Small Mammals of the Guthrie-Bancroft Farm - Year 6

Colby Hill Ecological Project, Lincoln and Bristol, Vermont

2007 Final Report

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Summary

In 2007 we again sampled small mammals in ecosystems 1, 6, 14, and 20 on the Guthrie-Bancroft parcel of Colby Hill in Lincoln, Vermont. This year we captured 290 individuals with on average capture success of 39.0%, verifying the presence of 12 species of terrestrial small mammals. The Hairy-tailed Mole (*Parascalops breweri*) was captured for the first time this year in a pitfall trap in "seepy terrain rich northern hardwoods forest" (ES 6). This increases the number of small mammal species known from the Guthrie-Bancroft parcel to 15. Two weasels (*Mustela* sp.) were captured in ES 20. Population levels were already high in June this year.

Introduction

We re-sampled of ES 1, 6, 14 and 20 in 2007. For a brief description of the four selected ES, see Appendix I. For overview of all six years of trapping at Guthrie-Bancroft, see Appendix II. The 2007 small mammal sampling took place between 20 June and 20 July 2007, over a month earlier than in 2006 (25 July -17 Aug. 2006). This early sampling did not appear to negatively affect abundances.

Material and Methods

As in 2006, in 2007 ecosystems were sampled with two replicate traplines of 14 stations with two Sherman traps per station. One line of 6 pitfalls along a plastic driftfence usually placed in a area of dense undergrowth to capture small shrews, for a total of 62 trap units per ecosystem. Traplines were run for three consecutive nights totaling 744 trapnights. At each station one trap was usually placed "low" in the micro-topography (undergrowth, along a log, or under woody debris) and the other trap "high" on a ridge, at the base of a tree, on a fallen log, or on a horizontal branch. Traps were baited with rolled oats flavored with peanut butter and checked every morning between 7:00 and 10:00 hours. As in prior years, habitat data were recorded at

each successful trap site using estimates of canopy cover, tree and log density, and ground cover type percentages.

As in 2006, we recorded maximum and minimum temperature and rainfall in ecosystem 20 (alder swamp, sedge meadow, edge of former beaver pond) with a digital thermo-hygrometer (Oregon Scientific, Inc.) and a standard All Weather Rain Gauge (Productive Alternatives, Inc., MN), which we monitored daily throughout the study period.

Data were mostly organized and analyzed using Microsoft Excel 2004. Diversity measures and similarity indices were calculated using the free program EstimateS 8.2.0 (Colwell 2009).

Animals that died in Sherman or pitfall traps during heavy rainfall or on cold mornings were kept for further examination and as vouchers specimens and will be preserved in the Zadock Thompson Natural History Collection of the University of Vermont. Sampled *Peromyscus* were marked with a rodent ear punch (National Band & Tag Company, Newport, KY). Procedures complied with guidelines recommended by the American Society of Mammalogists (Animal Care and Use Committee 1998).

Results and Discussion

Terrestrial Small Mammals

Figure 1 presents the map of the study area showing the sites re-sampled in 2007. Bar graphs represent percent of trapping effort for small mammal species captured at each of the four sites in 2007 (compare Table 1.2, App. II). Figure 2 (Appendix III) is a 3-D graphical presentation of these frequencies along with those from previous five (ES 1 and 6) or six (ES 14 and 20) years of sampling in the four ecosystems, showing the variation in recorded presence and abundance of each species (compare Table 1.2, App. II). The 2007 data continue the pattern of *Blarina brevicauda, Peromyscus* sp. and *Myodes gapperi* as the most dominant species in ES 1, 6 and 14 and a greater evenness and diversity of species in the more open and successional habitat of ES 20, which is gradually transforming from an open *alder swamp/sedge meadow* into a more forested site.

