A Conservation Plan for the Endemic Damselflies of the Northeast

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Summary

This plan focuses on four species of damselflies endemic to the Northeast (*Enallagma laterale, minusculum, pictum,* and *recurvatum*), and a fifth species (*E. daeckii*) that reaches the northern edge of its range in the region and is of conservation concern in some states. All five are typically found in well-vegetated ponds, and are subject to threats that alter water quality, water level, aquatic plant communities, and adjacent shorelines. Shoreline alteration in particular has been shown to negatively affect the chance of a pond being occupied, although the mechanism remains unclear. To reduce or eliminate these threats, we provide broad outlines of several conservation and research actions could be adopted by agencies or land managers where these species occur. Key to success in all cases will be detailed knowledge of occurrence and detectability, so we also identify the need for a standardized monitoring protocol that can be employed throughout the region. The plan closes with species profiles containing information on conservation status, distribution, flight period, and preferred habitat.

Overview

The northeastern United States supports a high diversity of species in the insect order Odonata (dragonflies and damselflies), with most states – and even many counties – having more species than much larger geographic areas (e.g., the state of California). Of the 228 species recorded in the region, a recent conservation assessment (White et al 2015) identified 89 as meriting high or moderate conservation concern, 15 of which have over 50% of their global range in the Northeast. The Northeast is particularly noteworthy in being a center of diversity for the damselfly genus *Enallagma* (the bluets), with 24 species known from the area between New Jersey and the Maritime Provinces of Canada. Four of these species are endemic to the Northeast: New England Bluet (*E. laterale*), Little Bluet (*E. minusculum)*, Scarlet Bluet (*E. pictum*), and Pine Barrens Bluet (*E. recurvatum*) (see Appendix for species profiles).

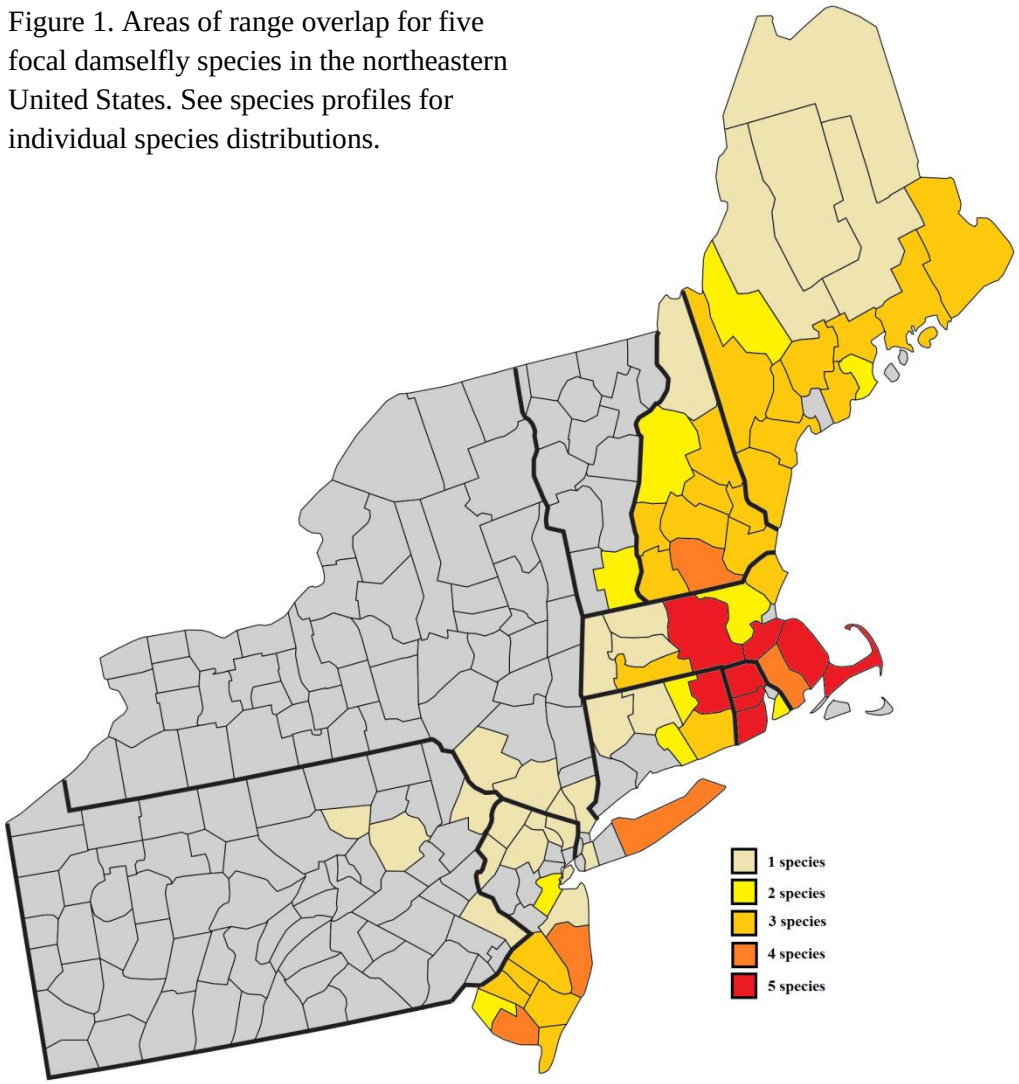
Because of their limited ranges and the significant history of land-use disturbance in the Northeast, these endemic damselflies are considered conservation priorities at multiple geographic scales. Each is considered a "species of greatest conservation need" (SGCN) in at least one state (Table 1), and all four are recognized as *Regional* SGCN for the Northeast as a whole (Terwilliger Consulting 2017). Three species are considered globally vulnerable to extinction by NatureServe (NatureServe 2019). A fifth species, the Attenuated Bluet (*E. daeckii*) is more widespread, but was included in this project because of conservation concern in some northeastern states. The abundance and distribution of these focal damselflies vary considerably across the region, although most overlap extensively in range, with peak co-occurrence in southeastern New England, Long Island, and southern New Jersey (Figure 1). In some states they are known from only a handful of sites, while in others they are more common. Habitat associations also vary, although most species are considered relative habitat specialists, typically breeding in ponds, lakes, and bogs with specific microhabitat characteristics.

