

Note

First records of Seaside Dragonlet (*Erythrodiplax berenice*) in New Brunswick, Canada: range expansion possibly mediated by climate warming

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Abstract

The first occurrences of Seaside Dragonlet (*Erythrodiplax berenice* (Drury, 1773); Odonata: Libellulidae) are reported for New Brunswick, Canada, from seven sites along the Bay of Fundy coast in the southern part of the province. The species joins a suite of several other Odonata species of southern affinity that have been newly documented for New Brunswick over the past 15 years, and its occurrence may represent range expansion resulting from warming climate.

Key words: Seaside Dragonlet; Érythrodiplax côtier; *Erythrodiplax berenice*; New Brunswick; climate warming

Seaside Dragonlet (*Erythrodiplax berenice*) is a dragonfly species strongly associated with saline habitats and the only truly marine dragonfly, with larvae commonly occurring in salinities exceeding that of seawater (Corbet 1999). In North America, the species is found in salt marshes along the Gulf of Mexico and the Atlantic coast from Florida to Nova Scotia (Paulson 2011). It is also found in saline lakes in the southwestern United States (Nikula *et al.* 2003). In Canada, Seaside Dragonlet has been reported from Nova Scotia and Quebec (Catling *et al.* 2005). In Nova Scotia, it was first recorded in Yarmouth County in 1957 and has since been found from localities scattered along the Atlantic coast of the southwestern part of the province, between Digby and Halifax Counties (Bridgehouse 2007; Brunelle 2010). A single inland collection from southern Quebec was made in 1911; it occurred away from suitable habitat, and the voucher specimen has since been lost (Skinner *et al.* 2012). Seaside Dragonlet has been found in Maine along the coast north to Washington County, just 2.8 km from the nearest coastline in New Brunswick (Abbott 2006–2022).

On 3 and 8 July 2012, we visited salt marshes at Belliveau Cove and Rossway, Digby County, Nova

Scotia, and found Seaside Dragonlet to be abundant. Specimens were identified using Paulson (2011). These sites are 82 km and 68 km, respectively, directly across the Bay of Fundy from mainland New Brunswick, and these observations prompted us to undertake subsequent directed surveys of the species in New Brunswick. On 11 July 2012, we searched five salt marsh sites in the South Musquash to Dipper Harbour areas of St. John County, New Brunswick (Table 1). An additional survey was undertaken at the South Musquash site on 4 September 2012. Seaside Dragonlet was not detected at any of the New Brunswick sites.

On 25 July 2020, we detected Seaside Dragonlet during a visit to a salt marsh at Little Lepreau, Charlotte County, New Brunswick (45.12867°N, 66.48373°W; Figure 1). Three males and one female were observed; two males were collected and deposited in the New Brunswick Museum invertebrate collections (NBM-IN-070583). We revisited the site on 1 August 2020, when a further nine males and four females were observed, and again on 7 August 2020, when another male and female were recorded. At this site, Seaside Dragonlet was generally associated with high marsh areas containing salt pannes and pools

TABLE 1. Locations surveyed for Seaside Dragonlet (*Erythrodiplax berenice*) in New Brunswick (NB) and Nova Scotia (NS), Canada. Site numbers for New Brunswick are listed in order of initial survey and correspond to Figure 2.

Site no.	Location	Latitude, °N	Longitude, °W	No. Seaside Dragonlet observed*			NB Museum accession number
				2012	2020	2021	
	Belliveaus Cove, Digby Co., NS	44.3842	66.0797	200+	—	—	
	Rossway, Digby Co., NS	44.5799	65.9345	10	—	—	
1	South Musquash, St. John Co., NB	45.1699	66.3135	0	4	—	NBM-IN-070586
2	Chance Harbour, St. John Co., NB	45.1241	66.3620	0	0	—	
3	Moose Creek, St. John Co., NB	45.1183	66.3791	0	1	—	NBM-IN-070587
4	Round Meadow Cove, St. John Co., NB	45.1137	66.3808	0	6	2	NBM-IN-070585; NBM-IN-070593
5	Dipper Harbour, St. John Co., NB	45.0961	66.4324	0	1	—	NBM-IN-070590
6	Little Lepreau, Charlotte Co., NB	45.1287	66.4834	—	19	8	NBM-IN-070583; NBM-IN-070584; NBM-IN-070588; NBM-IN-070591
7	West Quaco, St. John Co., NB	45.3344	65.5468	—	0	—	
8	Saint's Rest Marsh, St. John Co., NB	45.2275	66.1302	—	0	3	NBM-IN-070592
9	Lorneville Creek, St. John Co., NB	45.1857	66.1589	—	3	—	NBM-IN-070589
10	Newfoundland Creek, Albert Co., NB	45.6290	64.8082	—	—	0	
11	Long Marsh Creek, Albert Co., NB	45.6220	64.7880	—	—	0	
12	Gardner Creek, St. John Co., NB	45.2796	65.7183	—	—	0	
13	Tynemouth Creek, St. John Co., NB	45.3001	65.6581	—	—	0	
14	Emerson Creek, St. John Co., NB	45.2639	65.7802	—	—	0	

*— = site not surveyed that year.