Table 1.1 (App. II) shows actual numbers of individuals for the four sampled ecosystems including those from previous five or six years, respectively. In ES 1 and 6 number of captures and trap success was 20-40% higher than in all previous years even though the 2007 study period

was a month earlier than in 2006. ES 14 shows a marked decline over the previous two years and ES 20 shows a almost threefold increase in numbers over 2006 captures but 20% less than in

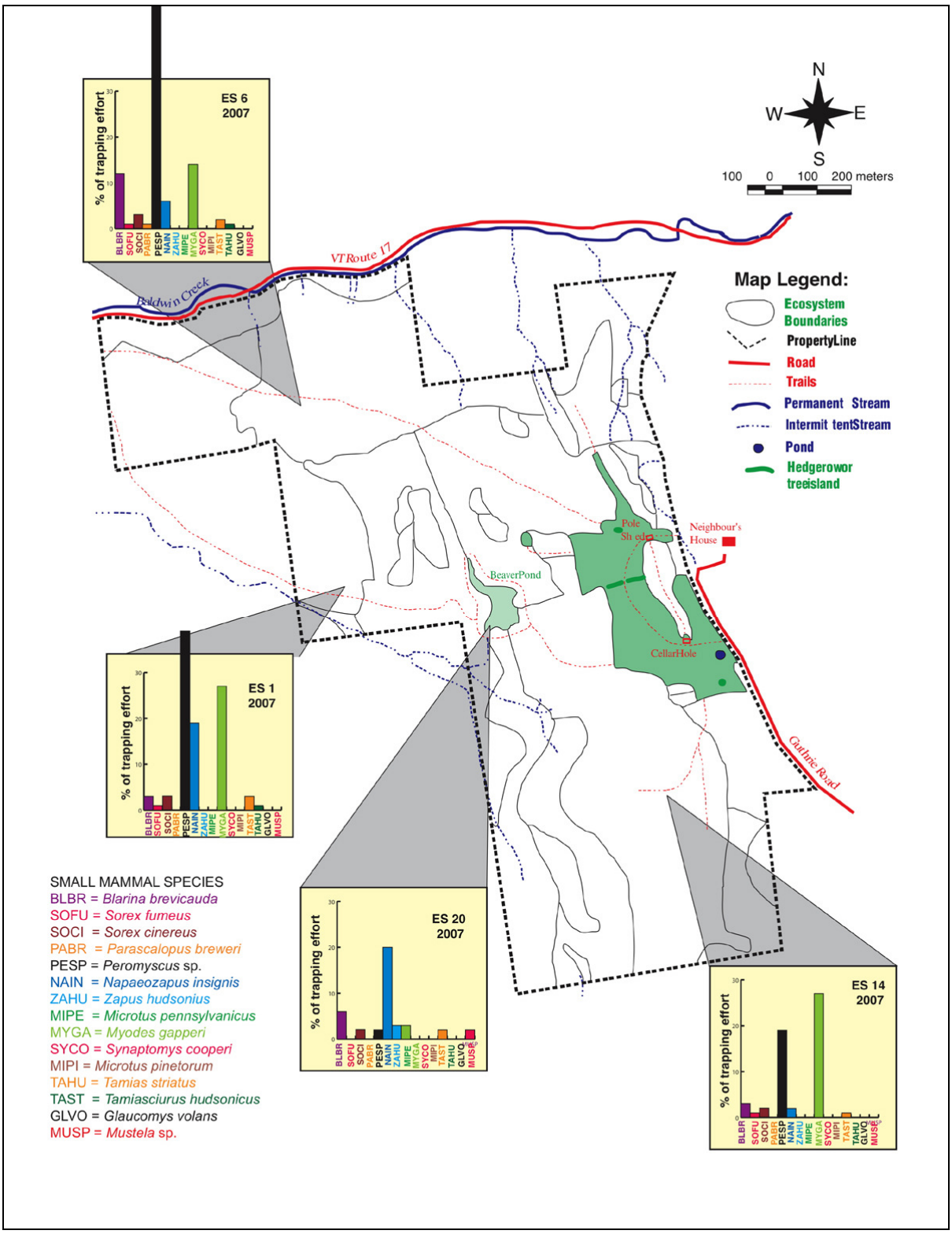


Fig. 1. Map of the Guthrie-Bancroft 2007 survey sites. Bar graphs show percent of trapping effort for 2007. The Hairy-tailed Mole (*Parascalops breweri; PABR – ES6*) was added in 2007. Compare with Table 1 (Appendix II).

