Odonata of the Lamprey River, NH

American Rubyspot (*Hetaerina americana*) in Raymond, 18-August-2011. Photo by Pamela Hunt

A report to the Lamprey River Advisory Committee

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Executive Summary

Extensive surveys for Odonata (dragonflies and damselflies) were conducted along the Lamprey River from Northwood to Durham in 2011 and supplemented with data collected in previous years. A total of 74 species has been reported along the river, 29 of which can be considered specialists of rivers and streams. Overall, the percentage and total number of such species at a site increased from the headwaters (mean of 6.5 river species) through the lower portions (e.g., Lee and Durham, mean of 23 river species). This increase in species richness likely results from the increased size and habitat diversity at downstream sites, since only a few species were restricted to upstream areas.

No river species of statewide conservation concern were detected along the Lamprey, probably because these species are more typical of larger rivers like the Connecticut and Merrimack. One common river group – the snaketails in the genus *Ophiogomphus* – seemed relatively rare compared to other rivers in New Hampshire. Given available data, the local rarity of *Ophiogomphus* might be related to in-stream conditions or to a general rarity in coastal plain streams. Issues known to affect the Lamprey, and thus potentially its odonate fauna, include sedimentation, temperature, and extremely high or low flows, but more detailed study would be needed to determine if any of these is affecting local species distributions. Overall, the odonate fauna of the Lamprey appears diverse and healthy and is likely to persist in the absence of large-scale perturbations such as extensive losses of riparian buffers, increased pollution, or excessive alteration of substrate conditions.

Introduction

The Lamprey River is the largest river in the Great Bay watershed of New Hampshire, traveling 47 miles from its headwaters at Meadow Lake in Northwood to its mouth at Great Bay in Newmarket. The lower half of the Lamprey (from Epping to Newmarket) is designated a Wild and Scenic River by the National Park Service and the entire river and its major tributaries are part of the New Hampshire Rivers Management and Protection Program. For much of its course, the Lamprey is in a fairly natural state; however, numerous sections have been altered by human activity, including dams, road crossings, developed areas, and farms.

To address issues facing the river from the multiple human impacts within its watershed, the Lamprey River Advisory Committee (LRAC) and Lamprey River Watershed Association (LRWA) conduct water quality monitoring, promote conservation activities, and provide outreach to residents and visitors within the watershed. The LRAC drafted a management plan that covers the lower portion of the Lamprey in 1995 and revised this document in 2007 (LRAC 2007). The management plan applies only to the designated sections of the river (Epping and downstream) and serves as the foundation for much of the conservation and outreach activity in this area. Water quality monitoring coordinated by the LRWA occurs throughout the watershed. In addition to local volunteer efforts to monitor the Lamprey, two USGS stream gauges – in Raymond and Durham – also measure flows and water levels.

Despite a long history of human use, wildlife habitat in the Lamprey River and its watershed is largely intact. Primary threats facing the river itself include reduced flows, sedimentation, pollutants, invasive species, and development in the river's riparian corridor (LRAC 2007). Among the wildlife priorities for the Lamprey are anadromous fish and freshwater mussels. Until recently, anadromous fish were prevented from accessing the river above the Wiswall Dam in Durham, but a fish ladder was installed in 2011. The river is also home to a diverse assemblage of freshwater mussels, including the endangered brook floater (*Alasmidonta varicosa*). Relatively little is known, however, about the aquatic insect populations in the Lamprey, despite the importance of these insects as parts of river food chains and potential indicators of water quality.

Aquatic insects are often used to assess water quality in rivers, with most efforts focusing on Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). Many of these so-called "EPT taxa" are known to be sensitive to temperature, pollution, oxygen levels, or combinations thereof (e.g., Nebeker and Lemke 1968). Another important component of riverine insect communities is the order Odonata – the dragonflies and damselflies. While apparently less sensitive than the EPT taxa to many environmental perturbations, odonates are larger, more persistent, and easier to identify, thus they can serve as a surrogate group with which to investigate the factors that influence diversity in aquatic systems. In addition, dragonfly exuviae (the larval skins left behind after emergence) are often identifiable to species and these can serve as valuable evidence that rare or elusive species are present in a given area. Amateur naturalists are showing a growing interest in odonates, which facilitates opportunities for the collection of large amounts of data. To this end, the Lamprey River Advisory Committee contracted with NH Audubon to undertake a survey of Odonata along the length of the river as part of a grant awarded by the National Park Service.

The surveys summarized in this report are also part of the New Hampshire Dragonfly Survey (NHDS), a joint project of NH Audubon and the NH Department of Fish and Game. The goals of the NHDS are: 1) collect data on species of potential conservation concern, 2) obtain statewide distributions of all species of Odonata, and 3) educate people about the ecology and conservation of Odonata. During the project's duration (2007-2011), trained volunteer "citizen scientists" collected the bulk of the records, which by the time the NHDS ended numbered over 18,000. In the larger context of the NHDS, this work along the Lamprey River represents the most significant effort along a river in the coastal watershed and, as such, provides a valuable reference point against which future changes can be measured.

Methods

Study Sites

Study sites were chosen to cover the full length of the Lamprey from headwaters to mouth (Figure 1, Table 1). The core of the study consisted of six sites surveyed by Morgan Dube, a student at the University of New Hampshire, who conducted a longitudinal study of the river's Odonata as part of a senior project. An additional four sites were surveyed by the author in an effort to complement Ms. Dube's project. Three of these sites were in Epping, thus filling in a large gap on the river between Raymond and Lee that was not surveyed by Ms. Dube. Two other sites, in addition to the sites visited in 2011, have data from both during (2007-2011) and prior to the NHDS. The latter data cover a range of dates from recent (e.g., 2000s) to over 30 years old (e.g., specimens at UNH).

