Conservation Planning for Endemic Damselflies of the Northeast

L-R: New England, Scarlet, and Little Bluets. Photos by Pamela Hunt

A report to the Sarah K. de Coizart Article TENTH Perpetual Charitable Trust

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January 30, 2020

Overview

In 2018, New Hampshire Audubon was awarded a total of $90,000 by the Sarah K. de Coizart Article TENTH Perpetual Charitable Trust for work on conservation planning for four species of damselflies largely endemic to northeastern North America. These species occur primarily from New Jersey to Maine, with one also widespread in Maritime Canada. They are all bluets in the genus *Enallagma* as follows: New England Bluet (*E. laterale*), Little Bluet (*E. minusculum*), Scarlet Bluet (*E. pictum*), and Pine Barrens Bluet (*E. recurvatum*). All are considered "Regional Species of Greatest Conservation Need" and each is listed as "threatened" or "special concern" by at least one of the seven states within their core United States range. Because of their endemism and occurrence in one of the most human-impacted areas of North America, there was interest across the region in developing a more comprehensive approach to these species' conservation.

Our proposal included seven distinct objectives, all leading toward development of a conservation plan. Those seven steps were in turn grouped into three broader project components, as show below:

1) Status assessment
    a. Compile existing data on all focal species
    b. Field surveys, with a focus on updating records that were >20 years old
2) Habitat Models
    a. Collect habitat data at survey sites using a standard protocol
    b. Create habitat models for each focal species
3) Conservation Plan
    a. Develop a monitoring framework to guide future monitoring across the region
    b. Prioritize sites based on their ecological condition and perceived risk
    c. Generate a list of conservation actions that could benefit these species and their habitats.

The project officially began in March of 2018, when NH Audubon convened partners from each state within the core range of these species. Partners on this call included representatives from the Maine Department of Inland Fisheries and Wildlife, University of Maine Farmington, New Hampshire Audubon, Massachusetts Natural Heritage and Endangered Species Program, Connecticut Department of Energy and Environmental Protection, New York State Natural Heritage Program, and New Jersey Division of Fish and Wildlife, as well as an independent Odonata expert from Rhode Island. Together, these individuals comprise the project's steering committee, and convened regularly by conference call to move the project along during 2018 and 2019. The report that follows presents the project's accomplishments in the order the objectives were presented above. It includes a number of appendices, and the Conservation Plan as a stand-alone document.

Component 1: Status Assessment

The first task given to each state was a compilation of existing data for each species (objective 1a), including a breakdown of the ages of each record (i.e., the last time a given species was reported at a given site). In the process, we decided to add a fifth species to the project, the Attentuated Bluet (*E. daeckii*). While not endemic to the Northeast (it ranges from southern New England south and east to Texas), this species is of conservation concern here at the northern edge of its distribution, and often co-occurs with the four original focal species. The results of this compilation are presented in Appendix 1a, which also includes data from Pennsylvania and Vermont, two states peripheral to the core ranges of all the target species. Once all data were compiled, the steering committee agreed that the first priority for surveying known sites should be locations where records were over 20 years old. This would update state databases and provide more current data on which other project components could be based.

Before surveys could begin, we needed a consistent methodology that would collect information on both damselflies and the habitat characteristics of the ponds and wetlands where they occur (or didn't occur). To this end, a pilot protocol was finalized by the end of May (objective 2a, in part; Appendix 2a). Key to its development was consideration of the data needs for our proposed habitat models, meaning that data had to be relevant to the way damselflies may select habitats *and* easily measurable in a short time by field personal scattered across the region. The protocol was modified slightly in 2019 following field testing in 2018.

Surveys focused on the focal damselflies were conducted in every partner state except Connecticut in 2018, and in all states in 2019 (objective 1b, Appendix 1b). Over 400 sites were eventually surveyed region-wide in the course of this project. The extent of survey effort varied considerably by state as a result of weather (there were several extended rainy periods), water levels, a late start to survey implementation in 2018, and staffing capacity. Appendix 1b shows the distribution of survey effort over the two years across the region. Over the course of the two seasons, all seven states were able to visit the majority of known sites for their highest priority species. In most cases where a high percentage of sites were "unsurveyed" for a species in Appendix 1b, this is because that species was not as high a priority in that state. Habitat data were collected in all states as well, although not at all sites surveyed in Massachusetts and New Jersey.

Overall, target species were recorded at 43-66% of historic sites that were surveyed, but there was considerable variation within the region in detection likelihood and discovery of new sites. These results are presented in Appendix 1b, but also summarized by species below. Although at present we lack the data to fully evaluate success rates (see Conservation Plan), we have opted to use 50% as a rough cut-off between good and poor detectability at historic sites.

Enallagma daeckii (Attenuated Bluet)

This southern species is gradually expanding its range in the region, as evidenced by several new records in southern New England, especially Connecticut. It was also documented on Long Island for the first time. In New Jersey, the species is not a conservation priority, but

even without a concerted survey effort it was found at several new sites. If this range expansion continues, the Attenuated Bluet may be less in need of conservation attention than once believed.

