Small mammal monitoring at the landscape scale
Denali National Park and Preserve

2005 Annual Report

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Executive Summary

Small mammal sampling in 2005 occurred only at the Rock Creek legacy plots (RF1, RF2, RR1, and RR2). Sampling was conducted at the end of summer (28-31 August) to continue the end of summer data series that began in 1992 and has been been the most useful when analyzing small mammal population dynamics. Density estimates for *Clethrionomys rutilus* and *Microtus miurus* were generally the highest recorded since sampling began. Density estimates for *Microtus oeconomus* was consistent with previous years. The conformance metric was significant, indicating a difference between this year and previous years, for those occasions where abundance and/or density was exceptionally high. It is not immediately clear why two species had a record high year, while a third showed no significant difference.

Introduction

As one element of the Denali National Park and Preserve Long-term Ecological Monitoring Program, the 2005 field season of small mammal sampling continued its multi-decade monitoring in Rock Creek, adding a fourteenth year to the data series begun in 1992. Sampling occurred only at the Rock Creek legacy plots at the end of summer. This report provides a brief overview of the estimates of small mammal abundance and density from the four legacy plots sampled during the 2005 field season in Rock Creek. The objective of this investigation was to continue to document dynamics of small mammal populations in the Rock Creek watershed.

Methods

The legacy trapping grids in Rock Creek were sampled 28-31 August 2005 (Table 1). Study plots included two riparian grids (RR1 and RR2) and two forested grids (RF1 and RF2). Sherman live traps were deployed on the plots for a 4-day period beginning on Saturday evening and concluding on Wednesday afternoon for a total of 11 trap checks (RR1 traps were opened Sunday morning so it had only 10 trap checks).

Each sampling plot was approximately 0.8 ha in area, and was laid out in a square configuration. Field procedures followed methodology described by Furtsch (1995) and Rexstad (1996) in which traps were baited with sunflower seeds and bedding, and checked 3 times per day. Captured individuals were identified by sex and species, reproductive status was determined, and net weight was calculated. Unmarked individuals were implanted with passive integrated transponder (PIT) tags and released. Data were error-checked in the field and PIT tag codes were verified against an inventory list to ensure integrity of the data collected.

Abundance estimates were computed for *Clethrionomys rutilus* (CLRU), *Microtus oeconomus* (MIOE), and *Microtus miurus* (MIMI) using the closed population models of Otis et al. (1978) as incorporated in program CAPTURE (Rexstad and Burnham 1991). Abundance estimates are possible only when marked individuals are recaptured. In some instances this summer, there were no recaptures, in which case the estimated abundance is equal to the number of individuals captured. If possible, we used the shrew capture data to estimate abundance of shrews, *Sorex* sp. (SOSP). Because most shrew captures are mortalities and the survivors are not marked, the removal estimator (M_{bh}) was used to make the estimates (Zippin 1956).

We also used the program Density (Efford, 2004) to estimate population density for *C. rutilus*, *M. oeconomus*, and *M. miurus* at 3 different scales: plot (RF1, RF2, RR1, RR2), habitat (forest, riparian), and overall. Because Density requires recapture information for the purposes of discerning movement distances, we were unable to estimate density for shrews.

We employed our measure of system health on small mammal populations at all 4 grids sampled. The measure, termed '*conformance*' (C) reflects how aberrant the population estimates from the current year are when compared with estimates from past years. Essentially a test for a difference between this year and past years, the measure is interpreted like a P-value. A large C indicates that an estimate from the current year appears to fall in the expected range for the attribute based on the past history. Conversely, a small C indicates that the current estimate is different (either high or low) and should be examined more closely. Formally, the metric constitutes a measure of the likelihood that observed abundance in the current year (2005) arises from the same underlying stochastic process that gave rise to previous years' observations. The metrics calculated were based on both abundance and density estimates from the last sampling session at each plot in every year. This allowed for a comparison of

conformance measures based on different responses (abundance and density). Because density estimates from different sample designs are directly comparable, we were able to utilize data from previous years when RF2 and RR1 used trapping webs, giving us a longer baseline than when using abundance estimates.

