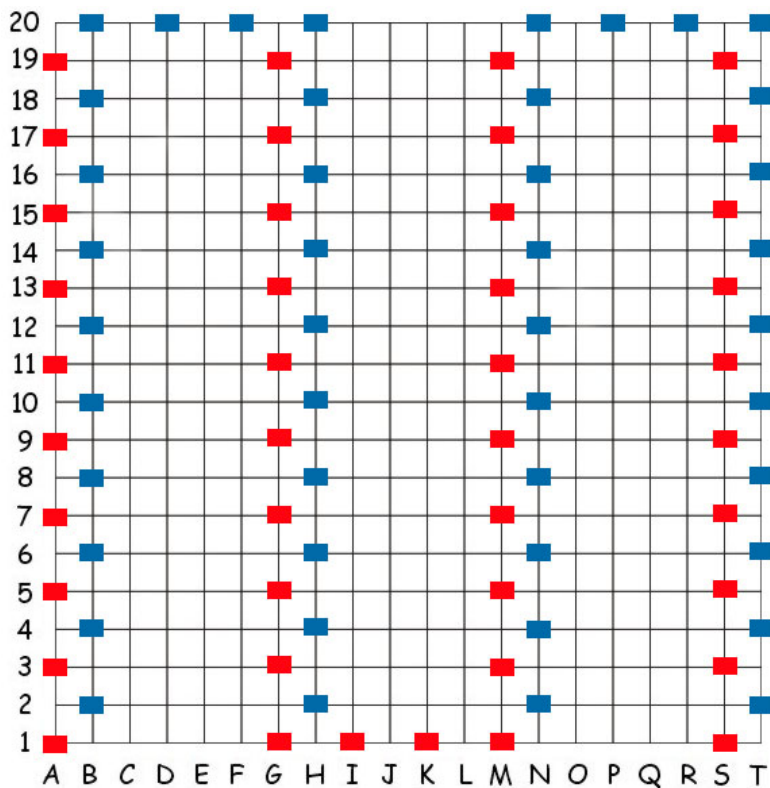
Figure 1. Food web for Kluane region. Links are drawn between species if the species consumed constitutes at least 5% of the consumer’s diet. The major species are shown in yellow boxes.

Charles J. Krebs
 krebs@zoology.ubc.ca
 March 2013

Monitoring Schedule

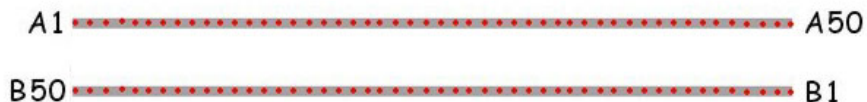
January	snow track transects for predators
February	snow track transects write annual report
March	snow track transects hare trapping owl census
April + May	mouse trapping
June	squirrel trapping
July	ground berry production soapberry production spruce seedling growth and survival spruce cone production hare pellet transects
August	mouse trapping squirrel trapping mushroom counts ground berry production collect ripe soapberries
September	
October	hare trapping
November	snow track transects
December	snow track transects

Typical Snowshoe Hare Trapping Grid Layout



The 86 rectangles on this diagram show the placement of the hare live-traps. The “traps” are coloured red if they are on a row flagged with red flagging tape or blue if they are on a row flagged with blue flagging tape (“odd” rows such as A,C,E... are flagged in red, “even” rows such as B,D,F... are flagged in blue). Grid spacing is 30m.

Typical 100 Station Transect Layout



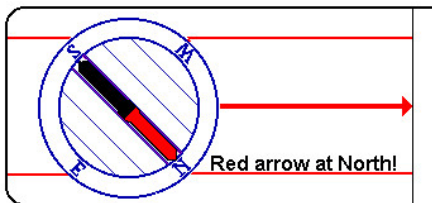
The red dots in this diagram represent the 50 stations (marked in the field with wooden stakes). Stations are 15m apart and the two transects are 100m apart.

Some areas have four transects (each with 25 stations) instead of two transects.

Compass Bearings and Distances

We often use a compass bearing and distance from a marker to help locate things we are measuring such as ground berry plots or cone trees. These bearings and distances are guides only and do not need to be perfectly precise. However, if the bearing is completely *inaccurate* then we potentially waste a lot of time looking for something in the wrong place.

How to take a compass bearing from a marker point to a tree (or plot):



Note that a full circle is 360 degrees (90=East, 180=South, 270=West, 360=North).

- Stand at the marker (typically a wood stake) and face the tree
- Hold the compass level and point it toward the tree.
- Turn the degree dial until the orienting lines are lined up with the magnetic needle as shown above
- Read the bearing off the degree dial. In the diagram above, the tree is NW from the marker, or about 315 degrees

Measuring distances to plots or trees:

It is useful to know roughly how far in meters the tree or plot is from the Marker. Take a few minutes at the beginning of the field season to measure how long your stride is (how many steps you take per meter). Walk from the Marker to the plot or tree and estimate the distance (in meters) based on your stride length. This is a guide for locating things in the future and does not have to be precise or perfectly accurate.

General Field and Data Entry Techniques

- Data sheets contain the key records of all of our efforts. It is important that they be filled in completely and clearly, your full name is on them, the date (including the year), and any special notations are explained. Make sure data sheets are reviewed at the end of each day so that any problems can be fixed while the details are still fresh in your memory.
- Any monitoring program must be concerned about the “Big Foot” effect - that our walking through the area may cause changes in the habitat. A major worry is establishing a trail down the sampling lines. Try to minimize trampling near the sampling stations and walk off the line when possible.
- You may be able to make interesting natural history observations in the course of doing this monitoring or in your other activities. Please put comments in the “General Comments” section of each data entry form in the Access database so that, for example, we will have a record of insect defoliation or high moose or grouse numbers at specific sites.
- Most data sheets have comments carried forward from the previous year, which may be relevant to the current year as well. Make a note on the data sheet if the comment is still relevant and therefore should be entered again for the current year. Comments are not automatically carried forward when entering the data into the computer.
- For some protocols we record a bearing from the grid or line marker to help locate the plot. These bearings are a guide only so they do not need to be precise.
- Use “-99” for missing data in the database. Never use “0” because that could be confused with actual data and confound the data analysis.

Spruce Cone Production Sampling

Purpose:

To estimate the size of the white spruce cone crop for each year.

Rationale:

Spruce seeds are an important food for red squirrels, rodents and many seed eating birds like juncos and chickadees.

Procedure:

Cone counts should be conducted when cones are large enough to see clearly with binoculars but before squirrels begin to harvest them. This window of time is usually in July or the first week of August of each year. At least 100 trees should be sampled on each area. At each sampling station, choose the closest **healthy** spruce tree to the stake that has a DBH (diameter at breast height, see side note) of **at least 10cm**. Mark the tree in two ways – (1) with green or yellow flagging tape wrapped around the trunk of the tree at chest height with the word "cone" written clearly on the flagging tape, and (2) with a numbered metal tag, also placed as close to DBH as possible. The tag should be attached to a **sturdy dead branch** that faces the stake. If an ideal dead branch is unavailable, tag the best branch possible and make notes in the comments. Use wire to secure the tag to the dead branch snug against the tree trunk. Use the recorded DBH from previous years to help relocate trees that have lost their flagging for some reason. Walk far enough away from the tree to find a good vantage point to view the tree top. It is not essential to use the same vantage point each year. Using a pair of binoculars, count the number of **new** cones in the top 3 meters (10 ft) of the tree. If the total number of cones exceeds 100-200, *estimate and record the number by eye approximately (to nearest 50,*



DBH – Measure the diameter where it is easy to measure, it does not need to be the forestry norm of exactly 1.3m above ground. The crucial point is to take the diameter in the same place each year. Mark the diameter location with forestry paint so that there is no question where to measure it in future years.

No need to measure the tree diameter every year **unless** you are choosing a new cone tree. DBH of all trees should be re-measured every 4 years (check your database to find the last year they were measured).

spend no more than 10 seconds on this estimate) and take a photograph of the top of the tree so cones can be counted later with more ease and accuracy. Write the estimate and the photo number on the data sheet as well as a note that a photo was taken.

Partially open cones: Although it is rare, it is possible for cones on a tree to start opening two or three weeks earlier than on nearby trees and this can be confusing. Cones from previous years are usually completely open and dried (see photo on previous page).



New cones, some of which are starting to open.

Never move a tag from one tree to another! If the old cone tree has died, it is essential to **leave the tag on the old dead tree**. A potentially new cone tree may already have a tag because it has been marked previously as a bark beetle tree. If you need to choose a new cone tree and it already has a tag on it, use that number and do **not** add a new tag.

Cone production data provide only an index to cone production since we do not count all the cones on the trees but only those visible from one side of the tree.

Data should be entered into the **Spruce Cone Production** section of the Access database.

If using photography:

Remember to record an **estimate** of cone numbers as well as taking a photo. Photograph the top 3 meters of the tree only. You need to identify which tree is in the photo.

