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Terrestrial Mammal Survey of Isle Au Haut, Knox County, Maine

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ABSTRACT

This study provides a comprehensive census of the terrestrial mammals of Isle Au Haut. Six traplines consisting of 50 Sherman (23 x 8 x 9 cm) and 16 Havahart (46 x 12 x 12 cm) live-traps were run for 3 nights each over the period of 1 September - 23 October 1992. Dominant vegetation was recorded at each trap station. Exact locations of the traplines were determined using a global positioning system. Trapline locations, vegetation, and animals trapped were entered as a series of geographic information system covers using ArcInfo. Tail length, body length, weight and sex of captured animals were recorded; animals were searched for the deer tick, Ixodes dammini, and marked by clipping dorsal hair before being released at capture site. Additionally, 70 kilometers of trails, stream and dirt road were repeatedly covered on foot and on bicycle while searching for mammal sign.

This paper is the first documentation of the eastern coyote (Canis latrans) on Isle Au Haut. The presence of the coyote, the boreal red back vole (Clethrionomys gapperi) and the raccoon (Procyon lotor) is discussed. The trapline nearest human activity had significantly fewer trapped mammals. The deer tick appears limited to the eastern side of the island. Acadia National Park's islands should continue to be routinely surveyed to monitor changes in mammal populations. Islands with human populations should receive extra attention due to the increased probability of human-introduced species and development affecting island ecology.

INTRODUCTION

Successful management of wildlife populations depends on a knowledge of which species are present in the management area. In addition to an initial inventory, surveys should be conducted on a regular basis to monitor long-term changes in species composition. This is especially true for islands where introductions, extinctions, and species turnover can provide greater insight into MacArthur and Wilson's (1967) theory of island biogeography.

Acadia National Park (ANP), the only national park in the northeastern United States, provides an excellent opportunity to study island dynamics. The Park includes the southern end of mainland Schoodic Peninsula, 32,000 acres on Mount Desert Island (located in Frenchman's Bay and connected to the mainland by an artificial causeway), 3,000 acres on Isle Au Haut (located in the eastern edge of Penobscot Bay, Figure 1), and many small islands of varying size and distance from the mainland. Mount Desert Island has received a great deal of study (see Greene et al. 1992) and two smaller islands were inventoried this past year (Mittlehauser et al. 1992). This study constitutes a terrestrial mammal inventory for Isle Au Haut.

STUDY AREA

Isle Au Haut lies in the outer reaches of Penobscot Bay in the Gulf of Maine. It has an area of 26.68 km ^{2} and is 18.0 kilometers from Naskeag on the mainland proper but only 5.74 kilometers from Large Deer Isle which is connected to the mainland by a bridge. The name Isle Au Haut translates into "the high island"; at 165.5 meters above sea level, it is one of the highest islands in Penobscot Bay. (Figure 1)

At the turn of the century, Isle Au Haut reached its maximum human population with approximately 300 year round residents. Today, the island maintains a year round population of roughly 50 people, increasing to near 300 people during the summer months, figures that have not changed noticeably since 1964. Most of the

buildings are located in the Thorofare settlement on the north side of the island, although Head Harbor in the southeast and Moore Harbor in the northwest also have small communities (Figure 2). The National Park Service owns about half of the island with its property consolidated in the south, west and central sections of the island. ANP maintains a small campground near Duck Harbor which is open for the summer months. A 22 kilometer dirt road circles the periphery of the island, but the section of road through the Park land is used minimally. The mainland is accessed by way of a ferry, owned by the Isle Au Haut Company, that runs twice a day from Stonington on Deer Isle to the town landing of Isle Au Haut.

Vegetation of the island is typical of northern boreal forest. Six major vegetation types were identified from aerial photographs: pitch pine forest, mixed hardwood-conifer forest, sphagnum-sedge bog, heath scrub, red maple forest, and spruce-fir forest. The six traplines for this study cover all of the above habitats and are a representative sampling of Park, town, and private land from all around the the island (Figure 3 and Appendix 3).

PREVIOUS STUDY

Manville (1964) spent twelve days on I.A.H. conducting an inventory of the island's vertebrates. He listed fifteen species of mammals, eleven of which were terrestrial (Table 1). His methods included limited trapping, archeological evidence and direct observation, but he also relied greatly on hearsay --stories of sightings by residents.

Crowell (1986) likewise collected most of his data from interviews with local residents in addition to relying on Manville's (1964) work. His study lists nine terrestrial species on Isle Au Haut (Table 1).

During 1990 and 1991, Park personnel conducted small mammal trapping on national park land (Connery et al. 1992) and Rand et al. (1993) conducted trapping on town land to determine the presence of Ixodes dammini, the northern deer tick, on

Isle Au Haut. These studies did not examine the possible presence of medium or large sized mammals.

Appendix II summarizes the locations of specimens collected from Isle Au Haut during previous studies.

METHODS

Six 250 meter transects of 50 Sherman (23 x 8 x 9 centimeters) and 16 Havahart (46 x 13 x 13 centimeters) live traps were set for three consecutive nights each. Trap stations consisting of two traps each were placed at 10 meter intervals. A line of Havahart traps ran 10 meters away from and parallel to the Sherman traps, reducing the possibility that the presence of larger mammals in or around traps influenced small mammal activity. Bait consisted of one part each: oatmeal, peanut butter, raisin, and 1 / 2 part paraffin. Exact trapline locations were determined post facto using a Trimble Basic Plus Global Positioning System (Appendix III). Eighteen nights of trapping between the fourth of September and the ninth of October 1992 resulted in a total of 1188 trap nights.

Transects were located throughout the island and contained representative habitat from all of the previously described vegetation types. The "Coombs" transect lies on private land on the northern tip of the island. It begins in mixed hardwood-conifer and enters pitch pine as it climbs up Coombs Mountain. The "Ranger" transect lies on the northern boundary of the Park just south of the town. It consists of mixed hardwood-conifer forest, sphagnum-sedge bog, and spruce-fir forest. The "Long Pond Trail - Eli Creek (LPEC)" transect lies approximately in the middle of the western side of the island. It begins in red maple forest, follows a creek bed up to a sphagnum-sedge bog and proceeds into mixed hardwood-conifer forest. The "Maple" transect lies west of the median ridge through the center of the southern half of the island. It runs through red maple forest. The "Duck Harbor" transect lies south of Duck Harbor on the Western Head. It runs through spruce-fir and mixed

hardwood-conifer forest. The "Boom" transect lies on the eastern shore parallel to Boom Beach. It runs through heath scrub and spruce-fir forest. (Figure 3 and Appendix III).

Traps were checked at dawn, closed during the day and reset at dusk. Traps had dry cotton in them to protect the animals from cold and were shaded to protect from excessive heat. Animals were released at the capture sight.

Data collected from trapping included species captured, capture location, sex and body measurements (weight, body and tail length). Captured animals were marked with a dorsal hair clip and recaptures were recorded. Two accidental mortalities (one Peromyscus and one Sorex cinereus) were preserved as study skins and are housed in the Natural History Museum at College of the Atlantic. The presence or absence of the deer tick, Ixodes dammini, was recorded and the ticks were collected and sent to the Maine Medical Center for positive identification.