2005. Since 2000 in these four habitats 1071 captures (including recaptures) were made in 3527 trap nights, recording 15 species with an average trapping success of 30.4%. In Table 1.2 (App. II) diversity indices calculated from proportions of the total number of small mammal captures in each ecosystem, based on trapping effort. As in the previous year the highest Simpson Index of diversity was obtained in ES 20 (1-D = 0.706), the lowest in ES 6 (1-D = 0.605). Similarly, the highest Shannon Wiener diversity was obtained in ES 20 (H' = 2.34) the lowest in ES 6 (H' = 1.93). In Table 1.3 (App. II) estimated biomass of small mammals per 100 trapnights has been recalculated using 2007 average or (for single individuals) actual weights of species caught.

ES 1 had the highest (1234.8 g/100 TN) and ES 20 the lowest (637.1g/100 TN) biomass in 2007. Likewise, over all years sampled, ES 1 had the highest and ES 20 the lowest **average** biomass with 785.4 g (5 years) and 501.3 g (6 years), respectively.

In 2007 the overall list of small mammals recorded from the Guthrie-Bancroft parcel was again increased by another species, the Hairy-tailed Mole (*Parascalops breweri*) in ES 6 increasing the number of trappable species on the land to fifteen (see Fig. 1.1, App. II). Also, Smoky Shrew (*Sorex fumeus*) and Red Squirrel *(Tamiasciurus hudsonicus),* were caught for the first time in ES 1 and ES 6. As in 2006, two more weasels (*Mustela* sp.) were caught in ES 20 re-enforcing that this is a common predator in this dense succesional habitat.

Climate Data

Minimum and maximum temperature and humidity were recorded with a thermohygrometer (Oregon Scientific), and the amount of rainfall was recorded with a all weather rain gauge (Productive Alternatives. Inc., Fergus Falls, MN) between 19 June and 20 July 2007 in Ecosystem 20 are shown in Figure 3. Temperature ranged between 11.5°C at night (29 Jun.) to 38.6°C during the day (27 June) in 2007 (10.1°C–32.7°C in 2002; 12.8°C -31.5°C in 2005). Rainfall in the 30-day period recorded in 2007 was 191.14 mm (2006: 21 days 105.8 mm; 2005: 17 days, 85.3 mm; 2002: 21-day, 41.2 mm).