To take good photographs the photographer needs to know how to operate the camera. So read the manual and take some time to learn how to change the settings on your camera. Using the Auto setting is not sufficient. Settings that are relevant include; *picture quality, ISO, white balance, exposure compensation, aperture, shutter speed, and using the timer*. **Never use digital zoom**; set the camera to use optical zoom only. Set the numbering system of the camera to continuous numbering of photos so that each photo is named in a logical order. At each station requiring a photo, make sure that the lens is clean and free of dust. Find a

good spot with the majority of the light coming from behind you and where you have a clear, unobstructed view of the top three meters of the tree. Use a tripod and the timer function on the camera to avoid camera shake is if there is not enough light for a fast shutter speed. If you are worried about exposure of the photos, take several photos of the tree with bracketed exposure settings. If the tree is moving due to wind, try using the sports setting to increase the shutter speed. Check to be sure that the image is clear by zooming in to full extent on. Do this for every single photo taken!

Use a minimum 3 megapixel camera, preferably 5 megapixels or more, with a minimum 3x *optical zoom*, preferably 10x. **Record the name of the photos** (eg lmg001, lmg002) on the data sheet.

Cones can be counted on the computer by opening the photo in a bitmap editor such as MS Paint and placing a dot on each cone as it is counted. Use an automatic mouse click counter such as OdoPlus (<http://www.fridgesoft.de/odoplus.php> - this program has also been stored on our Zeus file backup system).

Make sure when using a clicker counter to RESET to zero at the start of counting cones on a tree. If using OdoPlus, it works best to use the right mouse button for counting and reserve the left mouse button for scrolling ("color 2" on the Windows 7 version of the Paint program uses the right mouse button).

Summary Statistics:

The bootstrapped mean number of cones (and 95% confidence intervals) for each area and year is computed under the "Summary Statistics" option of the *CEMP_data* Access database.

Equipment:

- Data Sheets
- Binoculars
- Flagging Tape: Yellow or Green
- Marker Pen
- Clicker counters
- DBH tape for measuring tree diameter
- Camera with telephoto lens & tripod
- Aluminum tags
- Hammer

Time Estimates:

Field: 1 person day per area

Lab: up to 2 person days per area (if photos taken)

Data Entry and analysis: ½ person day per area

Spruce Cone Production

Date: July 28,

Year: 2014

GRID: KEMP-Chitty

Observers: Charles Krebs, Ryan Diamond,
Full names please Shawn Taylor

Tree Tag #	Loc	Dist (m)/ Direction	DBH (cm) (DBH 2013)	# Cones (Count)	# Cones (EST)	Photo num	Comments (Comments from 2013)
790	A/1	1/90	13.4	57		n/a	
789	A/3	2/270	16.1	394		132	
788	A/5	6/200	16.5	335		136	
431	A/7	3/110	10.6	58		n/a	
777	A/9	4/330	25.1	248		138	
781	B/2	1/270	12.2	226		n/a	
780	B/4	3/20	12.2	297	235	145	
779	B/6	2/90	21.3	935	490	144	
778	B/8	4/310	24.05	970	600	143	
776	B/10	2/300	25.4	590	600	139	
738	C/1	1/190		818	560	147	
739	C/3	1/280	15.0	196		142	
740	C/5	1/270	12.5	215		n/a	
741	C/7	3/70	12.7	245		n/a	
742	C/9	1/20	3.2	399	375	148	
771	D/2	3/350	16.4	190		n/a	
772	D/4	2/350	10.6	536	560	150	
773	D/6	1/90	13.7	185		n/a	
774	D/8	1/90	22.45	524	420	149	
775	D/10	4/30	20.3	232		n/a	
718	E/1	3/30	15.7	215		n/a	
719	E/3	1/200	11.6	122		n/a	
720	E/5	1/90	15.7	613	460	151	
721	E/7	2/360	13.3	98		n/a	
722	E/9	6/340	14.4	455	240	152	
770	F/2	4/220	14.6	210			
769	F/4	6/290	24.7		570	157	
768	F/6	1/270	13.2	140		n/a	
767	F/8	2/310	15.4	559	430	155-16	
766	F/10	2/280	11.3	74		n/a	
737	G/1	4/270	17.5	190		n/a	

Spruce Seedling Growth and Survival Protocol

Purpose:

The purpose of this protocol is to measure the vegetative response of seedlings to adult spruce tree mortality to quantify the impact of additional light and nutrients on the forest floor flora.

Rationale:

These data will provide us with an estimate of the growth rate of white spruce seedlings and their survival rate under the changing impacts of climate in this part of the Yukon.

Procedure:

This is being done in a pairing design by centering quadrats on recently dead spruce trees and on nearby healthy large trees, and doing mark-recapture measurements on the tree seedling recruits.

In 1997 we set out 6 quadrats each 10 meters on a side in areas at Silver grid and Sulphur grid. These were re-measured in 2006 and additional plots were put out in 2007. On the new plots set up in 2007, 50 trees between 10 cm and 1 m in height were tagged in circular plots (the plot diameters vary in order to ensure a sample of 50 trees). As some trees die, new ones taller than 10 cm will be tagged and measured and added to the database so that we continue to have a sample size of 50 on each plot.

1. Locate the tagged trees from previous samples with the help of the maps of each quadrat site. Do this systematically so as not to miss marked trees.
2. Measure the height in cm to the growing tip. For trees above 1 m height measure the DBH in mm as well as the height.
3. Note if the tree is split into two or more growing shoots. If split, measure the height of the tallest of the splits.
4. Record the FATE of the tree as per the data sheets. If the tree is healthy, the FATE = 1. All trees must be assigned a fate.

5. If the tree is dead, note this and remove the tag and destroy it. Do not re-use any tag numbers.
6. Replace any dead trees with a new previously unmarked tree > 10 cm height and < 100 cm height with a new tag number. Record this in the comments as a NEW TREE and measure its height. It may be necessary to increase the size of the plot if there are no available trees within the current plot. Be sure to update the map for the site so that the new trees will be easy to find in future years.
7. Note the DATE and the OBSERVERS on the data sheets.
8. When the plots are finished, enter and verify the data in the current ACCESS database KEMP_AINA.MDB

During the 2001 census seedlings were re-flagged using blue flagging tape. For new or re-tagged seedlings, a wire stake with blue flagging pinned at the base of the tree will be used (in preference to coated wire wrapped around the seedling stem or branch) to minimise future disturbance of the plant.

Spruce Seedling Survival

Centre Tree Status: Dead

Centre Tree DBH (cm): 65

Date: _____

Year: 2009

GRID: Silver, T-10

Map Datum: _____

Latitude: 0

Longitude: 0

Observers: _____

Full names please

Fates: 1 = Healthy (no change)
 2 = Broken off at growth tip
 3 = Browsed

5 = Unhealthy tree
 6 = Missing / lost
 7 = Dead

9 = Tag found loose - not reassigned
 11 = New tag
 12 = Other (specify)

Tag	Previous data		Height (cm)	IF HEIGHT > 1 M		Split?	Fate	IF BROWSED		Comments (Comments from 2009)
	Height (cm)	Diameter (mm)		Diameter (mm)	Height at diameter (cm)			Diameter at Browse (mm)		
1	280	21								
2	114	27								DBH taken under split
3	99									
4	500	122								
5	325	41								
6	325	73								
7	137	9								
8	53									Previously browsed
9										Tag removed in 2006
10	33									Split at base
11										Tag removed in 2006
12	27									
13	88									
14	96									
15	37									
16	66									
17										Tag removed in 2006
18	40									
19										Tag removed in 2006
20	44									
21	49									
22	68									
23	47									
24										Tag lost as of 2001
25	25									
26	37									
27										Tag lost as of 2001
28	33									Previously browsed, healthy
29	28									
30	46									Previously browsed, split into 3 all same height

Equipment List:

Data sheets (with note from previous sampling) & pencils
Callipers
DBH measuring stick
Tape measure
Flagging tape (blue/pink)
Data sheets in folder and pencils
1m and 30cm rulers
New tag maker and metal strips (plus something to punch holes in tags!)
Coil of 2mm wire
Needle-nose pliers and wire cutters

Time Estimates:

Field: 1 person day per site
Data Entry: 1 person day per area

Mushroom Counts Protocol

Purpose:

To estimate the standing crop of mushrooms (grams per 10 sq meters) at the peak of the mushroom season.



Rationale:

Mushrooms are an important alternate food for red squirrels and small rodents, and their abundance varies greatly from year to year.

Procedure:

Mushrooms should be counted at the peak of the mushroom season, which is normally August 1-15 at Kluane. Some preliminary surveys may be needed to pinpoint the maximum time of mushroom emergence. There is a timing trade off - count too early and you will miss mushrooms that haven't yet emerged, count too late and some mushrooms will already be harvested by squirrels.

The quadrat is a circle of 3 meters radius centered on the grid (or transect) marker stake. Use a 3m piece of non-stretchable string or tape pinned to the stake to locate the outer edge of the quadrat. At least 100 quadrats should be counted on each area. Within each circle count all the mushrooms that are visible of ALL SPECIES* and measure their cap diameters in cm (to one decimal point) in order to classify the mushrooms into the following three size classes: SMALL (<4 cm), MEDIUM (≥ 4 and <8 cm) and LARGE (≥ 8 cm). If the mushroom is oblong, measure two diameters and average them. Record in cm to one decimal place.