In total, data from 12 sites were used in the preparation of this report. These have been assigned to four "river segments" based on stream order (Table 1). In general, the upper stretches of the Lamprey are relatively shallow, with the substrate dominated by rocks and gravel. By the middle segment there are more frequent impoundments caused by dams or road crossings, and sediment increases in the river bed in areas of low gradient. These conditions persist into the lower segment, which in most respects does not differ significantly from the middle except for overall flows. Immediately above the head of tide in Newmarket, the Lamprey is heavily impounded by a dam and takes on the character of a pond rather than a river. For this reason, no surveys were conducted in this section.

Data Collection

All data from 2007-2011 were collected using the standards developed for the NHDS. While a specific field protocol was not involved, all data conformed to a common set of codes for abundance, vouchering, and breeding evidence (Hunt 2007). Visits were also spaced out across the season to maximize detection of species with differing flight periods. Sites surveyed by Morgan Dube were visited every two weeks from early June through mid-September. At each visit, Ms. Dube spent one hour searching for exuviae and one hour searching for flying adults. The primary Epping sites surveyed by the author were visited 3-4 times between late May and early September, with 1-2 visits to other sites along the river during this same time interval.

The targeted surveys mentioned above were supplemented by other data collected by the NHDS in 2007-2010 and by historical data from prior to the NHDS. The latter data were collected by a

variety of people over decades and were recently compiled into a statewide database by the author. In many cases, specific localities within towns were not available for these older records and species were tentatively assigned to the Lamprey based on their habitat affinities (Table 2).

Results

A total of 74 species of Odonata were recorded along the Lamprey River, including 29 considered typical of lotic (moving water) environments. Overall species richness was remarkably consistent along the length of the river (25-30 species at most sites), but the pattern for riverine Odonata was much different. In the upper reaches of the river, lentic (still water) species predominate, whereas these comprise an increasingly smaller percentage as one moves downriver (Appendix). The remainder of this report will focus on the lotic group of species, although the full list is available in the Appendix.

Lotic species richness increased consistently from the smaller headwater streams to the Lamprey in Lee and Durham (Figure 2). Seven species were found in all four river segments, although not always at each site. These species are the most generalist of riverine Odonata, rarely requiring habitat features other than flowing water and streamside vegetation. Some also inhabit ponds and marshes near streams. Another nine species were found in all segments *except* the headwaters, while one was restricted to *only* the headwaters segment. Of the remaining twelve species, seven were restricted to the higher order (5-6) portions of the river from Epping to Durham, with the remainder showing a variety of distribution patterns (Table 2).

Summary by family

Riverine Odonata on the Lamprey represent seven of the nine families known in New Hampshire. In general, each family occupies habitats with fairly similar characteristics, as outlined below. See Table 2 for more details on individual species' distributions along the river.

Calopterygidae (broad-winged damsels)

Four of the five New Hampshire species in this riverine-obligate family are known from the Lamprey. All occupy moving water with abundant streamside vegetation and require submerged vegetation for egg-laying. Species vary in specific habitat use, but, in general, all are widely distributed along the river. The least common member of this family – the sparkling jewelwing (*Calopteryx dimidiate*) – is currently known only from three sites in the Raymond-Epping portion of the river. The Lamprey marks the northernmost population of this coastal plain species in North America.

Coenagrionidae (pond damsels)

As the name implies, this group is predominant in lentic waters, with only a few species using streams and rivers. Those that do are often common and widespread, primarily in the lower reaches (4-6th order).

Aeshnidae (darners)

This is another family found primarily in lentic waters. Only two species are typical of rivers and both are widespread along the full length of the Lamprey. The absence of the springtime darner

(*Basiaeschna janata*) from 4th order segments is likely a sampling artifact, since this species tends to occur in lower densities than the fawn darner (*Boyeria vinosa*).

Gomphidae (clubtails)

Clubtails are the quintessential riverine dragonflies, with only a few species found in lentic waters. Twelve of the twenty-nine riverine Odonata found on the Lamprey are in this family. Clubtail larvae burrow into sand, silt, or mud and, as a result, most are found in lower gradient stretches of rivers. This is the case for nine of the twelve species along the Lamprey, the exceptions being 1) eastern least clubtail (*Stylogomphus albistylus*), which prefers riffle areas regardless of stream size, and 2) lancet clubtail and dragonhunter (*Gomphus exilis* and *Hagenius brevistylus*), which tend to be more widespread across habitats, including ponds and lakes. Several species typical of streams with sandy substrates (brook snaketail (*Ophiogomphus aspersus*), common sanddragon (*Progomphus obscurus*), and zebra clubtail (*Stylurus scudderi*)), were rare and found only in one or two segments.

Because clubtails are sometimes sensitive to habitat alteration (e.g., excessive sedimentation, warmer and less oxygen-rich water), some species are considered conservation priorities in parts of the northeastern United States (e.g., Hunt 2006). None of the highest priority species in New Hampshire has been recorded on the Lamprey. The presence of four species of *Ophiogomphus* in the river's lower stretches is of interest, because this genus is often considered a good indicator of higher water quality; however, none of these species was represented by more than three individuals, so it is unclear whether this reflects a decline in habitat suitability or general rarity in the watershed. Members of this genus are far more abundant and widespread to the north and west in New Hampshire, with very few records in the coastal plain overall.

Cordulegastridae (spiketails)

Spiketails are most typical of smaller streams, with only the twin-spotted spiketail (*Cordulegaster maculata*) likely to occur in streams of any size. Even so, this species was sparsely distributed along the length of the Lamprey, while the related delta-spotted spiketail (*Cordulegaster diastatops*) was found only in the headwaters area.