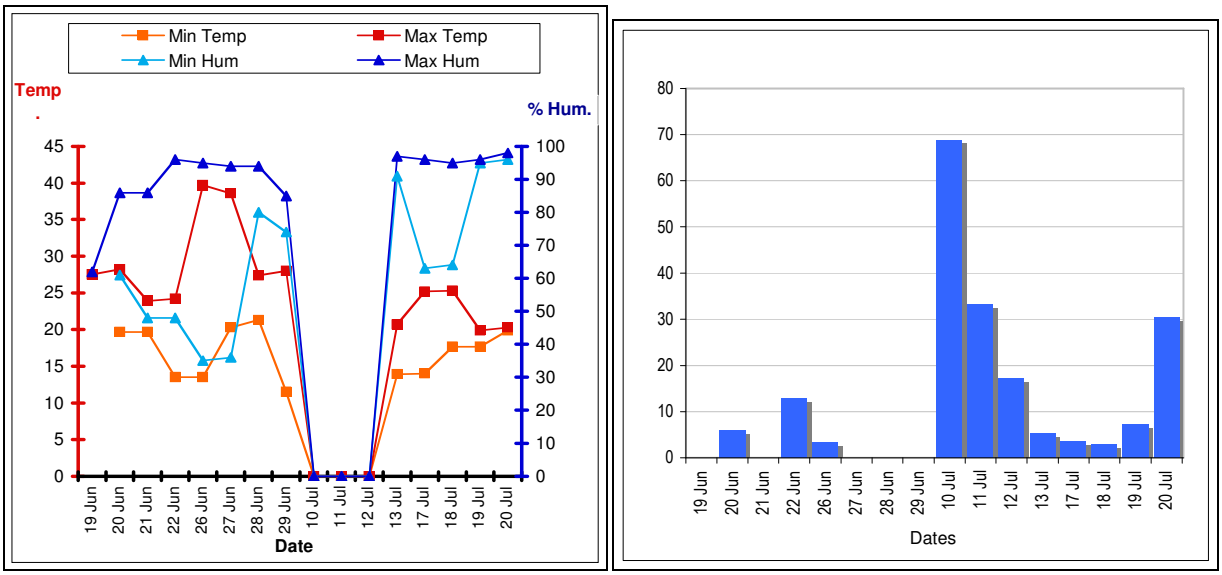


Fig. 3. a) 2007 Min/Max Temperature (°C) and Humidity (%) measured in Ecosystem 20 (Note: from 10-12 July the unit was out of order). b) 2007 field season rainfall (total measured: 191.14 mm)

Microhabitat Data

Microhabitat Data collected at each trap stations as summarized by ecosystem in Figure 4 (App. IV). The "alder swamp/sedge meadow" (ES 20), had the lowest canopy cover with 70.8% which is of course also reflected in the greatest average distance to the nearest tree measured in ES 20 (2.1m in 2007, Fig. 4 b). This site clearly shows an increase of canopy cover with ecological succession from open beaver meadow to forest over the study years (2006 = 70.5%, 2005 = 65.4%, 2002 = 15%; Fig. 4a). Correspondingly, ES 20 also had the highest percentages of herbaceous undergrowth with 62.6% (Fig. 4f), the highest grass cover (19.9% , Fig. 4g) and the lowest leaf litter (11.6%; Fig. 4i) of all sites. At the other extreme, ES6 had the densest average canopy cover (96.3%, Fig. 4a), the greatest average diameter breast height of nearest tree (31.7cm, Fig. 4c), the lowest herbaceous cover (21%, Fig. 4f)) and densest average leaf litter (60.5%, Fig. 4 i).

Figure 5 summarizes microhabitat data by small mammal species. Data for the Hairy-tailed mole (*Parascalops breweri,* n=1) are included for the first time. The meadow vole (*Microtus pennsylvanicus)* and the Meadow Jumping mouse (*Zapus hudsonicus)* were associated with the least canopy cover in ES 20 (39.7% and 54.2%; Fig. 5a) and the most grass cover (30% and 21.7%, Fig. 5g). The Red Squirrel (*Tamiasciurus hudsonicus)* was associated with the largest

trees (38cm dbh, Fig. 5c) and the most woody debris (17.5%, Fig. 5k). The Smoky Shrew (*Sorex fumeus)* was found in areas with the most herbaceous cover of (78.3%; Fig. 5f) followed closely by the Masked Shrew (*Sorex cinereus*, 68.5% Fig. 5f)). *Peromyscus* sp. were caught in areas with the densest leaf litter cover at 60.7% (Fig. 5i) and very high canopy cover (95.9%). The two weasels (*Mustela* sp.) were associated with dense herbaceous growth (67.5%)

Notes on species caught in 2007

Weasels *(Mustela* sp.)

Two weasels were captured in 2007 in Sherman traps set in the dense forbaceous growth of ES 20. All weasels this year survived the life-trapping and were released immediately. We chose to release weasels quickly to reduce mortality of the often considerably weakened animals in Sherman traps. For this reason some doubt remains that our two captures (and those from previous years) are ermines (*Mustela erminea)* given some size overlap with long-tailed weasels (*Mustela frenata)* as discussed by St. Pierre *et al.* (2006), and we left the identification of the Guthrie-Bancroft weasels as *Mustela* sp.

Plate 2: *Mustela* sp. caught and released on 28 June 2007 in ES 20 (Photo: © David Brynn 2008).

