Freshwater Mussel Survey in the Lamprey River and Exeter River Watersheds in Southeastern New Hampshire

Prepared for New Hampshire Fish and Game Department, Nongame Wildlife Program and the Lamprey River Advisory Committee

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SUMMARY

The summer 2010 survey investigated what species occur in the river and paid particular attention to sites that traditionally supported brook floater mussels, an endangered species in New Hampshire. These mussels require very clean, clear water and do not tolerate burial from material that drops from the water. The Lamprey has historically provided suitable habitat and supported a viable population.

The report indicates that populations of 5 of 6 mussel species in the Lamprey are in serious decline. Observations during the study seem to implicate heavy sedimentation due to severe storms and flooding as the cause.

INTRODUCTION

Biodrawversity LLC conducted a freshwater mussel survey in the Lamprey River and its tributaries, and the Exeter River in southeast New Hampshire. New Hampshire Fish and Game (NHFG) funded surveys in both watersheds to update records of the state-endangered brook floater (*Alasmidonta varicosa*). The Lamprey River Advisory Committee (LRAC) contributed additional funds for a watershed-wide freshwater mussel survey to supplement the NHFG project and to establish baseline conditions for mussel populations in the watershed. Historically, these two rivers might have supported up to seven freshwater mussel species, including eastern elliptio (*Elliptio complanata*), creeper (*Strophitus undulatus*), triangle floater (Alasmidonta undulata), brook floater, eastern lampmussel (Lampsilis radiata), eastern floater (*Pyganodon cataracta*), and alewife floater *(Anodonta implicata*). Of these seven species, only the brook floater is protected by New Hampshire's Endangered Species Act.

Freshwater mussels are important to the ecology of aquatic ecosystems and are also important indicators of ecosystem health (Nedeau 2008). Abundant and species-rich mussel assemblages might indicate good water quality, optimal physical habitat, and healthy and diverse native fish assemblages. The loss or decline of mussel species might indicate chronic problems such as poor water quality, loss of host fish, or habitat alteration. Unfortunately, the loss or decline of mussel species appears to be a common theme in streams and rivers throughout North America, and New Hampshire's rivers are no exception. Because mussels are long-lived animals (15 to >50 years), it is often difficult to detect population trends without careful long-term monitoring, and, therefore, it is also difficult to know when to raise concern and set priorities for protection. People had already raised concern about brook floater populations in the Exeter River and Lamprey River; this survey was considered a last-ditch effort to find the species in the Exeter River, and was a long-overdue resurvey of the Lamprey River's brook floater population.

The Brook Floater

The brook floater, which might be the most habitat-specific and sensitive mussel species in New England, appears to be on a trajectory toward extirpation in at least half of its native rivers in New Hampshire. In New Hampshire, brook floaters occur in the Connecticut and Merrimack Rivers and in coastal watersheds. Of the ten rivers where brook floaters have been found in the last three decades, only three (Suncook, Soucook, and Blackwater Rivers) might support viable populations. Historically, they may have been more widely distributed in New Hampshire, but they might have been eliminated from some watersheds during the first three centuries following European settlement (prior to the 1980s) before thorough mussel surveys were ever conducted. Prior to this survey, the brook floater was thought to be nearly (if not already) extirpated in the Exeter River, and its populations were fragmented and highly vulnerable in the Lamprey River.

The brook floater is one of the most endangered freshwater animals in northeastern North America. Outside of New Hampshire, it is listed as Endangered in Massachusetts and Connecticut; Threatened in Vermont, Maine, and New York; and extirpated in Rhode Island (Nedeau 2008). With few exceptions, qualitative surveys throughout the Northeast have generally demonstrated low population densities, fragmented distribution, limited or no evidence of recruitment, declining populations, and poor condition of individuals (i.e., excessive shell erosion). Biologists in the Northeast—from Maryland to New Brunswick—have all expressed concerns about the brook floater in the last decade for similar reasons and there is growing consensus that federal protection might be justifiable. There is an urgent need to identify where populations occur, assess population viability, identify environmental factors that are affecting known populations, and develop and implement protection and restoration strategies.