**FIGURE 1.** Male Seaside Dragonlet (*Erythrodiplax berenice*) photographed at Little Lepreau, Charlotte County, New Brunswick, Canada, on 25 July 2020. Photo: D.L. Sabine.

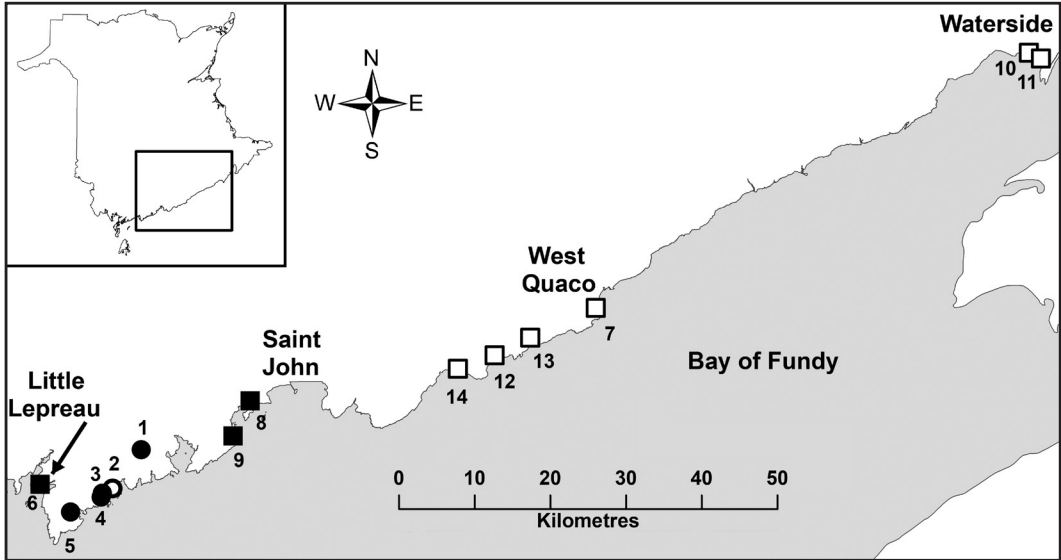


FIGURE 2. Sites surveyed for Seaside Dragonlet (*Erythrodiplax berenice*) on the Bay of Fundy in southern New Brunswick, Canada. Site numbers correspond to locations listed in Table 1. ● = species not detected in 2012 but present in 2020; ○ = species not detected in 2012 or 2020; ■ = site surveyed and species detected in 2020 and/or 2021; □ = site surveyed but species not detected in 2020 and/or 2021.

(Figure 3) and was typically detected by walking and flushing individuals perched on cordgrass (*Spartina* sp.). The Little Lepreau site is situated 5.3 km north-west of the nearest site previously surveyed in 2012 (Table 1).

This discovery prompted a survey of eight additional salt marshes, primarily between Little Lepreau and Saint John, with one survey to the east at West Quaco, during the first week of August 2020. Seaside Dragonlet was detected at five additional sites, four of which had been surveyed unsuccessfully in 2012 (Table 1, Figure 2). In July and August 2021, we directed a further search effort to six sites northeastward from Saint John, to Waterside, Albert County, in the upper Bay of Fundy. Seaside Dragonlet was discovered at only one additional site, Saint's Rest Marsh in Saint John, which was surveyed unsuccessfully in 2020, and is the easternmost population discovered thus far (Figure 2). In addition, two of the occupied sites discovered in 2020 were re-surveyed in 2021, both in mid-July and again in late August. Seaside Dragonlet was present during all visits at both sites, confirming at least short-term persistence of these populations. Voucher specimens from all sites have been deposited in the New Brunswick Museum invertebrate collections (Table 1).