SMALL and MEDIUM mushrooms: Record the number of small and medium sized mushrooms counted in the quadrat at each station. In order to convert the numbers to biomass, you need to precisely measure the diameters of a subset of 20-40 small mushrooms and 20-40 medium

* See end of this section (page 18) for exceptions!

mushrooms. Repeat this *for each area* and enter the diameters into the Access database. If there are fewer than 20 small or medium mushrooms on a particular area, then take diameters of all mushrooms counted at that site. There is no need to measure mushrooms outside of the quadrats to get more diameters. If there are huge numbers of mushrooms, do not take all the diameters from the first station, instead spread the measurements spatially by taking 2-3 diameters at each station until you have enough.

LARGE mushrooms (>=8cm diameter): Because large sized mushrooms can make up most of the biomass produced, you need to **record the diameter of every large mushroom**. This will ensure the final biomass estimates are as accurate as possible.

Old or New? If a mushroom is dry, shriveled and hard then assume it is from last year. If it is fleshy, even if rotten, assume it is from this year.

NOTE: If you find a stalk of a mushroom that has obviously been already harvested by squirrels, count the mushroom as a **medium** (it may have been large but this is conservative). We do not count mushrooms growing on tree trunks or tree limbs because they are woody bracket fungi, and they are not eaten by any animals that we know of.

Data Entry:

All count data and sample diameter measurements (small and mediums sized mushrooms) should be entered into the Access database. When you enter the number of large sized mushrooms counted, a box will pop up asking for each individual diameter (cm).

Summary Statistics (Biomass Estimates):

The wet weight of a large mushroom is calculated using the following formulas:

$$\text{Mushroom Cap Area} = 3.1415927 * ([\text{Cap Diameter}] / 2) * ([\text{Cap Diameter}] / 2)$$

$$\text{Wet Weight} = 1.095023 * (\text{Exp}(-1.06392 + (1.200234 * \text{Log}(\text{Cap Area}))))$$

(correlation coefficient R = 0.94)

Diameters are in cm and weights are in grams.

The wet weight regression is based on Kluane data compiled by Patrick Carrier for his MSc in 1995 and with additional data gathered in 1997 and 2000. Once all count and diameter data are entered, the bootstrapped mean biomass per 10 m² (standing crop) and 95% confidence interval for

each area and year is computed under the “Summary Statistics” option of the *CEMP_data* Access database.

Equipment:

Data sheets & pencils
 Non stretchable string - exactly 3m in length
 Thumb tack for pinning string to stake
 Ruler
 Clicker (tally counter)

Time Estimates:

Field: 2-4 person days per area
 Data Entry: ½ person day per area

Mushrooms that we do NOT count:

We do not count any mushrooms <2 mm in diameter. Also exclude the following species because we do not have diameter to biomass regressions for these species and we have no indication that these species are important food sources for small mammals.



Coral mushrooms



Puffballs



Gold fingers

Do not count these mushroom species but make notes about them in the comments field (including an estimate of the numbers or size).

Mushroom Counts

* Remember to measure 20-40 diameters from each of the small and medium size categories. Measure diameter of ALL large mushrooms.

Date: 30 July 2003

Year: 2003

GRID: Aisek

Observers: Richard Greer
Full names please

Transect or Row	Station No.	No. Small (0-4 cm)	No. Medium (4-8 cm)	No. Large (>8 cm)	Large Diameters (cm) / Comments (Comments from 2002: Individual diameters for each large mushroom must be recorded!)
A	1	2	0	0	
A	2	4	0	0	
A	3	1	1	0	
A	4	0	3	0	
A	5	9	0	1	9.3
A	6	3	0	0	
A	7	3	1	0	
A	8	9	0	2	8.9, 9.2
A	9	10	2	0	
A	10	1	2	0	
A	11	3	1	0	
A	12	0	3	0	
A	13	26	0	0	
A	14	9	0	0	
A	15	6	0	0	
A	16	3	0	0	
A	17	2	3	0	
A	18	2	1	0	
A	19	0	0	0	
A	20	0	6	1	10.3
A	21	1	0	0	8 puffballs
A	22	7	3	0	
A	23	7	4	0	
A	24	5	3	0	
A	25	5	5	0	
A	26	4	0	0	
A	27	3	1	0	
A	28	8	0	0	3 mushrooms just outside 7 meters
A	29	12	2	0	
A	30	11	0	0	3 puffballs
A	31	2	0	0	
A	32	4	0	0	

Ground Berry Production Protocol

Purpose:

To obtain an index of ground berry production each year.

Rationale:

Ground berries are an important food for small mammals and production varies greatly from year to year.

Procedure:

We count the number of berries produced in permanent quadrats in the boreal forest each year to give an index of berry production. We do not attempt to measure the total biomass production of ground berries per hectare.

Timing: The berries should be counted each summer when the plants have finished flowering. We've tested counting flowers but they are not a reliable predictor of final berry production. It is also preferable that the berries are still green when counted in order to minimize the amount of harvesting by mice which occurs once the berries begin to ripen in August. The optimal timing of counts may vary from year to year and some monitoring in late June to mid July should give a good estimate of when counts should be conducted.

Arctostaphylos uva-ursi and *Empetrum* generally will ripen earlier than other species while *Cornus* and *Vaccinium* generally ripen late in the summer. For each region the optimal timing for berry counts may be different by up to two or three weeks and it is important to make detailed comments about phenology at each site for each year.

Ground berries are monitored in permanent 0.4 x 0.4 meter square quadrats. Look for a good berry patch with at least 50% cover of one of the *target* species (see side note on page 24) within 5-7 meters of the grid or transect marker and place two quadrats side by side. Mark a nearby bush or tree with unique (eg. polkadot) flagging tape to indicate where the quadrats are located. Mark the quadrats with 4 spikes - one BLUE flagged spike at each outer corner of the quadrat closest to the transect marker (quadrat # 1),

Berries on the edge are counted if at least ½ of the berry is inside the quadrat.

Flowers: Do not count flowers because they do not reliably turn into berries.

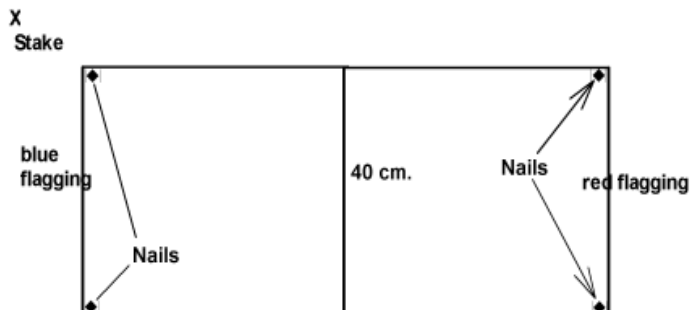
Bits & Pieces: When berries are harvested by mice sometimes small bits are left on the ground. Count these piles conservatively as 1 berry.

and one RED flagged spike at each outer corner of the adjoining quadrat (quadrat # 2). You will now have a 0.4 by 0.8 meter rectangle marked containing two quadrats. Estimate the distance in meters from the transect marker to the nearest quadrat (#1) and record the approximate compass bearing from the transect marker to the quadrats so we can locate the quadrats easily the following year. One hundred quadrats (50 sites, each with 2 quadrats) should be measured in each area. Note that not every transect marker will have a set of ground berry quadrats – only good sites are used.

In each quadrat, estimate the percent cover of each berry producing species and count the berries. **All** berries should be counted, including shriveled or tiny or dropped and over-wintered ones. Do this for each berry species - *Arctostaphylos uva-ursi* (kinnikinnick), *Arctostaphylos rubra* (red bearberry), *Empetrum nigrum* (mossberry, crowberry), *Geocaulon lividum* (toadflax), *Vaccinium vitis-idaea* (cranberry), *Cornus canadensis* (bunchberry). In the “Other” category include only blueberry, strawberry and rose. If two “Other” species occur in one plot, record the second species in the Comments field.

Percent Cover: It is theoretically possible to have >100% total cover because leaves overlap but if you are getting to 110 or 120% then perhaps your estimates are too high.

When to move a quadrat: We compare berry production in the same quadrats each year so, if at all possible, they should never be moved. If a tree falls on top of the quadrat so that it's impossible to count the berries or if it is destroyed for some reason, then it will have to be moved. Be sure to record any moves in the comments and check the "moved" checkbox when entering the data into the computer. If the plants are dying or being buried with spruce needles, make a comment about this but do **NOT** move the quadrat unless the cover of the target berry species has **decreased below 20%**. If the quadrat must be moved, a new site should be chosen with at least 50% cover of one of the *target* berry species (see note on next page) and this could be located at a different grid stake if necessary.