As noted in previous years, there is the suggestion of an inverse relationship between red-backed vole and shrew abundance. We added a new data point to the plot of mean shrew abundance against mean *Clethrionomys* abundance on the final sampling occasion in each year in Rock Creek.

Results

The estimates of abundance for northern red-backed voles (*Clethrionomys rutilus*), tundra voles (*Microtus oeconomus*), singing voles (*Microtus miurus*), and shrews (*Sorex* sp.) from the Rock Creek legacy plots are presented in Table 2. In instances where the number of individuals captured is less than 10, the abundance estimate is nearly identical to the number of individuals captured. While this is unlikely to be true, the amount of data available for abundance estimation was insufficient for the estimation routine to make a more reasonable approximation. Only 11 shrews were captured on the legacy plots in 2005 as compared with 5 in 2004, 53 in 2003 and a high of 123 in 2001.

As with previous annual reports, graphs are provided for end-of-summer abundance estimates for *C. rutilis*, *M. oeconomus*, and *M. miurus* from all 4 Rock Creek grids for the years 1992-2005 (Figure 1).

Density estimates for the Rock Creek legacy plots from the program Density are given in Table 3. When going from one hierarchical scope to the next (e.g., from individual plots to habitat type), the density estimate is approximately the mean of the density estimates at the previous level with a reduction in standard error (increase precision), indicating a benefit to pooling sites and increasing the sample size.

Table 4 contains conformance measures (C) based on abundance and density estimates from each plot for *C. rutilis, M. oeconomus,* and *M. miurus*. Conformance was very low for M. miurus on Rf1, RF2, and RR2 and somewhat low for *C. rutilis* on RF1, RR1, and RR2. We also pooled conformance measures across plots and species (Table 4).

Figure 2 shows the relationship between mean shrew abundance and mean *C. rutilus* abundance from the Rock Creek legacy plots over the span of 14 years. End of summer abundance estimates were used and averaged across all plots. Data from 2005 fits the pattern noted in previous reports that the yearly SOSP:CLRU relationship tends to be low:low, low:high, or high:low, but never high:high. In other words, these populations tend to be either both low or one low and the other high, never both high.

Discussion

The summer of 2005 was a banner season for small mammals in the Alaska interior. Anecdotal reports from around Fairbanks noted increased evidence of subnivean burrows after snowmelt, multiple observations of red-backed voles running across roads, and high predation rates by neighborhood felines. Before sampling in Denali, all indications were that population levels were very high and our results were in keeping with that expectation. Density estimates in 2005 were the highest recorded for *C. rutilus* on 3 of 4 plots (RF1, RR1, and RR2), for *M. miurus* on 3 of 4 plots (RF1, RF2, and RR2), and for *M. oeconomus* on 1 of 4 plots (RR2). Overall density across all four plots this year was almost twice as high for *C. rutilus* as the previous high density and more than twice as high for *M. miurus* (Table 5).

What may have caused or contributed to these high population levels this year? Our earlier work on a vole population model used a weather metric that combined the effects of daily temperature and snow depth (Debevec and Rexstad, 1999). Low winter temperature is detrimental to over-winter survival, but because voles live beneath the snow, it is ameliorated by increased snow depth. Figure 3 shows snow depth and minimum daily temperatures for the winters prior to each small mammal sampling occasion in Denali. There is nothing in either that sets this year apart from the others. Snowpack is consistent with other years in terms of timing of first snow, accumulation rate, and maximum depth. The range of minimum daily temperature (through February 2005) is also consistent with past years.

If over-winter weather was a major factor in the high population levels seen this year, then one would expect the effect to be seen in all species examined. However, high levels were only seen with *C. rutilus* and *M. miurus*, while the levels of *M. oeconomus* were entirely consistent with previous years. Was a food source common to *C. rutilus* and *M. miurus* particularly plentiful this year? Are there microhabitat differences between the species that might come into play? Are some species able to take advantage of favorable conditions and increase reproduction? "Green-up" occurred 2 weeks early this year (pers comm, C. Roland). How might this affect population dynamics? We need to know more about the ecology and reproduction capacity of these species if we hope to ascertain the mechanisms behind these population fluctuations.