Over the past 15 years, a number of Odonata species have been newly documented for New Brunswick, including Southern Pygmy Clubtail (*Lanthus vernalis* Carle, 1980; Harding 2007); Martha's Pen-



FIGURE 3. Salt marsh habitat at Little Lepreau, Charlotte County, New Brunswick, Canada, on 25 July 2020. Photo: D.L. Sabine.

nant (*Celithemis martha* Williamson, 1922; Klymko 2007); Halloween Pennant (*Celithemis eponina* (Drury, 1773)) and Citrine Forktail (*Ischnura hastata* (Say, 1839); Makepeace *et al.* 2017); Scarlet Bluet (*Enallagma pictum* Morse, 1895; McAlpine *et al.* 2017); Lilypad Forktail (*Ischnura kellicotti* Williamson, 1898; Klymko *et al.* 2019); and Black Saddlebags (*Tramea lacerata* Hagen, 1861) and River Bluet (*Enallagma anna* Williamson, 1900; Makepeace and Lewis 2020). For most of these species, the New Brunswick records are a northward expansion of the prior known distribution, and the species are being detected in the southwestern quadrant of the province. Three of the species are considered to be associated with the coastal plain

(Martha's Pennant, Scarlet Bluet, and Lilypad Fork-tail); climate warming has been suggested as a potential reason for the apparent range expansions of those species (McAlpine *et al.* 2017; Klymko *et al.* 2019).

This pattern of recent additions of Odonata species of primarily southern affinity to the southwestern portion of New Brunswick contrasts with the list of 11 Odonata species that were newly documented for the province during the previous decade (Brunelle 1999, 2000; Catling 2002; Sabine *et al.* 2004). These earlier reports were of species of both southern and northern affinities, with most occurring across latitudes either similar to or predominantly north of New Brunswick. Initial records of these earlier species were documented from areas widely scattered throughout the province. Documentation of new Odonata species in New Brunswick appears to have recently shifted from a pattern of detection of species already occurring in the province but previously overlooked, to detection of new species arriving through range expansion from the south.

Determination of whether a newly documented species represents a recent arrival resulting from range expansion or simply lack of prior detection by earlier surveyors can be challenging, because negative survey data are not often documented or reported. Seaside Dragonlet, in particular, occupies a specialized habitat where Odonata species richness and abundance are low and, thus, is seldom visited during general surveys. Hence, existing populations of Seaside Dragonlet are more likely to be undetected than many other Odonata species. However, we suggest that this is not the case in New Brunswick. In the 1990s, P.-M. Brunelle conducted extensive surveys of Odonata in Charlotte County and surrounding areas. Although details of negative search data for this species were not published, Brunelle did state that he found it curious that Seaside Dragonlet had not been found in the Bay of Fundy (Brunelle 2010), implying that a targeted survey had occurred. This is further supported by Bridgehouse (2007), who reported that Brunelle had unsuccessfully searched 27 salt marshes for Seaside Dragonlet in New Brunswick and Prince Edward Island. More significantly, our documentation of unsuccessful, prior, directed surveys in appropriate habitat and flight season, immediately following familiarization with the behaviour of the species in a neighbouring jurisdiction, provides evidence that it was likely not present in 2012. The subsequent discovery of the species at almost all of the same survey sites eight years later is strongly suggestive of range expansion during the intervening time.

The capacity of a dragonfly species to colonize new areas will be determined primarily by the ability of adults to migrate or disperse in appropriate numbers and on the suitability of newly colonized habitat

for successful reproduction. Seaside Dragonlet was considered to be a migratory species by Russell *et al.* (1998) and Geijskes (1967). In addition, ship transport has been suggested as a potential cause of vagrant occurrences of this species by Catling *et al.* (2017). Given the apparent capacity of adult Seaside Dragonlet for long-distance flight, dispersal to the Bay of Fundy coast of New Brunswick from nearby populations in Maine and Nova Scotia has likely been a long-term, ongoing process. The ability of this species to complete its life cycle in Bay of Fundy salt marshes, after arrival of vagrant or dispersing adults, is likely the more important factor determining successful population establishment.

Because of its larval habitat requirements, Seaside Dragonlet is unique among Odonata in that changes in ocean water temperatures might conceivably impact population establishment and persistence at the northern edge of its range. Water temperatures in the Bay of Fundy have increased in recent years, both subsurface (Koopman *et al.* 2014) and surface (Koopman *et al.* 2014; Diamond 2021). In the broader Gulf of Maine, continuous slow warming of water over the last five decades, with accelerated warming over the past 10 years, has been documented (Seidov *et al.* 2021). Annual mean air temperatures in Atlantic Canada increased by 0.7°C between 1948 and 2016 and are predicted to increase a further 1.3°C by 2050 (Zhang *et al.* 2019). It seems likely that the ongoing climate and ocean warming trend in the region have aided the apparent expansion of Seaside Dragonlet northward along the Bay of Fundy coastline into New Brunswick. Future expansion of the species to the upper Bay of Fundy, and eventually to the extensive salt marshes of the Gulf of St. Lawrence shoreline of New Brunswick, might be expected.

Author Contributions

Conceptualization: D.L.S., M.E.J.S., and H.S.M.; Investigation: H.S.M., D.L.S., and M.E.J.S.; Writing – Original Draft: D.L.S., M.E.J.S., and H.S.M.; Writing – Review & Editing: M.E.J.S., H.S.M., and D.L.S.

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