Macromiidae (cruisers)

Of the two New Hampshire species in this family, the stream cruiser (*Didymops transversa*) occurs over a broader range of stream sizes, as indicated by the data from the Lamprey. It tends to occur at low densities, which might explain its spotty distribution in this study. The other species, the swift river cruiser (*Macromia illinoiensis*) is more typical of larger rivers, but also seems less common than expected.

Cordulidae (emeralds)

Most members of this family inhabit ponds and bogs, with only a handful occurring in moving water. One of these is the generalist common baskettail (*Epitheca cynosura*), which is found in medium-sized streams as well as lentic habitats. Two riverine obligates are Uhler's sundragon (*Helocordulia uhleri*), a locally distributed species along the Lamprey, and the umber shadowdragon (*Neurocordulia obsoleta*), which is typical of slow stretches of higher order streams.

Discussion/Implications

The data presented in this report constitute the first comprehensive survey of Odonata along the entire length of a New Hampshire river. While extensive data exist for the Connecticut (Hunt et al 2010), Contoocook, Merrimack, and Androscoggin rivers, these are all much longer rivers, resulting in sites being significantly farther apart.

In general, the species mix on the Lamprey is similar to that of other well-surveyed rivers. A notable exception is the absence of 5-6 species more typical of larger rivers such as the Connecticut and Merrimack. In addition, as noted in the family accounts, some species reach distributional limits at different latitudes. In this regard, the Lamprey has a few southern species and few if any northern ones. The Lamprey also lacks the two species of pygmy clubtails (genus *Lanthus*), which are generally typical of very small – even intermittent – streams. One of these, the southern pygmy clubtail (*L. vernalis*) has been recorded in Lee and could possibly occur in the Lamprey headwaters region, as well as along tributary streams.

Through the efforts of the NHDS, the majority of riverine Odonata have been shown to be more common and widespread than previously believed. As a result, several species tentatively identified as of conservation concern (Hunt 2006) might not warrant such additional attention. Only two species of common to higher order rivers remain of concern (rapids clubtail (*Gomphus quadricolor*) and skillet clubtail (*G. ventricosus*)), but neither of these has been recorded in the Lamprey or anywhere in the coastal watershed. Of the species in the Lamprey, the clubtails in the genus *Ophiogomphus* are perhaps of the most conservation interest, as will be discussed below.

Perhaps the greatest threats to riverine Odonata involve changes in the composition of the river bed. Evidence suggests that species that prefer sand or gravel substrates will disappear from reaches above impoundments as these are increasingly dominated by mud or silt (Wagner and Thomas 1999). The Lamprey has few significant impoundments, although there are multiple slow stretches where sedimentation is a potential issue. Most of the areas surveyed for this project were generally not associated with ponded areas (Raymond 2 and Epping 1 being the main exceptions), and thus not likely affected by any major sediment issues. A more specialized study might be required to make direct comparisons between impounded and free-flowing sections of the river, studies which would also need to measure substrate characteristics.

Sedimentation can also be a problem after significant storm events, such as those that have happened along the Lamprey multiple times in the last five years (Figure 3). As in the case with impoundments, a rapid discharge of sediment-laden water from upstream can dramatically alter conditions where this sediment settles out. Such sedimentation has been proposed as a major factor behind dramatic declines in populations of brook floater mussels in the Lamprey (E. Nadeau, pers. comm.). Alternatively, storm scouring may remove sediment from higher gradient river reaches and, thus, reduce habitat suitability for burrowing invertebrates.

While the physiology of river dragonflies has not been extensively studied, some species are believed to be sensitive to low dissolved oxygen levels. These species tend to predominate in cooler, higher gradient streams. As a result, conditions that result in warming, including lower flows and/or high summer temperatures, might limit the ability of oxygen-sensitive species to

occupy some stream reaches. Dissolved oxygen can also be depleted in slow stretches where excessive nutrient inputs foster the growth of algae or aquatic plants. Data from the Lamprey (Walsh et al. 2011) indicate that dissolved oxygen levels in the river meet New Hampshire water quality standards, although the relevance of these standards to river Odonata is unknown. In one study, two dragonflies typical of higher-order streams – fawn darner and rusty snaketail – had the highest temperature tolerances of twelve aquatic insects tested (Nebeker and Lemke 1968), suggesting that there is considerable potential for adaptation within the order.

Flows in the Lamprey River are highly variable, both within and between years (Figure 3). While the long-term average shows a pulse in spring followed by a gradual decline and stable flows through September, this pattern does not typically manifest in most years. Instead, there are years with high spring flows (2007, 2011), high summer flows (2008, 2009), or generally low flows throughout (2010). Three of the last five years have seen below-average flows for most of the summer, during the same period when high temperatures have the potential to significantly increase water temperatures. As noted above, recent extreme flood events have significantly altered the distribution of sediment in many stretches of the Lamprey.

Among dragonflies and damselflies, the *Ophiogomphus* snaketails might be more vulnerable than other river species to changes in flows. Most snaketails live in well-aerated streams with sand and gravel substrates (Gibbs et al. 2004), and local extinction has been documented above dams at the southern edge of some species' ranges (e.g., Wagner and Thomas 1999). The four species documented in the Lamprey during the present study were never common (1-3 records of each). Given known sediment issues on the Lamprey, the possibility exists that they have suffered reduced populations in the same manner as mussels. Two other issues complicate such a hypothesis: First, these same species are generally rare throughout the coastal watershed, occurring in similarly low numbers in the Exeter, Cocheco, and Salmon Falls rivers in various combinations. The Lamprey might, therefore, represent the edge of their ranges, where species tend to occur in lower densities. Second, most clubtail larvae take several years to mature (Gibbs et al. 2004, and years of low abundance may reflect a small annual cohort rather than a small population overall. Similarly, they often emerge synchronously over a narrow range of dates and if surveys do not occur during the peak emergence, the species might appear less common than it actually is. Given the frequency with which the Lamprey was surveyed in 2011, this latter explanation for the rarity of *Ophiogomphus* is unlikely. In the absence of comprehensive historical data, it is, in any event, impossible to determine whether this genus has declined in the Lamprey or is simply rare, but the present study can now serve as a valuable baseline against which future changes can be assessed.