All instances of a low conformance value in 2005 correspond to a high abundance or density. The metric responds to significantly low or high attribute levels as compared to past years, leaving it up to the manager or researcher to determine whether the change warrants concern or action. Being the result of high small mammal population levels, these conformance measures do not generate alarm, but rather a curiosity about the cause for such an increase as discussed above.

As noted in previous reports, the fluctuations in shrew numbers seem to be out-of-phase with changes in *C. rutilus* levels. From Figure 2, we can generally see three different states when considering numbers of shrews and red-backed voles: (1) both populations low (1992, 1997, 2000, 2004), (2) shrew population high, red-backed population low (1994, 1998, 1999, 2001, 2003), and (3) shrew population low, red-backed population high (1993, 1995, 1996, 2002, 2005). It appears that these populations do not attain high levels at the same time. Considering the three states described, it also seems that states change almost every year. There have only been two occasions where the same state occurred two years in a row (state 2 in 1998 and 1999 and state 3 in 1995 and 1996). Is this statistically significant? From a bootstrap analysis, we get a p-value of 0.23, which indicates that with this particular state history (4 years in state 1, 5 years in state 2, and 5 years in state 3) it is not uncommon to have only two instances where the state stayed the same in consecutive years. We are, however, dealing with a small sample size. Supposing we go another 14 years with two more occurrences of consecutive years in the same state. We would calculate a p-value of 0.044 in that case. There may be something real happening, but we currently do not have the power to detect it.

There are a couple notes about the sampling effort this summer worth noting just for future reference. Training for the crew prior to sampling this year was minimal, consisting of a single visit to the UAF museum to view skins of the species we would most likely encounter. Only a cursory mention was made about sexing an individual, suggesting that those data are not very reliable this year, especially for younger individuals. Two points also should be noted about the trapping schedule. Traps on RR1 were not opened at the same time as the other grids, but were instead opened immediately following the first trap check. Hence, RR1 had one fewer trap checks than the other grids. Also, due to the high numbers of animals caught this year, the decision was made to eliminate the final trap check, resulting in 11 checks total (10 for RR1) instead of the usual 12. Even with four people checking traps, most checks took 4-5 hours, leaving very little down time before the next check. It was felt that the large number of animals we were catching would provide us with a large enough sample size so that we would not sacrifice any precision in our estimates by reducing the number of trap checks.

References

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Table 1: Schedule for 2005 field season for small mammal monitoring in Denali National Park and Preserve.

Date	Time	Event
27 August		Haul traps and gear to Rock Creek Legacy Plots
27 August	1800-2300	Set out and open traps RF1, RF2, RR2
		Set out traps (closed) RR1 [(1)]
28 August	0600-1100	Check traps RF1, RF2, RR2
		Open traps RR1
	1300, 2000	Check all traps
29 August	0600, 1300, 2000	Check all traps
30 August	0600, 1300, 2000	Check all traps
31 August	0600	Check all traps
	1300	Check and collect all traps

[(1)] RR1 traps were not opened the first night, resulting in 10 traps checks on RR1 and 11 traps check on all other grids.

Table 2: 2005 abundance estimates (N) for *Clethrionomys rutilus*, *Microtus oeconomus*, and *Microtus miurus*. at the Rock Creek legacy small mammal plots in Denali National Park and Preserve. Also included are total number of individuals caught (M_{t+1}), standard error for the abundance estimate (SE(N)), and lower and upper 96% confidence bounds (LCI and UCI).

