

**Small Mammal Inventory of the Apostle Islands National Lakeshore  
and St. Croix National Scenic Riverway**

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### **Abstract**

Island colonization by mammals is a function of island distance from source populations, island size, and the impedance through which mammals must travel to reach the islands. We inventoried small mammals at the Apostle Islands National Lakeshore, an archipelago of 22 islands in Lake Superior, and at the Saint Croix National Scenic Riverway, where islands were represented by isolated prairie patches surrounded by a forest matrix. At the Apostle Islands, trapping was conducted at thirteen locations on five islands and spanning 1,814 trapnights. At the Saint Croix Riverway, trapping was conducted at four locations encompassing 664 trapnights. All mammals were live trapped, tagged, and released. Four species were captured at the Apostle Islands with the southern red-backed vole the most abundant small mammal captured on all islands. At the Saint Croix Riverway, six species were captured including the meadow vole, the only species captured at both Parks. The other species included three mouse species, eastern chipmunk, and thirteen-lined ground squirrel. At the Apostle Islands, the combination of an island's distance from a source population coupled with the island's size appears to limit colonization. At the Saint Croix Riverway, prairie generalists were located, although no prairie obligates were captured, suggesting that colonization may be limited by the landscape matrix.

### **Introduction**

Understanding the distribution, abundance and dynamics of populations of organisms is one of the first steps in sound, scientifically-informed natural resources management. Because distributions of animals are greatly affected by geographic barriers, human-created barriers and conduits for dispersal, one must spend a great deal of effort conducting inventories of species of concern and/or of management interest.

The Apostle Islands National Lakeshore (APIS) is an archipelago of islands of varying sizes and with varying distances from source populations of mammals. Islands are ideal laboratories for studying dispersal and persistence of mammal populations, but are also problematic to the resource manager because of the processes that produce the patterns in distribution. MacArthur and Wilson (1967) suggested the patterns in the distributions of animals and plants on islands could be predicted by the size of the island and its distance to a mainland. These two factors increase the probability of extinction of populations and filter colonization, thereby making the management of plant and wildlife resource more complicated.

In a previous report (Smith and Maragi 2004) we discussed some of the environmental problems that small mammals face in the Apostle Islands and the resulting distribution patterns. From our field season in 2003, we (Smith and Maragi 2004) concluded that small mammals were likely to disperse to the islands in months of the year when the water between islands is frozen because of

the absence of hibernating and winter-inactive small mammals. We also found (Smith and Maragi 2004) that there were no exotic small mammals that typically co-occur with human settlements (e.g., house mouse [*Mus musculus*] and Norway rat [*Rattus norvegicus*]) on the islands. That may mean that these species did not get transported to the islands in the goods and personal effects of island inhabitants or it may mean that these species have since become extirpated.

It is still puzzling to me how the islands became populated with small mammals. Imagining individuals, weighing < 20 g, and < 150 mm in total body length, deliberately walking across 2 km of ice without any cover or perhaps swimming or passively floating on debris to the nearest island is difficult. And then imagining this happening regularly enough that viable populations could become established on islands is even more difficult. It is clear, however, that a small subset of mammal species that occupy the mainland also occupy the Apostle Islands. And though Belant and Van Stappen (2002) concluded that isolation was not an important filter, distance between islands and target island size combined might be an important filter for small mammals.

Although the Saint Croix National Scenic Riverway (SACN) is not an island archipelago, there may be habitats present within the boundaries of the Riverway that mimic islands. Prairie remnants in the Riverway may indeed be analogous to islands in many respects. Though the terrestrial habitats that surround them may not be as fine of a filter as water, separating the Apostle Islands, sharply contrasting habitats in the landscape may filter the prairie-specialists.

The goal of our study was to inventory small, distant islands (from the mainland) in the Apostle Islands and remnant, prairie “islands” in the Namekagon section of the Riverway. We hoped to document species occurrence and abundance in each park to help resource managers better understand the distribution patterns of small mammals in areas of the Parks that had not been previously inventoried.