Enallagma laterale (New England Bluet)

This species was detected at roughly half the known sites that were surveyed. Success rates were much higher in New Hampshire (73%) and New Jersey (71%), and much lower in Rhode Island (21%). The low detection rate in Rhode Island may be partially due to poor survey conditions, and it should be noted that this state only surveyed a small proportion of known sites. At the same time several new sites were discovered in Maine, New Hampshire, Massachusetts, and Connecticut, indicating that the regional population generally healthy. Concern is still warranted in New York and New Jersey where there are still far fewer sites than the other states.

Enallagma minusculum (Little Bluet)

This is the most northerly-distributed of the five focal species. Because it is common in the north, it was not a survey priority in Maine or New Hampshire, but both states detected it at 40-60% of known sites. In southern New England, the success rate declined from Massachusetts to Rhode Island to Connecticut, although there were several new sites found in Massachusetts and Connecticut. There are only three known sites in New York and New Jersey for this species, and it was found at only one of these – on Long Island. Here at the southern edge of its range, this species may be barely hanging on, and the single site in southern New Jersey may not even represent an established population.

Enallagma pictum (Scarlet Bluet)

The detection rate for this species was the highest of the four, averaging 66%. At the state level, only Massachusetts (10%) was significantly lower that 50%. Large numbers of new sites were also discovered, particularly in Maine, New Hampshire, and Connecticut, making it the most widespread species of the four in terms of occupied sites in 2018-19. It is particularly widespread at the northern and southern extremes of its range in Maine, New Hampshire, and New Jersey. Relatively low detection rates in Massachusetts, Rhode Island, and New York are sufficient reason to retain this species as a conservation priority in those states, and follow up surveys are recommended in Massachusetts to determine if the low detections in 2018-19 are an indication of local extirpation.

Enallagma recurvatum (Pine Barrens Bluet)

The core range of this species has generally been southern New Jersey, Long Island, Rhode Island, and Cape Cod. Surveys in 2018-19 found it roughly 50% of known sites region-wide, although detection success was particularly low on Long Island. In states peripheral to the core range, a new site was found in Connecticut, bringing that state's total to two, but it was not relocated at the only known site in New Hampshire. It is likely that populations at the northern range edge are ephemeral, and additional survey effort is warranted to determine if the species exists at other suitable sites nearby.

Component 2: Habitat Models

As noted above, standardized habitat data were collected at the majority of sites across the region (Objective 2a, Appendix 2a). However, because there were some data gaps and inconsistencies in data collection across the region, we were unable to use all survey sites in the final models. To streamline this process we divided the region into two sections: 1) North, comprising NH and ME and 2) South, comprising Cape Cod (MA), RI, CT, and NY. There were insufficient data collected in NJ to enable their use in the models. The northern models were run first, and these results informed how we approached the southern models. Steps in model development were as follows.

Survey ponds were categorized as "present" or "absent" based on the documented presence of one or more of the focal species in 2018 or 2019. Sites were considered "absent" if a focal species had never been recorded there, but historic sites where a focal species was not detected were excluded from either category.

In addition to the habitat data collected in the field, we used ARCGIS to extract land cover data for each pond (sourced from NOAA's Coastal Change Analysis Program). These data were collected in three buffers of 75, 150, and 1000 meters, which were chosen to approximate different regulatory distances or the watershed within which external factors (e.g., run-off) may influence a pond. Land cover categories were collapsed into two broad types: forest and impervious surface, with the latter including buildings, roads, pavement, bare rock, and lawns. Finally, because their limited dispersal ability may constrain *Enallagma* damselfly distribution (and this site occupancy) if ponds are more isolated, we also used GIS to determine the distance from each pond to the next nearest pond, and the average distance to the four nearest ponds.

The data collected in the field (Appendix 2a) also needed some manipulation before they could be used in models. We treated shoreline (0-5 meter from shore) and nearshore (5-30 meters) cover similarly to the GIS-derived land cover: combining multiple variables into indices of a) forest and b) impervious surface. Field-sketches of aquatic plant zones were converted to five variables: 1) floating (e.g., "water lilies:" *Nymphaea*, *Nuphar*, *Brasenia*, etc), 2) broad-leaf emergent (e.g., *Saggitaria*, *Pontedaria*, etc), 3) narrow-leaf emergent (sedges, rushes, grasses – hereafter "graminoid"), 4) stands of cattail (*Typha*) or *Phragmites*, and 5) the overall length of the vegetated zone. Substrate variables were scaled based on the proportions of each type into an index that ranged from 1 (peat) to 7 (bedrock).

The final set of predictors includes 19 variables: two abiotic (substrate and pH), five related to aquatic vegetation (floating, emergent, graminoid, Typha, and zone length), two related to distance between ponds, and ten derived from land cover at increasing distances from the pond (forest and impervious surface at 0-5, 5-30, <75, <150, and <1000 meters). For each species and region (north and south), we tested three models that represented the different scales at which damselflies might select habitat (Appendix 2b):

a) Local scale: eight variables related to vegetation and cover in or immediately adjacent to the pond
b) Pond scale: 13 variables including the previous eight, plus substrate, pH, length of the macrophyte zone, and the two variables related to inter-pond distances

c) Large scale: all 19 variables.