Table 1. State-level conservation status of five focal damselfly species in the northeastern United States. See also individual species profiles.

Species	NJ		NY		CT		RI		MA		NH		ME	
E. daeckii					SC				T					
E. laterale	SC		X										X	
E. minusculum			T		SC									
E. pictum	SC		T		SC		SC		T				SC	
E. recurvatum	SC		T		T		SC		T		SC			

SC = Special Concern, T = Threatened, X = Species of Greatest Conservation Need (in State Wildlife Action Plan) but not otherwise listed. Shading indicates that the species has not been recorded in that state.

Figure 1. Areas of range overlap for five focal damselfly species in the northeastern United States. See species profiles for individual species distributions.



To better understand the status of these damselflies, partners from all seven core range states (NJ, NY, CT, RI, MA, NH, and ME) surveyed known sites for all five species during 2018-19. These surveys were focused on a) determining if species were still present at sites where they had not been recorded in ten or more years, b) collecting data to inform habitat models, and c) identifying new localities (not all states). This conservation plan includes an overview of threats identified for these five species and/or their habitats, and outlines broad conservation actions that should benefit them when implemented at local or larger scales. It concludes with a more detailed profile for each species that includes information on range, status, flight period, and habitat associations. The latter were informed by the survey and habitat work mentioned above.

Threats identified for individual species or their habitats

Limited detailed work has been done on the conservation needs of damselflies specifically, and most existing plans focus instead on more broad-based threats and actions that apply to their habitats. Although threats often have multiple modes of action and regularly overlap (e.g. shoreline development and increased nonpoint source pollution), for the purposes of this conservation plan we have identified seven specific threats based in part on the types of conservation actions required to address them. These are presented below in order of perceived degree of impact (based on severity and extent) in the Northeast, and each is followed by a list of pertinent actions. These actions are numbered, with numbers referring to more detailed explanations in the final section of this plan.

For the purpose of addressing variation in threat intensity, we divided the region into four zones: North, Appalachian, Central Coast, and Southern New Jersey. The northern zone comprises all of Maine, New Hampshire, and central Massachusetts. It is an area with relatively low development pressure, although this still increases from north to south within the zone. The Appalachian zone includes southern New York (north of New York City), northwestern New Jersey, northeastern Pennsylvania, western Massachusetts and northwestern Connecticut. It has been separated from the others because the only focal species to occur here is *E. laterale* (there are some records of *E. minusculum* in western MA). Much of the area is undeveloped and there are some large protected areas, but its proximity to major metropolitan areas may put focal species habitat at increased risk. The Central Coast zone includes southeastern Massachusetts, Rhode Island, Connecticut, and Long Island, and is subject to the most intensive level of historical development pressure. It is also notable for high focal species co-occurrence, with four or five species present (Figure 1). Southern New Jersey is treated separately because this portion of the state contains extensive natural and/or protected habitats, and has been subject to relatively low development pressure despite high human densities in areas to the north and west.

<u>Shoreline Development:</u>

Developed shorelines are defined as those where human activity has removed natural vegetation, generally with respect to terrestrial habitats (but see below). Examples include roads, buildings, septic fields, lawns, and recreational access points (beaches, boat launches, docks). Direct alteration of shoreline vegetation removes habitat that is important for damselflies during

the adult maturation period immediately after emergence, and for foraging by females between reproductive bouts. Appropriate vegetation in a shoreline buffer also provides protection from predators and extreme weather events. Butler and deMaynadier (2008) found that two focal damselflies (*E. laterale* and *E. pictum*) in Maine are sensitive to high levels of local disturbance and thus less likely to occur at more heavily-developed ponds. Modelling using data collected in 2018-19 produced similar results for *E. minusculum, E. pictum,* and *E. recurvatum* at multiple scales across the Northeast (Butler and Hunt, unpublished data). Shoreline development is also linked to many of the subsequent threats in this section, since higher development density leads to increased inputs of fertilizers or contaminants (wetland degradation), potential water withdrawals, pesticide spraying, spread of non-native species, and disturbance from recreational activity. Because of the pervasive nature of this threat, it ranked highest overall in terms of concern across the study region. Many ponds in the Appalachian and Central Coast regions are on protected public land where this threat is lower, but it's possible that the *absence* of focal species from some non-protected sites in these zones could reflect historical extirpation following habitat degradation.

Conservation actions that address Shoreline Development:

1) Site assessment and prioritization
2) Protect or restore upland and shoreline habitat around occupied ponds

<u>Wetland Degradation:</u>

Wetland degradation in this context refers specifically to processes that alter the chemical or vegetative composition of wetlands. Most instances derive from inputs of anthropogenic contaminants such as fertilizer, pesticides, road salt, and other toxins, but this threat can also include sediment inputs that alter benthic substrate and thus potentially plant communities. Excessive nutrient inputs in particular can lead to algal blooms (and thus oxygen depletion) or growth of non-native wetland plants (e.g., *Phragmites*) that overtake native vegetation. Even native species such as cattails (*Typha*) may displace the less densely-packed emergent or floating vegetation that characterizes sites occupied by the focal species. *E. laterale, E. pictum,* and *E. recurvatum* are all highly associated with specific aquatic vegetation, both species and assemblages (Gibbons et al. 2002, Butler and deMaynadier 2008), so changes to vegetation structure or composition may affect them significantly more than other damselfly species. Extirpation of some focal species from historically-occupied wetlands may be linked to some of these changes in vegetation. Note that changes to substrate will affect the focal species differently. *E. minusculum* generally occurs in sandy or rocky ponds, while the others are associated with finer substrates and the denser aquatic beds that result. Overall, this threat is considered a moderate one across the region, with lower concern in the less developed northern states.