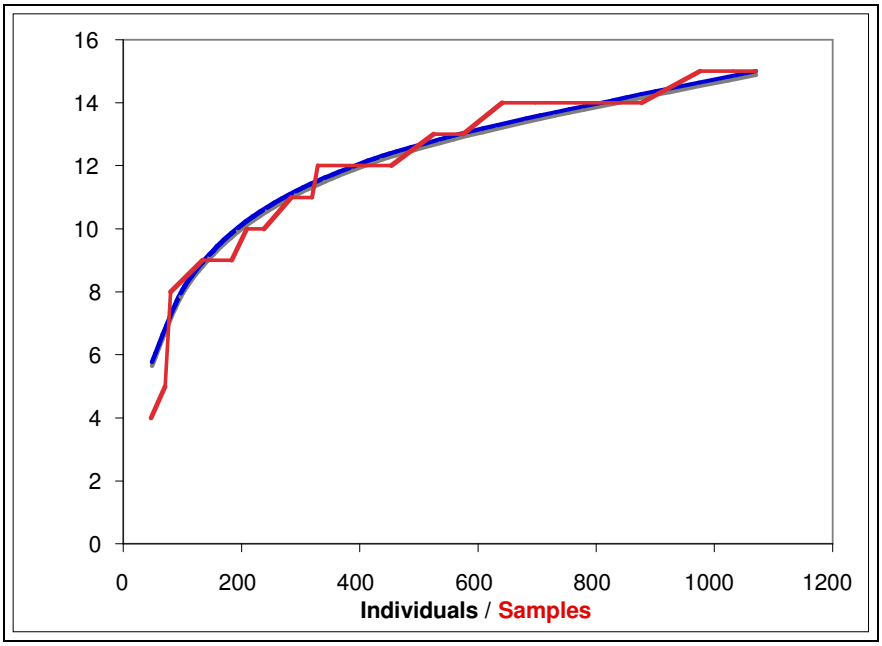
Hairy-tailed Mole *(Parascalops breweri)*

Although the hairy-tailed Mole *(Parascalops breweri)* is probably not rare or uncommon on the Guthrie-Bancroft parcel, 2007 was the first year we captured one in a pitfall trap in ES 6 (seepy terrain rich northern hardwood forest). The Hairy-tailed Mole ranges from southern Ontario across southern Quebec along the Appalachian Mountains south to North Carolina, being "most abundant in sandy loam soils with good surface cover and sufficient moisture" (Hallett 1978:3).

Species Accumulation Curve

The sample and individual-based rarefaction and accumulation curves are shown in Figure 6. The accumulation curve (jagged line) represents a single ordering of samples in this case the four

different ES sampled over the five (or six) years. The rarefaction curve (smooth line) represents the means of repeated re-sampling of all pooled individuals using EstimatesS (Colwell 2005). The smoothed rarefaction curve "represents the statistical expectation for the corresponding accumulation curve" (Gotelli and Colwell 2001:380).



Fig, 6 Sample based accumulation (jagged) curve and individual-based rarefaction (smooth) curve generated using EstimatesS (Colwell 2005) for the 15 species encountered at Guthrie-Bancroft from 2000 to 2007 with a total of 1071 captured individuals.

Similarity Indices (ß Diversity)

A number of similarity indices (ß diversity) have been proposed. We are presenting four different measures here for the four habitats sampled on the Guthrie Bancroft land, following Magurran (2004) and comparing first the 2007 results and then the 2000-2007 five (or six) year totals derived from Table 1.1 (App. II).

Whittaker's measure ß (Table 2)

Whittaker's measure $ß_w$ (Whittaker 1960) is one of the simplest measures of ß diversity and ranges from 0 (complete similarity) to 1(maximum ß diversity). We can also calculate overall ß diversity across the whole small mammal assemblage by dividing total richness (total number of species) by mean richness (average number of species in the four ES):

Overall ß Diversity =15/8 = 1.875.

The maximum value of the overall ß diversity will be the same as the number of sites (Magurran 2004).