Species	Plot	Date	M_{t+1}	Model	N	SE(N)	LCI	UCI
Clethronomys rutilus	RF1	28-31 Aug	55	M(h)	110	21.5241	81	170
	RF2	28-31 Aug	43	M(th)	50	4.7480	45	66
	RR1	28-31 Aug	74	M(b)	81	4.6142	75	96
	RR2	28-31 Aug	52	M(t)	61	4.2136	56	73
Microtus oeconomus	RF1	28-31 Aug	0	-	0	-	-	-
	RF2	28-31 Aug	0	-	0	-	-	-
	RR1	28-31 Aug	10	M(h)	10	2.3717	10	22
	RR2	28-31 Aug	23	M(h)	34	7.8050	26	61
Microtus miurus	RF1	28-31 Aug	25	M(th)	35	7.1441	27	60
	RF2	28-31 Aug	29	M(th)	58	17.5661	38	115
	RR1	28-31 Aug	1	-	1	-	-	-
	RR2	28-31 Aug	6	M(h)	8	3.3347	6	24
Sorex sp.	RF1	28-31 Aug	4	M(bh)	4	1.1166	3	3
	RF2	28-31 Aug	3	M(bh)	3	0.0835	3	3
	RR1	28-31 Aug	2	M(bh)	2	0.0000	-	-
	RR2	28-31 Aug	2	M(bh)	2	0.0000	-	-

Table 3: 2005 density estimates (animals per ha) for for *Clethrionomys rutilus, Microtus oeconomus,* and *Microtus miurus* at the Rock Creek legacy small mammal plots in Denali National Park and Preserve computed using the method of Efford (submitted). N/C indicates non-convergence in Density because of too few captures and/or recaptures.

	C. rutilus		***M. oeconomus***		***M. miurus***	
Scope	**D**	**SE(D)**	**D**	**SE(D)**	**D**	**SE(D)**
RF1	60.969	13.778	0	–	20.691	8.819
RF2	26.036	7.966	0	–	29.598	10.158
RR1	54.700	11.232	3.809	2.512	N/C	–
RR2	72.638	21.466	22.527	9.252	7.185	5.491
Forest	42.192	8.491	0	–	27.387	7.041
Riparian	62.512	10.853	12.082	4.195	3.258	2.128
Rock Creek	54.299	6.900	6.117	2.128	15.595	3.464

Table 4: 2005 Conformance (C) for Rock Creek based on abundance (first number) and density estimates (second number). Note that RF2 and RR1 show different numbers of years used depending on whether conformance was based on abundance or density. These plots were in the same location as previous trapping webs. Abundance estimates from different sample designs are not comparable, but density estimates are comparable, resulting in more years worth of data for these plots. *(Calculated with R functions vole.conformance & vole.density.conformance)*

Plot	**# Years**	***C. rutilus***	***M. oeconomus***	***M. miurus***	**Pooled species**
RF1	14 / 14	0.093 / 0.046	0.137 / 0.336	0.014 / 0.001	0.008 / 0.001
RF2	9 / 12	0.334 / 0.352	0.217 / 0.934	0.038 / 0.029	0.067 / 0.157
RR1	9 / 14	0.118 / 0.081	0.275 / 0.296	0.903 / 0.761	0.315 / 0.238
RR2	14 / 14	0.187 / 0.029	0.243 / 0.181	0.123 / 0.022	0.110 / 0.006
Pooled Plots		0.068 / 0.009	0.133 / 0.417	0.013 / 0.0003	0.004 / 0.0001

Table 5: Density estimates (animals/ha) over all legacy plots in 2005 compared with the previous high overall density estimates.