Conservation actions that address Wetland Degradation:

1) Site assessment and prioritization
2) Protect or restore upland and shoreline habitat around occupied ponds
3) Reduce agricultural and road run-off

Water Level Fluctuations:

Water levels rise and fall as a result of both natural and anthropogenic factors. In extreme cases, ponds can become flooded or partially dry, and the latter is probably of greater concern for damselflies. Causes of lowered water levels include groundwater withdrawals, seasonal drawdowns (often for the winter, or to control invasive aquatic plants), drought (see also Climate Change), and damage to or removal of dams. Flooding, in contrast, generally results from dam construction or extreme rainfall events. Groundwater withdrawal is probably the most important threat in this category, since it has the potential to seriously reduce available habitat in the shallow coastal plain ponds to which multiple focal species are restricted in the Central Coast. It is likely exacerbated by high human population densities in this same region, and has the potential to become worse under some climate change scenarios (see below). Direct effects of lowered water levels include drying out of aquatic vegetation (oviposition sites) in the shallow water at pond margins, potential incidental effects of increased temperature (e.g., lowered oxygen concentration, eutrophication), and loss of benthic habitat for nymphs. This threat was considered low-to-moderate in the north and south and highest in the Central Coast. For example, an estimated 20% of *E. minusculum* sites in Rhode Island appear to have been rendered unsuitable as a result of dam repair (with temporary loss of the impoundment) or removal (V. Brown, pers. comm.).

Conservation actions that address Water Level Fluctuations:

1) Site assessment and prioritization
4) Manage water levels to minimize impacts on target populations
5) Minimize groundwater withdrawals from coastal plain ponds

Aerial Insecticide Spraying

Concern over mosquito-borne disease (West Nile Virus, Eastern Equine Encephalitis) has resulted in increased insecticide spraying in populated parts of the Northeast. Some of the chemicals used in these applications are broad-spectrum insectides (e.g., pyrethroids, malathion) that are known to kill non-target insects including Odonata. Treatments more specific to mosquitos and other Diptera (methoprene, Bti) may still have incidental effects on local prey densities and assemblages and thus on damselfly food supplies. At present, aerial spraying intensity and spatial extent varies with the prevalence of mosquito-borne disease, and appears most frequent in some areas of southern New England. Since most spraying occurs later in the summer when specific mosquito vectors are more common, this threat is less likely to affect the early-flying *E. laterale* and *E. recurvatum* than the other species. Spraying of insecticides in conjunction with agriculture (e.g., blueberries in ME, cranberries in NJ) may also have impacts, but more research is needed.

Conservation actions that address Aerial Insecticide Spraying:

1) Minimize aerial pesticide spraying in close proximity to occupied ponds

Threat assessment research - insecticides

Non-native Species:

Depending on conditions, non-native (and some native) plants can significantly alter aquatic plant communities where focal species occur. Some invasive species convert relatively open habitats into dense monocultures unsuitable to most *Enallagma* damselflies, although not all species have the same potential impacts. Non-native fish, introduced to water bodies both intentionally (fishing) or unintentionally (bait) have been proposed as potential threats given that some *Enallagma* are closely associated with fishless ponds (McPeek 1990). More research is needed on the degree to which any of the focal species are so restricted, but available evidence suggests that all five focal species are able to coexist with fish, at least under present conditions. It is unknown whether non-native fish and other exotic predators could pose a risk to these damselfly species, though odonate nymphs appear to comprise a significant component of the diet of introduced Mudpuppy salamanders (*Necturus maculosus*) in Maine (Bevier and deMaynadier, 2017). Region-wide, this threat ranked relatively low, although we lack detailed data on the potential effects of individual species.

Conservation actions that address Non-native Species:

1) Site assessment and prioritization
7) Manage invasive or other problematic species to maintain preferred habitat
8) Develop best management practices for herbicide use in occupied ponds

Threat assessment research – non-native species
Threat assessment research – herbicides

Recreation:

Two human recreational impacts have been identified as potential threats to these damselflies or their habitats: off-road vehicles and boats. In the Central Coast, off-road vehicles are known to drive through portions of shallow coastal plain ponds, and in the process damage vegetation and even the hydrology of these fragile habitats. Watercraft recreation may impact damselflies in two ways. In some lakes and ponds, boat access is facilitated by using herbicides to control nearshore aquatic vegetation (both native and invasive), with unknown direct and indirect effects on damselfly populations. Secondly, wakes from motorized watercraft may cause mortality in emerging adults during mass emergence events (e.g., Wagner and Thomas 1996), although this threat has mainly been proposed on larger water bodies and remains poorly quantified. Overall, this threat ranked lowest across the region in terms of both extent and degree of concern, although it is acknowledged that it may need to be addressed at the site-specific level in some cases.

Conservation actions that address Recreation:

1) Site assessment and prioritization
8) Develop best management practices for herbicide use in occupied ponds
9) Manage recreation

Threat assessment research - herbicides

Climate Change:

As ectotherms, damselflies are not likely to be negatively impacted by increasing temperatures, but their habitats could be altered by changes in rainfall patterns and nitrogen cycling processes. In particular, the northeastern United States is likely to experience more variable precipitation events, including more intense storms and more frequent and longer summer droughts (Moore et al. 1997, Hayhoe et al. 2006). Both extremes have potential effects on damselfly habitat. Higher water inputs from storms could flood existing sites, possibly to the extent that near shore aquatic vegetation is impacted and no longer suitable for focal species. In extreme cases, floods could directly remove vegetation, displace damselfly nymphs, or breach dams that created suitable habitat in the first place. Drought could have effects similar to water withdrawal at shallower ponds. Some possible indirect effects of the increased temperatures associated with shallower waters may be increased growth of invasive plants, algal blooms (and subsequent oxygen depletion), or timing of life cycle events.