During the day 70 kilometers of trails, streams and dirt road were repeatedly searched on foot and on bicycle for incidental observance of scat, tracks, visual sightings or other sign of larger mammals. Data collected as incidental observance include species seen, location and time of sighting, location and descriptions of tracks. Scat was collected and photographs of scat and tracks were taken.

During the evenings of September 14,15, and 16 searches were conducted for bat species. Two of the evenings were spent in suspected bat habitat with a Summit Ultrasound Advice Mini-2 bat detector. A mist net was set up one evening for one hour after dark over a suspected flyway into a pond in the gravel pit north of town (Figure 2). Photographs of a bat in daylight were taken as incidental observance.

A questionnaire (Appendix I) was distributed to residents regarding domestic mammals as well as wild mammal sightings.

Data were analyzed using the Systat statistical package. A Bartlett's test for homogeneity of variances was used to determine if variance was significantly

different between transects and between habitats. Depending on the result of this test, either a Kruskal-Wallis test or an ANOVA was performed. If the ANOVA indicated significant differences, the Tukey Honestly Significant Difference test was then used to locate where differences occurred. Unequal sampling of habitat (Figure 4) required total number of captures per habitat to be treated as proportion captured per unit effort. An arcsine transformation allowed these proportions to be statistically analyzed.

RESULTS

The following is an annotated list of the mammals of Isle Au Haut.

Odocoileus virginianus, white-tail deer. Over 25 deer were sighted and their pellet groups are common throughout the island.

Lepus americanus, snowshoe or varying hare. Only four hare were sighted, however their pellet groups are common throughout the island.

Peromyscus maniculatus, deer mouse. Eighty-five Peromyscus were trapped, 15 of which were recaptures. Since salivary amylase electophoresis was not conducted, the possibility that some of these may have been white-footed mouse (P. leucopus) cannot be completely eliminated. However, Connery et al. (1992) and Rand et al. (1993) collected over 64 Peromyscus all of which were P. maniculatus. There is little reason to doubt that the deer mouse is the only member of Peromyscus presently on I.A.H. One mouse died in the trap and is preserved at the Natural History Museum at College of the Atlantic. Figure 3 shows location of transects where Peromyscus was caught.

Microtus pennsylvanicus, meadow vole. Eight meadow voles were trapped in the Boom and Duck Harbor transects. Figure 3 shows location of transects where Microtus was caught.

Clethrionomys gapperi, boreal red back vole. Two red back voles were trapped. One was in a Havahart in the LPEC transect, the other was in a Sherman trap in the Duck Harbor transect. Figure 3 shows location of transects where C. gapperi was caught. They were differentiated from the meadow voles by their distinctive coloration (Burt and Grossenheider 1976).

Tamiasciurus hudsonicus, red squirrel. Sixteen red squirrels were trapped and well over 180 were sighted. Figure 3 shows location of the transect where T. hudsonicus was caught. Their vocalizations can be heard throughout the island and the remains of spruce cones eaten by squirrels are common. This is by far the most visible and vocal mammal on the island, contrary to Manville's (1964) statement that they are "peculiarly silent". Melanistic specimens have been seen on the island (Mattingly, pers. comm.) however none were sighted during this study.

Sorex cinereus, masked shrew. One specimen was found dead in a trap from the Maple transect. Figure 3 shows location of the transect where S. cinereus was caught. Its unicuspids were examined to differentiate it from the pygmy shrew, Microsorex hoyi. Its skull is located in the Natural History Museum collection at College of the Atlantic.

Procyon lotor, raccoon. Two of the traplines, Ranger and Boom, were repeatedly ransacked by a larger mammal: either raccoon or coyote. The manner in which the traps were taken apart suggests an animal with more manual dexterity than found in a coyote's paw. A clear set of tracks were found and photographed along the Duck Harbor Trail just north of the Eli Creek Cabin.

Canis latrans, eastern coyote. Three coyote scat were collected. Coyote have been on I.A.H. for approximately four years. (Mattingly, pers. comm.)

Mustela vison, mink. Three mink scat were collected. They are known as common all around the island.

Bat species. During the searches with the bat detector five bats were located: three at the south end of Long Pond, one over the pool in front of the Eli Creek Cabin, and one at the ponds in the town gravel pit on the north end of the island. Efforts to capture bats in the mist net were unsuccessful. The behavior of the observed bats (feeding low over the water) suggests Myotis species. On October 8 at 1400 hours a lone bat was observed feeding over the pond in the gravel pit. Although close photographs were taken, it was not possible to positively identify its species. Due to its general morphology, it was probably a Myotis (spp.) or a big brown bat, Eptesicus fuscus.

Questionnaire Results:

Twelve questionnaires (34%) were returned. Domestic pets and livestock include the following : a minimum of 18 domestic dogs, a minimum of six domestic cat, a minimum of six domestic rabbit, three goats, two horses and one cow. All pets are kept outside at least some of the time and are usually not restrained. Wild mammal sightings are outlined in Table 2.

Statistical Results:

The Bartlett's test showed no significant difference in variance of total number of mammals captured between transects (p=5.966 n=6). An ANOVA test showed a significant difference in total number of captures between transects (f=4.510 p=0.015 DF=5) (Figure 5). The Tukey HSD showed this difference to be between the Duck Harbor and Coombs transects (p=0.006).

The Bartlett's test showed no significant difference in variance of total number of mammals captured between habitats (p=13.765 n=6). An ANOVA test showed no significant difference in total number of captures between habitats (f=0.696 p=0.636 DF=5).

When testing for a difference in weight and length of Peromyscus by sex males were significantly heavier than females (t=2.159, p=.034 n=84) (Figure 6) but not

significantly longer (t=1.863 p=.066 n=84) (Figure 7). There was a significant difference in weight by transect (f=2.864 p=.020 n=84) (Figure 8). The Tukey HSD showed this to be between the Ranger and LPEC transects (p=.031). The Bartlett's test showed a significant difference in variance for length by transect (p=.018 n=6). The Kruskal-Wallis showed there to be a significant difference in length by transect (p=.030 U=12.345 n=84) (Figure 9). The Mann-Whitney U-test then showed this difference to be between the LPEC transect and Ranger (p=.011), LPEC and Maple (p=.051), LPEC and Boom (p=.034), and between Ranger and Duck Harbor (p=.009).

Sex ratio by transect is summarized in Table 3. The variation in sex ratio by transect likely results from observer experience level (observer confidence in sexing ability increased as the field season progressed) as well as small sample size (for the Coombs transect n=3). An ANOVA to determine the effect of transect and sex on weight showed no significant effect (Table 4). An ANOVA to determine the effect of transect and sex on length showed a significant effect from transect alone (f=2.493 p=.039) (Table 5).

Tick Results:

Three Ixodes dammini ticks in the larval stage were collected from Peromyscus maniculatus. All ticks were collected from the Boom transect in spruce-fir habitat. The ticks were identified by staff at the Maine Medical Center. Previous study has shown that on Isle Au Haut, I. dammini larvae found on P. maniculatus have a 21% rate of infection by Borrelia burgdorferi, the Lyme disease spirochete (Rand et al., 1993). The study also showed that infected larvae can survive the molt into nymph stage. Nymphs on Isle Au Haut had a 45% rate of infection.