**Target berry species:**

Arctostaphylos uva-ursi

(bearberry)

Vaccinium vitis-idaea

(cranberry)

Arctostaphylos rubra

(red bearberry)

Empetrum nigrum

(mossberry / crowberry)

Plot showing blue and red flagged nails

Summary Statistics:

The bootstrapped mean number of berries per quadrat (and 95% confidence interval) for each species in each area and year is computed under the “Summary Statistics” option of the Access database.

For each berry species, in each quadrat, the number of berries are first adjusted to a number per 50% cover (quadrats with <5% cover for that species are ignored). The regression used to adjust all observed berry counts to a standard 50% cover quadrat is:

Adjusted number of berries = Observed berry count x (50/Observed % cover))

This regression is used for all ground berry species.

Equipment:

Data sheets & pencils

0.4 square meter quadrats - best to have 2 of these to mark out both adjoining quadrats at the same time

6 to 8 inch long spikes - 4 per set of 2 quadrats

Flagging - *polkadot* to mark location, *red* and *blue* to mark spikes

Clicker (tally counter)

Compass

Hammer

String to subdivide quadrats to assist with counting

Time Estimates:

Field: 1 person day per area

Data Entry: ½ person day per area



Arctostaphylos uva-ursi
(bearberry or kinnikinnick)



Vaccinium vitis-idaea
(cranberry)



Arctostaphylos rubra (red
bearberry)



Salix reticulata (not berry
producing so do not record;
do not confuse with rubra!)



Empetrum nigrum
(mossberry or crowberry)



Geocaulon lividum
(toadflax)



Cornus canadensis flower
(bunchberry)



Cornus canadensis berries
(bunchberry)

We do not record Twin flower (*Linnaea borealis*). Twin flower can easily be confused with kinnikinick or cranberry so the following table with photos compares the three.



Linnaea borealis (twin flower): Leaves are light green and lighter in structure. Leaves are opposite.



Arctostaphylos uva-ursi (kinnikinick): Leaves are leathery, dark green and slightly hairy on top, pale below. Leaves are alternate and lack the brown spots of cranberry.



Vaccinium vitis-idaea (cranberry): Leaves are glossy, dark green above and stiffly concave with rolled edges; undersides are pale and have brownish spots; alternate on stems.



Ground Berry Quadrats

Record % cover and the number of berries of each species in each quadrat.
Note: Blue flagging on Quadrat 1 (closest to stake)
Red flagging on Quadrat 2 (farthest from stake)

A. vva-ursi = kinikinnik
A. rubra = red bearberry
Empetrum nigrum = mossberry
Geococum lndrum = loafrix
Vaccinium vils-idea = cranberry
Cornus canadensis = bunchberry

Date: 26 July 2003
Year: 2003
GRID: Donjek
Observers: Liz Hoyer
Full names please

Transect / Row	Station No.	Quadrat No.	Distance (m)	Bearing	A. vva-ursi cover berries	A. rubra cover berries	Empetrum cover berries	Geococum cover berries	Vaccinium cover berries	Cornus cover berries	Other cover berries	Comments
A	1	1	1	150	0	50	0	0	0	0	0	plants healthy - Vaccinium
A	1	2	0	0	0	40	0	0	0	0	0	
A	2	1	5	340	0	55	7	0	0	5	0	
A	2	2	0	0	0	70	10	0	0	5	0	Shepherdia
A	3	1	3	340	0	90	0	0	0	0	0	
A	3	2	0	0	0	90	1	0	0	0	0	
A	4	1	1	50	0	50	0	0	0	0	0	
A	4	2	0	0	0	75	0	0	0	0	0	
A	5	1	2	10	0	50	0	0	0	1	0	
A	5	2	0	0	0	50	0	0	0	1	0	
A	6	1	2	120	0	60	1	0	0	10	0	
A	6	2	0	0	0	65	2	0	0	15	10	
A	7	1	1	10	0	70	0	0	0	0	0	
A	7	2	0	0	0	35	0	0	0	2	0	
A	8	1	4	215	0	45	0	0	0	1	0	
A	8	2	0	0	0	55	0	0	0	10	5	
A	9	1	2	10	0	65	0	0	0	20	3	
A	9	2	0	0	0	30	0	0	0	1	5	
A	10	1	3	280	0	30	0	0	0	5	0	
A	10	2	0	4	0	45	0	0	0	10	0	

Soapberry Production Protocol

Purpose:

To obtain an index of soapberry (*Shepherdia canadensis*) production each year.

Rationale:

Soapberries are an important food for grizzly bears and other mammals and birds. Soapberry production varies greatly from year to year.



Procedure:

We count the number of berries produced on the exact same stems of soapberry bushes each year to give an index of soapberry production. We do not attempt to measure the total biomass production of soapberries per hectare.

Timing: The counts should be made in July of each summer when the berries are still green in order to minimize the amount of harvesting by bears, birds, and mice which occurs once the berries begin to ripen. The optimal timing of counts may vary from year to year and some monitoring in late June should give a good estimate of when counts should be conducted.

Soapberry bushes may be male or female and only the female bushes produce berries. The plant should be marked with a combination of blue and polka dot flagging tape. Use the marker pen to label the flagging tape with the bush number.

The unit of measure is an individual soapberry plant BRANCH or STEM - not the entire plant. Choose branches with diameters near the base of the stem in the range of 5-15 mm and as close to 10 mm as possible. Berries should be counted on 2 branches from each plant. Tag the branch to be sampled LOOSELY as near the base as possible with permanent aluminum tags with unique numbers. Each of the two branches should also be marked loosely with red flagging. A total of 20 branches (10 plants) should be counted on each area if possible.

For each branch counted, measure the diameter (in millimeters, to one decimal place) of the branch near its base. Use a permanent marker pen to **mark on the stem exactly where the diameter is taken**. Count the total number of berries produced, including shriveled ones. Measure the branch diameters each year since the branches will grow. If the tagged branch has died, change the tags to a new branch and note this in the comments.

Soapberries may vary in size from year to year and from site to site. A collection of 25-50 **ripe red berries** should be obtained from each site and weighed so we can estimate the average wet weight of a single berry from each area. Do not collect all the ripe berries from a single bush! Aim to collect two berries from each bush covering a large proportion of the sampling area. Assuming the berries are counted when green, this will require a later trip to the site to collect the berries when they are red.



IMPORTANT: Soapberry branches will bruise and easily break at the junctions if not handled carefully.

Summary Statistics:

The number of berries on each branch is adjusted to a standard 10 mm diameter branch using the average slope (0.7105) from the combined regression on all the 1997-2001 data, for all berry counts greater than zero:

No. of standardized soapberries = $(\text{SQRT}(\text{Observed no. soapberries}) + ((10 - \text{Observed diameter}) * 0.7105))^2$

where diameter is in mm. These standardized counts are then bootstrapped to obtain the mean and 95% confidence limits for the soapberry counts from each area and year under the “Summary Statistics” option of the *CEMP_data* Access database.

Equipment:

- Data sheets & pencils
- GPS to locate soapberry bushes
- Aluminum tags and Dymo label maker
- Coated wire or lock ties

Flagging – POLKA DOT or striped with BLUE to mark bush, RED to mark individual branch

Permanent Marker Pen to mark the bush number on the flagging tape and also to mark the diameter location on the stem itself

Caliper

Clicker (tally counter)

Time Estimates:

Field: 1/3 – 1 person days per area

Lab: 2 person days for all areas

Data Entry: 1 person day for all areas

Soapberry Counts

Note: each plant should be located within a 5 meter radius of a station. If plants are located farther from the station, it is important to record a specific GPS reading of UTM coordinates for each plant.

Date: 20 July 03

Year: 2003

GRID: Alsek

Observers: Liz Hofer, David Henry
Full names please

Fates:
1 = OK
2 = Partial Browse (fresh only, ignore old browse)
3 = Unhealthy
4 = RETAGGED (natural death, browse, breakage)

Average wet weight of a ripe (red) berry: 0.1748 g (n=48)
(Collect 25-50 ripe berries at each site if possible. These will have to be collected about mid August)

Eastings	Northing	Transect or Row	Station No.	Bush No.	Stem No.	Diameter (mm)	No. Berries	Fate	Comments (Comments from 2002)
682420	6743481	off	0	1	1	6.6	0	1	
0	0	off	0	1	2	9.5	0	1	
0	0	off	0	2	1	7.0	3	1	
0	0	off	0	2	2	6.1	0	1	
0	0	off	0	3	1	10.0	7	1	
0	0	off	0	3	2	10.0	5	1	
0	0	off	0	4	1	8.0	13	1	
0	0	off	0	4	2	7.8	35	1	This branch comes from another branch
0	0	off	0	5	1	15.6	0	1	S. 1 and S. 2 are the same branch
0	0	off	0	5	2	12.5	3	1	
0	0	off	0	6	1	7.5	28	1	
0	0	off	0	6	2	7.5	6	1	
0	0	off	0	7	1	11.0	12	1	
0	0	off	0	7	2	13.0	35	1	
0	0	off	0	8	1	6.2	10	1	
0	0	off	0	8	2	9.6	0	1	
0	0	off	0	9	1	9.8	6	1	Original bud
0	0	off	0	9	2	11.9	21	1	
0	0	off	0	10	1	12.9	10	1	
0	0	off	0	10	2	12.8	8	1	

Snowshoe Hare Trapping Protocol

Purpose:

To monitor snowshoe hare population changes.