Because it is a pervasive threat that affects the entire range of the focal species, climate change is of high concern, but actions specific to damselfly conservation have not been developed. Any action that addresses threats influenced by climate change can be appropriate in a local context, but it will also be important to identify sites or broader areas that are either more resilient to climate change or which may serve to facilitate population movement. Range shifts to the north and east by *E.daeckii, E. laterale* and *E. pictum* over the last two decades (Hunt 2012, Butler et al. 2019) suggest that most of our focal species may be relatively secure from this threat, albeit not across the entirety of their ranges. Similarly, a climate vulnerability analysis in New York predicted that *E. recurvatum* would at least remain stable in a warming climate (Schlesinger et al 2011).

Conservation Actions

Until more is known about the biology of these endemic damselflies, including how they respond to threats, the most effective conservation actions are those that target habitat. Such actions can apply to either a single occupied water body or to a complex of habitats including multiple wetlands, road networks, and adjacent uplands. In either case, an important first step in some parts of the region will be to prioritize sites for conservation action. This can be based on a combination of factors including population size, history of occupancy, waterbody and species protection status, number of focal species present, or known threats operating at a given site. The updated site data collected in 2018-19 should be useful in guiding prioritization. In states with relatively few sites for a given species, prioritization may not be necessary, since all known sites could be considered priorities. At the other extreme, states with large numbers of well-distributed sites may not need to prioritize sites or even implement actions based on perceived species habitat security. Examples of the latter include *E. laterale* in NH, MA, RI, and CT, *E. minusculum* in NH and ME, and *E. pictum* in ME, NH, and NJ. However, even if a state does not prioritize sites for conservation action, the status of these species as northeastern endemics is reason enough to keep them on the "conservation radar," for example as SGCN in State Wildlife Action Plans. As such, some level of species tracking is advisable to ensure that they persist on the landscape, especially if new threats emerge that have not yet been identified.

1) Site assessment and prioritization

Assess how many sites for priority species are either protected (e.g., fee or easement), man-made (e.g., behind dams, reclaimed cranberry bogs, etc.), or subject to management (e.g., draw-downs, herbicide treatments, activity restrictions). This action is closely tied to overall site prioritization as discussed above, and may not be needed (or feasible) in states with a large number of sites. Knowing such site characteristics, however, can inform which other conservation actions below are most appropriate at a given site.

2) Protect or restore upland and shoreline habitat around occupied ponds

Regulations governing development around lakes and ponds vary across the Northeast. In some states, there are sequential buffers with more activities restricted closer to the water body than farther away. For example, in both Maine and New Hampshire, there is a narrower zone where no impervious surfaces are allowed, and where vegetation generally cannot be removed without a state permit. With increasing distance, more activities are allowable out to a "final" larger buffer beyond which the regulation no longer applies. Existing structures are grandfathered in all cases. In other states (e.g., NY and NJ) buffer widths may vary depending on wetland designations, region of the state (NJ), or municipality (CT).

State	"No development zone"	"Limited development zone"
ME	100 feet	250 feet
NH	50 feet/150 feet	250 feet
MA	0 feet*	100 feet
RI		50 feet
CT		100 feet**
NY†		100 feet
NJ‡	50-150 feet	300 feet

* Applies only to new projects or alterations

** This is a recommendation from the Connecticut Department of Energy and Environmental Protection and not codified in statute. Wetland buffers in Connecticut are adopted and enforced at the municipal level.

† Regulated wetlands and waterbodies only (including coastal plain ponds)

‡ New Jersey buffers vary with respect to region and wetland classification. For example, the smaller buffers apply to wetlands with "intermediate" or "exceptional" resource value.

3) Reduce agricultural and road run-off

To some degree, the shoreline buffer regulations discussed above are also intended to reduce non-point inputs into occupied water bodies (and also leakage from septic systems on waterfront properties), but they do not address pollutants or nutrients that enter from roadways or larger agricultural operations nearby. Enhancing vegetated buffers can help reduce external inputs, but otherwise implementing this action will likely vary on a case-by-

case basis. Previous site prioritization may allow conservation practitioners to identify locations where threats such as eutrophication are present, and then work with specific landowners to reduce nutrient run-off from yards, camp roads, and septic fields.

4) Manage water levels to minimize impacts on target populations

There are two aspects to water level management. First is the development of Best Management Practices (BMPs) as they relate to drawdowns (e.g., during the winter or for dam repairs). These would dictate the timing and extent of drawdowns so as to minimize impacts to damselfly nymphs and/or important aquatic vegetation. In addition, and even before BMPs are developed, there is a need to make land managers more aware of water level issues at sites where focal species occur. This action can be particularly relevant when aimed at agencies or organizations that manage multiple sites. For example, many impoundments are managed for waterfowl by State fish and wildlife agencies, and this management should incorporate other species' needs where appropriate and possible. In such cases, it will be beneficial to work with the managing agency to ensure that flooding or drawdowns are not done in a manner that potentially harms damselflies. Outreach is also needed to inform managers and the general public that drawdowns are not always effective at controlling nuisance vegetation.

5) Minimize groundwater withdrawals from coastal plain ponds

In the vicinity of especially sensitive habitats such as coastal plain ponds, it may be necessary to specifically regulate groundwater withdrawals. Any such regulations would need to consider existing infrastructure and housing, local zoning and development, and agricultural practices, and as a result might be difficult to implement. At the very least, new proposals for water withdrawal from priority ponds should be subject to more thorough review when possible.

6) Minimize aerial pesticide spraying in close proximity to occupied ponds

In some areas, pesticide spraying is already restricted in the vicinity of ponds occupied by focal species. At a minimum, similar restrictions should be considered in other states where this threat is present. Important in both cases is up-to-date knowledge of where sensitive damselfly species occur. It will also be important to establish better connections between entities involved in spraying and natural resource agencies, perhaps through more rigorous environmental review. See also the list of research actions.

