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Occurrence of the Maritime Shrew (*Sorex maritimensis*) in Black Spruce (*Picea mariana*) Forest Stands in Southeastern New Brunswick

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Twenty-one specimens of *Sorex maritimensis* (Maritime Shrew) were collected in coniferous forest of central New Brunswick, a habitat considered atypical for the species. We suggest *S. maritimensis* uses a wider range of habitat types than previously documented.

Key Words: *Sorex maritimensis*, Maritime Shrew, *Picea mariana*, Black Spruce, forest wildlife, New Brunswick.

The disjunct eastern population of the Arctic Shrew (*Sorex arcticus*) has recently been recognized as a separate species, the Maritime Shrew (*S. maritimensis*) (Wilson and Reeder 2005), based on genetic analysis by Stewart el al. (2002). Before the taxonomic division, most information on either species was based on studies conducted in the western population (*S. arcticus),* and few publications exist on habitat use by the eastern population, now *S. maritimensis*.

Sorex arcticus occurs in meadow environments and wet Tamarack (*Larix laricina*)–Black Spruce (*Picea mariana*) forest (Clough 1963; Buckner 1966; Wrigley et al. 1979), whereas *S. maritimensis* has been characterized as an associate of grass–sedge marshes, lowlying floodplain, wet meadows, and marsh margins (Herman and Scott 1994; Perry et al. 2004; Scott and Hebda 2004; McAlpine et al. *in press*).

The type specimen of *Sorex maritimensis* was captured in marsh (Smith 1939), and the sampling by Perry et al. (2004) focused on alder (*Alnus* sp.) in wet areas. A recent study (Dawe and Herman 2005*) working in open wetland habitat concluded that *S. maritimensis* is associated with open wetlands with abundant graminoids, particularly *Calamagrostis canadensis* (Bluejoint Reedgrass), and low tree cover.

Maritime Shrew specimens were collected during a study of the effects of pre-commercial forest thinning on small mammals in southern New Brunswick.

Study Area

Our work was conducted in Black Spruce forests of southeastern New Brunswick, a habitat considered atypical for *S. maritimensis*.

Maritime Shrews were collected from nine naturally regenerating clear-cuts, ranging in age from 16 to 29 years since harvest. The sites were open coniferous forest on moist substrates with minimal grass. The sites would not be categorized as wet forest or wetlands (Warner and Rubec 1997), and there were no grassy meadows for a distance of at least several kilometres that would be typical of sites where Dawe and Herman (2005*) reported capturing *S. maritimensis*.

Dominant tree species were Black Spruce, Balsam Fir (*Abies balsamea*), and Eastern White Pine (*Pinus strobus*), with smaller amounts of Red Maple (*Acer rubrum*), birches (*Betula* spp.), and alders (*Alnus* spp). Four of nine capture sites had been pre-commercially thinned 5 to 10 years prior to the survey.

Our study sites are characterized by moist, semi-productive soils on moderate–poorly drained sites and would be classified as Eco-site 2 in the New Brunswick Ecological Land Classification (Zelazny 2007).

Methods

We surveyed relative abundance of small mammals in 45 sites with 16 Sherman (H. B. Sherman Inc., Tallahassee, Florida) live traps (dimensions 7.6 × 8.9 × 22.9 cm) and 16 pitfall traps (8.9 cm diameter, 10.8 cm depth) per site, spaced at 20-m intervals along a single 300-m transect. Trapping was conducted between June and September 2005 and between May and early October 2006. Traps were set for seven consecutive nights in each site. Shrews were removed from the sites unless captured alive (<5% captured alive).