Presence-absence models were generated using nonparametric multiplicative regression (NPMR – Hyperniche©). Such models compare all input variables in terms of their ability to predict whether the focal species is present at a site, with the dependent variable represented as "probability of occurrence," expressed as a percentage. The final set of variables in the model is that which does the best job of predicting occurrence: taking variables away makes the model less predictive and adding variables fails to improve significance. Model significance was evaluated using a variety of statistical procedures, but those are not outlined here. It is important to note that all models generate a list of predictor variables, but if the model is not significant it means none of those variables was a good predictor of focal species presence. Two metrics are calculated for each variable in the final model: sensitivity and tolerance. Sensitivity is an indication of how strongly a variable influences occurrence and tolerance is related to the range of each variable where presence is most likely (lower values indicate a lower range). We used sensitivity to rank variables within each model, but those values are not reported here. The summaries that follow are based solely on the results of significant models. Remember that variables are considered "important" is they significant affect the chance of a pond being occupied by a focal species. This can be loosely equated to "preference" but it is important to note that it does not measure causality.

Summary of Model Results (see also Appendix 2c)

General Overview

In many cases, our models have identified two *local* land cover variables as important predictors of focal damselfly presence: forest cover and impervious surface, in most cases as estimated in bands 0-5 and/or 5-30 meters from the shoreline. Generally, these two variables operate inversely of one another, in that sites with higher forest cover tended to have less imperious surface. For the purposes of this report and associated documents, this relationship will be referred to simplistically as an "alteration gradient." Low alteration means high forest cover and limited impervious surface, while high alteration is the opposite (although there are certainly exceptions). In most cases, damselfly presence was less likely at more altered sites. Note that "more altered" sites might still have significant forest cover in the vicinity, so the important thing is a *relatively* high cover of roads, lawns, buildings, and other human-made features. In a handful cases, models returned *positive* associations with impervious surface, but these are generally believed to spurious correlations, especially in the more heavily-developed landscapes of southern New England and Long Island.

Enallagma daeckii

Models for this species were variable and difficult to interpret, and even counterintuitive, perhaps as a result of a small sample size. For example, likelihood of presence *increased* with reduced length of the macrophyte zone and also increased in ponds with more altered shorelines. Specific vegetation relationships included higher occupancy of ponds with moderate amounts of broad-leafed emergents and low cover of floating plants.

Enallagma laterale

In the northern portion of its range, *E. laterale* shows limited significant association with any particular vegetation variable (e.g., positive association with floating vegetation in the local model, but not at the other scales), but when abiotic variables are considered it shows strong association with low pH (more acidic) and substrates in the sand/silt range. Probability of presence is also higher at ponds with less altered shorelines and if nearby ponds are relatively close. In the southern models, presence was more likely at sites with more altered shorelines, but this may be an artifact of overall landscape condition.

Enallagma minusculum

Perhaps because it is widespread in the north and thus under sampled in this study, models for the northern states were generally not significant. Only at the large scale were significant predictors identified, and the most easily interpretable were positive associations with pH and substrate, and a strong negative relationship with impervious cover within 1000 meters. In this model, *E. minusculum* was more likely at less acidic ponds with coarser substrate, which matches the general impression that it prefers more oligotrophic ponds and lakes with sandy or gravelly bottoms and limited emergent vegetation. The association with coarser substrates was also evident in the south. The southern models tended to identify negative relationships with floating plant cover and altered shorelines, and a weak positive influence of graminoid vegetation. The latter matches the observation that *E. minusculum* differs from the other species under consideration in that it is commonly found at sites with extremely limited emergent vegetation – often only scattered sedges, grasses, or reeds.

Enallagma pictum

By far the most important variable in predicting *E. pictum* presence is the amount of floating vegetation, although this variable is surprisingly not significant at smaller scales in the southern four states. In the north it is also associated with sand/silt substrates. Like the other species it is more likely to occur in ponds with less altered shorelines and more forested surroundings.

Enallagma recurvatum

The most important variable for this species at all scales was the presence of graminoid vegetation. Although there was some variability depending on scale, it tended to be less likely at sites with more altered shorelines.

Component 3: Conservation Plan

The conservation plan is included with this report as a separate document, but progress on the specific objectives is also summarized here.

Because detections of target species varied considerably among states, it proved difficult to develop a monitoring plan that would serve each state's needs (Objective 3a). In Maine and New Hampshire, populations appear robust and more widespread than previously believed (with the exception of *E. recurvatum* in NH), and a monitoring plan would be complicated by the sheer number of sites. Where some species are particularly rare (Long Island and Connecticut), there is greater interest in more frequent monitoring to make sure targets persist, and also to access the effectiveness of conservation actions. Another issue is our finding that target species were only detected at roughly half of known sites. In some cases, they were missed on an initial visit but found on a second or third, indicating that there can be considerable variability in detection success – even when the species is clearly present. Rather than attempting to develop a comprehensive monitoring plan, a more important first step will be field studies that determine which factors (weather, time of year, etc.) influence detectability, and then develop a more rigorous sampling protocol that decreases the chances of failing to find a species when it is present. This would save both time in the field and result in more useful data. Development of such a sampling protocol was identified as an important action by the steering committee, and is discussed in more detail in the Conservation Plan.