Brook floaters inhabit streams and rivers of varying sizes in shallow water, low to moderate flow velocities, and stable substrates. In fast water, they will often be found clustered in hydraulic refugia such as behind boulders and along streambanks. The brook floater never occurs in lakes or ponds, but may inhabit the upstream ends of small impoundments created by lowhead run-of-river dams. Like most other mussel species, the brook floater is rare or absent in headwater streams and high-gradient river reaches that are prone to scour. It is frequently found in streams with low calcium levels, low nutrients, and good water quality.

Like other native mussel species, the larval phase of a brook floater, called a glochidia, is an external parasite on fish. The parasitic phase is essential for larval development and is also the period of a mussel's life cycle when long-distance dispersal may occur. Laboratory studies indicate that the brook floater is a host generalist. Glochidia are capable of transforming on a variety of host fish species: longnose dace (*Rhinicthys cataractae*), blacknose dace (*Rhinicthys atratulus*), golden shiner (*Notemigonas chrysoleucas)*, pumpkinseed sunfish (*Lepomis gibbosus*), yellow perch (*Perca flavescens*), tessellated darter (*Etheostoma olmstedi*), margined madtom (*Noturus insignis*), and slimy sculpin (*Cottus cognatus*) (Barry Wicklow, Saint Anselm College, unpublished data). Given its large number of widely distributed host fish, the brook floater's rarity is likely due to aspects of its biology and ecology that are unrelated to host availability, such as sensitivity to water quality or habitat conditions. The brook floater has a unique tendency to gape (relax its adductor muscles and open its valves) when removed from the sediment, making it vulnerable to predators, tissue damage, and desiccation. It is not known how this trait might contribute to its sensitivity and rarity.

Its populations are often restricted to river segments occurring in relatively undisturbed areas of watersheds, often upstream of urban areas, suggesting that it may be sensitive to many of the stressors present in developed watersheds. Stream fragmentation resulting from dams, causeways, impoundments, channelization, and inhospitable stream segments results in fragmented populations. Many populations have such low densities that there is a high risk of extirpation from stochastic demographic or environmental events. Brook floaters in New Hampshire have very small linear ranges within rivers, which makes them especially vulnerable to human impacts.

STUDY SITES

Mussel surveys were confined to the mainstem Exeter River (six sites) and the Lamprey River watershed with much emphasis on the Lamprey River in Epping and Lee where brook floaters historically occurred. In the Lamprey River watershed, surveys were also conducted in the Piscassic River, North River, Hartford Brook, North Branch River, Little River, and Pawtuckaway River. A total of 31 "sites" were surveyed, but some of these were long continuous surveys covering 0.5-3.0 miles of habitat and lasting as long as 24 person-hrs per "site".

These types of continuous, long-duration surveys are the best way to document the distribution of highly fragmented populations of rare species, but the tradeoff is that fewer sites can be surveyed within an allotted amount of time. Site selection was based on where brook floater were historically known to occur (if known), with additional sites selected based on habitat suitability and access. Much of the focus was on finding brook floater, and, therefore, unsuitable impoundments and lakes were not surveyed. Streams considered too small for brook floater were often surveyed to determine if eastern pearlshell (*Margaritafera margaritafera*) existed in the watershed, but small high-gradient headwater streams were not surveyed because mussels typically do not occur in these systems.

METHODS

- Two biologists worked together at all times to conduct snorkel surveys of the Lamprey River and Exeter River. One person conducted snorkel surveys in tributaries of the Lamprey River. Surveys were conducted on 11 days between July 22 and September 1, 2010. Five people took part in the surveys, led by either Ethan Nedeau or Jeff Cole of Biodrawversity.
- All surveys were timed; survey times ranged from 15 minutes at sites with no potential mussel habitat, to 24 person-hrs (12 hrs x 2 people) in long continuous stream sections. Actual survey times (minus time for set-up, moving between sites, recording data, and rest stops) were recorded so that catch-per-unit-effort (CPUE) could be accurately computed.
- Surveys were adaptive; more time was spent in suitable habitats and where target species were encountered. Surveyors passed relatively quickly through unsuitable habitats such as deep deadwater sections (such as upstream of the Wadleigh Falls Dam) or sections with very high gradient.
- Surveyors recorded precise counts for uncommon mussels and either counted or estimated abundance of common species; only eastern elliptio was common enough to preclude exact tallies although accurate counts of elliptio were recorded in two long stream reaches. CPUE statistics were computed for each species at each survey site.
- Originally, we had intended to include quantitative surveys using quadrats or transects in areas where brook floaters were at higher densities. Limited substrate excavation was also going to be conducted to detect juvenile mussels. However, extremely low encounter rates precluded use of quantitative methods, and instead, we only conducted qualitative surveys to attempt to detect as many animals as possible.
- Shell length and shell condition of brook floaters were recorded to assess age structure, recruitment, and shell condition. All brook floaters were photographed to keep a digital record of shell condition. We also recorded microhabitat (depth, substrate, flow conditions) and a GPS location of each brook floater encountered during the survey.