Other issues generally considered in the conservation of riverine dragonflies are water pollution, shading, and the condition of the riparian buffer (Samways and Steytler 1996). Many dragonflies appear tolerant of pollutants and this problem is usually less severe in higher gradient systems like most of the Lamprey. Shading generally affects streams through its role in temperature moderation, with subsequent changes in dissolved oxygen concentration and/or plant growth. In addition to providing shade, riparian vegetation can be important during emergence, when it provides shelter for dragonflies that are still soft-bodied and highly vulnerable to predators. A comprehensive study in South Africa (Samways and Steytler 1996) proposed a vegetated buffer of 20-30 meters along streams to allow for both sufficient shading and suitable resting habitat.

Because the Lamprey remains largely forested, neither the shade nor buffer issues are likely of major significance to the river's odonate community, although negative effects are certainly possible in localized areas where multiple stressors co-occur. In addition, some data (e.g., Ormerod et al. 1990) suggest that the composition of riparian vegetation can influence species distributions, but such studies have not been conducted for Odonata found in the Lamprey.

Overall, the Odonata of the Lamprey River appear to be secure from a conservation standpoint and can only benefit from continued protection of riparian corridors and careful consideration of point and non-point inputs of fertilizers, waste, and stormwater. If sedimentation is indeed affecting a handful of species, there is little that can be done to mitigate such impacts from a dragonfly perspective. If a given species persists elsewhere in the river – or in nearby rivers – chances are good that it can disperse back into an affected stretch with time and even recolonize areas where the current substrate remains altered.

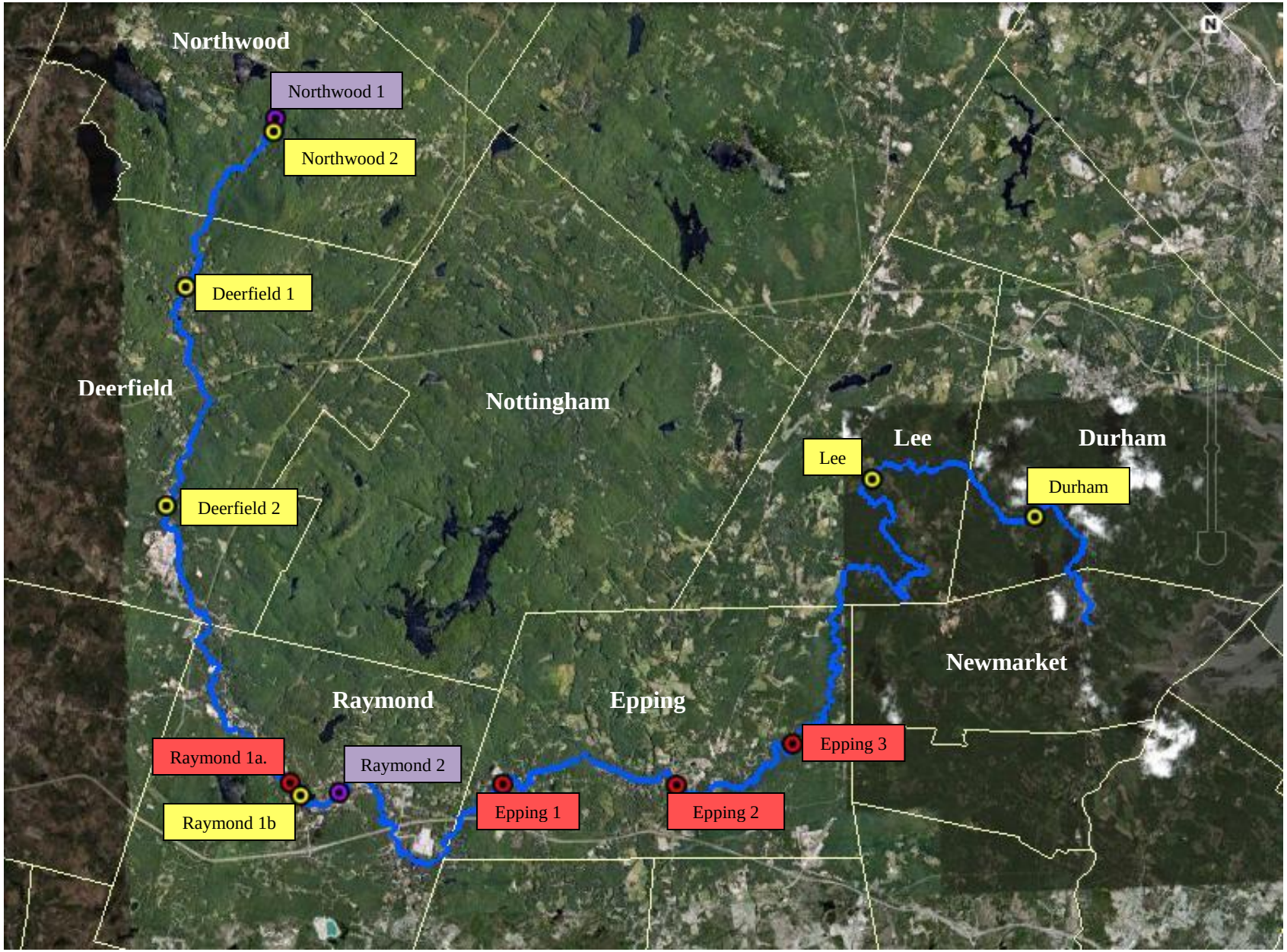


Figure 1. Locations of study sites along the Lamprey River (river shown in blue). Yellow sites surveyed primarily by Morgan Dube, red sites by Pamela Hunt, and purple sites by a combination of NHDS volunteers. See Table 1 for more details.