To some degree, the same variability in detection across the region makes site prioritization (Objective 3b) difficult. In states where a species is rare, conservation actions may be implemented as soon as they are feasible, whereas no actions may be implemented at all where a species is common. A better understanding of how habitat is selected across the region may provide some insight on how to move forward in this objective, but it was not finalized for the purposes of this report.

Because all five species are similar ecologically, albeit with subtle variation in habitat needs, the conservation plan (Objective 3c) is intended to apply to all of them. It can be adapted in specific situations when a conservation practitioner knows which species are present, their level of concern, and what threats are operating at a given site. In addition to an initial overview, the plan consists of three sections: 1) a description and ranking of known threats, and 2) a list of actions that could be taken to address these threats or otherwise ensure species persistence at a site, and 3) species profiles for the five target species. Our intent is that knowledge of a threat in a given jurisdiction can more easily lead to implementing the conservation action(s) that can best mitigate or eliminate that threat and thus minimize the chances that a species is extirpated from a site.

Conclusions

This project sought to update our knowledge of five damselfly species of conservation concern in the Northeast. To this end, we were quite successful in surveying a significant number of sites from New Jersey to Maine, in the process finding new sites for our focal species in all seven states. Success at relocating focal species at historic sites varied across the region, being highest in Maine and New Hampshire and lowest in southern New England and New York, but low success may have been due to local weather conditions as much as possible absence. Results of these surveys can be used by states to re-evaluate the conservation status of the five focal species, and to prioritize future conservation actions.

For the first time, we now have habitat data collected for all species in a similar manner across the region, and a preliminary attempt at modelling habitat relationships. The results of these models tend to confirm previously-known habitat relationships, but their more important outcomes are perhaps a consistent indication that these damselflies are less likely to occur in ponds with more altered shorelines. This is an important consideration in future conservation efforts for these species, especially in the more developed areas of southern New England, Long Island, and to a lesser extent New Jersey.

To better address shoreline development and other threats, we have developed a conservation plan that outlines the threats and links them to specific actions that can benefit damselflies and their habitats. It also identifies research and monitoring needs that will ultimately allow us to fine tune conservation strategies. Our goal is that this plan is used by management agencies, landowners, and their conservation partners to ensure that these unique insects continue to persist here in the Northeast. The conservation plan is a separate document that accompanies this report.

Acknowledgements

This project would not have been possible with the dedicated assistance of partners, contractors, and volunteers in all seven states, and in a few cases outside the region. The steering committee consisted of Allen Barlow (NJ Division of Fish and Wildlife), Virginia Brown (RI), Ron Butler (University of Maine, Farmington), Phillip deMaynadier (Maine Department of Inland Fisheries and Wildlife), Lynn Harper (Massachusetts Natural Heritage and Endangered Species Program), Pamela Hunt (NH Audubon), Laura Saucier (Connecticut Department of Energy and Environmental Protection), Robert Somes (NJ Division of Fish and Wildlife), and Erin White (NY Natural Heritage Program). Field work was conducted by Nina Briggs, William Conner, Jim Duncan, Holly Grant, Peter Hazelton, Emily Kelley, Hailey Mealey, Blair Nikula, Ellen Peher, Valinn Ranelli, Autumn St. Pierre, Tim Simmons, Michael Thomas, Lauren Wadleigh, Alan and Della Wells, and some members of the steering committee. Jason Breid, Michael Thomas, and Harold White provided external comments on the conservation plan.

Explanation of Costs:

Of the total grant award of $90,000, $60,000 was set aside for disbursement to other states to facilitate their field work. Poor weather and a late start resulted in less field work being conducted than hoped in 2018, and only $12,500 of the initial set-aside of $30,000 was used in that year. This money included stipends for field observers and mileage reimbursement for their travel. An additional $11,500 was used internally at New Hampshire Audubon to support staff time and expenses associated with both field work and project management. $2500 earmarked to support initial modelling efforts by a project partner at the University of Maine was not needed when this partner provided this service gratis. This left $21,000 remaining of the initial grant installment of $45,000. With receipt of the second $45,000 installment in January 2019, the project budget stood at $66,000. As expected, contractor costs were significantly larger in 2019, totaling $25,300 for field work and a projected $10,000 for modelling. $14,500 was used internally, including final report preparation. At the close of January 2020, this leaves approximately $16,200 remaining of total project funds. Our plans for this significant sum include the following:

1) Work with the steering committee to prepare a manuscript for publication that presents the results of the modelling effort. Costs for this item will include staff time and any publication costs (e.g., page charges). The Sarah K. de Coizart Article TENTH Perpetual Charitable Trust will be acknowledged as the primary funder of this effort.
2) Present these same results at one or two scientific meetings in 2020. The first of these is the April 2020 meeting of the Northeast Association of Fish and Wildlife Agencies, where we have been invited to participate in a symposium on aquatic invertebrates. The second is the annual meeting of the Dragonfly Society of the Americas in Oklahoma in June. Funds would be used in both cases to offset costs associated with travel and talk preparation.
3) There are still sites in parts of New England that were not surveyed in 2018-19. As funds allow, they will be used to conduct a third year of field work at these sites.
4) As noted in the conservation plan, there is interest in a pilot project to measure detectability in one of more focal species, with the intent to better inform future monitoring efforts. We think such a project is well suited for an undergraduate research project or as part of a Masters project, and if a qualified student is identified some funds could be made available to facilitate their work.