## Methods

Small mammals were live - trapped in the Apostle Islands National Lakeshore and the Saint Croix National Scenic Riverway during the summer months (June – early September) 2004. Trapping locations in the Apostle Islands were chosen due to their unique habitats (old air strip site on South Twin and farmstead site on Basswood Island) or habitats that were representative of the entire island. Sites on the Namekagon section of the Saint Croix Riverway were primarily prairie remnants or sites that could be restored to prairie. Trapping locations were chosen with the help of SACN biologist, Robin Maercklein.

Six traps were laid down along six transects making a 36 trapping station grid, with one trap per station (Fig. 1). Distances between traps equaled 10 m or 15 m creating 50 m<sup>2</sup> or 75 m<sup>2</sup> trapping grids. All traps in trapping stations were laid on the ground near structures (coarse woody debris, rocks, etc.) where possible. In addition to the 36 ground trapping stations, five traps per grid were attached to trees at each corner of the grid (where possible) and one nearest the center of the grid. In the Apostle Islands, all ground and tree traps were non-folding, galvanized Sherman traps (7.6 cm x 7.6 cm x 25.4 cm). At SACN, all ground traps were non-folding,

galvanized Sherman traps of the same size, but in trees we used Tomahawk 102 traps with Sherman traps wired on top.

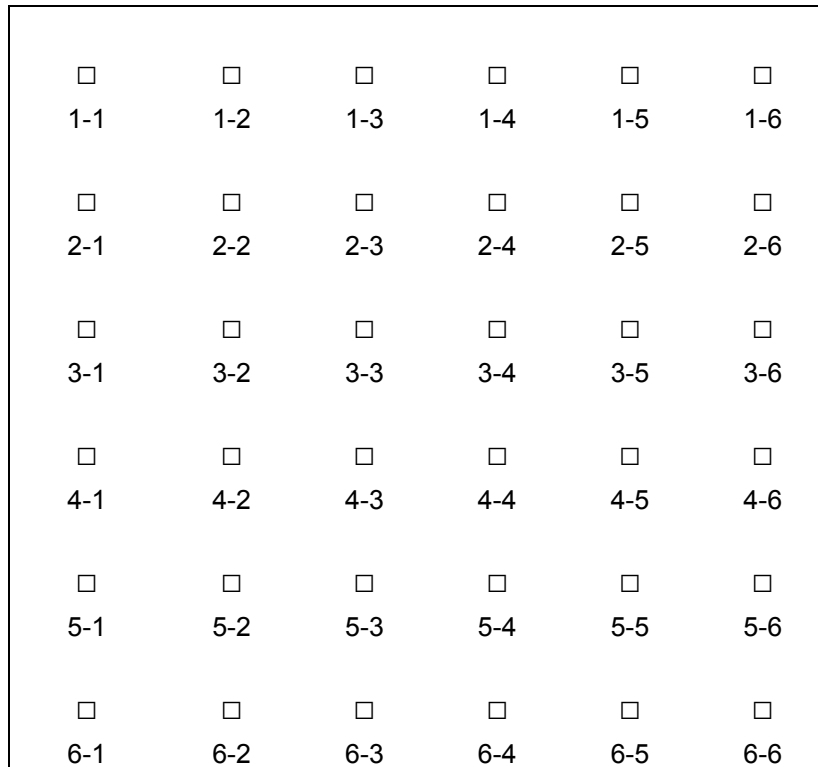


Figure 1. Layout of trapping grids in APIS and SACN in 2004. Squares represent ground traps and the numbers refer to individual trap stations.

Traps were baited with a mixture of peanut butter, rolled oats, honey, and black oil sunflower seeds. Bait was attached to the back door of the trap and two 5 cm x 5 cm cotton nestlets were used to provide bedding for captured mammals. All captured animals were tagged with a Monel 101 ear tag and released.

Each location was trapped for one week (seven nights of trapping) whenever possible. Trapnights were calculated as the number of nights a trap was open to capture a small mammal. Schedule of trapping is listed in Table 1.

Table 1. Small mammal trapping locations, dates and trapnight for inventory work in the Saint Croix National Scenic Riverway and Apostle Islands National Lakeshore, 2004.