Sorex maritimensis specimens were identified by examining external morphology and dentition (van Zyll de Jong 1983), in particular evenly graded unicuspids with the third larger than the fourth; distinctive tri-coloured pelage with the back very dark brown, sides lighter brown, and underparts greyish brown; bi-coloured tail with dark tip hairs; and relatively large feet compared to other congenerics (i.e., *Sorex cinereus* (Cinereus Shrew), *S. hoyi* (American Pygmy Shrew), and *S. fumeus* (Smoky Shrew)). Cranial measurements were taken from five specimens. Sampling methods were approved by the University of New Brunswick Animal Care Committee (Permit # 06019). We compared stand age and 14 stand structure variables measured in sites where Maritime Shrews were captured and sites where Maritime Shrews were not captured using two sample *t*-tests to compare means. Statistical tests were performed using the program R - 2.4.1 (R Development Core Team 2006*). We measured stand structures and understory herbaceous ground vegetation (<1m tall) within the trapping area in each site using a range of sample plots. Percent cover of herbaceous ground vegetation (totalveg), fine woody debris (FWD) (1-10 cm diameter), moss (moss), seedlings and low branches (lowbranch), and leaf litter (hwleaves) were estimated within 50, 1 m^2 quadrats spaced randomly along four transects running parallel to the 300 m trapping transect. Deciduous and coniferous canopy closure (hwcan, swcan) (%) was measured using a spherical densiometer on all four sides of the quadrat and averages were calculated from the 4 measurements. Characteristics of the overstory tree layer were measured in six, 5.64-m fixed radius (100 m^2) plots per site, spaced 60 m apart on alternating sides of the 300 m trapping transect. Plot centers were established ≥ 10 m from the trapping transect to avoid disturbing traps when habitat variables were measured during the trapping period. In each fixed radius plot I counted the number of deciduous and coniferous trees (hwstem, swstem) (>1.3 m height, alive), measured the diameter at breast height (hwdbh, swdbh) (dbh), and identified to species and measured the diameter and height of all stumps and snags. The height of one representative tree (height) was measured using a Suunto clinometer at each plot. Volume of CWD (logs ≥ 10 cm dbh diameter) was sampled using the perpendicular distance sampling (PDS) method (Williams and Grove 2003). Downed logs are sampled with probability proportional to their volume; thus, the greater the log's volume, the more likely it was to be sampled. Estimated stand volume of downed wood was determined by multiplying the volume factor (VF) by the number of logs sampled at each plot. A log was sampled if a right angle (90 degrees) can be made with the log and the sample point and the distance from the log to the sample point is within the limiting distance. The limiting distance (LD) is determined by the volume factor (20m^3/ha) and the diameter of the log at the perpendicular point. Volumes of stumps and snags were calculated using the diameters and heights measurements ($V = \pi r^2 h$) and the total volume of CWD for each site was calculated as volume of CWD logs + volume of stumps and snags (CWDvol).

Results

Fifteen of the 21 Maritime Shrews were captured in pitfall traps and 6 were captured in Sherman live traps. External measurements (Table 1) corresponded to *S. arcticus/S. maritimensis*: average total length 106 mm (SD 7.5), average tail length 40 mm (SD 3.2), average hind foot 13 mm (SD 1.0), and an average mass of 6.4 g (SD 1.3). Average skull length was 19.0 mm (SD 0.4), average skull width was 9.5 mm (SD 0.1), and the postmandibular canal was present (van Zyll de Jong 1983). Sex was not recorded but two specimens (433 and 638) were lactating. Other species collected at sites where *Sorex maritimensis* were captured included *S. fumeus* (present in four of nine capture sites), *S. hoyi* (present in eight of nine capture sites), *S. cinereus* (present in all capture sites), *Blarina brevicauda* (Northern Short-tailed Shrew) (present in one capture site), *Myodes gapperi* (Southern Red-backed Vole) (present in eight of nine capture sites), and *Peromyscus maniculatus* (Deer Mouse) (present in five of nine capture sites).

Density of softwood trees >10 cm dbh ($P = 0.002$), total basal area ($P = 0.002$), and softwood canopy cover ($P = 0.04$) were significantly lower in sites where Maritime Shrews were captured than in sites where Maritime Shrews were not captured (Table 2). The amount of total vegetation cover <1 m in height ($P = 0.001$) and low branches ($P = 0.06$) were higher in sites where Maritime Shrews were captured than in sites where Maritime Shrews were not captured (Table 2).