Rationale:

One of the main prey species in the Kluane system is the snowshoe hare which shows 9-10 year cycles in abundance throughout Canada and Alaska. Recent peak densities occurred in 1989-90 and 1998-99 and 2007. The peak in 2007 was relatively low with about half the density of hares in the 1998-99 peak. Hares are more nocturnal than diurnal and you will see more animals in the evening and the early morning than you will see in the middle of the day.



Procedure:

Snowshoe hare trapping is hard work because the grids are large (20 by 20 checkerboards with 30 m between the points), and animals must be processed as quickly as possible to avoid trap stress at all times but especially during the breeding season. This means that especially during the breeding season the hare traps should be set at 2000h or later and checked again at 0600 hours. It is critical that we do not have trap deaths during the trapping sessions for obvious ethical reasons and also because this interferes with the population changes we are trying to study.

1. Snowshoe hare live trapping on control grids will be done twice per year in March or April (centered on April 1, the start of the biological year), and September or October. Hares will also be trapped at other times of the year as we have time to improve the accuracy of estimates or for particular studies.
2. Three control grids will be trapped each with 86 traps. If hare numbers are so high that trap saturation occurs, you should add more hare traps to the control grids.
3. Traps should be prebaited with alfalfa cubes and a small handful of rabbit chow for 4 to 7 days before trapping begins. If rain or snow

compromises the bait (hares will not eat soggy alfalfa) or if there are many hares and the bait is likely to be eaten quickly, the bait may have to be re-supplied. Hare trapping sessions will go for 3-5 days in total until *approximately* 50% of the hares trapped are recaptures. Trapping sessions can have one or two non-trapping days in the middle if there is a concern that individual hares are getting caught too often (no hare should be caught more than 2 nights in a row).

4. Live trapping should be done with fresh alfalfa cubes and chow. If trapping in summer add a slice of apple (12-16 slices from a large apple – slices are less likely to fall outside the trap than chunks). This acts as an extra lure when there is plenty of natural green food available and also for hydration for the hare. In winter the extra lure of apple is not necessary and a packed snowball in each trap will provide adequate hydration.
5. All live traps should be placed in active runways as evidenced by hare pellets or tracks and have good cover from above in case of rain. A small board may be placed on top of the trap to provide extra cover. Trappability is often low in hares and every effort must be made to increase trappability. Make sure the base of the trap is supported on all four corners, so that the trap sits solidly on the ground. If there is a high probability of rain then traps should not be set. If it rains unexpectedly and hares have gotten wet, or the handling bags are getting wet, then the hares should be released without handling in the hope that the moisture has not reached the skin.
6. Traps not in use for long periods or in winter when snow might bury them should be stood on end, with the operational trap door end facing up.
7. Approach hares in traps quietly and run them into trapping bags as quickly as possible to minimize stress. If a delay is unavoidable then cover the trap with a spare trapping bag so the hare can't see. Keep quiet yourself and the hare will settle quickly.
8. The first thing to do always, once the hare is in the bag, is weigh the hare. There are two reasons to always take the weight **first** – (1) the hare is already hanging in the bag in a manner ideal for weighing and (2) it's really easy to forget to take the weight at the end after actually handling the hare! Next, settle the hare on your lap so it calms down and enter the location and total weight on the data card. Then record the ear-tag number (or give it a **right** ear-tag if needed) and record the sex and right hind foot measurement.

9. The following data must be recorded for each hare:

location (grid stake number)

tag number (Number and possibly a letter – check both sides of tag and both ears)

weight (check and record burlap bag weight frequently)

sex and reproductive status:

males: S = testes scrotal; A = testes abdominal

females: L = lactating (nipples enlarged, matted fur, lactation fat beneath skin visible, milk can be expressed possibly); NL = not lactating, no matted fur

maturity

percent white pelage

right hind foot length in mm

nose bleed from trap damage - none, mild, severe

other **comments** - pregnant, ear tag in poorly etc.

10. Recaptured hares should be reweighed but it is not necessary to re-check sex or RHF.
11. Check sex and breeding condition very carefully. Sexing errors are one of the most common errors in the data and there is no good excuse for this.
12. The data for each grid are recorded on separate data cards. Recapture lists are made after each check. For each trapping session, start a new data card and record the following information:
Grid, Date, Check #, Weather, Time, Trapper(s) name(s), followed by the **data for each animal** on a separate line. Write legibly.
13. Traps must always be checked and repaired as needed. Always carry a pliers in the field when setting hare traps.
14. Make a note of traps that must be replaced on each grid and keep a complete set of traps in position. All traps in the field should be equipped with a red squirrel escape.
15. All live-trapping data should be entered into the CEMP Small Mammal Access database within 3 days of the end of the trapping session so that questions of what is written on the cards can be sorted out immediately. (Or if the data cards are to be sent to Kluane to be entered, check the cards carefully at the end of each session to make sure they are legible and that no data are missing.) All these data entered into the computer must be proof-read for accuracy. Always be on the lookout for nonsense errors - hares that change sex from one

Maturity:

Record whether adult or juvenile only if it is obvious to you. All hares >1400g will most certainly be an adult but there is a grey area especially in the 1250-1400g range. It is extremely rare for a hare to breed in the first summer in which they are born so any hare in breeding condition can be classed as adult.

A juvenile male penis is rounded at the tip compared to the pointed tip of an adult male.

day to the next, unlikely hind foot measurements, or trap positions that are extremely distant or don't exist.

Summary Statistics:

After all capture data have been entered into the *CEMP Small Mammals* Access database, population estimates can be computed under the "Petersen/Schnabel Estimates" option of the database. Alternatively there are options to export the data in a format suitable to run the Capture program (part of Program MARK), the Mouse Menu program (Jolly estimates) or Efford's Density 5 program.

Equipment List – Setting traps:

Pliers – needle nosed for fixing traps
Alfalfa cubes (about 2 per trap)
Rabbit chow (a small handful for each trap)
Apple (summer only – cut in slices so pieces will not fall outside of the trap;
16 slices per large apple (or 12 if hot weather)

Equipment List – Checking traps:

Data card & pencil (plus spare)
Burlap bag (plus spare)
3 kg scale
RHF measurer
Tagging pliers
Tags
Pliers – needle nosed for fixing traps
Bag of apples for re-setting
Alfalfa cubes and rabbit chow

Time Estimates:

Field: 4-7 person days per area (depending on hare population size)
Data Entry: ½ - 1 person day per area trapped

Snowshoe Hare Pellet Counts

Purpose:

To estimate the population density of snowshoe hares indirectly from fecal pellets. Hares have a 10 year cycle and vary greatly in abundance from year to year.

Rationale:

Snowshoe hares are the main food source of lynx, coyote, great-horned owls and goshawks, and are part of the diet of many other predators in the boreal forest.

Procedure:

Snowshoe hare pellets are counted on hare pellet plots once each year to give an index of hare numbers from year to year. From 1976 to 1996 we counted hare pellets and estimated population density of hares by live trapping and marking individuals. There is a strong relationship between pellet counts and hare numbers at Kluane.

There should be 100 transects counted on each area. Each transect should be 2 inches (5.08 cm) wide and 10 feet (3.048 m) long and marked with permanent markers. Place a marker at each end of the transect as well as a third marker somewhere in the middle to define the direction of the transect in case one of the end markers gets lost or kicked out of place during the year. The transects should start about 30cm from a transect stake marker and ideally they should run in the same direction of the transect.

First year: For the first year it is difficult to tell old pellets from fresh pellets so do not record counts for this year. Transects should be set out and all pellets cleared from the transect (do NOT disturb the surface layer – we are not trying to find buried pellets). Pellets should be cleared from a 20 cm buffer strip on all sides of the transect to reduce the risk of old pellets rolling or getting kicked into the transect.

Each year forever after: Count and record **all** pellets on each transect (even if you think that they look old – trust that all pellets were cleared from the transect last year and remember that some pellets can look old within a year). Clear the transect and surrounding area of pellets. Remember that we count what pellets

Pellets **on the line** are counted as long as they are at least $\frac{1}{2}$ inside the quadrat.

are on the surface only – there is no need to dig in the moss or litter or disturb the surface.

Summary Statistics:

Under the “Summary Statistics” option of the *CEMP_data* Access database, the mean number of pellets per 0.1548 sq m transect on each area is computed by bootstrapping from the raw data counts. These means are converted to hare density estimates using the following regression[†]:

Density of hares per ha over previous year = $1.567 * \text{Exp}((0.888962 * (\text{Log}(\text{Bootstrapped Mean}))) - 1.203391)$

where all logs are to base e. Note that because the pellets have accumulated over the past 1 year, the estimated density is the average over the past year.