Location	grid name	dates	trapnights
<i>SACN</i>			<i>664</i>
Namekagon R.	Olson's	25 June - 1 July 2004	172
Namekagon R.	Campsite	26 June - 1 July 2004	170
Namekagon R.	MH	27 June - 1 July 2004	174
Namekagon R.	FSNH	28 June - 1 July 2004	148
<i>APIS</i>			<i>1814</i>
Rocky	Fern Gully	7-12 July 2004	235
Rocky	JOTT	7-12 July 2005	194
South Twin	Chevy	16-21 July 2004	233
South Twin	FOD	16-21 July 2004	235
Cat	Fisher Forest	5-9 August 2004	200
Cat	Princess Grove	5-9 August 2005	199
North Twin	Mystic	14-17 August 2004	163
North Twin	Yew Hell	14-17 August 2005	156
Basswood	East Side	22 Augst 2004	74
Basswood	West Side	22 Augst 2004	3
Basswood	McCloud	1-2 September 2004	78
Basswood	Beehive	1-2 September 2004	41
Basswood	Em's backyard	1-2 September 2004	3

*Apostle Islands National Lakeshore trapping site descriptions*

Rocky Island:

“Fern Gully” array (75 m<sup>2</sup> grid size) was located on Rocky Island, and had 95%-100% canopy cover. The dominant species were northern white cedar (*Thuja occidentalis*), sugar maple (*Acer saccharum*) and an occasional paper birch (*Betula papyifera*). The understory was littered with large diameter coarse woody debris and lush ferns.

“Jott” array (50 m<sup>2</sup> grid size) was located on Rocky Island, and had 95%-100% canopy cover. The dominant tree species were northern white cedar, sugar maple and yellow birch (*Betula alleghaniensis*). The understory vegetation was sparse with many large diameter downed trees.

South Twin Island

“FOD” array (50 m<sup>2</sup> grid size) was located on South Twin Island, and had 60% canopy cover. It was located on an old air strip, now grown over with grasses and herbs, adjacent to a more boreal forested area. The dominant tree species were white pine (*Pinus strobus*), sugar maple, yellow birch, northern white cedar and trembling aspen (*Populus tremuloides*). It had high vertical diversity with lush understory and dense tree regeneration.

“Chevy” array (50 m<sup>2</sup> grid size) was located on South Twin Island, and had 95%-100% canopy cover with little understory vegetation, but a great deal of fallen trees and smaller diameter coarse woody debris. The dominant tree species were northern white cedar, white pine, balsam fir (*Abies balsamea*), and yellow birch.

#### Cat Island:

“Fisher Forest” array (50 m<sup>2</sup> grid size) was located on Cat Island, and had about a 90-95% canopy cover. The dominant tree species were northern white cedar, yellow birch, sugar maple and white and red pine (*Pinus resinosa*). The understory vegetation was thick with fallen trees, shrubs and ferns.

“Princess Grove” array (50 m<sup>2</sup> grid size) was located on Cat Island, and had about 95% canopy cover. The location was a sugar maple hardwood forest with northern white cedar, white pine and paper birch found occasionally. There were many uprooted trees, Canada yew (*Taxus canadensis*) and ferns.

#### North Twin Island:

“Yew Hell” array (50 m<sup>2</sup> grid size) was located on North Twin Island, and had about 40% canopy cover. The vegetation mainly consisted of dense patches of Canada yew, which was 1.5 m and taller. The dominant tree species were balsam fir, yellow birch, sugar maple and an occasional paper birch.

“Mystic Lakeshore” array (50 m<sup>2</sup> grid size) was located on North Twin Island, and had 75% canopy cover. The dominant tree species were balsam fir, paper birch and yellow birch. The understory vegetation was dominated by Canada yew.

#### Basswood Island:

“West Side” array (50 m<sup>2</sup> grid size) was located on Basswood Island, and had 95%-100% canopy cover. The dominant tree species were sugar maple, red oak (*Quercus rubra*), with an occasional eastern hemlock (*Tsuga canadensis*). The understory vegetation was sparse with some ferns and sugar maple saplings. There were many fallen trees and smaller diameter coarse woody debris.

“East Side” array (50 m<sup>2</sup> grid size) was located on Basswood Island, and had 85%-90% canopy cover. The dominant tree species were sugar maple, paper birch, red oak, balsam fir, and eastern hemlock. There was a lush understory of ferns and fallen trees.