Appendix 1a. Breakdown of records for five species of *Enallagma* damselflies in the northeastern United State prior to 2018.

State	Record Age (years)	*Enallagma daeckii*	*Enallagma laterale*	*Enallagma minusculum*	*Enallagma pictum*	*Enallagma recurvatum*	Sum
ME	>20	Does not Occur	2	23	1	Does not Occur	26
	10 to 20		25	98	18		141
	<10		0	4	2		6
	Sum		**27**	**125**	**21**		**173**
NH	>20	Does not Occur	12	9	0	0	21
	10 to 20		8	5	2	0	15
	<10		24	34	45	1	104
	Sum		**44**	**48**	**47**	**1**	**140**
VT	>20	Does not Occur	0	Does not Occur	0	Does not Occur	0
	10 to 20		1		0		1
	<10		0		1		1
	Sum		**1**		**1**		**1**
MA	>20	4	20	4	2	9	39
	10 to 20	2	38	12	13	15	80
	<10	7	28	2	12	9	58
	Sum	**13**	**86**	**18**	**27**	**33**	**177**
RI	>20	3	13	1	0	6	23
	10 to 20	21	55	19	20	17	132
	<10	1	2	0	3	0	6
	Sum	**25**	**70**	**20**	**23**	**23**	**161**
CT	>20	0	11	1	0	0	12
	10 to 20	0	9	2	2	0	13
	<10	1	4	3	2	1	11
	Sum	**1**	**24**	**6**	**4**	**1**	**36**
NY	>20	0	7	0	1	4	12
	10 to 20	0	5	1	7	6	19
	<10	1	1	2	3	4	11
	Sum	**1**	**13**	**3**	**11**	**14**	**42**
PA	>20	1	1	Does not Occur	Does not Occur	Does not Occur	2
	10 to 20	0	1				1
	<10	0	1				1
	Sum	**1**	**3**				**4**
NJ	>20	1	2	0	8	21	32
	10 to 20	3	5	0	16	13	37
	<10	16	7	1	31	12	67
	Sum	**20**	**14**	**1**	**55**	**46**	**136**
All US	>20	9	68	38	12	40	167
	10 to 20	26	147	137	78	51	439
	<10	26	67	46	98	27	264
	Sum	**61**	**282**	**221**	**188**	**118**	**870**

Appendix 1b. Results of *Enallagma* damselfly survey effort in the northeastern United States in 2018-19. Number in parentheses below the state abbreviation is the total number of sites visited in that state. "Current" sites is the sum of occupied historic sites and new sites, while "max" sites also includes *all* historic sites even if the species was not recorded there in 2018-19. "Percent of sites" is based on the number of known sites in each state prior to 2018 field work. "Occupied" shaded red indicate a low detection rate for a species in a state (but only if there were at least five sites known prior to this project). "Unsurveyed" values shaded blue indicate that a species was not a survey priority in that state.

		Numbers of Sites						Percent of Sites	
STATE	**SPECIES**	**checked**	**occupied**	**new**	**remaining**	**current**	**max**	**occupied**	**unsurveyed**
ME (116)	*E. laterale*	26	11	12	1	23	39	0.42	0.04
	E. minusculum	21	12	20	101	32	142	0.57	0.83
	E. pictum	23	20	30	0	50	53	0.87	0.00
NH (89)	*E. laterale*	33	24	23	17	47	73	0.73	0.34
	E. minusculum	20	8	7	23	15	50	0.40	0.53
	E. pictum	42	32	23	13	55	78	0.76	0.24
	E. recurvatum	1	0	0	0	0	1	0.00	0.00
MA (79)	*E. daeckii*	5	1	6	8	7	19	0.20	0.62
	E. laterale	37	25	12	50	37	99	0.68	0.57
	E. minusculum	12	5	8	6	13	26	0.42	0.33
	E. pictum	20	2	2	7	4	29	0.10	0.26
	E. recurvatum	27	14	5	6	19	38	0.52	0.18
RI (35)	*E. daeckii*	8	4	4	16	8	28	0.50	0.67
	E. laterale	14	3	2	47	5	63	0.21	0.77
	E. minusculum	15	5	0	0	5	15	0.33	0.00
	E. pictum	14	7	2	2	9	18	0.50	0.13
	E. recurvatum	11	4	0	5	4	16	0.36	0.31
CT (61)	*E. daeckii*	1	1	18	0	19	19	1.00	0.00
	E. laterale	18	9	25	6	34	49	0.50	0.25
	E. minusculum	6	0	9	0	9	15	0.00	0.00
	E. pictum	6	5	11	0	16	17	0.83	0.00
	E. recurvatum	1	1	1	0	2	2	1.00	0.00
NY (22)	*E. daeckii*	0	0	1	0	1	1	N/A	N/A
	E. laterale	12	5	1	1	6	14	0.42	0.08
	E. minusculum	2	1	0	1	1	3	0.50	0.33
	E. pictum	11	5	1	0	6	12	0.45	0.00
	E. recurvatum	9	1	0	5	1	14	0.11	0.36
NJ (35)	*E. daeckii*	9	4	12	11	16	32	0.44	0.55
	E. laterale	7	5	0	7	5	14	0.71	0.50
	E. minusculum	1	0	0	0	0	1	0.00	0.00
	E. pictum	18	17	7	37	24	62	0.94	0.67
	E. recurvatum	8	7	3	38	10	49	0.91	0.83
Totals (437)	*E. daeckii*	23	10	41	35	51	99	0.43	0.60
	E. laterale	147	82	75	129	157	351	0.56	0.47
	E. minusculum	77	31	44	131	75	252	0.40	0.63
	E. pictum	134	88	76	59	164	269	0.66	0.31
	E. recurvatum	57	27	9	54	36	120	0.47	0.49