Table 1. Sites visited along Lamprey River and surveyed for Odonata from 2002-2011.

Site Code	Position	Site Name and description	River Segment	Stream Order	# of visits *	Latitude	Longitude
Northwood 1	0	Meadow Lake and adjacent areas of Northwood Meadows State Park	Headwaters	NA	4	43.201	71.206
Northwood 2	1	small stream that enters the Lamprey below Meadow Lake	Headwaters	1	7	43.202	71.201
Deerfield 1	2	Lamprey River @ Blake Hill Road	Upper	3	7	43.163	71.234
Deerfield 2	3	Lamprey River @ southern junction of Routes 43 and 107	Upper	4	7	43.105	71.242
Raymond 1	4	Lamprey River from (a) Langford Road to (b) Griffins Mill	Upper	4	10	(a) 43.042 (b) 43.040	(a) 71.202 (b) 71.199
Raymond 2	5	Lamprey River @ Main Street	Upper	4	2	43.038	71.185
Epping 1	6	Lamprey River @ Mary Blair Park	Middle	5	3	43.040	71.130
Epping 2	7	Lamprey River behind Epping Town Hall	Middle	5	6	43.040	71.074
Epping 3	8	Lamprey River @ Route 87	Middle	5	5	43.050	71.034
Lee	9	Lamprey River @ Lee Hook Road	Lower	6	13	43.114	71.005
Durham	10	Lamprey River @ Packer's Falls	Lower	6	8	43.103	70.952

* Includes data from 2000s prior to NHDS. Sites with 7 or more visits were part of Morgan Dube's senior research project at UNH during 2011.

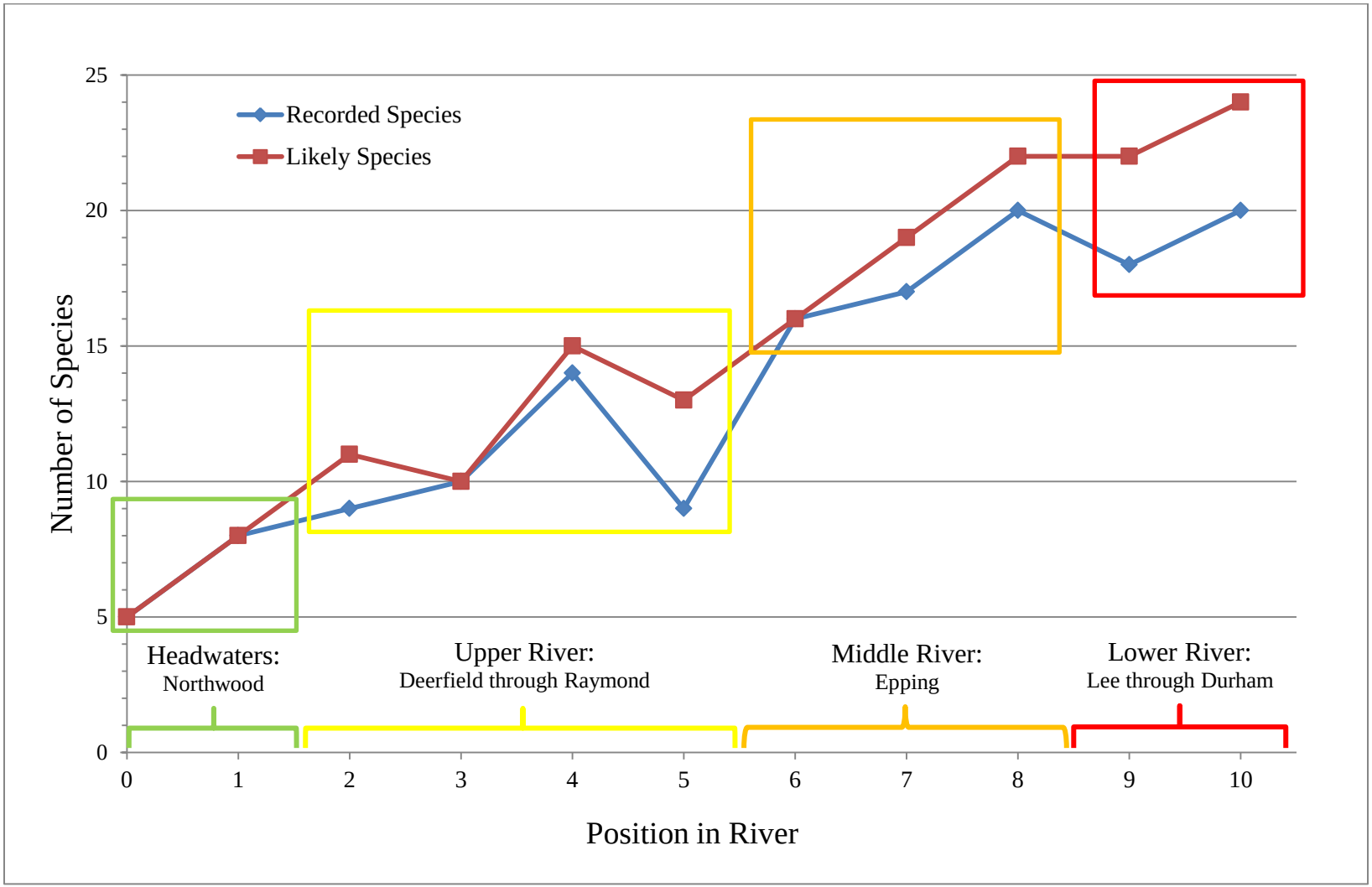
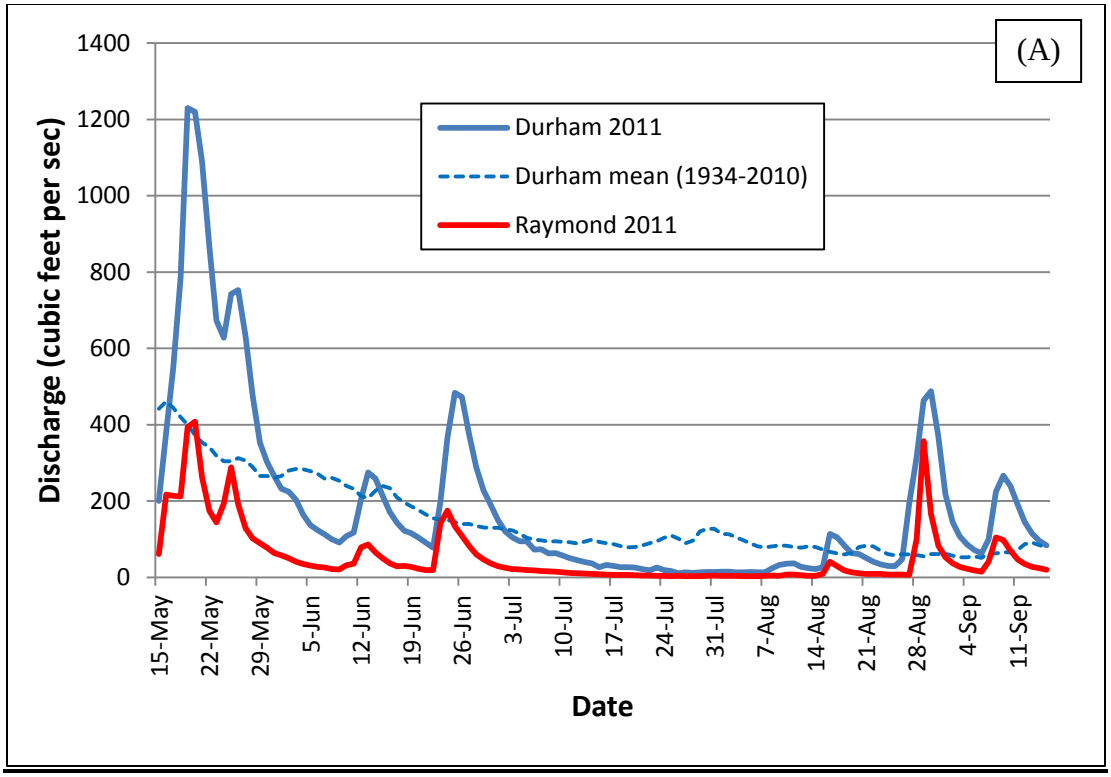