7) Manage invasive or other problematic species to maintain preferred habitat

Where non-suitable vegetation encroaches at occupied sites, it may be necessary to implement some form of vegetation control, be it either mechanical (e.g., direct pulling), biological (e.g., beetles and purple loosestrife), or chemical (usually herbicides, see below). In many cases, this action will also need to be considered in conjunction with separate efforts to control vegetation for aesthetic or recreational purposes, as per the following action.

Research is still needed to determine the efficacy of most control methods, as well as their potential effects at different stages of damselfly life cycles.

8) Develop best management practices for herbicide use in occupied ponds

Where herbicide application is proposed solely for the purposes of recreational access (e.g., watercraft or beach), or to maintain clear waters for perceived aesthetic reasons, it may be necessary to restrict this activity where focal species are present. In many states, the environmental review process may serve to manage this activity, but in cases where it does not, or where it is more easily circumvented, additional means of restriction may be necessary. Creating Best Management Practices that minimize impacts to damselflies (e.g., timing and extent of treatment) could be one way to reduce this threat.

9) Manage recreation

This action mainly addresses the threat posed by recreational vehicular use. See the preceding action for impacts related to providing water craft access. Because the incidence of off-road vehicles in or near shallow ponds is highly localized across the region, the best way to address it is to implement stricter protections of wetland buffers, although such protections are likely to be difficult to enforce. Even less is known about any effects of boat wakes on emerging damselflies, and that aspect of the recreation threat requires more research.

Research and Monitoring Actions

1) Regional Monitoring Framework

The need for a regional monitoring framework was listed as an objective in the original project proposal, but the partnership decided not to move forward on this front due to the previously-mentioned variation in the distribution and abundance of the focal species across the region. States with fewer than 20 sites for a given species may desire some level of regular monitoring, while those with dozens (or even over 100: e.g., *E. minusculum* in Maine) are likely to have more pressing conservation priorities. As a result, developing and coordinating a monitoring framework that covers such disparate state-specific priorities is not advisable at this time.

However, there was interest in at least proposing a consistent sampling frequency for states that wish to track these species more closely. In Massachusetts, the protocol for surveying rare plants calls for the following visit frequency: every five years if Endangered, seven years for Threatened, and 10 years for Special Concern. If a species is not detected for 25 years, a final check is recommended before a site is reclassified as "State Historic." In the absence of better data on detectability (see below), a similar approach is recommended for priority damselflies in areas of the Northeast where they are of conservation concern. Given concerns about detectability, it was suggested that if "Endangered" species are *missed* at the five year survey the site be revisited again within three years rather than five.

2) Monitoring Protocol

Over the course of surveys in 2018-19, it became clear that there is considerable variation in detection probability for the focal damselflies. The chance of finding a species depends on factors as varied as time of day, time of year, visit frequency, area surveyed, local weather, and surrounding habitat characteristics. While it may be difficult to develop a sampling protocol based on survey areas, temporal and weather variables are easier to incorporate into a standardized field methodology. Surveys should obviously be restricted to a species' flight period, and ideally as close to peak numbers as possible, although it is acknowledged that flight season may occur earlier or later in a year depending on seasonal weather patterns. Diurnal activity is similarly weather dependent, but existing information indicates that success is generally higher in the middle of the day. Due to difficulty in identifying *Enallagma* nymphs, existing data is based largely on mature adults, and these should remain the focus of future monitoring efforts.

To best inform a more rigorous sampling protocol, we recommend a detailed study at a handful of sites that investigates the effects of visit timing and conditions on damselfly detectability. This would entail multiple visits over the course of a species' flight season so as to capture the full range of abundance (e.g., Carpenter 1990), and use a modelling approach to recommend survey parameters such as visit frequency and timing as well as weather conditions. This project is well-suited for a student project at the advanced undergraduate or Master's level.

3) Investigate effects of upland habitat loss/degradation on adult damselflies

It is generally understood that adult damselflies require intact upland habitats for key parts of their life cycles, particularly immediately after emergence and between mating bouts (for females). However, data on the potential effects of shoreline habitat alteration are lacking, save for the association between pond occupancy and relatively unaltered shorelines found during the course of habitat modelling. More data on the structure and composition of buffer vegetation may be useful for future habitat management at priority sites, or for habitat restoration at degraded ones.

4) Threat assessment research

We still lack detailed knowledge on the modes of action of most of the threats identified in this document. In many cases this is because the threat is better understood at the scale of the habitat rather than populations of any given species. To this end, more detailed research into the interactions between damselflies and any of the following threats may help inform future conservation actions and fine-tuning of existing ones:

a) Non-native species: Of particular interest are those aquatic plants that may supplant the native species more typical of preferred habitat. Are these used as frequently by focal species? Do they alter habitats in such a way as to reduce occupancy?
b) Insecticides: The effects of insecticide spraying on aquatic prey communities is of particular interest, since these could still affect focal damselfly species outside of the adult flight season.

c) Herbicides: Because most herbicides are not selective, more data are needed on their effect on plant species or assemblages selected by focal damselflies. Does timing of application affect winter larval survival? Can herbicide treatment restore native communities impacted by invasive species or eutrophication?

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White, E.L., P.D. Hunt, M.D. Schlesinger, J.D. Corser, and P.G. deMaynadier. 2015. Prioritizing Odonata for conservation action in the northeastern USA. Freshwater Science 34: 1079-1093.