Equipment List:

Data sheets & pencils

2 inch wide transect markers - 3 for each transect (permanently left at each site)

Elastic cord to wrap around end markers and define transect

Hammer

2 large spikes for placement in front of marker to keep line taut

10 ft measuring tape to check that the transect length is correct (in case one of the end markers has been displaced)

Time Estimates:

Field: 1-2 person days per area

Data Entry: ¼ person day per area

[†] Krebs et al. (2001) Estimating snowshoe hare population density from pellet plots: a further evaluation. *Canadian Journal of Zoology* 79(1):1-4.

Snowshoe Hare Turd Transects

REMEMBER *** After counting and recording all turds on the transect, clear the turds from the transect area (plus at least 20 cm from all sides of the transect).

Date: 20 July 03

Year: 2003

GRID: Paint Mtn

Observers: Richard Greer
Full names please

Transect or Row	Station No.	No. Turds	Comments
A	1	0	
A	2	0	
A	3	1	
A	4	0	
A	5	0	
A	6	0	
A	7	10	
A	8	0	
A	9	0	
A	10	0	
A	11	1	
A	12	0	cheese stake is missing in middle
A	13	0	
A	14	0	
A	15	2	
A	16	0	
A	17	0	one old turd
A	18	0	
A	19	0	
A	20	3	
A	21	0	
A	22	0	
A	23	0	
A	24	1	
A	25	1	
A	26	0	
A	27	0	
A	28	0	

Red Squirrel and Ground Squirrel Protocol

Purpose:

To monitor red squirrel and ground squirrel population density changes at Kluane.

Rationale:

Red Squirrels have the second largest biomass of all herbivores in the Kluane boreal forest. Males and females defend non-overlapping territories in the Yukon, relying on spruce cone crops to survive through the winter. Cones that are harvested in the fall are stored underground in middens, ensuring winter survival for the territory owner. Non-territorial animals are pushed into sub-optimal habitats (non-spruce areas), where winter survival is often poor and depends on the severity of the winter. With the exception of extremely cold weather, red squirrels are active above ground all year.



Arctic ground squirrels are also an abundant herbivore at Kluane but unlike the red squirrels they hibernate during the 8 winter months. They can be caught in the same traps as red squirrels, and consequently we index their population densities together by grid trapping twice each summer.

Procedure:

Squirrels will be live trapped 2 times a year so that population estimates can be determined, once in late May-early June to get an estimate of overwintering survival, and once in late July and early August to get an estimate of juvenile production and summer survival. Time the trapping sessions so that there is approximately 10 weeks between spring and summer census.

1. Red squirrels and ground squirrels are trapped 2 times a year for 3-4 consecutive days in late May- early June, and in late July- early August on 10x10 grids with 50 traps per grid.
2. A single Tomahawk Live trap is set at each alternate stake, prebaited with peanut butter and locked open for 1-3 days prior to each trapping session.

3. On each trapping day, check and reset all 50 traps three times with 1.5 hour intervals between checks. Begin by setting traps at 0700 and end with the last check at 1130. Stand traps on end at the end of each day to ensure that they are closed. Take care to place the traps in shady areas and never leave animals in traps for more than 1.5 hours. On hot days, traps should be locked open after the second check.
4. All squirrels are tagged in both ears with a National #1 Monel tag. Check each tag before using it to ensure that the tooth will go through the hole. After the tag is in place, check to make sure that it has locked properly. On the first capture within a trapping session, record the following information for each animal:
 - Location** - record the stake location
 - Species**
 - Left eartag & Right eartag numbers**
 - Weight** - in grams. Remember to record the bag weight for each animal. Net weight can be calculated in the field or during data entry.
 - Sex** - "ML" or ♂ for males, "F" or ♀ for females
 - Reproductive Condition** - males: (scrotal or abdominal); females: (small nipples vs lactating)
 - Zygomatic Arch** (ground squirrels only) – use calipers to measure the widest part of the skull in mm.
 - Comments** - record any wounds, note if juvenile, record notes on eartag or general condition of animal
5. In the second and subsequent checks, recaptured animals are those that have been caught during an earlier check. Record only the tag numbers and location and a circled R to indicate that it is a recap. If an already tagged animal needs a new tag make a careful note about this in the comments. When the data are entered into the Access Database the original **fate** for the retagged animal (from the first time it was caught in this trapping session) must be changed to **retag** (3).
 NOTE - it is important that both eartags be read even for recaptured squirrels as this will help catch errors. DO NOT read one tag and assume what the other is. This only helps to perpetuate errors.
6. The data for each grid are recorded on separate data cards. Recapture lists are made after each check. For each trapping session, start a new data card and record the following information:

If an animal is NEW (ie, you are putting an eartag in), put a box around the eartag number. If the animal has a rip in the ear, or needs just one tag, do not draw a box but record "RETAG in Left (or Right) ear" in the COMMENTS space.

Grid, Date, Check #, Weather, Time, Trapper(s), followed by the **data for each animal** on a separate line. Write legibly.

7. All data must be entered onto the CEMP Small Mammals ACCESS database.

Summary Statistics:

After all capture data have been entered into the *CEMP Small Mammals* Access database, population estimates can be computed under the "Petersen/Schnabel Estimates" option of the database. Alternatively there are options to export the data in a format suitable to run the Capture program (part of MARK) or for the Mouse Menu program (JOLLY estimates) or for Efford's DENSITY 4 program.

Equipment List – Checking traps:

- Data card & pencil (plus spare)
- 1 kg scale
- Tagging pliers
- Tags
- Pliers – needle nosed for fixing traps
- Trap bag
- Peanut butter for re-setting

Time Estimates:

- Field: 6 person days per area
- Data Entry: ½-1 person day per area





Scrotal male



Lactating female

Mouse Trapping Protocol

Purpose:

To monitor vole, mouse and chipmunk numbers.

Rationale:

In many years there are few mice and voles in the Kluane forests, but, in some years, outbreaks or cyclic highs occur and some or all of the 7 common species reach high abundance and become the major prey of some of the predators that we are studying.

Procedure:

We monitor small rodents by live trapping small areas on three study sites. It requires considerable practice to be able to handle small rodents without damaging yourself or them, and to be able to identify the species clearly. The most common small mammals are the red-backed vole (formally *Clethrionomys rutilus*, now called *Myodes rutilus*), voles of the genus *Microtus*, and the deer mouse (*Peromyscus maniculatus*). Red backed voles are very distinctive, having a rich russet back, and live primarily in forests. *Microtus* voles are uniformly dark brown in colour and live primarily in grassland or in areas with grass cover. Deer mice have white feet, large eyes, and a long tail.

1. Small mammal trapping should be done two times per year. The first will be in late May after the snow has gone and the last in late August to early September, before the first snow falls. It is crucial to trap all areas within a one to two week time span.
2. **PREBAITING PROCEDURE:**
Each grid should be prebaited 3 to 7 days in advance of trapping. Traps (Longworth) should be left permanently on the grids at all times. Locate all traps and throw a handful of oats into each and make sure they have dry cotton and are securely locked open. All traps sit within cages to protect from interference from squirrels in areas where squirrels disturb traps. Cages should be made immovable by having a heavy log or branch rest on top. Trap cover boards should be positioned in such manner that traps are not exposed to the direct rays of the sun and are protected from rain. Also make sure that the

entrance to the trap is not flush up against the wire mesh of the cage and that the trap entrance is placed flat on the ground.

3. TRAPPING PROCEDURE:

All grids should be trapped within a one to 1.5 week time span. Each trapping session should last a minimum of 2 nights. Traps should be set in the evening after 1900h.

1. Traps should be carefully cleaned with a putty knife and the treadle and door latch should be tested to ensure they are working (use pliers if necessary). If they are still not working, clean the latch and treadle with water or replace with a new tunnel. Each trap should receive a handful of oats, then a handful of cotton bedding, and one piece of apple in the front (be careful that the apple doesn't roll under the treadle). The next day the traps should be checked as soon as there is enough daylight to read the eartags (check 1) and again after 7pm (check 2). The following morning (check 3) the traps should be locked open. If densities are high and a large number of new mice are still being caught on the morning of day three (> 30% new mice), one more night check should be carried out (i.e. that evening (check 4) and the following morning (check 5).

How much Cotton bedding?

Add enough cotton that the mouse can build a cozy nest but be careful to not use too much. If the box is stuffed with cotton the mouse will not have enough room to build a nest or may not even enter the trap.