	2005	**Previous High (yr)**
C. rutilus	54	32 (1993)
M. miurus	16	6 (1996)
M. oeconomus	6	11 (1997)

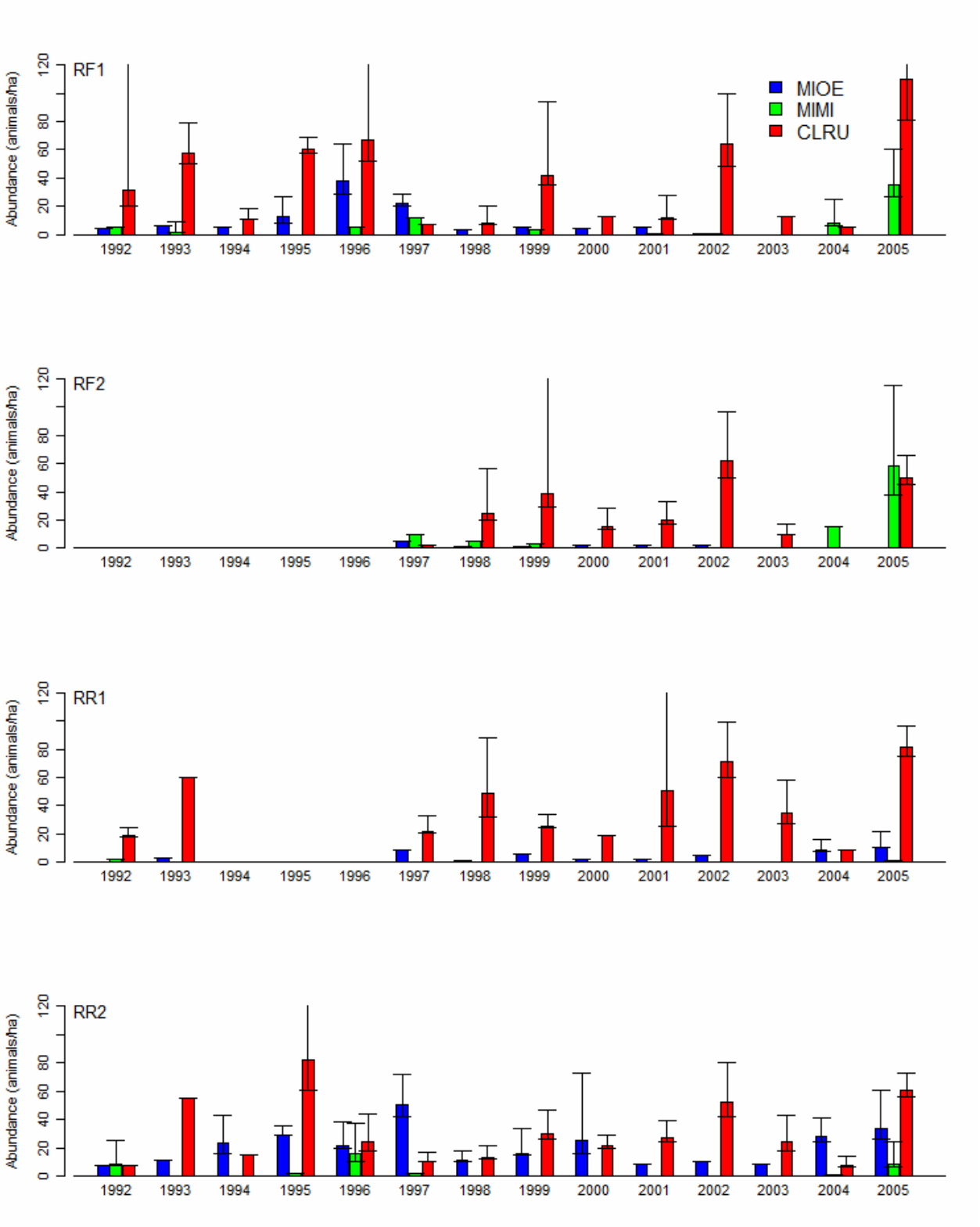

Figure 1: 1992 to 2005 abundance estimates for *Microtus oeconomus* (MIOE), *M. miurus* (MIMI), and *Clethrionomys rutilus* (CLRU) at end of field season on Rock Creek legacy plots. Error bars represent 95% confidence intervals. RF1 and RR2 were sampled 1992-2005. RR1 was sampled 1992-93 and 1997-2005. RF2 was sampled 1997-2005. *(Generated with R function vole.plot5.)*