Figure 2. Odonata species richness along the Lamprey River. Colored boxes correspond to the four river segments as defined in Table 1. For details on sites see Figure 1 and Table 1.

Table 2. Distribution and abundance of 29 riverine Odonata along the Lamprey River, NH. Key to species data as follows: U = uncommon (usually <6 individuals/visit), C = common (6-20 individuals/visit), A = abundant (>20 individuals/visit), H = historic record (predating the NHDS) from this site, H? = historic record from this town but not specifically associated with this site, p = species likely to occur at site based on presence at sites immediately up and down stream. "Number of riverine species" includes categories U, C, A, and H, while "likely species" also includes H? and p.

	Stream order:	NA	1	3	4	4	4	5	5	5	6	6
Scientific Name	**Common Name**	Northwood 1	Northwood 2	Deerfield 1	Deerfield 2	Raymond 1	Raymond 2	Epping 1	Epping 2	Epping 3	Lee	Durham
CALOPTERYGIDAE												
Calopteryx aequabilis	river jewelwing			U	U	U	p	U	U	U	C	U
Calopteryx dimidiata	sparkling jewelwing					U			H	U		
Calopteryx maculata	ebony jewelwing		U	C	A	C	H?	U	U	C	C	C
Hetaerina americana	American rubyspot					C			U	p	H	C
COENAGRIONIDAE												
Argia fumipennis	variable dancer	U	U	C	C	A	A	U	C	A	C	C
Argia moesta	powdered dancer				U	A	U	A	C	C	A	A
Enallagma divigans	turquoise bluet						U	A	p	U		
Enallagma exsulans	stream bluet					C	A	A	C	A	C	A
AESHNIDAE												
Basiaeschna janata	springtime darner	U		U				U	U	U	U	U
Boyeria vinosa	fawn darner		U	C	C	U	p	U	U	C	U	C
GOMPHIDAE												
Dromogomphus spinosus	black-shouldered spinylegs		U			H?	p	U	U	C	U	U
Gomphus abbreviatus	spine-crowned clubtail							C	U	A	p	C
Gomphus adelphus	mustached clubtail										U	H?
Gomphus exilis	lancet clubtail	U	C	U	U	U	U	C	U	U	U	C
Hagenius brevistylus	dragonhunter			U	U	U	U	U	U	C	U	U
Ophiogomphus aspersus	brook snaketail					U						H?
Ophiogomphus carolus	riffle snaketail										U	U
Ophiogomphus mainensis	Maine snaketail											U
Ophiogomphus rupinsulensis	rusty snaketail									U	U	U
Progomphus obscurus	common sanddragon								H	H	U	
Stylogomphus albistylus	eastern least clubtail			U	A	C	U	U	p	U	U	U
Stylurus scudderi	zebra clubtail									U	p	H?
CORDULEGASTRIDAE												
Cordulegaster diastatops	delta-spotted spiketail		U									
Cordulegaster maculata	twin-spotted spiketail		U	p	U					U	p	H?
MACROMIDAE												
Didymops transversa	stream cruiser	U							U	p	U	U
Macromia illinoiensis	swift river cruiser					U				U	H?	H
CORDULIDAE												
Epitheca cynosura	common baskettail	U	U	p	U	U	U	U	U			
Helocordulia uhleri	Uhler's sundragon			U				U				C
Neurocordulia obsoleta	umber shadowdragon						U	A	U	C	U	C
	number of riverine species:	5	8	9	10	14	9	16	17	20	18	20
	likely riverine species:	5	8	11	10	15	13	16	19	22	22	24
	mean (likely) by stream order:	6.5		12.25				19.0			23.0	