Appendix 2a: Northeast Endemic *Enallagma* Survey Protocol

The "Northeast Endemic *Enallagma*" project is a two-year, seven state effort to improve our current knowledge of the population status and conservation needs of five species of damselflies in the region from New Jersey to Maine. The project focuses on four endemic species (*E. laterale*, *E. minusculum*, *E. pictum*, and *E. recurvatum*) and one more widespread species which reaches the northern edge of its range in New England and is of conservation interest where it occurs (*E. daeckii*). Two of the specific objectives of the project are to 1) update state Heritage databases and 2) create habitat models for these species, and to that end a subgroup of the steering committee has developed a survey protocol and data sheet for use by all participants in the project. The present document provides instruction on carrying out surveys, and where relevant the justification for some parts of the protocol. A copy of the data form is provided at the end for reference.

Because the flight periods of the target species are variable, each site will need to be visited twice, once in the "early" part of the season and once in the "late." *Enallagma laterale* and *E. recurvatum* are active from late May (south) into late June (north), while the remaining three fly from late June through mid-to-late August. These two visits need not occur in the same year, although it is encouraged. While observer, timing, weather, and damselfly data need to be recorded on each visit, habitat data need be recorded only once. We recommend that habitat data are collected on the second visit to allow vegetation to mature. If a target species is not detected at a site where it is known to occur, one or more follow-up visits are allowed in an attempt to determine whether it is still present.

Part One: Location information and survey conditions

There are multiple ways of describing the location of a survey site, and the first few lines of the data form provide a number of options. At the very least, we will need latitude and longitude, preferably in decimal degrees although specific requirements of State Heritage programs may dictate alternative approaches. This section also includes space for metadata about a specific survey, including date, observer, and weather. Once location data have been recorded for a site, it is not necessary to repeat anything except site name and state on subsequent visits.