DISCUSSION

Of greatest interest is the recent discovery of Clethrionomys gapperi on Isle Au Haut. Three red back voles were trapped in 1991 by Rand et al. (1993) and this

constitutes their first documented occurrence on the island. The relationship between Clethrionomys and Microtus on islands has received a great deal of study.

Cameron (1964) studied islands in Canada where C. gapperi was absent yet Microtus pennsylvanicus was present and he reviewed information on islands in Great Britain where C. gareolus , M. arvalis , and M. agrestis exist in exclusion of each other. He concluded that the first species to reach an island and establish a population will be able to prevent latecomers from successful colonization.

Crowell (1973, 1983, Crowell and Pimm 1976) introduced C. gapperi and Peromyscus maniculatus to 11 small (< 40 ha) islands in Penobscot Bay that had previously been inhabited only by Microtus pennsylvanicus. On the mainland C. gapperi excludes Microtus from woodland habitat, yet on the study islands Microtus inhabits woodland as well as its more typical grassland habitat. When C. gapperi and Peromyscus were introduced, Microtus inhabited the grassland habitat rather than the woodland which C. gapperi had colonized. Within a few years, however, the population of C. gapperi had become extinct and Microtus returned to the woodland. Crowell suggested that Microtus was continually recolonizing the small islands and that C. gapperi's poor dispersal ability prevented it from recolonization. Although C. gapperi has a slower intrinsic rate of increase (Safriel and Ritte 1983), larger home range requirements, and more frequent fluctuations in population (Grant 1970), Crowell suggests that extrinsic factors rather than demographic stochasticity determine community structure on Penobscot Bay islands. Whether C. gapperi will be able to overcome these challenges and successfully colonize Isle Au Haut can only be determined by further monitoring of its status on the island.

The coyote has inhabited Isle Au Haut for approximately four years and its presence was most noticeable during the winter of 1990 when coyotes killed sheep on neighboring York Island (Mattingly, pers. comm.). Coyotes have been known to swim distances of approximately one and a half kilometers (Harrison, pers. comm.)

so it is not surprising that they arrived on Isle Au Haut. The deer, raccoon, hare, and small mammals on Isle Au Haut provide a plentiful food source and the island's size is sufficient to support a permanent coyote population.

The raccoon was brought to Isle Au Haut about 12 years ago with the hopes of providing subsistence for resident trappers (Mattingly, pers. comm.) and its presence is noted without discussion in Crowell (1986) and Rand et al. (1993). It has since expanded south into the Park lands and has become a common sight all around the island. The establishment of a raccoon population here is evidence of the influence that human populations can have on island ecosystems.

Unlike Manville (1964) and Crowell (1986), I do not list river otter and muskrat as present, however, residents have reported seeing both animals on the island within the past five years. Failure to find sign of these medium sized semi-aquatic mammals is probably due to biased sampling methods rather than their absence. Although three streams were searched for sign of these mammals, none of the traplines were located along waterways and many of the island's streams were not searched. Manville's reasons for listing these mammals (and also the other mammals which only received one X in Table 1) did not come from contemporary evidence; both otter and muskrat remains are found in Indian shell heaps and a resident had reported to Manville that otter were present in the past. Although reports from residents can be useful, they should not be considered as conclusive evidence because they are subject to observer bias and variation in observer experience.The questionnaire results reflect this variation.

The three reports of fox (Vulpes fulva) are likely to have been young coyote. While they may actually have been fox, I found no additional evidence to suggest that fox are present on the island. One resident said that they were on the island 'many years ago' and Crowell (1986) listed them as extirpated. The one report of a weasel (Mustela sp.) may have been accurate or it may have been a small mink.

Again I found no evidence to suggest that weasel are present on the island. Two reports of beaver (Castor canadensis) may be sightings of the one 'problem' beaver that was brought to the island in the 1970's from the mainland. The beaver died on the island without establishing a population. Crowell's (1986) listing of beaver as uncertain status on the island probably refers to this introduced individual. Also, two autumns ago a hunter's dogs returned from a stream in town with a dead beaver. The beaver appeared to have just come out of the ocean. Eight people reported rabbit sightings without reporting hare sightings. This is probably due to the common use of the word rabbit to represent most lagomorphs rather than the presence of New England cottontail rabbit (Sylvilagus transitionalis) on the island. Three people reported sightings of flying squirrels (Glaucomys sp.). One of these said that two pet flying squirrels (sex unknown) were released on the island about 15 years ago. If they had established a population some would probably have been trapped, so their continued presence on the island is doubtful. The one skunk (Mephitis mephitis) sighting is probably a case of mistaken identity. One report of a fisher cat (Martes pennanti) was from ten years ago. Two people reported moose (Alces alces) tracks and a transient moose visited the island a few years ago.

The total number of mammals trapped was significantly different between the Duck Harbor and Coombs transects. These are the transects where the largest and smallest number of mammals respectively were trapped. The Coombs transect was closest to human activity; an active gravel pit is ten meters west of the first trap station. Although it is also the only transect with pitch pine habitat, human activity is more likely the cause of the small number of mammals being located in this area. The pitch pine habitat is located at the top of Coombs mountain at the opposite end of the transect than the gravel pit. Two of the three mammals trapped in this transect were in the pitch pine habitat. The Duck Harbor transect is near the campground, but it does not receive direct human impact. The first six stations, while in spruce-fir

forest, also had a grassy understory. This additional vegetation may allow the increase in mammal numbers.

The raw differences in capture number by habitat results from differential sampling of each habitat as shown in Figure 5. Transformed data show no significant difference in capture number by habitat. This suggests that all habitats on Isle Au Haut are equally likely to be inhabited by species that were trapped.

Males were significantly heavier and almost significantly (p=.066) longer than females. Burt and Grossenheider (1976) do not mention sexual dimorphism within Peromyscus. The dimorphism on Isle Au Haut may be due to small sample size or it may reflect the giganticism and dwarfism common to island species (Carlquist 1965). LPEC mice were significantly lighter in weight than Ranger mice. They were also significantly shorter in length than Ranger, Maple, and Boom mice. Data was not recorded regarding age of mice, it is possible that LPEC mice were younger than those trapped at other transects. The sex ratio at LPEC was two to one (male to female),which would suggest that males there are smaller than males at other transects. An ANOVA to test this showed that there is no significant difference in length of males by transect (f=1.835 p=0.125 DF=5) but there is a significant difference in weight of males by transect (f=3.154 p=0.016 DF=5). The Tukey HSD showed this difference to be between LPEC and Ranger transects and LPEC and Maple transects. Because LPEC was the first transect trapped there may be a high degree of error in the sexing. It is possible that LPEC actually has a large number of females who were trapped and that that is the cause of the weight difference by transect.