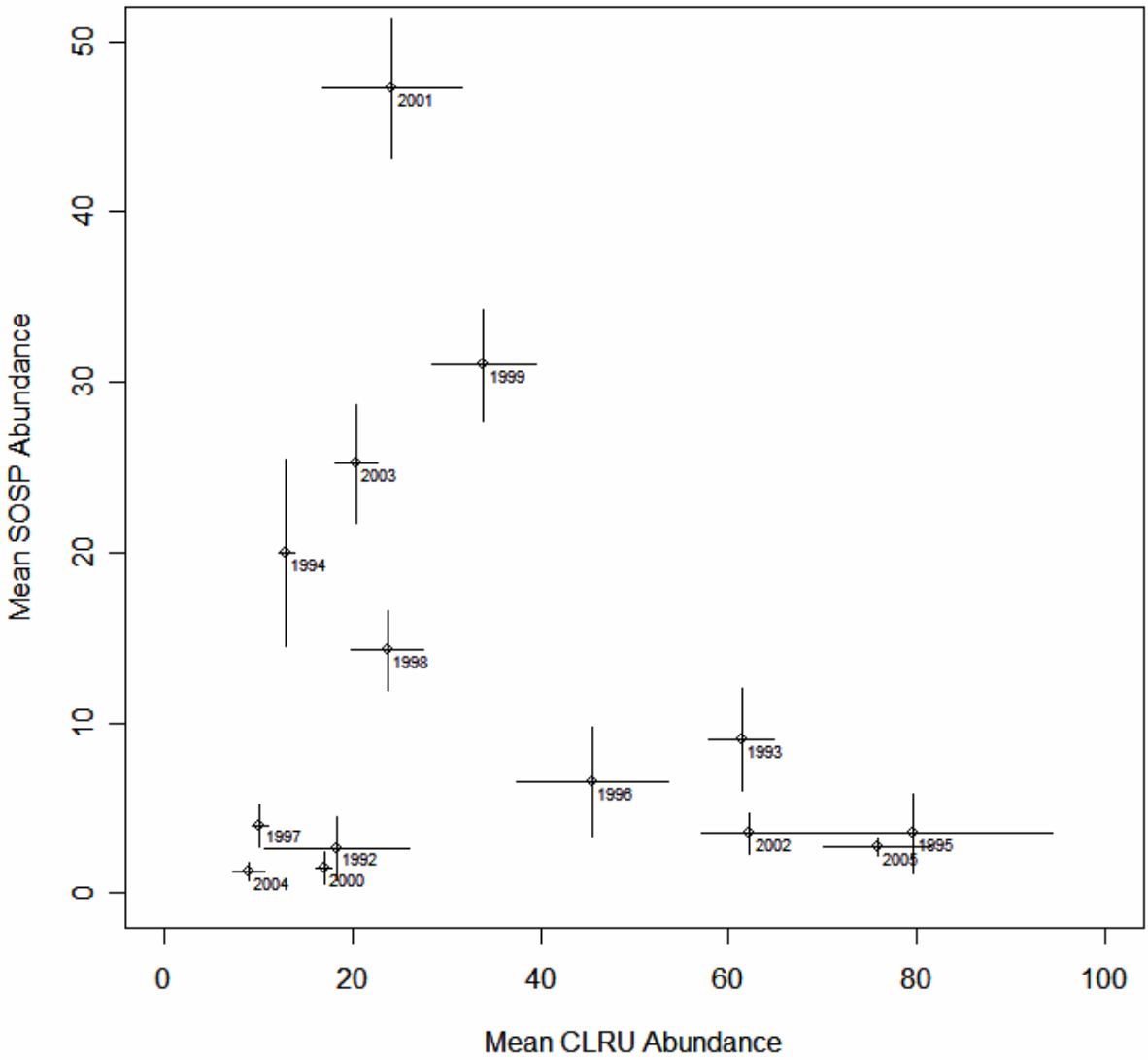

Figure 2: Mean shrew (SOSP) abundance plotted against mean *C. rutilus* (CLRU) abundance for the 1992-2005 end of summer sampling occasions on the legacy plots in Rock Creek. Error bars represent ± 1 standard error. Standard errors incorporate both sampling error on each plot, and variability among plots.