- At all survey sites, general habitat parameters were noted, including substrate, flow, river depth and width, major channel features, aquatic vegetation, and adjacent land use. Representative habitat photographs were taken at all sites. Presence and species of snails were noted at many of the survey sites.
- Spatial data were entered into GIS (ArcGIS 9.2). Relevant datalayers (orthophotos, hydrography, land use, etc.) were included in the GIS analysis.

RESULTS

1. Species Assemblage and Relative Abundance

Six mussel species were found during the survey, including (in order of abundance) eastern elliptio, eastern lampmussel, triangle floater, brook floater, creeper, and eastern floater. Of these, only three species were found in the Exeter River, including several thousand eastern elliptios, approximately 350 eastern lampmussels, and six triangle floaters. All six surveyed tributaries of the Lamprey River supported mussels, but collectively, only three species were found including approximately 350-400 eastern elliptios, seven triangle floaters, and two eastern floaters. In the Lamprey River, where most of the survey effort was focused, five species were found including high densities of eastern elliptios, approximately 40 eastern lampmussels, 30 triangle floaters, 11 brook floaters, and four creepers.

2. Species Summaries

Eastern Elliptio: This species was present in all of the waterbodies surveyed for this report and greatly outnumbered all other species. Although precise tallies were not always recorded, counts were recorded for two long reaches of the Lamprey River and it outnumbered all other species combined by 400:1. Both the Lamprey River and Exeter River contained high densities of this species. All size classes of eastern elliptio were present in both the Lamprey River and Exeter River, perhaps slightly biased toward smaller animals, suggesting high level of recruitment with some evidence of limited longevity or high adult mortality rates. Relatively low numbers were found in Hartford Brook, Pawtuckaway River, and North Branch River. Overall, there was strong evidence of viable eastern elliptio populations throughout the Lamprey River and its larger tributaries, and the Exeter River.

Eastern Lampmussel: This species was present in the Lamprey River but occurred at low densities; approximately only 40 animals were found at seven of 12 survey "sites". Most animals (17) were found at Site 8 (L-8) during a relatively brief survey; eastern lampmussel CPUE at this site was 6.8 mussels/person-hr, which was nearly six times higher than it was at any other survey site in the Lamprey River. Elsewhere in the Lamprey River, the average CPUE for eastern lampmussels was only 0.49 mussels/person-hr, meaning that on average it took

approximately two hours to find a single eastern lampmussel. This species was not found in any of the Lamprey River's tributaries. The species was found at two of the six survey sites in the Exeter River, including approximately 300 animals at Site 2 (E-2) and 50 animals at Site 1 (E-1). Overall, the Lamprey River population may be in jeopardy because of low population densities; we found just one area where recruitment is likely occurring. The Exeter River population might be faring better based on relatively high densities in two of the survey sites.

Triangle Floater: The triangle floater was widely distributed in both the Lamprey River and Exeter River watersheds, but at very low densities. A total of only 30 was found in the Lamprey River, seven animals (combined) were found in four tributaries of the Lamprey River, and six live animals were found in the Exeter River. Most animals (15) were found at Site 8 (L-8) during a relatively brief survey; triangle floater CPUE at this site was 6.0 mussels/person-hr, which was nearly six times higher than it was at any other survey site in the Lamprey River. Elsewhere in the Lamprey River, the average CPUE for triangle floater was only 0.31 mussels/person-hr, meaning that on average it took more than three hours to find a single triangle floater. Except for the four live animals found at one site in the Piscassic River, live counts at other tributaries were either 0 or 1. Although evidence of recruitment was not observed (i.e., very small animals), most of the animals were "middle aged" and had fairly intact shells, and we provide no evidence of a geriatric population. At the site with highest triangle floater densities, average shell length was 46.8 mm (range: 41-52 mm). Overall, triangle floater populations in the Lamprey River and its tributaries, and in the Exeter River, may be in jeopardy based on low population densities and limited evidence of recruitment.