Whether purposeful or inadvertent, human caused introductions alter the community structure. MacArthur and Wilson's (1967) theory of island biogeography and studies investigating or applying aspects of the theory (such as Crowell 1986) do not take human-induced introductions into account. Nor do they account for

human-caused extinctions. It is highly probable that raccoons were part of the IAH fauna during the 1800's, were extirpated by trapping pressure, and that their introduction 12 years ago was actually a reintroduction (Mattingly, pers. comm.). As human populations continue to increase northeast through Maine they will have an ever greater impact on coastal island ecosystems. Managers must recognize the possible impacts and incorporate increased human populations and their effects into management plans.

FUTURE RESEARCH

Isle Au Haut should receive future monitoring to record changes in its mammal population. Special attention should be given to the continued presence or absence of Clethrionomys gapperi. In addition to regular surveys, a full scale Mustelid study should be conducted. This study should focus on the ecology of mink on Isle Au Haut and investigate the presence or absence of river otter and short and long tailed weasel. During this study surveys for river otter would likely be sufficient to determine the presence or absence of muskrat as well. As with all areas of Acadia National Park, a thorough investigation into the bat population is also needed.

ACKNOWLEDGEMENTS

I would like to thank the Resource Management Department at Acadia National Park for making this study possible. Special thanks go to Kent Mattingly and Wayne Barter, the rangers on Isle Au Haut who gave me a great deal of support and shared their knowledge of the island and its fauna. The residents of Isle Au Haut were extremely friendly and helpful and made it a joy to work on the island. Matthew Skolnikov kindly gave permission to trap on his land on Coombs Mountain. Special thanks also go out to John S. Sullivan whose financial and moral support were indispensable to this project. Dr. Peter Rand and his staff at the Maine Medical Center graciously made their services available for tick identification. A final thanks to Dr. John Anderson, Jennifer Rock, Bruce Hazam, and Timothy Cole whose friendship, advice, and field work made this project an enjoyable adventure.

Figure One: Eastern Penobscot Bay, Maine. Isle Au Haut is 5.74 km from Stonington on Large Deer Isle and 18 km from Naskeag on the mainland.

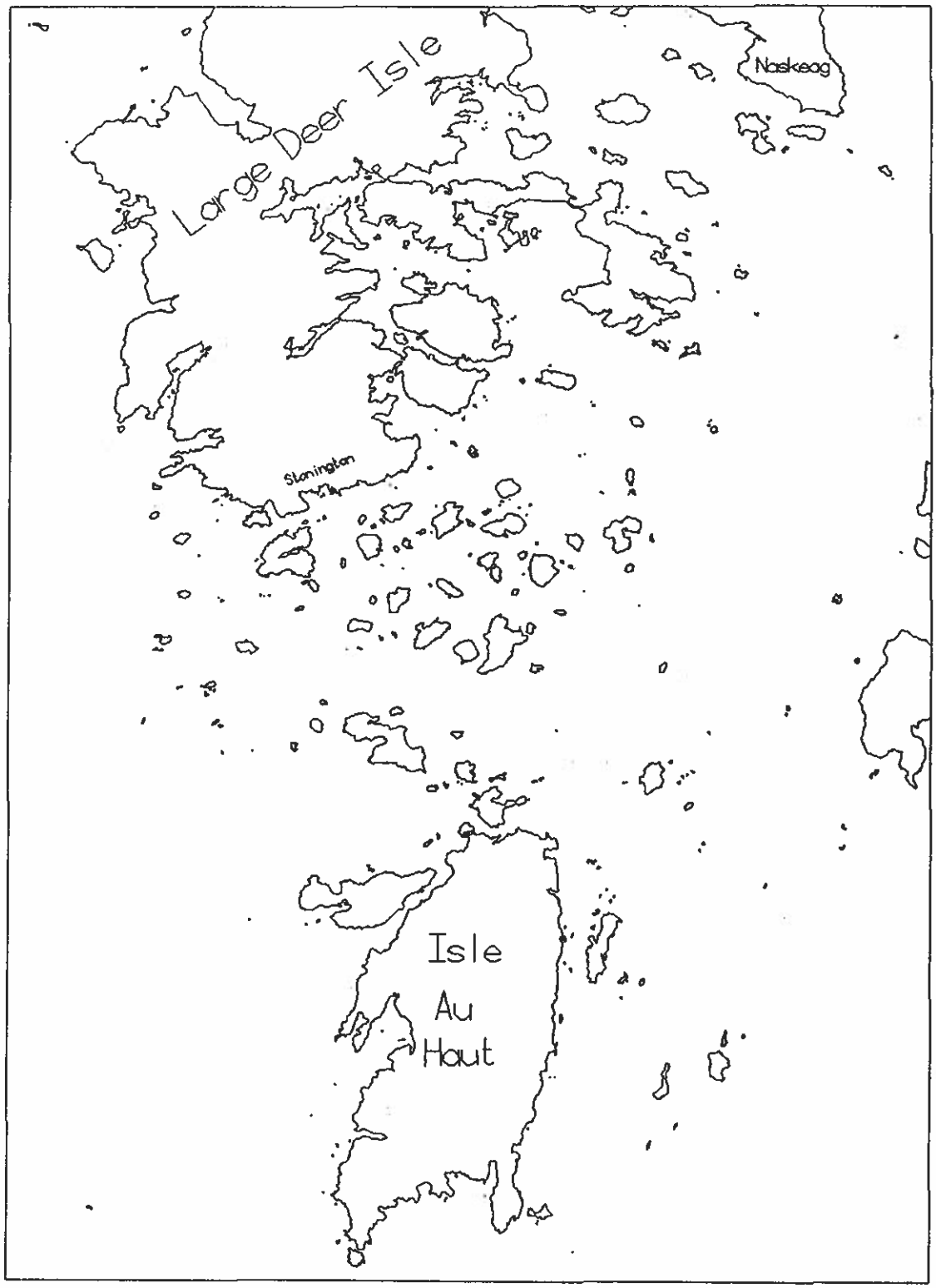

Large Deer Isle
Naskeag
Stonington
Isle
Au
Haut

Figure Two: Isle Au Haut, Knox County, Maine. This map shows the general localities on the island including Long Pond and the Loop Road.

