

Note

Discovery of novel Four-toed Salamander (*Hemidactylum scutatum*) occurrences in New Brunswick, Canada

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Abstract

Four-toed Salamander (*Hemidactylum scutatum*) has the broadest geographic distribution of any North American plethodontid. However, in New Brunswick, Canada, its known distribution has previously been limited to a single site in Fundy National Park, where the species was first confirmed in 1983, its presence verified until at least 2012, and where it is still presumed to occur. Recently, during a series of general amphibian surveys and opportunistic observations, novel occurrences of this species were discovered. Specifically, we observed eight individuals at two sites in the town of Riverview, 59 km northeast of the Fundy National Park site. Our discovery expands knowledge of the species in New Brunswick and the northern limit of its distribution. The Riverview sites are relatively disturbed (e.g., high human foot traffic, all-terrain vehicle use, some incidental tree harvest, invasive plant species, infrastructure development, and litter). The Riverview High School forest site is isolated from other forested areas by paved roads. There are major differences between these sites and where the species has previously been observed in New Brunswick: the Fundy National Park site is relatively undisturbed and surrounded by extensive forest. This suggests that populations of this species in New Brunswick can persist in marginal, patchy, anthropogenically-disturbed habitat, which has implications for conservation and management.

Key words: Amphibian; Atlantic Canada; geographic distribution; *Hemidactylum scutatum*; Plethodontidae; the Maritimes

With the broadest geographic distribution of any North American plethodontid, Four-toed Salamander (*Hemidactylum scutatum*) ranges across eastern North America as far south as the Gulf of Mexico, westward to Oklahoma, Missouri, and Minnesota in the United States, and north into Ontario, Quebec, and Nova Scotia, Canada (IUCN SSC Amphibian Specialist Group 2022). In New Brunswick, Canada, its known distribution has previously been limited to a single site, Marven Lake, in the heavily forested 430 000-ha Fundy National Park, Albert County (45.571633°N, 65.093460°W). A single individual was first observed at Marven Lake on 3 May 1983 (Woodley and Rosen 1988; McAlpine 2010). The persistence of the Marven Lake population has been confirmed through presence-absence surveys in 1999 and 2000 and sampling in 2012 to secure a voucher specimen and tissues

(whole animal: NBM-AR-009764; tissue: NBM-FTC-AR-2012.001-002; McAlpine *et al.* 2013). No additional occurrences of the species have previously been reported in New Brunswick despite searching throughout the province since 1983 (D.F.M. and G.F.M.J. unpubl. data), although these searches were based on the Marven Lake occurrence and, therefore, not all known habitat may have been appropriately targeted. Here, we document novel occurrences of the species in New Brunswick, Canada.

On 11 July 2023, during a survey for a study on Eastern Red-backed Salamander (*Plethodon cinereus*) behaviour, a single *H. scutatum* adult male (snout-vent length [SVL] = 35 mm; total length [TL] = 75 mm; mass = 0.81 g; Figure 1a, 1bi) was observed in a forest adjacent to Riverview High School in Riverview, Albert County, New Brunswick (hereafter referred to



FIGURE 1. a. Adult male Four-toed Salamander (*Hemidactylum scutatum*), Riverview, New Brunswick, 11 July 2023. b. Unique ventral patterning of four specimens found at the Riverview High School site on i. 11 July 2023, ii. 1 September 2023, iii. 23 October 2023, and iv. 4 November 2023, as well as two specimens found at the Riverview Water Tower site on v. 26 September 2024, and vi. 18 October 2024. These six ventral patterns, along with size differences between individuals, confirm that each individual is unique. Note: black outlines were added around the salamanders, and their black ventral blotches were coloured in to standardize patterns regardless of differing light conditions between photographs. c, d. Photographs of the forest and fen habitat at the Riverview High School site. e, f. Photographs of the wooded meadow and bog habitat at the Riverview Water Tower site. Photos and drawings a–d: Joshua J.A. Christiansen. Photos e–f: Issac M. Acker.