Discussion

Our results indicate that *Sorex maritimensis* is also associated with young coniferous forest containing low tree density and low overhead canopy cover combined with greater amounts of near-ground cover provided by herbaceous vegetation, shrubs, and low branches. The capture of *S. fumeus* in half of the sites containing *S. maritimensis* weakens the hypothesis that *S. maritimensis* is competitively excluded from habitats occupied by this closely related shrew (Perry et al. 2004).

Moisture has been proposed as the primary factor affecting local abundance of shrews (Getz 1961; Miller and Getz 1977; Wrigley et al. 1979). Shrubs and understory vegetation can trap moisture, thus increasing local humidity (Harmon et al. 1986; Yahner 1986; Tallmon and Mills 1994). In the young, regenerating Black Spruce forests in our study sites, the combination of moist soils and abundant understory cover seems to provide suitable habitat for *S. maritimensis*.

It has been suggested that the viability of *S. maritimensis* populations could be an issue because the fragmented condition of open wetlands within its range could limit dispersal and the quantity of available

TABLE 1. Details on location, trap type and body measurements of Maritime Shrew captured in central New Brunswick, 2005-2006.

Shrew no.	Site no.	Capture date	Stand age (years)	Silviculture treatment	Trap type	Maritime Shrew: weight ($n = 21$)	total length ($n = 18$)	tail length ($n = 18$)	hind foot length ($n = 18$)	skull length ($n = 5$)	skull width ($n = 5$)	Location
124	35	18 July 2006	16	control	pitfall	5.7	104	40	13	–	–	45°98.048'N, 66°32,499'W
21	36	18 July 2006	18	control	pitfall	6.4	115	45	12	19.20	9.45	46°00.146'N, 66°32.927'W
129	36	19 July 2006	18	control	pitfall	6.1	103	38	13	18.95	9.50	46°00.146'N, 66°32.927'W
147	36	24 July 2006	18	control	pitfall	6.6	107	41	13	19.55	9.60	46°00.146'N, 66°32.927'W
153	25	4 June 2006	18	PCT	pitfall	6.7	90	30	11.5	–	–	46°11.045'N, 65°15.327'W
710	48	25 August 2006	18	PCT	pitfall	6.7	109	41	14	–	–	46°04.582'N, 66°25.179'W
714	48	26 August 2006	18	PCT	pitfall	6.4	106	38	14	–	–	46°04.582'N, 66°25.179'W
720	48	27 August 2006	18	PCT	Sherman	5.8	104	41	13	–	–	46°04.582'N, 66°25.179'W
721	48	27 August 2006	18	PCT	Sherman	5.8	106	42	15	–	–	46°04.582'N, 66°25.179'W
727	48	28 August 2006	18	PCT	pitfall	6.3	109	42	14	–	–	46°04.582'N, 66°25.179'W
730	48	28 August 2006	18	PCT	pitfall	6.7	105	41	15	–	–	46°04.582'N, 66°25.179'W
734	48	28 August 2006	18	PCT	pitfall	6.5	104	43	14	–	–	46°04.582'N, 66°25.179'W
570	44	16 August 2006	20	control	pitfall	6.5	101	36	14	18.75	9.30	46°01.530'N, 66°29.299'W
638	47	23 August 2006	22	control	pitfall	6.5	107	39	14	–	–	46°02.393'N, 66°13.390'W
639	47	23 August 2006	22	control	pitfall	5.8	107	40	13	–	–	46°02.393'N, 66°13.390'W
657	47	27 August 2006	22	control	Sherman	6.0	–	–	–	–	–	46°02.393'N, 66°13.390'W
661	47	27 August 2006	22	control	Sherman	6.1	–	–	–	–	–	46°02.393'N, 66°13.390'W
882	14	1 August 2005	22	PCT	pitfall	2.9	–	–	–	–	–	46°09.382'N, 65°27.105'W
434	28	20 June 2006	24	PCT	pitfall	6.0	112	42	14	–	–	46°18.473'N, 65°61.916'W
433	28	20 June 2006	24	PCT	Sherman	9.6	117	40	14	18.60	9.40	46°18.473'N, 65°61.916'W
784	51	23 September 2006	29	control	Sherman	3.5	86	38	12	–	–	46°15.250'N, 65°50.337'W
					Average	6.4	106	40	13	19.0	9.5	
					SD	1.3	7.5	3.2	1.0	0.4	0.1	