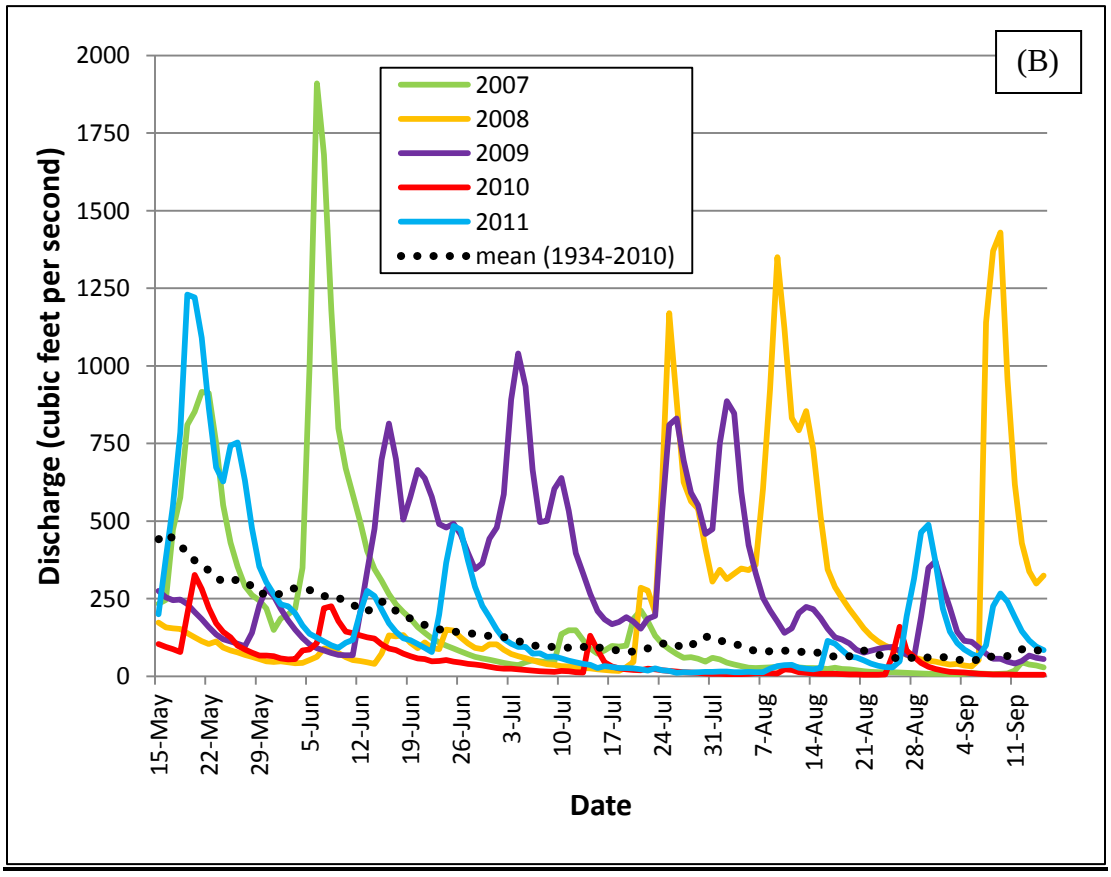


Figure 3. Stream discharge data for the Lamprey River. A) Comparison of an upstream (Raymond) and downstream (Durham) station during the survey period in 2011. B) Data from the Durham station from 2007 to 2011. Data from USGS (http://nh.water.usgs.gov/WaterData/index.htm).

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Appendix. Distribution of all Odonata recorded along the Lamprey River, excluding uncertain records (H? and ? from Table 2). See Table 1 for details on sites.

Scientific Name	Common Name	Northwood 1	Northwood 2	Deerfield 1	Deerfield 2	Raymond 1	Raymond 2	Epping 1	Epping 2	Epping 3	Lee	Durham		Headwaters	Upper	Middle	Lower
CALOPTERYGIDAE	**BROAD-WINGED DAMSELS**																
Calopteryx aequabilis	river jewelwing			x	x	x		x	x	x	x	x			x	x	x
Calopteryx dimidiata	sparkling jewelwing					x			x	x					x	x	
Calopteryx maculata	ebony jewelwing		x	x	x	x		x	x	x	x	x		x	x	x	x
Hetaerina americana	American rubyspot					x			x		x	x			x	x	x
LESTIDAE	**SPREADWINGS**																
Lestes congener	spotted spreadwing			x								x			x		x
Lestes inaequalis	elegant spreadwing			x											x		
Lestes rectangularis	slender spreadwing	x	x	x	x	x		x						x	x	x	
Lestes vigilax	swamp spreadwing			x				x							x	x	x
COENAGRIONIDAE	**POND DAMSELS**																
Argia fumipennis	variable dancer	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x
Argia moesta	powdered dancer				x	x	x	x	x	x	x	x			x	x	x
Chromagrion conditum	aurora damsel			x											x		
Enallagma divigans	turquoise bluet						x	x		x					x	x	
Enallagma exsulans	stream bluet					x	x	x	x	x	x	x			x	x	x
Enallagma geminatum	skimming bluet						x								x		
Enallagma signatum	orange bluet						x		x						x	x	x
Ischnura posita	fragile forktail			x	x	x	x	x	x	x	x				x	x	x
Ischnira verticalis	eastern forktail		x			x	x	x	x	x	x	x		x	x	x	x
Nehalennia gracilis	sphagnum sprite		x											x			
Nehalennia irene	sedge sprite		x											x			
AESHNIDAE	**DARNERS**																
Aeshna canadensis	Canada darner	x		x										x	x		
Aeshna tuberculifera	black-tipped darner	x												x			
Aeshna umbrosa	shadow darner	x	x	x								x		x	x		x
Aeshna verticalis	green-striped darner	x									x			x			x
Anax junius	common green darner	x												x			