as the high school site; 46.055°N, 64.801°W, ~50 m elevation). On 1 September 2023, the site was revisited and a second adult male *H. scutatum* (SVL = 29 mm; TL = 55 mm; Figure 1bii) was observed during another survey to study *P. cinereus* behaviour. On 23 October 2023, a juvenile *H. scutatum* (SVL = 20 mm; TL = 35 mm; mass = 0.13 g; Figure 1biii) was observed during an opportunistic survey of the high school site. A presumptive female adult *H. scutatum* (SVL = 25 mm; TL = 35 mm; Figure 1biv) was also observed at the site on 4 November 2023. At a second site about 2 km from the high school (Riverview Water Tower Site, hereafter designated the tower site; 46.038°N, 64.812°W, ~50 m elevation), four adult individuals were observed separately on 15 September 2024 (SVL = 31 mm; TL = 59 mm), 21 September 2024 (SVL = 36 mm; TL = 80 mm), 26 September 2024 (SVL = 35 mm; TL = 75 mm; Figure 1bvx), and 18 October 2024 (SVL = 35 mm; TL = 75 mm; Figure 1bvi). All were measured, photographed, and released at the site of capture. None of the eight individuals displayed deformities, injuries,

or tail autotomy. Species identification was verified by James H. Baxter-Gilbert, Mount Allison University, and photo vouchers of the four specimens from the high school site are archived in the New Brunswick Museum (NBM-OBS-AR-567.1-567.4).

Although estimating a population size from our searches is desirable, we are hesitant to do so. First, our survey efforts were not consistent with those used during Eastern Red-backed Salamander behavioural surveys, when the first two individuals were found. The third was found when we visited the site and opportunistically searched for less than 2 h, and the fourth salamander was found opportunistically during a walk by one of us. Similarly, all four of the water tower individuals were found opportunistically during nature walks by one of us. Second, these searches did not use standardized sampling protocols, which would allow estimations of abundance or population size. Additional research using a standardized approach is needed to determine population size and trends at this site.

Four-toed Salamanders have bluish-white venters

marked with irregular black blotches that are unique to individuals (Harris and Gill 1980). We took ventral photos of six of the eight individuals observed (Figure 1b). By examining the ventral spots of those six, and comparing their relative sizes, the eight salamanders were determined to be unique individuals. We considered individuals with an SVL >20 mm to be sexually mature (Kilpatrick 1997), and individuals were identified as males if they exhibited squared snouts (Rucker *et al.* 2021). However, because we observed only two of the three adults at the high school site during the mating season (September to November), our determination of the sex of the others must be considered provisional (Rucker *et al.* 2021). Determination of sex was not made for the four individuals found at the tower site.

The high school site is on an isolated ~7-ha parcel of woodland bounded by Findlay Boulevard, Whiteline Road, and Riverview High School and its access road. The site is further isolated by extensive adjacent suburban and commercial development. The forest stand is a mix of Jack Pine (*Pinus banksiana* Lambert), Red Maple (*Acer rubrum* L.), and White Birch (*Betula papyrifera* Marshall), with scattered Black Spruce (*Picea mariana* (Miller) Britton, Sterns & Poggenburgh), Eastern White Pine (*Pinus strobus* L.), Grey Alder (*Alnus incana* (L.) Moench), Grey Birch (*Betula populifolia* Marshall), Northern Red Oak (*Quercus rubra* L.), and Red Spruce (*Picea rubens* Sargent). The understorey is mostly ericaceous dwarf shrubs, such as Bunchberry (*Cornus canadensis* L.; Figure 1c), but also Bracken Fern (*Pteridium aquilinum* var. *latiusculum* (L.) Kuhn) and various mosses including Gиргенсоhn's Peatmoss (*Sphagnum girgensohni* Russow), Red-stemmed Feather Moss (*Pleurozium schreberi* (Willd. ex Brid.) Mitt.), and Common Haircap Moss (*Polytrichum commune* Hedw.). All Four-toed Salamanders at this site were found under fallen or cut woody debris or rocks. Within the woodland is a small (0.4 ha), poor fen with minimal open water that is dominated by Divine Bogmoss (*Sphagnum divinum* Flatberg & K. Hassel), Feathery Bogmoss (*Sphagnum cuspidatum* Ehrh. ex Hoffm.), Flat-top Bogmoss (*Sphagnum fallax* (H. Klinggr.) H. Klinggr.), Gиргенсоhn's Peatmoss, Golden Bogmoss (*Sphagnum pulchrum* (Lindb. ex Braithw.) Warnst.), and Red Peatmoss (*Sphagnum rubellum* Wilson) with low, emergent Grey Alder, Tamarack (*Larix laricina* (Du Roi) K. Koch), and White Spruce (*Picea glauca* (Moench) Voss) and bordered by Broad-leaved Cattail (*Typha latifolia* L.) and Speckled Alder (*Alnus incana* ssp. *rugosa* (Du Roi) R.T. Clausen; Figure 1d). Petranka (1998) reports that these salamanders require habitat with upland forests for foraging and breeding, adjacent to fishless wetlands, such as swamps, marshes,

and fens for laying eggs. The high school site is consistent with this description and all four individuals at this site were observed within 20–40 m of the fen margin. Other amphibian and reptile species known to occur at this site include Eastern Red-backed Salamander, Spotted Salamander (*Ambystoma maculatum*), Green Frog (*Lithobates clamitans*), Northern Leopard Frog (*Lithobates pipiens*), Spring Peeper (*Pseudacris crucifer*), Wood Frog (*Lithobates sylvaticus*), Maritime Garter Snake (*Thamnophis sirtalis pallidulus*), and Red-bellied Snake (*Storeria occipitomaculata*; unpubl. data).