“McCloud” array (75 m<sup>2</sup> grid size) was located on Basswood Island, and had about 20% canopy cover. It was located in an open field that was once used for agriculture or grazing. The vegetation consisted of broad-leaved herbs and grasses, with a few patches of asparagus (*Asparagus officinalis*). The dominant tree species were white pine, red oak, trembling aspen, and sugar maple.

“NF” array (50 m<sup>2</sup> grid size) was located on Basswood Island, and had 100% canopy cover. There was very little understory vegetation, but had many downed trees and smaller diameter coarse woody debris. The dominant tree species were sugar maple, eastern hemlock and trembling aspen.

“Em’s Back Yard” array (50 m<sup>2</sup> grid size) was located on Basswood Island, and had 90%-95% canopy cover. The dominant tree species were sugar maple, red oak, and an occasional trembling aspen and balsam fir. There was a great deal of smaller diameter coarse woody debris.

#### *Saint Croix National Scenic Riverway trapping site descriptions*

“Campsite” trapping array was located in the field north of campsite N5.1 on the Namekagon River. The array was 75 m<sup>2</sup> in size and entirely located in a human-disturbed field that was naturally regenerating to some prairie forbs and grasses. There were signs of the previous land owners’ impact on the property: fence posts, hay grass species, exotic plants, and gravel road to the site. There were two lone jack pine trees (*Pinus banksiana*) on the north and east sides of the grid. No tree traps were hung in this grid although 8 tree traps were attached to red and white pine trees along the gravel road leading down to the trapping grid.

“Mosquito Hell” trapping array was located on the bluff above the “Campsite” array. It was 75 m<sup>2</sup> in size. The site was an old opening in mostly jack pine forest with very coarse sandy soil and an understory of sweet fern, grasses, and brambles (*Rubus* spp.). The east side of the site was jack pine bracken woodland grading into jack pine savanna to the west. The opening was only a few hectares in size and most of our traps were under a canopy of < 30% jack pine.

“Olson’s” trapping array (75 m<sup>2</sup> grid) was located just north of McDowell bridge on a peninsula of land jutting into the Namekagon River. Olson’s was formerly an agricultural field with jack, white, and red pines surrounding the opening. A vacant structure was located on the southwest side of the field and signs of past human use of the field were evident. There were, however, prairie grasses and forbs colonizing the east side of the field suggesting that prairie restoration might be very successful on this site with the help of prescribed fire. Few trees occupied our trapping grid and canopy coverage was < 5% jack and white pine. We did not hang tree traps on this grid

“FSNH” trapping array (50 m<sup>2</sup> grid) was located on the same peninsula jutting into the Namekagon River just west and a little north of Olson’s. This site was down in the floodplain of the river and was 90% covered in tree canopy. Black ash (*Fraxinus nigra*) and speckled alder (*Alnus incana*) dominated the canopy with ferns, mosses and stinging nettle (*Laportea canadensis*) in the understory. Getting to and from this location was very difficult and trapping in the floodplain was extremely memorable due to the abundance of stinging nettle and mosquitoes. Tree traps in this grid were placed on black ash trees.



## Results

### *Apostle Islands National Lakeshore*

We trapped small mammals on five islands in the Apostle Islands archipelago for a total of 1814 trapnights among ground traps between July and September 2004 (Table 1). Total trapnights by island were: South Twin Island 468, Rocky Island 429, Cat Island 399, North Twin Island 319, and Basswood 199 trapnights. In addition to these we maintained 5 tree traps on each grid on each island for a total of 260 trapnights. We did not include these in the total trapnight effort because we never had a capture in these traps and because the location (trees) was ecologically different.

We captured and released 303 rodents and shrews, including: southern red-backed vole (*Clethrionomys gapperi*), masked shrew (*Sorex cinereus*), red squirrel (*Tamiasciurus hudsonicus*), and meadow vole (*Microtus pennsylvanicus*, Table 2). The southern red-backed vole was the most commonly captured small mammal on the islands (Fig. 2); constituting 70% of the captures and 67% of the total small mammal biomass (Fig. 3). It was also the most abundant small mammal captured on the islands in 2003 (Smith and Maragi 2004).