Table 2 Whittaker's Measure $ß_w$

2007 Totals of all 4 Ecosystems			
	ES 6	ES 14	ES 20
ES 1	0.059	0.07	0.38
ES 6		0.13	0.41
ES 14			0.33

2000-2007 Totals of all 4 Ecosystems			
	ES 6	ES 14	ES 20
ES 1	0.20	0.26	0.26
ES 6		0.23	0.24
ES 14			0.20

With Whittaker's measure ES 1 and ES 6 are the most similar. ES 6 and ES 20 are the most dissimilar in 2007. For all years ES 1 and ES 6 are tied with ES 14 and ES 20 as most similar.

Jaccard Similarity Index (Table 3)

$C_J = a / a\text{-}B+C$

where a = the number of species found in both sites, B = the total number of species in sample 1; and C = the total number of species in sample 2 (Magurran 2004)

Table 3. Jaccard Similarity Index

2007 Totals of all 4 Ecosystems			
	ES 6	ES 14	ES 20
ES 1	0.889	0.875	0.455
ES 6		0.778	0.417
ES 14			0.5

2000-2007 Totals of all 4 Ecosystems			
	ES 6	ES 14	ES 20
ES 1	0.667	0.583	0.583
ES 6		0.615	0.615
ES 14			0.667

The result for the Jaccard Similarity index is essentially the same as above except that here higher values mean more and lower values less similarity.

Sorenson Quantitative index (Table 4)

$C_N = 2jN / (N_a + N_b)$

where N_a = the total number of individuals in site A; N_b = the total number of individuals in site B; and 2jN = the sum of the lower of the two abundances for species found in both sites.

Table 4. Sorenson Quantitative Index

2007 Totals of all 4 Ecosystems			
	ES 6	ES 14	ES 20
ES 1	0.94	0.93	0.63
ES 6		0.88	0.59

2000-2007 Totals of all 4 Ecosystems			
	ES 6	ES 14	ES 20
ES 1	0.80	0.74	0.74
ES 6		0.76	0.76

ES 14	0.67	ES 14	0.80

Again the higher the value of the Sorenson index, the more similar the sites will be, that is the lower the ß diversity. The measure can be transformed into an index of diversity by subtracting the results from 1 (Magurran 2004).

Morisita-Horn index (Table 5)

$C_{MH} = 2 \Sigma (a_i b_i) / d_a + d_b) * (N_a * N_b)$

where N_a = the total number of individuals at site A; N_b = the total number of individuals at site B; a_i = the number of individuals in the *i*th species in A; b_i = the number of individuals in the *i*th species in B; and d_a (and d_b) are calculated as follows:

$d_a = \Sigma a^2_i / N^2_a$

Table 5. Morisita-Horn Index

2007 Totals of all 4 Ecosystems			
	ES 6	ES 14	ES 20
ES 1	0.88	0.89	0.44
ES 6		0.75	0.24
ES 14			0.14

2000-2007 Totals of all 4 Ecosystems			
	ES 6	ES 14	ES 20
ES 1	0.97	0.96	0.46
ES 6		0.89	0.43
ES 14			0.41

This is another similarity measure. Subtract the results from 1 to obtain a measure of dissimilarity or ß diversity (Magurran 2004). With this index ES 1 and ES 14 are the most similar for 2007 samples and ES 14 and ES 20 are the most dissimilar. For all years ES 1 and ES 6 are the most similar, but ES 14 and ES 20 remain the most dissimilar.

Conclusions

The study period being over a month earlier in 2007 than in 2006 did not seem to negatively affect abundance levels. With 290 individual captures including 12 species (Table 1.1, Appendix II) captures were 28.9% higher than in 2006. Trapping success ranged from 21.5 to 53.2 % in the four habitats sampled in 2007.

The first-time capture of the Hairy-tailed Mole *(Parascolops breweri)* continues the trend of a slow increase of known species from Guthrie-Bancroft over the years of this long-term study and continued rise of the species accumulation curve (Fig 6). Very high captures of the Woodland Jumping Mouse *(Napaeozapus insignis)* this year, compared to previous years, may

point to a population peak in multi-annual cycles of this species and their almost equal high numbers both in well-drained upland (ES 1, n=19) and the more saturated habitat (ES 20, n=20) reinforce previously voiced doubts that this species is closely associated with water (Miller and Getz 1977). The Meadow Jumping Mouse (*Zapus hudsonius*) however, is clearly restricted to the "alder swamp sedge meadow" area of ES 20.