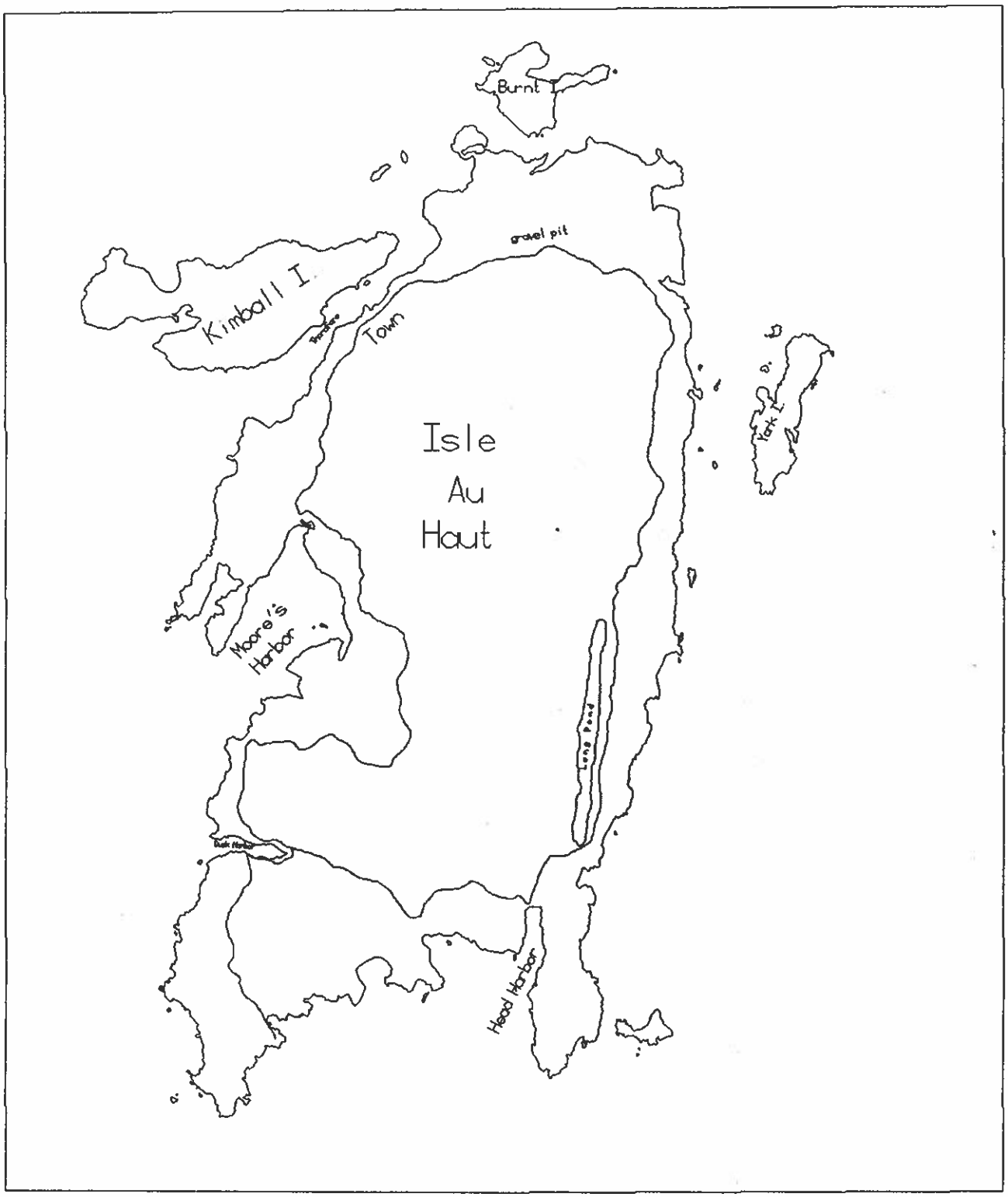
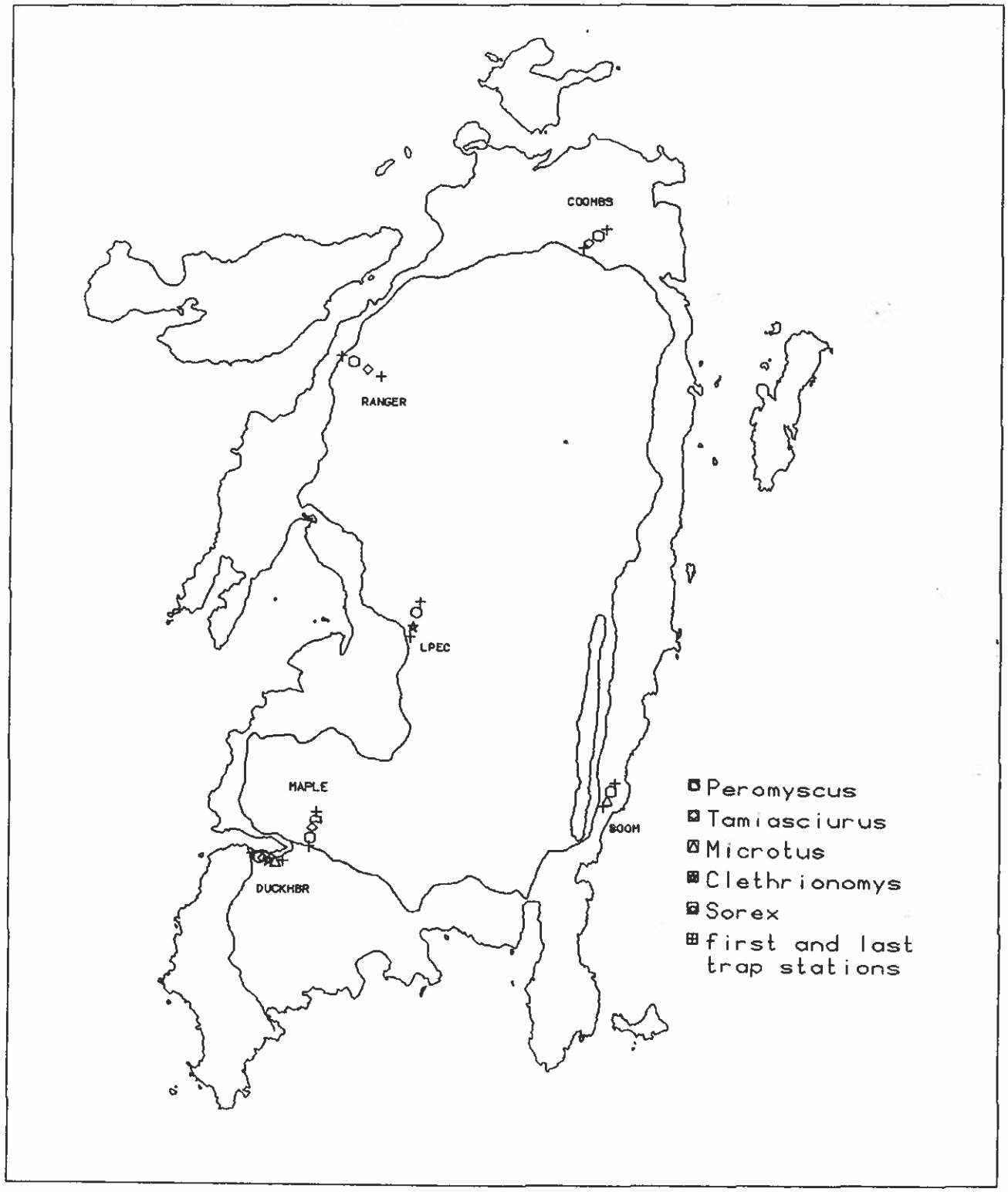

Burnt I.
gravel pit
Kimball I.
Town
Isle
Au
Haut
York I.
Moore's Harbor
Long Pond
Head Harbor

Figure Three: Isle Au Haut, Knox County, Maine. This map shows the locations of the six traplines and indicates which species were trapped at each.