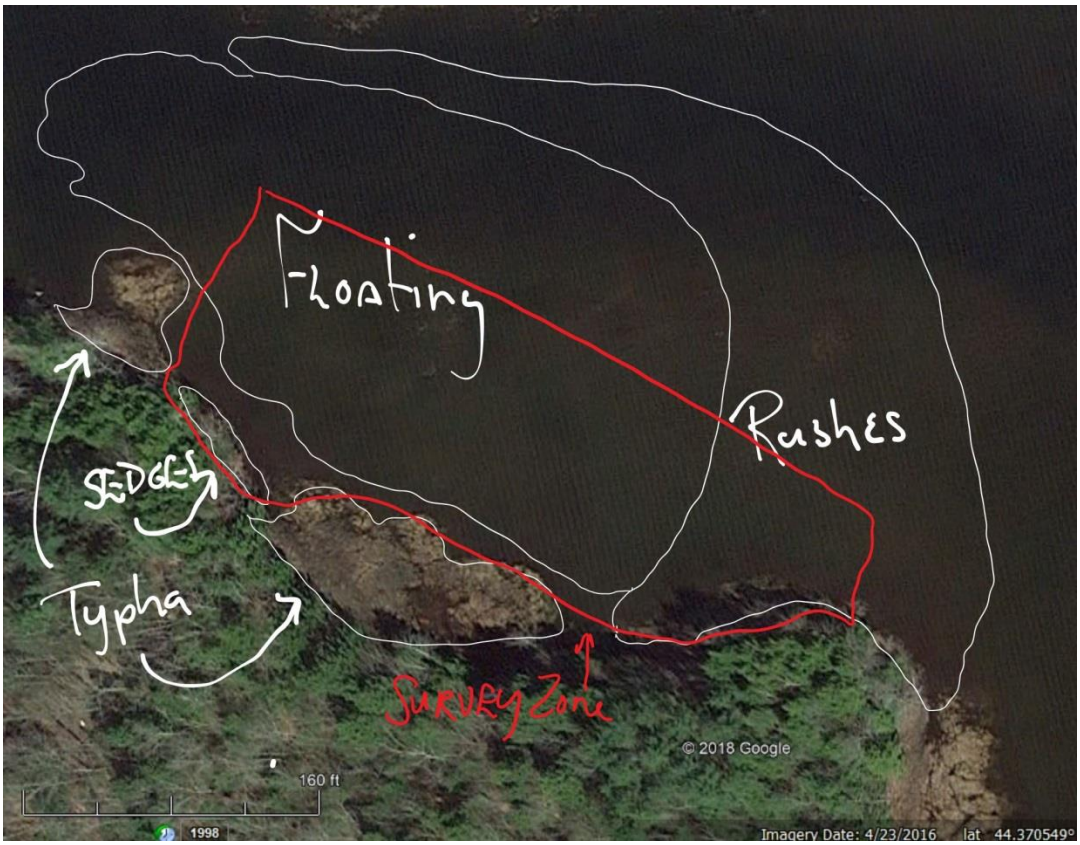
Part Two: Habitat information

We are asking for a fair bit of habitat data for each site. Variables of interest are based on known habitat relationships in at least part of the target species' ranges, and also include parameters of conservation interest and those that are generally used to describe water bodies. They are grouped into four categories: a) aquatic plants, b) substrate, c) chemistry, and d) shoreline habitat. The observer should delineate a survey zone in a suitable section of the water body and visit the same area on both survey visits. All data collected (as outlined below) should be collected in or adjacent to this area.

BEFORE VISITING A SITE, BE SURE TO PRINT OUT AN AERIAL PHOTO OF THE PROPOSED SURVEY AREA. This will be important during data collection. The simplest way to do this is to zoom in on the area of interest in Google Earth, where you can also use the "time

slider" to select an image that shows aquatic vegetation (e.g., a June/July photo instead of an April or October one). **Be sure to include a scale bar on the printed image.**

a) Aquatic plants. ON THE AERIAL PHOTO, start be delineating the survey zone and labelling it appropriately. Then, by comparing what you see in the field to the photo, outline the extent of the four vegetation types on the form (they can overlap). An example of this is shown below. If there are extensive areas of invasive species, make note of this on the form. The check boxes on the form are designed to remind the observer to account for each of the four vegetation classes. Even if a class is not present at the site, please check the box so that the people conducting data entry and calculating percentages know that class was not omitted by mistake. Photos are encouraged for possible identification of plants to species, but are not required.



b) Substrate. Estimate the percentage of each substrate type listed on the form. These should add up to 100%

c) Chemistry. Using a pH/conductivity meter, collect three values each for pH and conductance (units of). Also assign the water body to one of five types based on perceived nutrient status. Note that "shallow" vs "deep" mesotrophic lakes may be difficult to distinguish from shore, in which case you should use your best judgement.

d) Shoreline habitat. We are collecting data on both the immediate shoreline (within 5 m or the water – see form) and the broader area of uplands up to 30 m inland (= "nearshore").

For each habitat category present, estimate its % cover in the categories provided. Note that since these are broader categories, the total for each zone will not necessarily add up to an even 100%.

Part Three: Damselfly diversity and abundance

On each visit, surveyors should spend 45-60 minutes searching the survey zone for the target species. If multiple observers are present, the total time can be reduced proportionally so as to achieve the same number of "observer-minutes" (e.g., 2 people searching for 25 min is the same as one searching for 50). The observer(s) should cover the survey area in a systematic fashion, and include searches of shoreline vegetation since many *Enallagma* will spend considerable time in nearby shrubs or grasses, especially under breezy or otherwise less suitable conditions. Most searches can be conducted on foot ("wading" at the top of the form), but where water is deeper it may be important to conduct part of the survey from a boat. Time spent capturing and identifying damselflies (e.g., distinguishing between *laterale* and *recurvatum*) should not count toward the total survey time.

For each target species detected, we will need at least an estimate of relative abundance using the five categories on the form. Actual counts can be substituted in all cases (and are encouraged), but simple "presence/absence" is ultimately insufficient for the purposes of the models we hope to build using these data. If a voucher (specimen or photograph) is taken for a target species, please indicate this in the table, as well as any reproductive behavior observed.

Although not a focus of this project, there is also interest in broader patterns of community composition in damselflies, and space is provided at the bottom of the data form for a list of associated non-target species. Relative abundance can be included for each species if it was noted. Full lists of ALL Odonata (e.g., including dragonflies) are also an option in this section.

Endemic Damselfly Data Form

Site Name _____ **Delorme** (map #) _____
Township _____**County, State**_____
Date _____ **Surveyor(s)** _____
Air Temp _____ % Cloud_____ Wind Speed _____
Time Start : _____**Time Stop:** _____ **Survey Method** Wading_____ Boat_____
Lat/Long (Dec Deg/ utm) _____ _____ Datum _____

Aerial Sketches & Dominant Plant Images	**Sketch**	**Images**
Floating Plant Zone (Spatterdock, Water Lily, Watershield, Pondweed)		
Emergent Broadleaf Zone (Pickerel Weed, Arrowhead, Water Arum)		
Rush/Sedge/Grass Zone (rushes, sedges, grasses, pipewort, spikerush)		
Typha/Phragmites Zone (Cattail, Common Reed)		

Invasive Species Noted:

Near-shore Substrate Type (within 1 m of shoreline – approx % of each type)
Peat____ Silt/Muck ____ Sand/Silt____ Sand____ Gravel____ Boulder/Cobble____ Bedrock _____
Other (specify) _____

pH ____ /____/____ **Conductance** ____ /____/____ (both measured at 5+m intervals, 1 m from shore)

Lake/Pond Type: (entire lake/pond – not just survey zone)
- ☐ Eutrophic (shallow, warm, abundant algae & aquatic veg.)
- ☐ Shallow Mesotrophic (clear, low-mod. amounts of aquatic veg.)
- ☐ Deep Mesotrophic (clear, low-mod. amounts of aquatic veg.)
- ☐ Oligotrophic (very clear, few plants & algae, shallow or deep)
- ☐ Acidic pond (dark color, acidic flora or peatlands nearby)

Shoreline/Nearshore Habitat Characteristics: % cover categories: 0, <5, < 20, < 40, < 60, < 80, < 100 of total

Habitat	**Shoreline of Survey Zone***	**Nearshore** (~5 to 30 m inland)
Deciduous Canopy		
Coniferous Canopy		
Woody Shrubs/Saplings		
Herbaceous Ground Cover		
Forest Harvest Activity		
Agricultural Field		
Old Field		
Mowed Lawn		
Recreational Trail		
Buildings		
Road (specify dirt or paved)		
Piers, Floats, Swimming Areas		
Other (specify types and %)		

***** (extending ~10 m beyond either end of zone & ~ 5m inland)

target species	**relative abundance***	**voucher (sp/ph)**	**tandem**	**wheels**	**ovip**

* 0, 1-5, 6-20, 21-50, 50+

other damselfly species observed:

Appendix 2b. Variables used in habitat models. See text for additional explanation.

Variable Group/Variable (abbreviation)		Model Scale (# variables)		
		Local (8)	**Pond (13)**	**Large (19)**
Abiotic Factors				
	Substrate granularity (Substrate)		X	X
	Mean pH		X	X
Aquatic vegetation				
	Length of macrophyte zone (MacroLgth)		X	X
	Floating plant cover (Floating)	X	X	X
	Broad-leafed emergent cover (Emergent)	X	X	X
	Narrow-leafed emergent cover (Graminoid)	X	X	X
	Cattail/*Phragmites* cover (Typha)	X	X	X
Landscape composition				
	Distance to nearest waterbody (NearPond)		X	X
	Average distance to 4 nearest waterbodies (4 Ponds)		X	X
	Forest cover index 0-5 m (For <5)	X	X	X
	Forest cover index 5-30 m (For <30)	X	X	X
	Impervious surface index 0-5 m (Imp <5)	X	X	X
	Impervious surface index 5-30 m (Imp <30)	X	X	X
	% forest within 75 m (For <75)			X
	% forest within 150 m (For <150)			X
	% forest within 1000 m (For <1000)			X
	% impervious surface within 75 m (Imp <75)			X
	% impervious surface within 150 m (Imp <150)			X
	% impervious surface within 1000m (Imp <1000)			X

Appendix 2c. Results for *Enallagma* habitat models in different regions and scales. Variables listed are those that contribute significantly to a given model's predictive power, whereas "None" indicates that there was no good model for that species/region/scale combination. At the bottom of the variable list, the model's power to predict presence/absence of a given species (in a given region) is indicated as either strong (**) or weak (*). Variables in blue are positive predictors, those in red negative predictors, and those in parentheses have negligible weight. Variables in black show more complicated relationships with species presence, and are discussed in the text where appropriate. Variables highlighted in yellow are significant ones that show up in models for multiple regions for a given species. See text for discussion of model interpretation and **Appendix 2b** for variable names.

Region	**North (NH and ME)**			**South (MA, RI, CT, NY)**		
Model Scale (# variables)	**Local (8)**	**Pond (13)**	**Large (19)**	**Local (8)**	**Pond (13)**	**Large (19)**
E. daeckii	Does not occur			None	MacroLgth Emergent Imp <30 (For <30) (Imp <5) (Mean pH) **	MacroLgth NearPond Floating Imp <1000 *
E. laterale	Floating For <30 Imp <5 (Emergent) (For <5) **	Mean pH Substrate Imp <30 (For <30) **	Mean pH Substrate For <1000 4 Ponds **	None	Substrate Imp <30 Imp <5 For <5 (Emergent) (MacroLgth) **	Substrate Imp <30 Imp <5 For <5 (Emergent) (MacroLgth) **
E. minusculum	None	None	Imp <1000 Imp <75 Mean pH Substrate **	Floating Imp <30 (Graminoid) **	Substrate Floating Imp <30 Typha **	Substrate Floating Imp <150 (Imp <1000) (Imp <30) **
E. pictum	For <30 Imp <5 Floating (Emergent) **	Floating For <30 Substrate For <75 Typha **	Floating Substrate For <30 Imp <150 (Forest <75) (Imp <1000) **	None	None	Mean pH Floating For <1000 Imp <75 (Imp <5) *
E. recurvatum	Does not occur			For <30 Graminoid For <5 Imp <5 **	For <30 For <5 Graminoid (Imp <75) **	Graminoid For <5 Imp <1000 Floating **