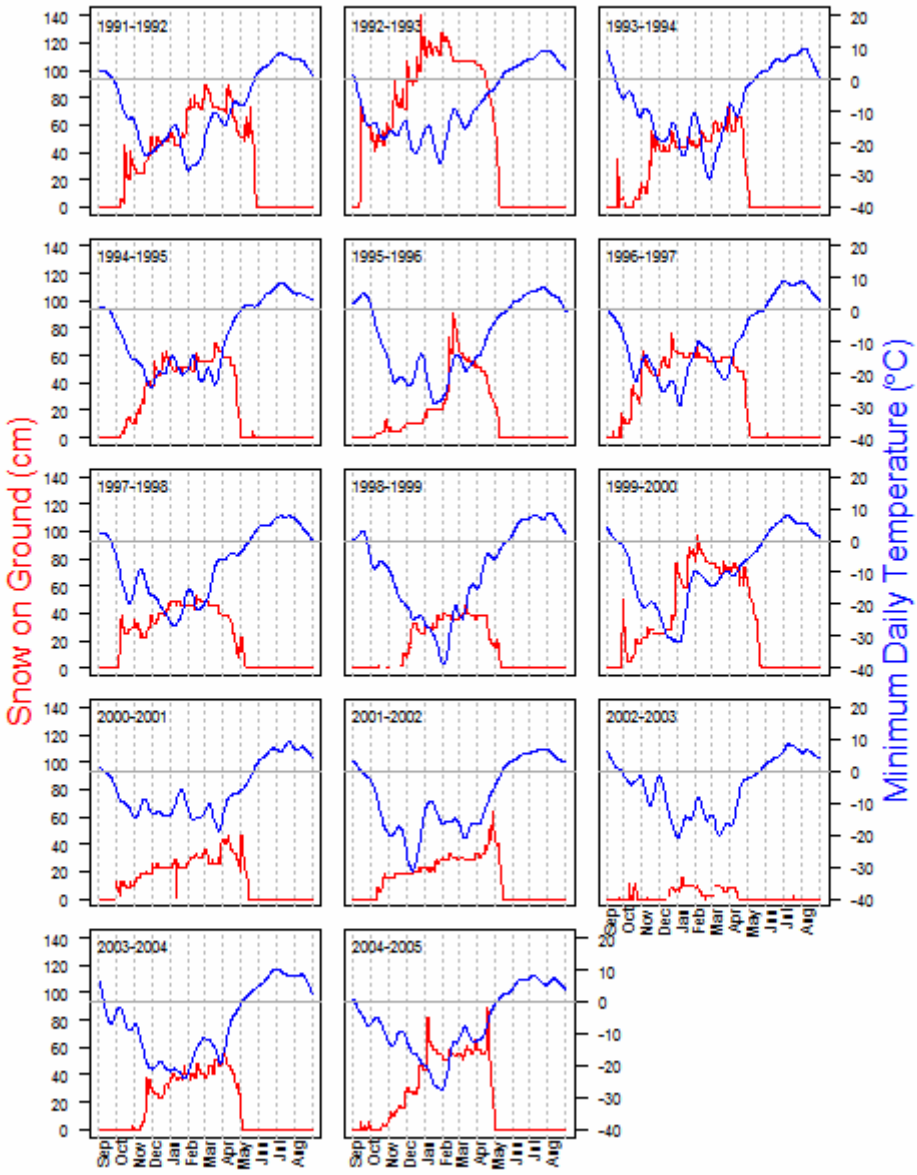

Figure 3: Snow on the ground and minimum daily temperature (smoothed) for all winters prior to small mammal sampling in Denali (1991-92 through 2004-05). 2004-05 snowfall was "middle of the road" in terms of time of first snowfall, accumulation rate, and maximum snowpack. 2004-05 minimum daily temperatures were well within the "normal" range.