COOMBS
RANGER
LPEC
MAPLE
DUCKHBR
BOOM
Peromyscus
Tamiasciurus
Microtus
Clethrionomys
Sorex
first and last trap stations

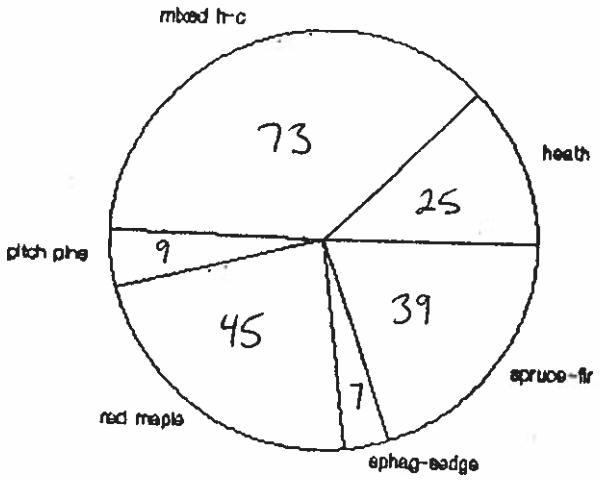


FIGURE 4. Pie chart showing differential sampling of habitat types. Data were transformed with an arcsine transformation before statistical testing. $N = 198$

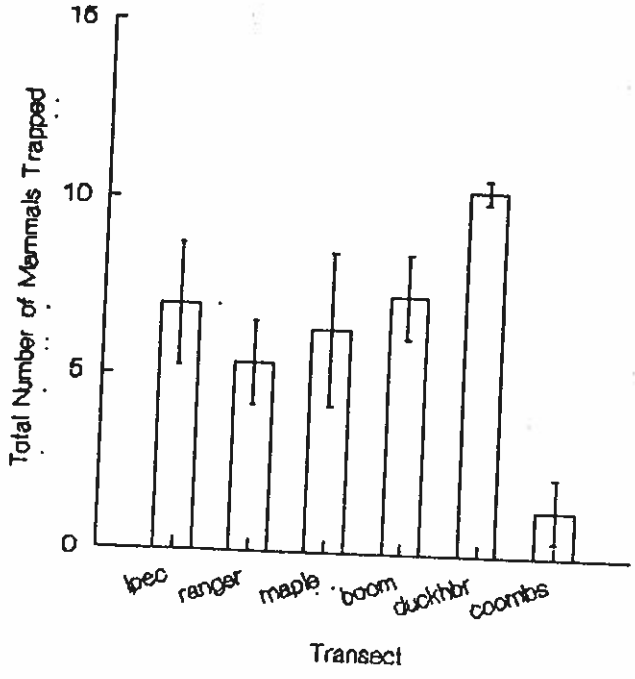


FIGURE 5. Total number of mammals trapped per transect per night (+/- 1 SE).

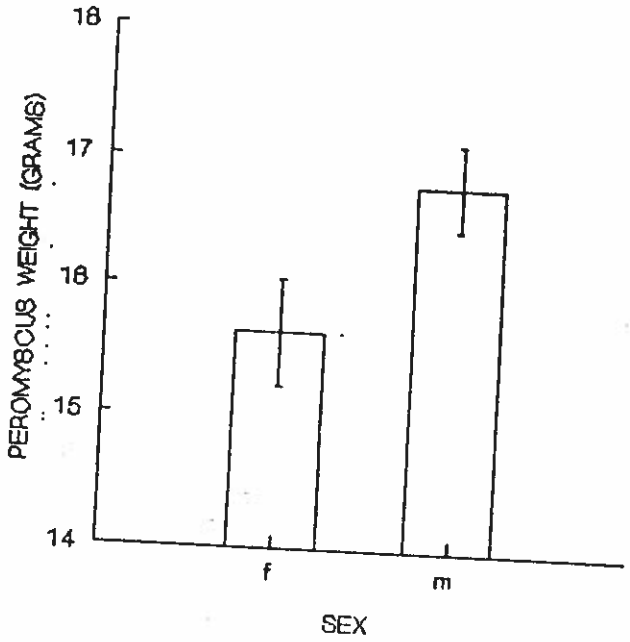


FIGURE 6. Mean weight of Peromyscus by sex (+/- 1 SE).

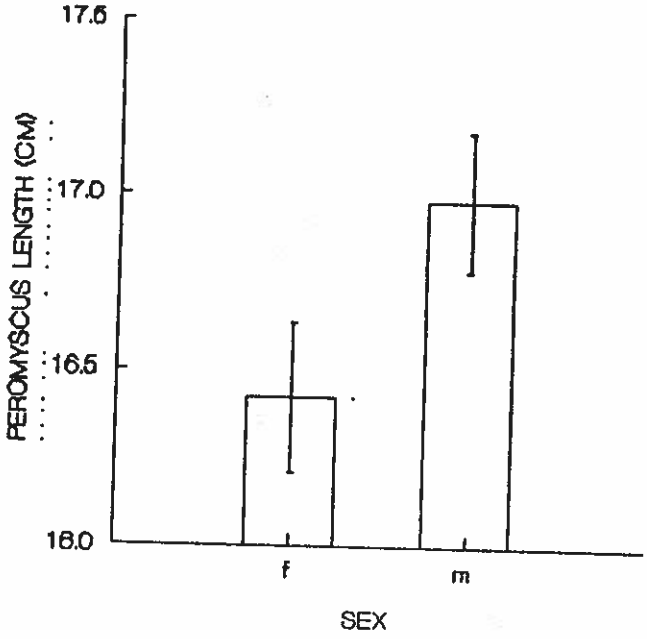


FIGURE 7. Mean length of Peromyscus by sex (+/- 1 SE).

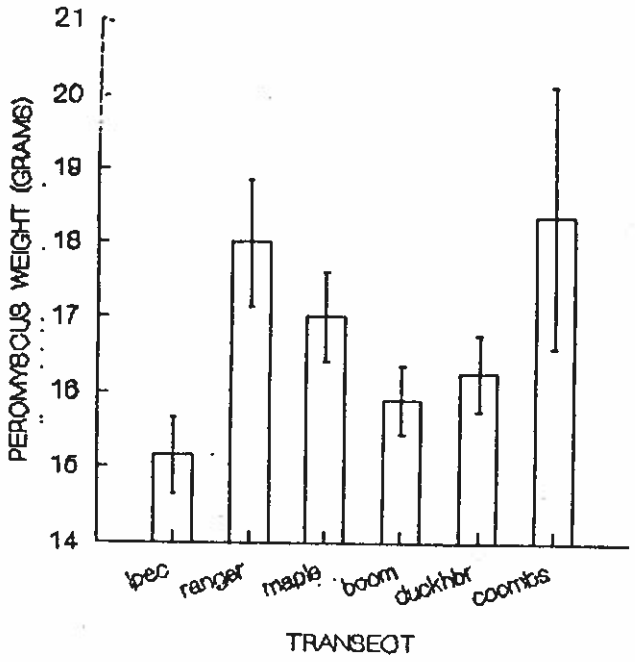


FIGURE 8. Mean weight of Peromyscus by transect (+/- 1 SE).