Creeper: Although not state-listed in New Hampshire, this may be the rarest freshwater mussel species in the Lamprey River based on results of our surveys. Only four live creepers were found in the mainstem Lamprey River, and none in the tributaries or in the Exeter River. Three creepers were found in the lowermost surveyed reach of the Lamprey River between Wiswall Dam and Wadleigh Falls Dam, for a CPUE of 0.18 mussels/hr for that survey reach. But for the Lamprey River alone, average CPUE was 0.02, meaning it took an average of 50 hours to find a single creeper. Overall, the creeper population is likely terminal in the Lamprey River; it is difficult to fathom any other outcome for such a low-density population unless they are concentrated in areas that we did not survey.

Eastern Floater: Only two eastern floaters were found during the survey, both in the North River. This species is almost always rare in streams and small rivers, but quite common in lakes and ponds. It can even tolerate eutrophic, man-made farm ponds. The species is probably stable in lakes and ponds in the watershed.

Brook Floater: We were unable to locate any brook floaters in the Exeter River, which further strengthens the conclusion that the species is extirpated from the

watershed. We did not detect the species in any of the tributaries of the Lamprey River, nor did we observe suitable habitat in these streams.

Only 11 live brook floaters, and no shells, were found in the Lamprey River. Four animals were found in Lee and seven were found in Epping. The total survey effort for the Lamprey River was 72.3 hours of actual survey time, translating to a CPUE of 0.15 animals/person-hr, meaning that it took an average of 6.7 person-hrs to find a single brook floater. The average shell length of the 11 brook floaters was 53.0 mm, with a range from 47.0-60.0 mm and a standard deviation of 4.48. There was no evidence of recruitment; the smallest/youngest animals found were probably at least 10 years old and toward the latter third of their expected lifespans. The shell condition index was 0.68, indicating moderate to severe levels of shell erosion. Both the demographic analysis and the shell condition analysis were hampered by low sample sizes; there were simply too few brook floaters for robust analyses.

Except for two brook floaters that were found within a few meters of each other at one site, nearly all of the brook floaters were isolated, separated by distances 100-1000s of meters despite often highly suitable habitats in intervening reaches. Although we found brook floaters further upstream and further downstream than had been documented in prior surveys, population densities were much lower. Overall, the likelihood of successful fertilization and recruitment seems very low for such a low-density population. We believe that the brook floater population in the Lamprey River is critically imperiled if not terminal.

Snails were generally not common in the stream habitats that we focused on. Only three species were routinely found, including *Ferrissia rivularis*, *Campeloma decisum*, and *Helisoma anceps*. The Chinese mystery snail (*Cipangopaludina chinensis*) was found in the Lamprey River upstream of the Route 125 Bridge; the "deadwater" sections of the Lamprey provide suitable habitat for this invasive species, but otherwise it primarily occurs in lakes and ponds.

3. Habitat

Most survey sites contained habitat that could support freshwater mussels, although habitat was least suitable and much more limited in smaller tributaries and high-gradient stream reaches. Brook floaters were found in areas with shallow depths (0.5-1.5 feet) and moderate water velocities, usually in areas with a combination of sand, gravel, and cobble substrates. This combination of habitat parameters was quite common in the reach between Bunker Pond and Epping and Lee Hook Road, although there were some long "deadwater" reaches that we consider unsuitable for brook floaters. In general, brook floaters were far less common, and more patchy, than we might have predicted based on available habitat.

We surveyed the entire distance between Route 125 and Route 87 in Epping and found isolated patches of suitable habitat but no live or dead brook floaters. We also surveyed approximately 25 percent of the distance between Route 87 and the Wadleigh Falls Dam, but the river throughout much of that reach was deep, with a low gradient, slow water velocities, extensive large woody debris, and substrate of unstable sands with clayey banks and occasional boulders. The reach between Lee Hook Road and the Wiswall Dam was not surveyed; the upstream part of that reach appears (from aerial photographs) to provide some suitable habitat, but the lower part of the reach appears to be mostly a deep impoundment; brook floaters have never been found in that reach. Very little habitat was found in the upper river upstream of the dam that creates Bunker Pond in Epping; a series of unsuitable impoundments, major road crossings, and nearby development seem to have eliminated potential habitat near the center of Raymond, and then the river becomes higher in gradient further upstream and naturally provides very little brook floater habitat.