4. For each session, please record the **location** and **date**, the **check number** within the trapping session, **weather** and the **FULL name of the trapper(s)**. The following information should be recorded for each capture:

Eartag Number (please take care with this crucial item). Only experienced trappers should tag small mammals.

species

location on grid

weight to nearest 0.5 g (use pesola type scales
- 50 or 100 g)

sex “ML” or ♂ for males, “F” or ♀ for females

reproductive condition:

Males Testes **Scrotal** (S) or **Abdominal** (A)

Females

Vagina **Perforate** (P) or **Not Perforate** (NP)

Nipples **Lactating** (L) or **Small** (S)

Pubic Symphysis - **closed** (C),
slightly open (SO), **open** (O)

age “Juv” or “Adult”

Also record the following in the comments if necessary:

Killed (if the animal was killed)

Preg (if the animal is obviously pregnant)

Litter (number of young if a litter is born in the trap)

5. All data are to be recorded on data cards in the field with a separate card for each grid. Please note any factors which affect the catch ie. heavy rain, trap disturbance by squirrels, etc. All data should be transferred as soon as possible to the CEMP Small Mammal ACCESS database.
6. Note that *Microtus* species are often difficult to tell apart and if positive identification cannot be made, enter the species as *Microtus* sp. It is possible to distinguish between mature male *M. oeconomus* and *M. pennsylvanicus* because the former (*oeconomus*) have very pronounced flank glands and small testes, while the latter (*pennsylvanicus*) have no flank glands and large testes. *Microtus pennsylvanicus* also have slightly longer tails (relative to body length) than *oeconomus*. *Microtus miurus* have shorter tails and tan coloured ears.
7. Chipmunks are sometimes caught in the evening checks. Care must be taken to never hold them by their tail because they easily lose their tails. They can easily escape from a bucket so they should be handled by putting them directly into a bag from the trap. Their ears are also easily ripped so take care to place the eartags low and deep enough that they catch some cartilage.

Recaptures: what to record

SPECIES, EARTAG, LOCATION & SEX

(re-sexing helps pick up errors in sexing or recording eartags)

lactational fat from normal body colouration (blow at the hair to reveal the skin).

Medium Nipples:

If the nipples are clearly visible but there is not much lactational fat and you are sure that she is no longer lactating you can record **M** for medium nipples.

First day of checking traps within this trapping session First check of this day First check of the entire trapping session

Grid J Date 23 Aug 06 Day 1 Check of Day 1 Check of Session 1 Observer Alice Kenney Coded

Species	Eartag right tag for squirrels	Loc.	Weight (g)			Sex	Reprod	RH/ZA	Age	Comments
			Total	Bag	Net					
<i>Microtus</i> <i>murus</i>										
Mm	3402	A4			16.2	♀	NPSC		juv.	
Cleth	3437	E10			14.5	♂	A		juv.	
Mm	3472	G8			19.0	♀	PSC		juv.	
Chip	3180	B1	57.7	4.2	53.5	♂	A			Abdominal testes
Pero	3240	D2			25.5	♀	NPSC			Closed pubic symphysis
										Not perforate
										Small nipples

Box indicates a newly tagged animal (fate=2)

H = Hare Pero = Peromyscus Time Start: 0700 hrs
 RS = Red Squirrel Mic = Microtus Time End: 0745 hrs
 GS = Ground Squirrel Cleth = Clethrionomys Weather: overcast, calm, 11°C

Sample
Data Card

Summary Statistics:

After all capture data have been entered into the *CEMP Small Mammals* Access database, population estimates can be computed for any or all species under the "Petersen/Schnabel Estimates" option of the database. Alternatively there are options to export the data in a format suitable to run the CAPTURE program (part of MARK) or for the Mouse Menu program (JOLLY estimates) or Efford's DENSITY 4 program.

Equipment List – Checking traps:

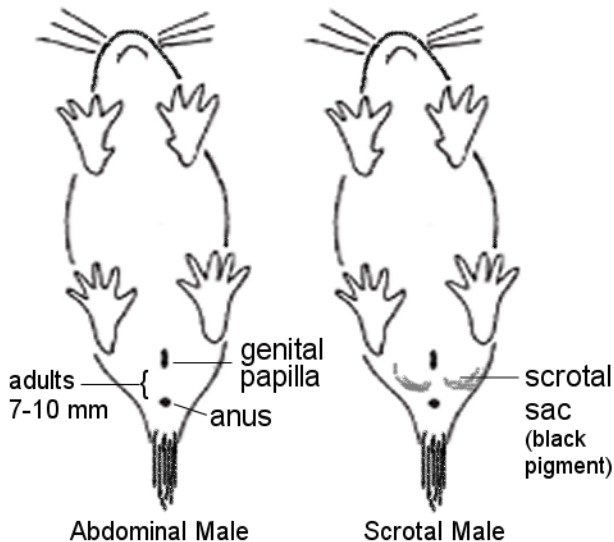
Data card & pencil (plus spare)
 50 g and 100 g scales
 Tagging pliers with elastic bands & Tags
 Putty knife for cleaning traps
 Pliers – needle nosed for fixing traps
 Spare tunnels
 Trapping bucket (28 cm diameter, 50 cm tall) with oats
 (the oats are used for re-baiting traps *and* as a cushion
 between the mouse and the hard plastic bottom)
 Apples cut into cubes (1 apple = 32 pieces)
 Clean cotton
 Garbage bag for picking up wet cotton
 Magnifying glass or reading glasses for reading tags
 Handling glove
 Small bag for handling chipmunks
 Band-aids

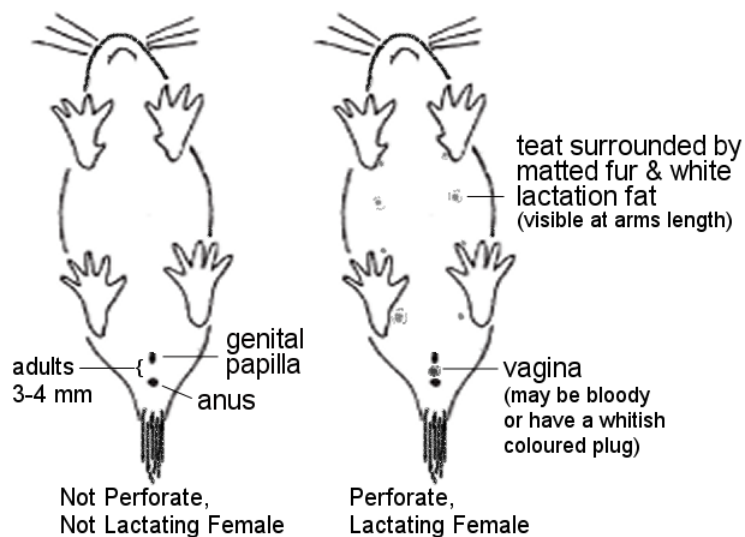
Maternity:

Record whether adult or juvenile only if it is obvious to you. All animals >20g for any species will likely be an adult but there is a grey area especially in the 15-22g range. Look at weight, breeding condition and, especially for *Peromyscus*, pelage colour (juveniles are lighter grey compared to darker, and sometimes browner, adults) to help decide but beware that by August even juveniles could potentially be breeding.

Time Estimates:

Field: 4 person days per area
 Data Entry: ½-1 person day per area







Microtus miurus (singing vole); notice tan coloured ear patches.



Microtus oeconomus (root vole)



Peromyscus maniculatus (deer mouse)



Microtus pennsylvanicus (meadow vole); very similar to *oeconomus* but tail may be slightly longer relative to body.



Chipmunk



Clethrionomys/Myodes rutilus (red backed vole)

Microtus drawings from S.O. MacDonald, *The Small Mammals of Alaska, A Field Handbook of the Shrews and Small Rodents*.

Track Transect Protocol

During the winter as an index of numbers we count tracks of mammal predators along 25 km of established snowmobile tracks, or "transects". We have permanent markers at 5 km distances where we measure snow depth and we use the snowmobile odometer to tell us each track's location along the transect.

1. Track counts are done on Day 1 or Day 2 following snowfall. At the low point of the hare population cycle, when predator densities are low, track counts are done on Day 2 or Day 3.

2. Each day record:

Date

Observer

Temperature

Weather on the day before the count (C=cloudy, S=sunny)

Weather on the day of count (C=cloudy, S=sunny)

days since last snowfall (DSLS)

hours since snowfall stopped even if only approximate

day number of the track count for that location. That is, the maximum age of the tracks. This will differ from DSLS when transect routes are changed.

Total distance over which transect was conducted.

Location code for transect.

Snow depth at each 5 km post-stake from Kilometer 0 to Km 25.

3. Because it is very time-consuming to do a thorough track transect, we have two methods, one more and one less intensive. We have to do this because lynx and coyote often follow in hare trails, and so the transect has to be conducted very thoroughly, checking each well-traveled hare run carefully for predator tracks. This is especially important when hare numbers are high. Also, lynx and coyote may spend much time in a small area when hare numbers are high; each individual predator may cross the transect frequently over a short distance. This too has to be monitored.

Two types of transects:

Official - Go slowly and deliberately, checking each well-traveled hare trail for predator tracks.

Minimal - Count all obvious tracks, with no heroic measures to search for tracks on hare trails.

On the first and second days after a snowfall, do 'Official' counts, and

on each day after that do 'Minimal' counts. Note that sometimes a wind can produce just as effective a clean slate as a fresh snowfall for track counting purposes, and this must be noted and then treated as a fresh snowfall.