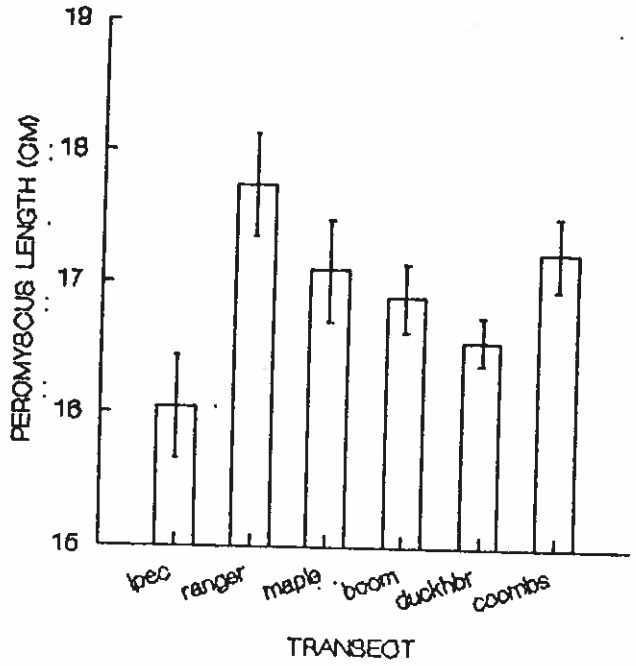


FIGURE 9. Mean length of Peromyscus by transect (+/- 1 SE).

Latin name	common name	reported by: Manville 1964	Crowell 1986	Cole 1993
Procyon lotor	raccoon		X	XX
Mustela vison	mink	X	X	XX
Mustela sp.	weasel	X	M. ermina ?	
Lutra canadensis	river otter	X	X	
Ondatra zibethicus	muskrat	X	X	
Tamiasciurus hudsonicus	red squirrel	XX	X	XX
Peromyscus maniculatus	deer mouse	XX	X	XX
Microtus pennsylvanicus	meadow vole	XX	X	XX
Sorex cinereus	masked shrew		X	XX
Clethrionomys gapperi	red backed vole		(absent)	XX
Blarina brevicauda	short-tailed shrew	X	?	
Condylura cristata	star-nosed mole	X	?	
Lepus americanus	snowshoe hare	XX	X	XX
Odocoileus virginianus	white-tailed deer	XX	X	XX
Order: Chiroptera	bat species	X		XX

TABLE 1. Species listed from Manville (1964),Crowell (1986) and the present study. X indicates listed as present without direct, contemporary evidence; blank space indicates not listed as present ; (absent) indicates listed as not present. For Manville and Cole, XX indicates species directly observed or physical evidence collected by the author.

listed mammals	# reporting sightings	added mammals	# sightings
coyote	6	deer	7
fox	3	mink	8
raccoon	12	mice	4
weasel	1	voles	2
muskrat	1	squirrel	2
beaver	2	fisher cat	1
river otter	2	moose	2
rabbit	8	shrew	1
hare	4	bat	1
flying squirrel	3		
skunk	1		

TABLE 2. Results from 12 resident questionnaires that were returned. (Appendix 1)

n	transect	female:male ratio	
19	Eli Creek	1:2	(7:12)
9	Ranger	1:2	
15	Maple	1:2	
17	Boom	1:1	(8:9)
21	Duck Harbor	3:4	
3	Coombs	1:2	

TABLE 3. Peromyscus sex ratio by transect. Variation from a 1:1 ratio is probably due to observer experience and sample size.

source	f	p
transect	2.065	.080
sex	1.874	.175
transect X sex	1.152	.341

TABLE 4. ANOVA results for Peromyscus weight by transect and sex.

source	f	p
transect	2.493	.039
sex	1.495	.225
transect X sex	1.095	.371

TABLE 5. ANOVA results for Peromyscus length by transect and sex.

APPENDIX I

Resident questionnaire. Thirty-five questionnaires were taken from a box placed in the General Store, twelve (34%) were returned.

DOMESTIC PETS

DO YOU OWN ANY OF THE FOLLOWING? IF SO, PLEASE CIRCLE AND INDICATE HOW MANY.

dog cat rabbit ferret hamster other_____

IS YOUR PET KEPT IN THE HOUSE ALL OF THE TIME, SOME OF THE TIME, OR NEVER?

WHEN YOUR PET IS OUTSIDE, IS IT RESTRAINED BY A CHAIN OR CAGE OR IS IT FREE TO ROAM?

HAS YOUR PET EVER ESCAPED OR HAVE YOU EVER LOST YOUR PET ON ISLE AU HAUT?

LIVESTOCK

DO YOU OWN ANY OF THE FOLLOWING? IF SO, PLEASE CIRCLE AND INDICATE HOW MANY.

cattle goats sheep horse pig other_____

HAVE THEY EVER ESCAPED OR HAVE YOU EVER LOST ANY LIVESTOCK ON I.A.H?

WILD MAMMALS

HAVE YOU EVER SEEN DIRECTLY ANY OF THE FOLLOWING ON I.A.H.:

coyote fox raccoon weasel muskrat beaver

river otter rabbit hare flying squirrel skunk other_____

HAVE YOU EVER SEEN INDIRECT EVIDENCE OF THE ABOVE MAMMALS (SCAT, TRACKS, TREE MARKINGS, ETC.)?

HAVE YOU EVER HEARD STORIES OF SOMEONE ELSE SEEING ANY OF THE ABOVE?

PLEASE USE THE BACK SIDE TO COMMENT ON ANY WILD MAMMAL SIGHTINGS. INFORMATION SUCH AS WHERE THE ANIMAL WAS SIGHTED, HOW LONG AGO AND BY WHOM WILL BE MOST HELPFUL.
IF YOU MENTION ANY UNUSUAL SIGHTINGS, OR IF YOU ARE WILLING TO ALLOW ME TO TRAP ON YOUR LAND, PLEASE INCLUDE YOUR NAME, ADDRESS, AND HOW I MAY CONTACT YOU.
THANK YOU FOR YOUR HELP!

APPENDIX II

One of the goals in the Acadia National Park General Management Plan (ANP 1992) is to "document the locations, scope, and sizes of Acadia's natural history and archeological collections currently distributed among repositories nation wide." In support of this goal, I researched the current (1992) locations of study skins and skulls from Isle Au Haut, Knox County, Maine. Included in the list below are all museums asked to search their collections even if they did not have any IAH specimens.