The tower site is on the edge of a continuous parcel of forested land of ~475-ha bounded by Trites Road, Coverdale Road, residential developments, and power line access lands. The site is isolated by extensive adjacent suburban and commercial development to the east and the Petitcodiac River to the north, but is adjacent to extensive continuous forested land to the west and south. This forest stand is similar to that of the high school site but includes younger trees because of previous harvesting. The understorey is also similar to that of the high school site, but also includes patches of Bog Cranberry (*Vaccinium oxycoccus* L.) and Woodland Strawberry (*Fragaria vesca* L.), as well as introduced clover (*Trifolium* L.), Virginia Creeper (*Parthenocissis quinquefolia* (L.) Planchon), Yellow Iris (*Iris pseudacorus* L.), Garden Lady's-mantle (*Alchemilla mollis* (Buser) Rothmaler), and a variety of non-native thistles. All Four-toed Salamanders at the tower site were found under rocks or woody debris in a cleared, heavily overgrown meadow within the forested land (Figure 1e). Adjacent to the cleared meadow is a small (2.4-ha) bog with more open water than at the high school site (Figure 1f). All four individuals at the tower site were observed within 200 m of the bog margin. Additional bogs are scattered across the ~475-ha parcel of forest, and a large bog (~26-ha) is within 800 m of the cleared meadow. The tower site is also consistent with Petranka's (1998) description of Four-toed Salamander habitat. Other amphibian and reptile species known to occur at this site include Blue-spotted Salamander (*Ambystoma laterale*), Eastern Newt (*Notophthalmus viridescens*), Eastern Red-backed Salamander, Spotted Salamander, American Bullfrog (*Lithobates catesbeianus*), Green Frog, Northern Leopard Frog, Spring Peeper, Wood Frog, American Toad (*Anaxyrus americanus*), Maritime Garter Snake, Red-bellied Snake, and Smooth Green-snake (*Opheodrys vernalis*; unpubl. data).

Although the Riverview sites are only 59 km northeast of Marven Lake, the discovery of additional locations for this species in New Brunswick is important and expands our knowledge of this species at the northern limit of its distribution (Gilhen

1984). Both Riverview sites are highly disturbed. The high school site experiences high foot traffic from the school, long-term incidental tree harvest, development and maintenance of a disc golf course, and it is bounded by paved roads on all sides. The tower site was cleared for residential development within the past 50 years, but development ceased, and the site is now gradually being reforested. The cleared meadow where salamanders were found is also used as an illegal dumping area for soil, plants, rocks, concrete pads, and potentially toxic materials like shingles and appliances. There is also all-terrain vehicle and foot traffic through the meadow. Given the lack of data for this species in the province, we are uncertain whether the salamanders at Riverview sites were introduced, represent a range expansion, or simply had been missed because of the novel habitat they occupy.

The disturbed and isolated nature of both Riverview sites contrasts with Marven Lake, which is surrounded by extensive undisturbed forest in a national park. Although population continuity between the Riverview sites is unknown, the presence of individuals at these sites suggests that the species may be more widespread in New Brunswick than previous records indicate. The data presented here also suggest that the species can persist in what appear to be isolated, anthropogenically disturbed habitats. This has implications for guiding future surveys for Four-toed Salamanders in New Brunswick, as well as the species' conservation and management in the province.

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Author Contributions

Investigation: G.A.C., J.J.A.C., K.E.M., I.M.A., M.J.W., D.F.M., G.F.M.J., and J.L.R.; Funding Acquisition: J.J.A.C., G.A.C., and J.L.R.; Project Administration: J.J.A.C., G.A.C., and J.L.R.; Resources: J.L.R.; Supervision: J.L.R.; Visualization: J.J.A.C. and G.A.C.; Writing – Original Draft: J.J.A.C.; Writing – Review & Editing: G.A.C., K.E.M., I.M.A., M.J.W., D.F.M., G.F.M.J., and J.L.R.

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