TABLE 2. Comparison of mean (+/- S.E.) stand structure variables of Maritime Shrew capture and non-capture sites in New Brunswick, 2005-2006. Values in bold are significant at p = 0.05.

	Sites			
Variable	where Maritime Shrews were captured	where Maritime Shrews were not captured	*t*	*P* value
Stand age (years)	21 ± 2	28 ± 1	3.67	**0.0033**
Number of small softwood trees <10 cm/ha	3909 ± 1331	3123 ± 443	0.81	0.4328
Number of small hardwood trees <10 cm dbh/ha	2385 ± 417	2461 ± 286	0.15	0.8800
Number of softwood trees >10 cm dbh/ha	533 ± 153	1188 ± 87	3.72	**0.0024**
Number of hardwood trees >10 cm dbh/ha	120 ± 90	174 ± 30	1.09	0.2997
Total basal area (m^3/ha)	10.4 ± 2.5	19.7 ± 1.4	3.72	**0.0018**
Hardwood canopy cover (%)	8.1 ± 1.2	11.5 ± 1.4	1.09	0.2911
Softwood canopy cover (%)	44 ± 8.5	61.5 ± 2.4	2.36	**0.0414**
Fine woody debris (1–10 cm) (%)	4.4 ± 0.7	4.4 ± 0.4	0.14	0.8926
Total Vegetation Cover (<1 m) 54.4 ± 10.0 28.7 ± 3.4 4.01 0.001				
Moss cover (%)	36.7 ± 4.2	30.3 ± 3.2	0.84	0.4126
Leaf litter cover (%)	40.2 ± 6.7	41.6 ± 3.2	0.01	0.9923
Herbaceous ground vegetation (%)	54.4 ± 10.0	28.7 ± 3.4	4.01	**0.0014**
Low branch cover (%)	15.9 ± 7.7	8.6 ± 1.2	2.17	0.0559
Volume of coarse woody debris (m^3/ha)	15.1 ± 7.2	19.1 ± 2.4	0.35	0.7304
Number of stumps/ha	490.7 ± 60.1	594.4 ± 51.5	1.37	0.1828

habitat (Dawe 2005; Dawe and Herman 2005*). We found *S. maritimensis* in forested areas, but those forests contained comparatively less tree cover than control sites. Small patches of moist ground may therefore be important.

The inclusion of moist Black Spruce forest (an abundant vegetation type in the region) in the habitat of *S. maritimensis,* based on our results, suggests that the amount of available habitat for the species could be considerable. Quantification of this moist forest is difficult, however, because wet areas or small grassy openings in forest stands are generally too small to be delineated in forest inventories. Wet area mapping, a new technology that uses digital elevation models (DEMs) and hydrographic data to identify wet areas and depth to surface water across forested landscapes beyond waterways and wetlands (Murphy et al. 2008), may be helpful in detecting the potential distribution of *Sorex maritimensis*.

It is unlikely that our results indicate a shift in habitat use to forested areas but rather reflect the fact that most previous research on these shrews has been done in wet meadows. Significant trapping effort is required to document rare species, and we suspect that wet forest sites have not been adequately sampled in the past. McAlpine et al. (*in press*) summarized a range of habitat use besides wetlands, including drier agricultural fields (Smith 1940), but the habitat use was still generally near grassy areas. Our results suggest that *S. maritimensis* is not restricted to open wetland or grass-dominated types and that this species' use of habitat in moist coniferous forest is similar to that recorded for *S. arcticus*.

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