We captured meadow voles this year on Basswood Island. This species was not captured on any of the islands inventoried in 2003 (Smith and Maragi 2004). The captures on Basswood Island have good documentation in field notebooks and field technicians had previously handled meadow voles so we are confident of our inventory. Meadow voles have six distinct metatarsal pads on their hind feet and these characteristics are indicated in the field notes for each capture on Basswood Island. Also, this island is near the mainland, has had a long history of agriculture, and contains two remaining farmsteads with late successional fields that are ideal habitats for meadow voles (Kurta 1995).

### *Saint Croix National Scenic Riverway*

We trapped small mammals for seven consecutive days on three prairie remnants and one flood plain site for a total of 664 trapnights. We also maintained eight tree traps for a total of 40 trapnights. We caught 59 individual small mammals belonging to six species (Table 3). Of the four species captured at APIS, only the meadow vole was also caught at the Saint Croix Riverway. The other five species included three mice, the eastern chipmunk, and the thirteen-lined ground squirrel. Total biomass of captures across all trap sites in the Riverway was 2231.5 g of small mammal.

Table 2. Totals of individuals captured by species, sex, age, and total biomass of the species by island, APIS, 2004.

Island	species <sup>1</sup>	number of individuals <sup>2</sup>	number of captures	males	females	adults	subadults	juveniles	weight (g)
Basswood	CLGA	26	30	17	8	18	6	0	485.5
Cat	CLGA	63	158	44	18	43	6	14	1501.5
North Twin	CLGA	98	221	72	26	57	33	7	2382.5
Rocky	CLGA	16	30	8	7	13	0	2	341.0
South Twin	CLGA	19	49	15	4	10	8	1	431.5
Basswood	MIPE	21	24	17	4	19	2	0	508.5
Rocky	MIPE	1	2	1	0	0	0	1	6.5
Basswood	SOCI	18	18	7	11	18	0	0	70.5
Cat	SOCI	8	8	5	1	6	0	0	32.0
North Twin	SOCI	2	2	1	1	2	0	0	8.0
Rocky	SOCI	18	18	13	5	18	0	0	90.5
Rocky	TAHU	10	10	6	3	9	0	0	1405.0
South Twin	TAHU	3	3	2	0	2	0	0	380.0
Total		303	517	208	88	215	55	25	7643

<sup>1</sup>CLGA = southern red-backed vole; MIPE = meadow vole; SOCI = masked shrew; TAHU = red squirrel

<sup>2</sup>Numbers of males and females or age classes do not add up to the number of individuals in all cases because some escaped before sex or age was determined.

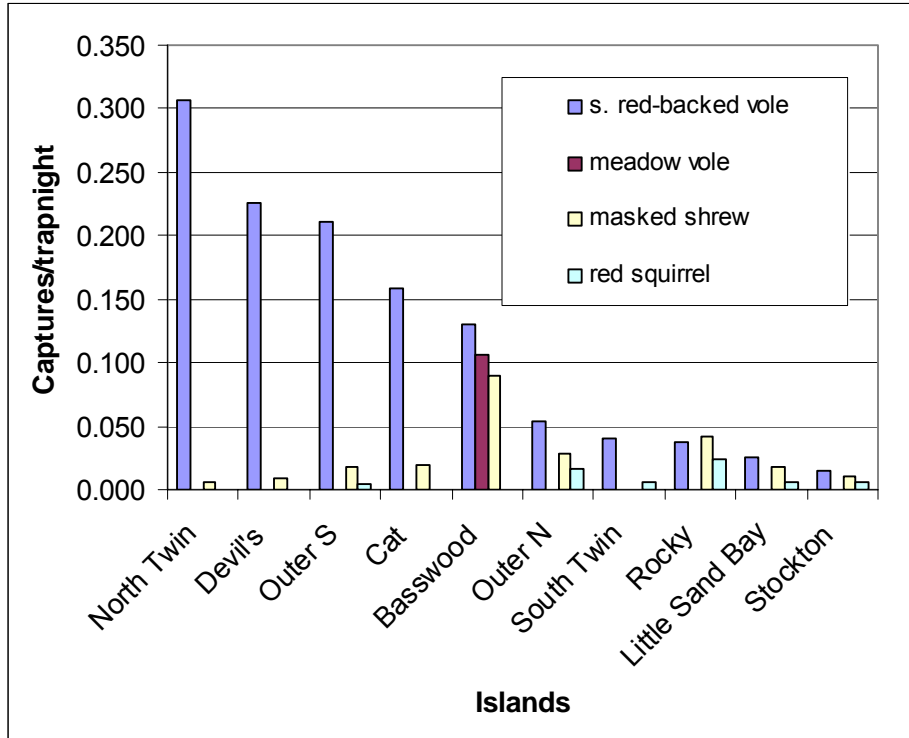


Figure 2. Captures/trapnight of each of the species captured in the Apostle Islands National Lakeshore, 2004. Data from Devil's, Outer, and Stockton Islands and Little Sand Bay collected in 2003 are presented for comparison.