Appendix: Species Profiles

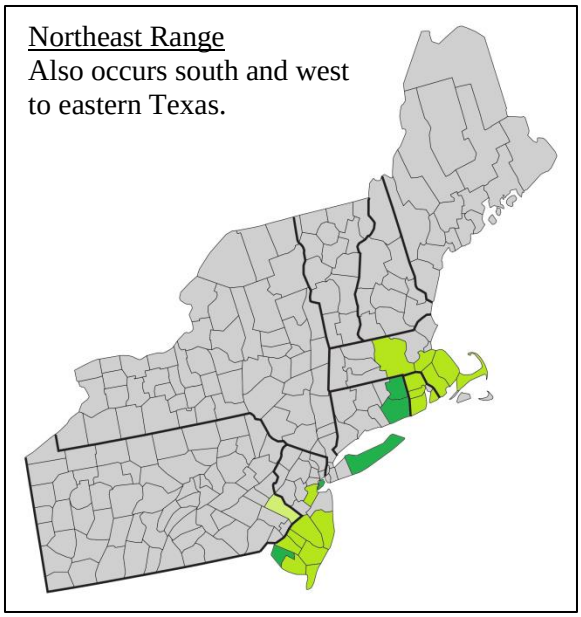
The following pages provide information on the five focal species in a consistent format and are intended as a quick reference guide only. More detail on threats and conservation actions are in the main body of the Conservation Plan. Each profile contains the following common elements:

1) Photo of an adult male
2) County-level range map for the Northeast. When a species occurs outside this area the extended range is noted. Shading on these maps indicates age of county record, with paler shading for records over 20-years old and darker shading for counties where the *first* records are less than 10-years old.
3) Distribution and Status table. This includes a summary of the number of sites in each state as of 2019. "Old" records are those over ten years old, while "recent" ones are ten years or younger. It also provides the conservation status in each state, including state listings and NatureServe S-ranks (key below). Below the table are global conservation rankings and the vulnerability score from a northeastern conservation assessment (White et al. 2015).

Status indicator	Meaning
State listings	
SGCN	Species of Greatest Conservation Need (included in State Wildlife Action Plan)
SC	Special Concern
T	Threatened
E	Endangered
NatureServe ranks (G-ranks use same definitions)	
SH	State Historic (not reported for 25 years)
S1	Critically imperiled
S2	Imperiled
S3	Vulnerable
S4	Apparently secure
S5	Secure
NR	Not Ranked

4) Description of the species' flight period and a graph of seasonal abundance. To create the latter, all records of each species were assigned to one of three ten-day periods in each month and summed across the region. The graphs were then standardized so the highest value is represented by "1.0."
5) Change in Status. This text is used to comment on any noteworthy changes to distribution or abundance.
6) Habitat description

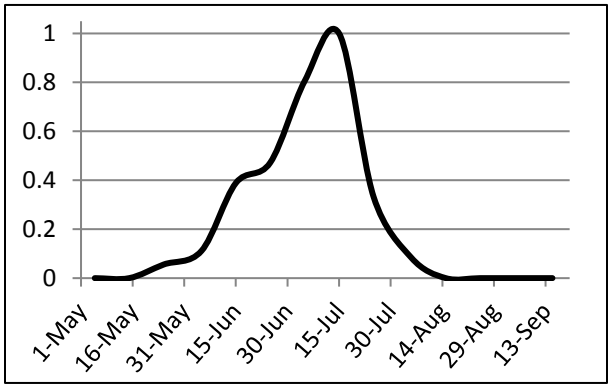
Enallagma daeckii – Attenuated Bluet



Distribution and Status

	Number of Sites			State Status	
	old	recent	total	Listing	S-rank
PA	1	0	1		SH
NJ	8	24	32		NR
NY	0	3	3		S1
CT	0	19	19	SC	S1
RI	20	9	29		NR
MA	6	13	19	T	S1
Sum	35	68	103		

Global Scores: G4, IUCN Least Concern
Northeast Vulnerability: Moderate

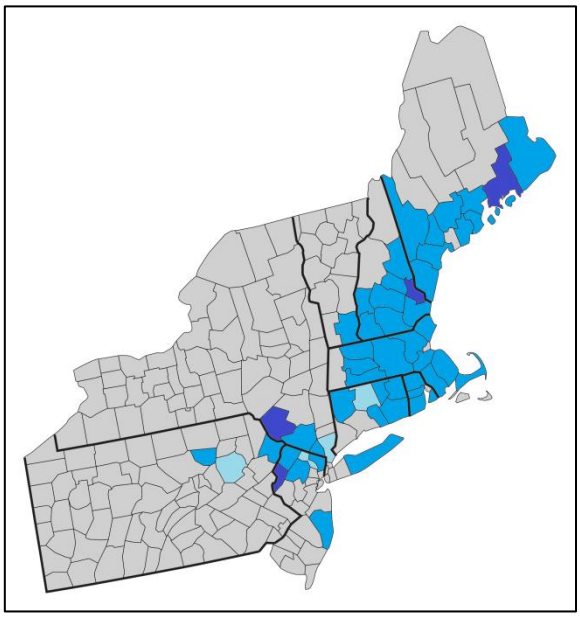


Flight period: Early June to early August, with peak in first two thirds of July. Some emerge in late May in southern NJ.

Change in Status: Recent increase in records in Connecticut and Cape Cod, and apparent colonization of Long Island, suggest a northerly range expansion. In light of this possible expansion, the absence of recent records elsewhere in eastern Massachusetts likely reflects limited survey effort.

Habitat description: Occurs in a variety of well-vegetated habitats, including lakes, ponds, swamps, and the backwaters of sluggish streams and rivers. May spend a considerable amount of time perching in dense shaded shoreline vegetation.