Scientific Name	Common Name	Northwood 1	Northwood 2	Deerfield 1	Deerfield 2	Raymond 1	Raymond 2	Epping 1	Epping 2	Epping 3	Lee	Durham		Headwaters	Upper	Middle	Lower
Basiaeschna janata	springtime darner	x		x				x	x	x	x	x		x	x	x	x
Boyeria vinosa	fawn darner		x	x	x	x		x	x	x	x	x		x	x	x	x
Nasiaeschna pentacantha	Cyrano darner							x								x	
GOMPHIDAE	**CLUBTAILS**																
Dromogomphus spinosus	black-shouldered spinylegs		x					x	x	x	x	x		x		x	x
Gomphus abbreviatus	spine-crowned clubtail							x	x	x		x				x	x
Gomphus adelphus	mustached clubtail										x						x
Gomphus borealis	beaverpond clubtail	x												x			
Gomphus exilis	lancet clubtail	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x
Gomphus spicatus	dusky clubtail		x			x								x	x		
Hagenius brevistylus	dragonhunter			x	x	x	x	x	x	x	x	x			x	x	x
Ophiogomphus aspersus	brook snaketail					x									x		x
Ophiogomphus carolus	riffle snaketail										x	x					x
Ophiogomphus mainensis	Maine snaketail											x					x
Ophiogomphus rupinsulensis	rusty snaketail									x	x	x				x	x
Progomphus obscurus	common sanddragon								x	x	x					x	x
Stylogomphus albistylus	eastern least clubtail			x	x	x	x	x		x	x	x			x	x	x
Stylurus scudderi	zebra clubtail									x						x	x
CORDULEGASTRIDAE	**SPIKETAILS**																
Cordulegaster diastatops	delta-spotted spiketail		x											x			
Cordulegaster maculata	twin-spotted spiketail		x		x					x				x	x	x	x
MACROMIIDAE	**CRUISERS**																
Didymops transversa	stream cruiser	x							x		x	x		x		x	x
Macromia illinoiensis	swift river cruiser					x				x		x			x	x	x
CORDULIDAE	**EMERALDS**																
Cordulia shurtleffi	American emerald	x												x			
Dorocordulia lepida	petite emerald	x												x			
Dorocordulia libera	racket-tailed emerald	x	x						x					x		x	
Epitheca canis	beaverpond baskettail					x									x		
Epitheca cynosura	common baskettail	x	x		x	x	x	x	x					x	x	x	

Scientific Name	Common Name	Northwood 1	Northwood 2	Deerfield 1	Deerfield 2	Raymond 1	Raymond 2	Epping 1	Epping 2	Epping 3	Lee	Durham		Headwaters	Upper	Middle	Lower
Epitheca princeps	prince baskettail						x								x		
Epitheca spingera	spiny baskettail	x												x			
Helocordulia uhleri	Uhler's sundragon			x				x				x			x	x	x
Neurocordulia obsoleta	umber shadowdragon						x	x	x	x	x	x			x	x	x
Somatochlora williamsonii	Williamson's emerald	x												x			
LIBELLULIDAE	**SKIMMERS**																
Celithemis elisa	calico pennant	x	x						x					x		x	
Celithemis eponina	Halloween pennant		x						x		x	x		x		x	x
Erythemis simpicicolis	eastern pondhawk	x	x											x			
Leucorrhinia frigida	frosted whiteface	x	x											x			
Leucorrhinia hudsonica	Hudsonian whiteface			x											x		
Leucorrhinia proxima	belted whiteface			x											x		
Ladona exusta	white corporal	x												x			
Ladona julia	chalk-fronted corporal	x	x	x	x			x						x	x	x	
Libellula cyanea	spangled skimmer	x	x	x	x	x								x	x		
Libellua incesta	slaty skimmer	x	x		x	x	x	x	x	x	x	x		x	x	x	x
Libellula luctuosa	widow skimmer		x				x	x	x	x	x	x		x	x	x	x
Libellula pulchella	twelve-spotted skimmer	x			x						x	x		x	x		x
Libellula quadrimaculata	four-spotted skimmer	x							x					x		x	
Pachydiplax longipennis	blue dasher	x	x	x	x	x	x	x	x	x				x	x	x	
Pantala flavescens	wandering glider										x						x
Perithemis tenera	eastern amberwing						x								x		
Plathymis lydia	common whitetail	x	x					x		x		x		x		x	x
Sympetrum internum	cherry-faced meadowhawk	x	x	x	x	x					x			x	x		x
Sympetrum vicinum	autumn meadowhawk	x	x	x	x	x		x		x	x	x		x	x	x	x
# species	74	30	27	24	19	24	18	27	27	27	28	29		41	44	40	40
# riverine species	29	5	8	9	10	14	9	9	17	20	18	20		10	20	24	25
percent riverine species	39	17	30	38	53	58	50	33	63	74	64	69		24	45	60	63