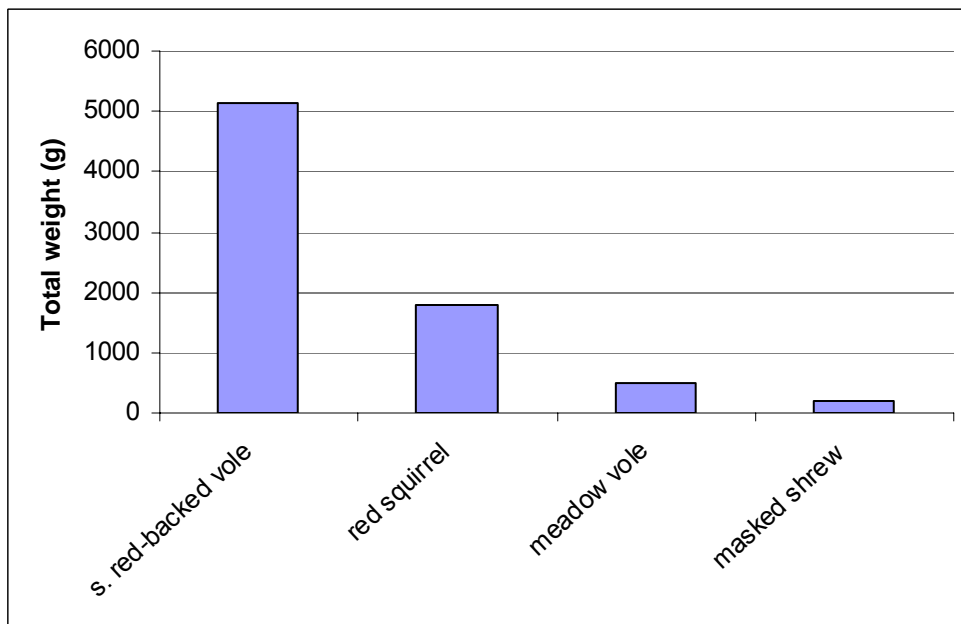


Figure 3. Biomass of all small mammal species captured in the Apostle Islands National Lakeshore, 2004.

Table 3. Trapping location names, species captured, number captured and number of recaptures and total weight (biomass) of each species in SACN, 2004.

trapping location	species	number of individuals	number of captures	weight (g)
Olson's	meadow vole	25	30	559.0
Olson's	thirteen-lined ground squirrel	1	0	115.0
FSNH	woodland jumping mouse	1	2	16.0
FSNH	North American deermouse	3	13	47.0
FSNH	eastern chipmunk	7	10	601.0
FSNH	meadow jumping mouse	6	7	100.0
MH	meadow vole	1	0	14.5
MH	thirteen-lined ground squirrel	3	0	367.0
Campsite	meadow vole	11	15	272.0
Campsite	thirteen-lined ground squirrel	1	0	140.0
Total		59	77	2231.5

## Discussion

### *Apostle Islands National Lakeshore*

There were interesting findings in this inventory that differed from the 2003 inventory of the mainland and Stockton, Outer, and Devil's Islands (Smith and Maragi 2004; Fig. 4). Last year, we found North American deermice (*Peromyscus maniculatus*) on the mainland as well as on all of the islands except Devil's Island. This year we did not capture deer mice on any of the islands. One reason we selected the islands in the northeastern part of the archipelago was because we were interested in knowing why deer mice were not on Devil's Island but were on Stockton and Outer Island. Finding them absent on Cat, North and South Twin and Rocky suggests that perhaps deer mice are not as good of a disperser/colonizer as southern red-backed voles. We would have expected deer mice on Basswood Island and it is very likely this species is there. However, each time we set up trapping grids on Basswood we had to take them down because of problems with black bears (*Ursus americanus*). During our first trapping session on Basswood we had two grids set out for one night and on the second session, in September, we had three grids set out for two nights.