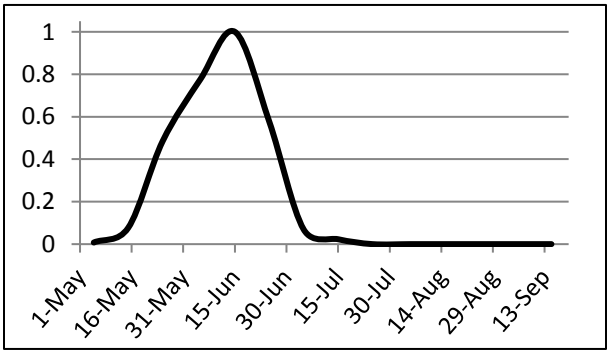
Enallagma laterale – New England Bluet



Distribution and Status

Number of Sites				State Status	
	old	recent	total	Listing	S-rank
PA	1	1	2		S1S2
NJ	7	7	14	SC	S3
NY	4	10	14	SGCN	S3
CT	10	34	44		S3S4
RI	65	7	72		S4
MA	29	23	52		S3S4
VT	0	1	1		S1
NH	9	64	73		S3
ME	16	23	39	SGCN	S3
Sum	141	170	311		

Global Scores: G3G4, IUCN Least Concern
Northeast Vulnerability: Moderate

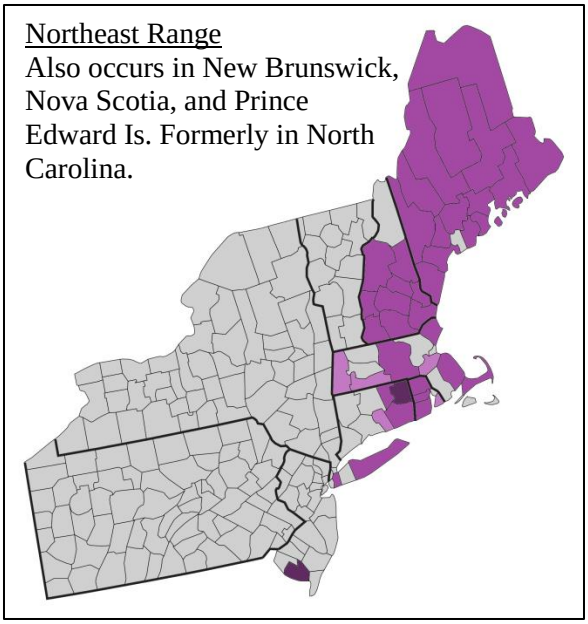


Flight period: Emerges in mid/late May to the south and early June in the north. Peak activity in June across most of range, with occasional individuals still flying in Maine and NH as late as mid-July.

Change in Status: Appears secure in most of range, and apparently expanding to the northeast in Maine, where it now occurs close to the Canadian border (Butler et al 2019). Possible range expansion noted in southern New England as far back as the 1990s (Wagner and Thomas 1999).

Habitat description: Occupies a wide variety of wetlands across its relatively broad range. In the south-coastal portion of its range, it occupies coastal plain ponds characterized by sandy bottoms and abundant emergent aquatic vegetation. Farther north and in the interior, it still uses vegetated pond margins, but also occurs in peatlands and more heavily vegetated habitats such as beaver ponds. Studies conducted in Maine and Cape Cod found a strong association with floating-leaved aquatic vegetation, and this is probably a unifying characteristic of occupied sites range-wide.

Enallagma minusculum – Little Bluet

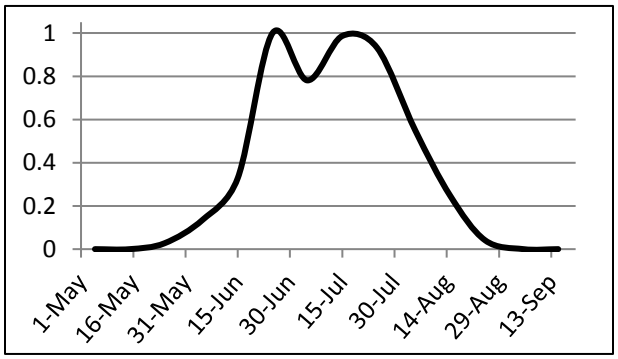


Distribution and Status

	Number of Sites			State Status	
	old	recent	total	Listing	S-rank
NJ	0	1	1		
NY	1	2	3	T	S1
CT	5	10	15	SC	S2
RI	15	5	20		NR
MA	11	15	26		S3
NH	9	64	73		S3
ME	106*	36	142		S4
Sum	147	133	280		

Global Scores: G4, IUCN Least Concern
Northeast Vulnerability: Moderate

* = E. minusculum was not a focus of this study in Maine, and as a result most sites were not surveyed in 2018-19. It is presumed that most of these "old" sites are still occupied by the species.

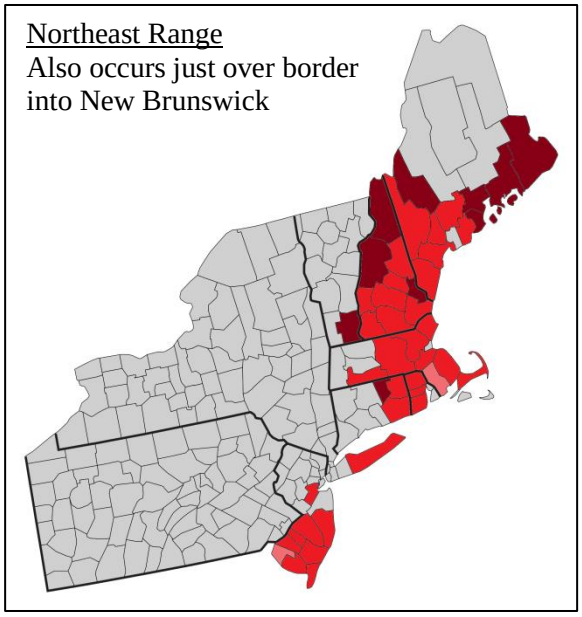


Flight period: Begins emerging in early/mid-June across U.S. range, remains common through mid-August, and not detected after August.

Changes to Status: No significant changes in range noted in recent years. Occurrence south of New England seems tenuous, given number of sites involved. The population in southern New Jersey and a presumed extirpated one in North Carolina may represent isolated colonization events that do not persist far from the species' core range.

Habitat description: On Long Island and in southern New England, this species occurs in coastal plain ponds and other sandy ponds with fringing emergent vegetation. In New Hampshire and Maine, however, it has been documented in a much wider range of habitats, including ponds and small lakes and reservoirs with rocky shorelines, and even slow stretches of sandy rivers. A key habitat component in all cases appears to be sparse graminoid vegetation in the littoral zone (especially pipewort: *Eriocaulon*), and shrub cover (e.g., *Vaccinium*) right down to the shoreline.