Maria Rutzmoser, Mammal Department
Museum of Comparative Zoology
Harvard University
Cambridge, MA 02138
as of 4 August 1992:

Sorex cinereus cinereus			4 specimens	R.S. Palmer
MCZ 56266	female,	skin and skull	9 August 1945	Strawberry Hill
MCZ 56267	male,	skin and skull	28 June 1945	Northeast corner
MCZ 56268	female,	skin and skull	29 June 1949	Northeast corner
MCZ 56269	male,	skin and skull	29 June 1949	Northeast corner
Tamiasciurus hudsonicus gymnicus			3 specimens	R.S. Palmer
MCZ 50681	female,	skin and skull	29 June 1949	Northeast corner
MCZ 50682	female,	skin and skull	29 June 1949	Northeast corner
MCZ 50683	female,	skin and skull	30 June 1949	Northeast corner
Peromyscus maniculatus abietorum			9 specimens	R.S. Palmer
MCZ 55835	female,	skin and skull	29 June 1949	Northeast corner
MCZ 55836	male,	skin and skull	29 June 1949	Northeast corner
MCZ 55837	male,	skin and skull	29 June 1949	Northeast corner
MCZ 55838	male,	skin and skull	9 August 1945	Strawberry Hill
MCZ 55839	male,	skin and skull	9 August 1945	Strawberry Hill
MCZ 55840	male,	skin and skull	9 August 1945	Strawberry Hill
MCZ 55841	male,	skin and skull	9 August 1945	Strawberry Hill
MCZ 55842	female,	skin and skull	9 August 1945	Strawberry Hill
MCZ 55843	female,	skin and skull	9 August 1945	Strawberry Hill
Microtus pennsylvanicus pennsylvanicus			4 specimens	R.S. Palmer
MCZ 56017	male,	skin and skull	28 June 1949	Northeast corner
MCZ 56018	male,	skin and skull	28 June 1949	Northeast corner
MCZ 56019	female,	skin and skull	28 June 1949	Northeast corner
MCZ 56020	female,	skin and skull	28 June 1949	Northeast corner
Lepus americanus stuthopus			2 specimens	R.S. Palmer
MCZ 50427	female,	skin and skull	28 June 1949	Northeast corner
MCZ 50428	female,	skin and skull	30 June 1949	Northeast corner

Linda Gordon, Division of Mammals
National Museum of Natural History
Smithsonian Institution
Washington, D.C. 20560
as of 27 July 1992:

Microtus pennsylvanicus pennsylvanicus 11 specimens R.H. Manville
(the following are skin and skull)
USMN# 00289197 Field # 1046 male 26 July 1963 Thorofare settlement
USMN# 00289199 Field # 1048 male 28 July 1963 1/2 mile N Champlain Mt
USMN # 00289201 Field # 1050 female 28 July 1963 1/2 mile N Champlain Mt
USMN# 00289203 Field # 1057 male 30 July 1963 1/2 mile S Thorofare Settlement
USMN # 00289206 Field # 1063 male 2 Aug. 1963 1/2 mile N Champlain Mt
USMN # 00289208 Field # 1065 female 2 Aug. 1963 1/2 mile N Champlain Mt
(the following are skull only)
USMN# 00289198 Field # 1047 female 27 July 1963 Thorofare settlement
USMN # 00289202 Field # 1051 female 28 July 1963 1/2 mile N Champlain Mt
USMN # 00289207 Field # 1064 female 2 Aug. 1963 1/2 mile N Champlain Mt
USMN # 00289209 Field # 1066 male 2 Aug. 1963 1/2 mile N Champlain Mt
USMN # 00289210 Field # 1067 female 2 Aug. 1963 1/2 mile N Champlain Mt

Odocoileus virginianus borealis 1 specimen R.H. Manville
USMN # 00288852 Field # 1056 female 1963 skull only

NMNH computer database is incomplete for rodents and specimens preserved in formalin or stored in alcohol. Manville 1964 suggests that he deposited 1 Lepus americanus, 1 Tamiasciurus hudsonicus, and 12 Peromyscus maniculatus in this museum.

Melissa Morales, Mammal Department
Field Museum of Natural History
Roosevelt Rd at Lake Shore Drive
Chicago, IL 60605
as of 24 November 1992: no IAH specimens

Skip Byers-Basso, Taxidermy
College of the Atlantic Natural History Museum
105 Eden Street
Bar Harbor, ME 04609
as of 1 October 1992: no IAH specimens

Philip Myers, Associate Curator
Museum of Zoology
University of Michigan
Ann Arbor MI 48109
as of 1 May 1992: no IAH specimens

Judy Hazen Connery, Biologist
Acadia National Park
Route 233
Bar Harbor, ME 04609
as of 1 May 1992: no IAH specimens
Manville 1964 suggests that he deposited specimens of Peromyscus maniculatus and Microtus pennsylvanicus in the Park Naturalist's collection at Acadia National Park.

Kenneth Crowell, Department of Biology
St. Lawrence University
Canton, NY 13617
as of 26 May 1992: no IAH specimens

Wolfgang Fuchs, Department of Mammalogy
American Museum of Natural History
Central Park West at 79th Street
New York NY 10024
as of 2 March 1993: waiting for response to letter of inquiry

APPENDIX III

Exact locations of the traplines were determined post facto on January 23 and 24, 1993 using a Trimble Basic Plus global positioning system (GPS). The GPS unit only works with a clear view of the sky and with minimal canopy cover. Consequently, some of the endpoints of the traplines were not able to be determined. When this occurred, the location of the nearest clearing or roadside was used and is indicated below.

TRANSECT 1, LPEC (same as used by Connery et al. 1992)

This begins along a stream that crosses the Loop Road halfway between the Long Pond Trail and the Eli Creek Cabin Parking Area. Approximately 70 meters upstream is a rebar. This is Station 1 (529298 * 4876836 UTM). From the rebar to the last station (529457 * 4877067 UTM) it is .281 km at 53 degrees magnetic north. The habitats are red maple, sphagnum-sedge bog, and mixed hardwood conifer.

TRANSECT 2, RANGER (same as used by Connery et al. 1992)

This runs along the north boundary of the park beginning at the Loop Road near the Ranger Station. The rebar for Station 1 is one meter in from the road side (528707 * 4879588 UTM). From this location to the last station (529034 * 4879588 UTM) it is .455 km at 152 degrees magnetic north. The habitats are mixed hardwood conifer, sphagnum-sedge bog, and spruce-fir.

TRANSECT 3, MAPLE

This begins approximately 100 meters east of the intersection with Western Head Road and the Loop Road. The rebar for Station 1 is approximately 10 meters north of the road (528401 * 4874898 UTM). From this location to a clearing 10 meters southeast of the last station (528489 * 4875108 UTM) it is .227 km at 41 degrees magnetic north. The habitat is red maple.

TRANSECT 4, BOOM (Rand et al. 1993 used the same location for two 7 X 7 meter grids)

This begins just north of the Boom Beach parking lot. Station 1 (531158 * 4875286 UTM) is at the same location as Orange Flag #A1 which was previously used by Rand et al. (1993). From Station 1 to the last station (531278 * 4875443 UTM) it is .197 km at 55 degrees magnetic north. Habitats are heath scrub and spruce-fir.

TRANSECT 5, DUCKHBR (same as used by Connery et al. 1992)

This begins approximately 100 meters south of the latrine on Western Head Road. I was unable to find the rebar placed there by Connery et al. (1992). On the east side of the road is a stone wall. Station 1 is located next to the wall where it begins to run parallel to the road. The station is about 3 meters east of the road (527847 * 4874774 UTM). From this location to the last station (528201 * 4874744 UTM) it is .355 km at 113 degrees magnetic north. The habitat is spruce-fir and mixed hardwood-conifer.

TRANSECT 6, COOMBS

This transect runs on private property belonging to Matthew Skolnikov. He should be consulted before entering the property. Station 1 (530903 * 4880544 UTM) is just east of the gravel pit on the north side of a stream. From this station to the last station (531122 * 4880712 UTM) it is .275 km at 71 degrees magnetic north. The habitat is mixed hardwood-conifer and pitch pine.

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