Again this year we did not catch any exotic mammals such as house mouse or Norway rat. Although it seems likely that they would have been brought to the islands in goods and packages for the settlements and lighthouses on the islands, they do not appear to have persisted, if they were, indeed, introduced. We could infer from these findings that the Apostle islands may be resistant to exotic mammal introductions because of the filtering effects of isolation and island size.

An interesting finding on three of the islands this year was the number of rodents infested with *Ixodes* spp. (ticks). The most notable infestations were found on North Twin, Cat, and



Figure 4. Apostle Islands map showing where trapping was conducted in both 2003 and 2004.

Basswood Islands. Some of the mammals had such an amazing parasite load that they appeared to be orange. Ticks were mostly restricted to the dorsal surface of the voles and primarily around the head, neck and ears but some had them on their abdomens as well. We were unable to tag some individuals because there was not enough integrity in the pinna tissue to hold a tag.

It is likely that the microtine populations were down from last year. Microtines typically display a four year cycle in their populations and last year populations were high on the mainland (D.F. Smith unpubl. data), and higher in the islands than this year. This might also explain the abundance of ticks on the voles. Ticks likely responded to the high vole population last year and this year they are overabundant on the fewer individuals in the population.

Lastly, we noted red squirrel vocalizations on all the islands we surveyed even if we didn't capture them there. Also, we saw a fisher (*Martes pennanti*) on North Twin Island.

#### *Saint Croix National Scenic Riverway*

Trapping locations were suggested to us by Robin Maercklein because he had the knowledge of the area and we had hoped to target wetland and prairie habitats. The prairie remnants we inventoried were small, abandoned agriculture pastures that were naturally reverting back to a "prairie" condition with prairie vegetation, but they were still dominated by domestic animal forage grasses. Due to their stage of succession back to prairie, we caught small mammal species that would occupy prairies but also are commonly found in pastures and hayfields. Prairie obligates like the prairie vole (*Microtus ochrogaster*) were absent from these sites and

may never be present because of the isolation of these prairie patches and the landscape matrix surrounding them.

We were excited to find woodland jumping mouse (*Napaeozapus insignis*) and meadow jumping mouse (*Zapus hudsonius*) in the same trapping grid (FSNH) on the Namekagon River. Although surprising at first to see these two coexisting in the same floodplain habitat, on close inspection, the floodplain forest along the Namekagon River contained both wooded patches and productive openings.

All *Peromyscus* specimens were closely examined, and we did not catch any white-footed mice (*Peromyscus leucopus*). This species was found by Jackson (1961) in Washburn and Burnett Counties but many of his records of this species are now suspect following DNA analysis of museum specimens (J. Kier, pers. comm.). All deer mouse (*Peromyscus maniculatus*) captures were of the subspecies *gracilis*. Like the prairie vole, *P. m. bardii* subspecies are distributed more to the south, and the prairie remnants on the Namekagon River may be too isolated or too far north for this subspecies to colonize.

In conclusion, it appears that island isolation combined with island size indeed filters small mammals from colonizing the more distant, smaller islands of the archipelago. In 2003, when we inventoried islands more distant from the mainland but larger in size (Outer and Stockton Island) we found deer mice. However, in 2004 when we inventoried smaller islands (North Twin, South Twin, and Rocky) we did not capture them.

None of the small mammals on the islands we inventoried in 2003 and 2004 hibernate in winter (e.g. meadow jumping mouse) or are inactive in winter (e.g. flying squirrels) which would suggest that small mammals disperse to the islands in winter. If summer, water crossings were more common, we would expect to see winter-inactive animals on the Apostle Islands.

In the St. Croix National Scenic Riverway, the surrounding forest matrix appears to act in a similar way as water in filtering out the prairie mammals. Though the remnants we inventoried had some prairie indicators (plants) there were no small mammals that are prairie specialists. However, presence of the thirteen-lined ground squirrel suggests that if the prairie remnants within the Riverway were within the ranges of prairie specialist small mammals, they might be present. Thus, we recommend inventorying the prairie remnants in the southern portion of the Riverway.

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