4. For each track that you count (all mammal predators and moose), record:
species
location: distance along the transect to the nearest 0.5 km.
distance it stayed on the trail if more than 250m. In the case of lynx note if it is a family group (adult plus kits) or adults together. This may not be straightforward in late winter, so take the extra time to determine if possible. Note carefully lynx tracks for animals walking in a group stepping in the same prints.
when hares are at their cyclic low, it would be useful to count **hare tracks** as well as predator tracks to get an idea of local hare hot spots.
5. Cross out the track with an 'X' or the day's date (useful for snowtrackers) to make sure that it is not counted the next day.

Summary Statistics:

After all track data have been entered into the *Track Transects Access* database, the bootstrapped mean number of tracks per trap night per 100 km (and standard errors and 95% confidence intervals) is computed for each species. These means can be computed per season or for any chosen time interval. The mean number of tracks per trap night per 100 km is also computed using Jolly's Method 2 (ratio method). The Jolly method takes into account the different lengths of transects and should give a better estimate.

Time Estimates:

Field: 1 person day per transect x 15-30 transects per season (depends on snow conditions and predator density)

Data Entry: ½ -1 person day per field day

Owl Census Protocol

Purpose:

To monitor great horned owl population trends in relation to changes in abundance of the snowshoe hare and other prey species.

Rationale:

There are many species of raptors within the Kluane boreal forest community. Great Horned Owls are found throughout the study area, and are a major predator on the hares.

Procedure:

The owl census involves going out at dusk (when a pair of owls will be calling together), and taking compass bearings on the hooting from different angles (as close to 90 degrees contrast as possible) along the highway. The pair can then be pinpointed on a map. While doing this, a note should be made of any other hooting birds in the area, and bearings can then be taken on these as time permits. As the evening progresses, the pair of birds may split up and move around their territory. This makes sorting out individual pairs more difficult. By using this technique systematically throughout the study area a map of the breeding pairs will emerge.

The same routine is done one hour before sunrise.

Time Estimates:

Field: $\frac{1}{2}$ person days * 10-20 days

Data Entry: $\frac{1}{3}$ person day per field day

Weather Stations

Purpose:

To measure temperature, precipitation and snow depth at specific monitoring sites.

Rationale:

Weather data are presently being recorded by Environment Canada at Haines Junction and Burwash Landing. Given the mountainous terrain in the Kluane region we need to obtain more localized weather information to quantify how temperature, rainfall and snow levels vary from the southern parts of Kluane to the northern regions and how they vary from year to year.

Procedure:

SUMMER PRECIPITATION:

In 2000-2001 we established 6 automated weather stations (with HOBO Data Loggers and Boxcar Pro 4 software) and in 2011 we replaced all the rain gauges and switched to Watchdog Data Loggers and SPecWare9 Pro software. We are currently using the rain gauges on these stations to record summer precipitation.

By May 1 or earlier each year we should exchange the Watchdog Data Logger in each rain gauge with a new one that has been launched at the end of April. A separate set of Watchdog loggers has been obtained to allow you to exchange these in the field without needing a computer in the field. Be sure the loggers are labelled with the name of the site.



Data download: Use the Spec9Pro.exe program on the main computer to download the data from each rain gauge Watchdog logger. The download cord fits a serial port and is most easily used on the old Dell desktop computer. The correct COM port must be identified by means of the TEST PORT command. Once you have done this, plug in the Watchdog logger and go to GET DATA FROM AN ORIGINAL WATCHDOG LOGGER (B or C series). Follow the instructions on the screen.



Launching a Watchdog Data Logger: The loggers do not record any data until they have been launched by the Spec9Pro software. Launching a logger erases all data stored on it so be sure to check that your download was successful before re-launching. On the Logger menu click LAUNCH ORIGINAL WATCHDOG (B or C series). Fill in the properties screen and click OK to start the logger. Make all units metric. Take the launched loggers to the field to exchange them for the loggers currently in the rain gauge. Be sure they are labelled with the weather station site.

Read the SpecWare 9 Pro and Basic Quick Start Guide for further details.

SNOW DEPTH AND TEMPERATURE RECORDING:

In 2004 we started measuring snow depth using temperature i-buttons. The i-buttons are mounted on wooden stakes at 0, 5, 10, 15, 20, 25, 40, 60, and 80 cm intervals above the ground and are set to record temperature every 4 hours. The snow depth is determined by comparing the temperature profiles of i-buttons at different heights. Snow is a good insulator so the temperature of a buried button remains warmer than the above-snow air temperature and diurnal fluctuations are dampened.



There are two of these 9-button stakes located at each weather station. Each stake is mounted with cable ties onto the permanent structure supporting the weather station. They are positioned so that the temperature buttons face **north** to minimize influence by sunshine. They should be set out in August each year (not before because the button's memory will fill up too soon).

Duplicate Stakes:

Due to a high failure rate of the buttons, it is useful to have duplicate button stakes at each site.

Around June 1 each year the 9-button “winter” stakes should be collected and brought back to base camp in order for the button data to be read into the computer and the data summarized. At this time, replace the stakes with two 2-button “summer” stakes at each site. These summer 2-button stakes should be set to record temperature every 4 hours at 60 and 80 cm above ground. This

is a backup record of summer air temperatures. The 9-button winter stakes should be re-launched and put out again in August.

Installing OneWire software (to read i-button data)

Note this software requires java to be installed so you may need to be connected to the internet to successfully install the OneWire software. The OneWire software can be downloaded from <http://www.maxim-ic.com/products/ibutton/software/tmex/index.cfm>. Download version 4.01R2 32 bit driver (4.4 MB).


You need 2 bits of hardware – the DS1402D-Blue Dot receptor chord and the USB adapter both from <http://www.maxim-ic.com/products/ibutton/products/accessories.cfm> and costing about \$20.




<http://www.maxim-ic.com/products/ibutton/products/accessories.cfm> and costing about \$20.

We use i-button model DS1921G. This model has a measurement range of -40 to 85C and an accuracy of $\pm 1C$ (http://www.maxim-ic.com/quick_view2.cfm/qv_pk/4023).



1. Run the OneWire setup file (it will tell you if you need to abort and install java first)
2. When installation is finished there should be 2 executable programs – “OneWireViewer” and “Default 1-Wire Net”
3. plug the USB chord in
4. For *one time only*, run “Default 1-Wire Net.exe” and select “Auto-detect”
5. Open OneWireViewer . The first time this is opened you will be asked some questions – defaults are all OK.

Downloading Temperature Data


1.  Open OneWireViewer
2. plug in i-button chord
3. place i-button in chord reader, find number in device list and click on it
4. go to *Thermochron* tab, the status tab tells you about the mission that is active
5. go to the *temperatures* tab in the *thermochron* tab
6. right click, copy data (**with labels**) to clip board
 - if no data show up i-button is bad or was not launched
 - if only a few data points show up, right click and “rescale graph”
7. paste in an excel spreadsheet ([‡]see notes below about excel formula)
 - choose *delimit with commas and spaces* if given the choice, otherwise parse data afterwards using *data>text to columns*

[‡] If you use an existing excel file (eg *Buttons_Silver_May08.xls*) you can copy the summary formula to the current year’s data file. The summary formula are “array formula” (or “CSE formula”) so if you make a change to the formula, you need to update it with <Control><Shift><Enter> (with the cursor INSIDE the formula bar) to make it work properly. Be careful that there are not empty records at the bottom of the sheet because these will be interpreted as “January” and included in the calculations resulting in an incorrect average temperature for Jan 1-15. To delete empty

8. rename excel spreadsheet with i-button stake and height of i-button (eg Silver2_10cm)
9. add the same name labels plus column titles into the top of the sheet
10. after all i-buttons are downloaded, save file using stake name and date.

Note: Before removing an i-button from the chord reader, click on the top line in the device list (ie unselect the current i-button) otherwise the OneWireViewer program sometimes hangs.

Launching i-buttons

1.  Open OneWireViewer
2. plug in i-button chord
3. place i-button in chord reader, find number in device list and click on it
4. go to *Thermochron* tab and to the *status* tab below
5. click on “*disable mission*” button – mission status should go to “*false*”, this may take a few seconds
6. go to “*Clock*” tab at top and click on “*synchronize clock to PC time*”
7. go back to *Thermochron* tab and click on “*start new mission*” button
8. Set sample rate to 240 (these are minutes, therefore temperature will be recorded every 4 hours to give us about 340 days of data); make sure that the rollover option is NOT selected, the alarm is NOT activated, there is NO mission delay, etc and press “okay” – mission status should go to “true” with sample rate of 240
9. Check on i-buttons a day later to check that they have been logging. Go to the *Thermochron* tab and then to the *temperatures* tab and look for a few data points in the graph, they should be the temperature of the place where the i-button was stored. If the i-button temperature recorded is not accurate, replace the i-button and calibrate again.

records, go to the last record (<Control><Down Arrow>), select the row below the last row of data, click <Control><Shift><Down Arrow> to select to the end, then right click and choose Delete records (just hitting the Delete button on your keyboard does not delete the records).

Summary Statistics:

Downloaded files should be imported into EXCEL and collated each year.
These files should be stored on the shared Zeus web site.

Time Estimates:

Field and Data Entry: $\frac{1}{2}$ person days per area * 2 days per year
Analysis: 1-2 person days per area each year