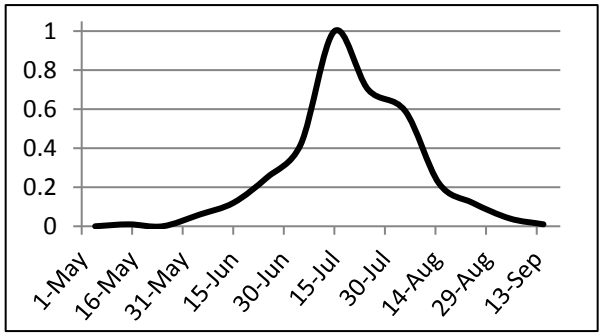
Enallagma pictum – Scarlet Bluet



Distribution and Status

Number of Sites				State Status	
	old	recent	total	Listing	S-rank
NJ	25	32	57	SC	S3
NY	6	6	12	T	S2
CT	0	17	17	SC	S2
RI	13	12	25	SC	S2
MA	14	15	29	T	S2
VT	0	1	1		
NH	1	77	78		S3
ME	3	50	53	SC	S2
Sum	62	210	272		

Global Scores: G3, IUCN Least Concern
Northeast Vulnerability: Moderate

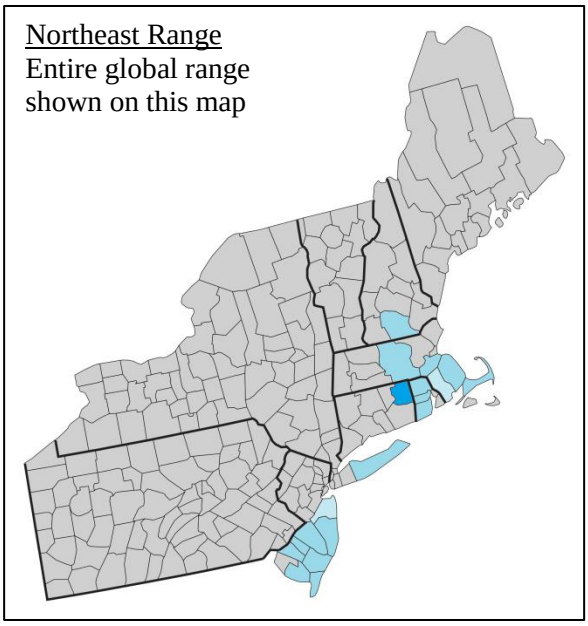


Flight period: Primarily July through mid-August, but in New Jersey may emerge as early as late May and linger into mid-September.

Changes to Status: Unknown in northern New England until the 2000s, and by 2017 had spread northeast along the coast to southwestern New Brunswick. Although this species' tendency to occur farther from shore on lily pads can make detection more difficult, its distinctiveness makes it unlikely that it was completely undetected in the north prior to 2000. The lack of recent records in parts of the south is more likely the result of limited survey effort rather than extirpation, since it remains common in southern New Jersey.

Habitat description: Occurs in a wide variety of lakes and ponds, always with floating vegetation such as *Nuphar*, *Nymphaea*, and *Brasenia*. Some sites also have extensive boggy margins. Most occupied ponds in southern portion of range are sand-bottomed, and many are classified as "coastal plain ponds." In NJ, it also readily colonizes impoundments and abandoned cranberry farms. In the north, where coastal plain ponds are rare or absent, many occupied ponds still conform to the "shallow and sandy, with floating aquatic plants" description, but the species appears far less restricted. For example, it occurs in sheltered coves of some very large lakes and/or far from the coastal plain.

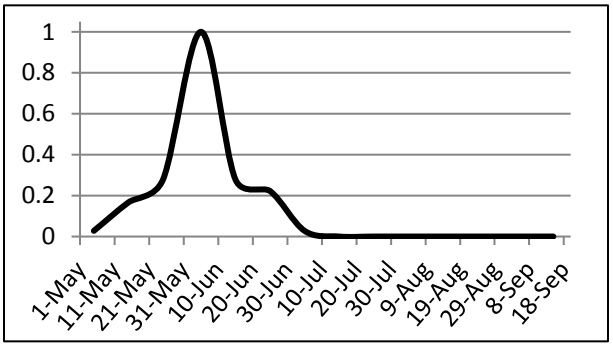
Enallagma recurvatum – Pine Barrens Bluet



Distribution and Status

	Number of Sites			State Status	
	old	recent	total	Listing	S-rank
NJ	33	16	49	SC	S3
NY	10	4	14	T	S1
CT	0	2	2	T	S1
RI	19	4	23	SC	S2
MA	11	27	38	T	S2S3
NH	1	0	1	SC	S1
Sum	74	53	127		

Global Scores: G3, IUCN Least Concern
Northeast Vulnerability: High



Flight period: Late May to mid-June. May emerge in early May in NJ and linger into early July in MA.

Change in Status: Appears stable in core range from southern New Jersey to southeastern Massachusetts. The species was last documented at the single New Hampshire site in 2007, after only being discovered there in 2002. Since this location was far from the core range, it likely represented an isolated colonization event, and then succumbed to the species' known high local extinction rate (41%, Gibbons et al. 2002). Records from southern Maine in the mid-1990s were never verified and the species is no longer included in the State list (Brunelle and deMaynadier 2005). It was also not found in Maine following extensive search effort in 2018-19 (Butler et al. 2019).

Habitat description: This species has the most restricted range of the five focal damselflies, and in that sense its habitat requirements are probably more consistent across the region. Over most of this range it is restricted to sandy coastal plain ponds with fringing shoreline vegetation. Important plant species include *Juncus militarus* (bayonet rush), and some sites also have a partial boggy mat.