The accumulation and rarefaction curves (Fig. 6) point to a gradual leveling of species accumulation over time, but they don't exclude the possibility that additional species might be found with additional sampling effort.

Magurran (2004) discusses the different similarity measures warning that all except for the Morisita-Horn index are strongly influenced by species richness and sample size. She continues saying that "A disadvantage of the Morisita-Horn index is that it is highly sensitive to the abundance of the most abundant species" (Magurran 2004:174).

Especially when looking at Figure 3 (Appendix III) we can detect some consistent patterns in the four ecosystems sampled over the years. In ES 1 and 6 two or at the most three species dominate the small mammal community through all five years sampled. In ES 14 with its denser undergrowth and more mixed coniferous and deciduous tree cover this pattern is slightly less extreme than in ES 1 and 6. In the successional habitat of ES 20 a more even distribution in pattern of species characterizes the small mammal community throughout the six years we sampled there.

Acknowledgments

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Appendix I

Ecosystem descriptions and summary comments of microhabitat and small mammal findings for sites sampled in 2007

Ecosystem descriptions are based on M. Lapin (2000).

ES 1 = Well-drained, steeply sloping, fine sandy loam spodosol beech-maple-red oak-sweet birch forest (*mesic red oak hardwood forest*). - A record of 8 species recorded this year with *Sorex fumeus* and *Tamiasciurus hudsconicus* for the first time. *Peromyscus* sp. was the dominant species and a record number of 19 *Napaeozapus insignis* were recorded this year. This habitat had second highest leaf litter ground cover (52.5%) after ES 6 (Fig. 5i). and the highest nearest log diameter (13.8, Fig 4 e).

ES 6 = Seepy terrain rich, moderately well-drained, steeply to very steeply sloping, seepy loam over fine sandy loam spodosol, Northern Hardwood Forest *(Rich Northern Hardwood forest).* Es 6 had the densest canopy cover (96.3%, Fig 4a), corresponding highest average leaf litter (60.5%, Fig. 4i), largest average nearest tree diameter (31.7cm, Fig 4c) and lowest average herbaceous cover (21%, Fig.4f) and highest exposed rock (4.9%, Fig. 4j). A record number of 9 species and 99 individuals (almost double from previous years) was recorded this year, with *Sorex fumeus, Tamiasciurus hudsconicus* and *Parascalops breweri* recorded for the first time.

ES 14 = Somewhat poorly drained, gently sloping, stony silt loam to fine sandy loam inceptisol, red spruce-balsam fir-hemlock-yellow birch (*spruce-fir northern hardwood forest).* - Highest level of exposed bare soil (8.5%, Fig. 4h) and woody debris (8.9%, Fig. 4k) groundcover. As in 2006 seven small mammal species were recorded this year but no additional. Numbers oft he dominant rodents (*Peromyscus, Napaeozapus* and *Myodes*) were quite similar to 2006 and 2005.

ES 20 = Very poorly drained, level, muck over stony sandy loam inceptisol, alder-willow shrub swamp/sedge meadow (*Alder swamp/sedge meadow complex*). - Herbaceous cover (62.6%) and grass cover (19.9%) continue to be high and in turn canopy cover (70.8%) and leaf litter ground cover (11.6%) are the lowest of the four sampled habitats. This year 8 species were recorded in this habitat, a record over previous years. Meadow vole (*Microtus pennsylvanicus*) numbers continued to be low (n = 3). Woodland Jumping Mouse (*Napaeozapus insignis*) numbers reached a record high (n = 20) and the Meadow Jumping Mouse *(Zapus hudsonius)* continues to be detected in low numbers (n = 3) in this habitat but nowhere else on the Guthrie-Bancroft parcel. The short-tailed shrew *(Blarina brevicauda)* was recorded again in 2007 (n = 6), after it had not been recorded in the previous two years. Weasels (*Mustela* sp.) are a consistent presence in the dense herbaceous growth for the fourth year in a row.