Three 100-year floods have occurred in the Lamprey River in last five years. There were frequent signs of extensive flood "damage" including severely eroded banks, accumulation of tremendous amounts of large woody debris, and vast deposits of sand and fine gravel. One of the historic brook floater beds downstream of the Wadleigh Falls Dam appears to have been largely smothered by sand deposits up to 2-3 feet deep. Accumulations of large woody debris are acting as sediment traps, changing flow and substrate conditions in ways that are generally detrimental to brook floaters. It will probably take several years for the eroded riverbanks and stream channel to stabilize. Although some highly mobile, habitat-generalist species (e.g., eastern elliptio) might thrive in current conditions, recent flood damage has probably contributed to the possible demise of brook floaters in the Lamprey River. Also, the summer of 2010 was unusually dry and flow conditions were near historic lows (probably at 7Q10) and there was significant channel dewatering and silt accumulation in shallow, non-impounded, and free-flowing portions of the river. Both large floods and droughts can cause significant mussel mortality.

DISCUSSION

A total of five mussel species was found in the Lamprey River but four of these exhibit symptoms of non-viable populations. These symptoms include very low population densities, restricted distributions, and little or no evidence of recruitment (i.e., young animals). This survey did not cover every inch of the Lamprey River; long reaches were not surveyed and even the reaches that were surveyed were not surveyed in a manner that would be expected to locate every rare mussel. It is possible, although not likely, that significant mussel beds exist in areas that we did not survey. Nevertheless, results do indicate relative densities and give a reasonably good snapshot of distribution, and these results provide the basis for significant concern about the river’s mussel fauna. We believe that the brook floater is now extirpated from the Exeter River.

Biodrawversity has studied brook floater populations in 27 rivers in New England, including four in New Hampshire, seven in Connecticut, six in Massachusetts, one in Vermont, and nine in Maine. Studies were generally conducted in using the same methods as the Lamprey River survey, allowing for comparisons of CPUE, demographics, shell condition, and spatial distribution. The Lamprey River contains one of the lowest density populations in New England; CPUE was fourth lowest among all the populations. The Lamprey River population is comprised mostly of middle-aged and older animals, with very little evidence of recruitment compared to other populations in New England. The shell condition index is high (e.g., highly eroded shells) compared to populations in most other rivers. Finally, the brook floater population exhibits a highly restricted distribution in the Lamprey River. Overall, the Lamprey River brook floater population may be one of 7-8 in New England that is terminal.

The status of the Lamprey River's brook floater population is especially dismaying because fairly high numbers of brook floaters were encountered during surveys in the 1990s. These file reports were provided by New Hampshire Fish and Game and the investigators were noted below (if known). Although it is sometimes hard to extract data out of older reports, the following results were obtained during surveys in the 1990s:

- 1993 (Cutko): Below Wadleigh Falls; 12 CPUE
- 1994 (Albright): Site designation confusing. Six "plots" or sites; sites 1-4 near Epping had a CPUE of 20.0 per hr.
- 1995 (Craig): Surveyed Albright's locations (1-3, Epping) found 20.6 CPUE.
- Two additional reports (author unknown): Site 4 (Epping) = 5.6 CPUE, Wadleigh Falls = 9.1 CPUE.

Our survey effort more than tripled prior survey efforts, including a resurvey of all historic areas plus surveys in adjacent reaches, and resulted in a CPUE of only 0.15. Brook floaters do appear to occur in the same areas as they had before, but now exist at much lower numbers. The populations are now too small for quantitative monitoring.

RECOMMENDATIONS

- Sometime in the next few years, if and when funding becomes available, we recommend a final brook floater survey in the Lamprey River that focuses specifically on the reaches where they are known to occur plus adjacent unsurveyed reaches. The goal should be to locate every brook floater within these reaches, and based on the outcome of the surveys, to consider moving isolated animals into the most optimal habitat, especially if brook floaters are concentrated in certain areas already. Details of this research and monitoring plan should be determined via discussions with

New Hampshire Fish and Game Department and the U.S. Fish and Wildlife Service.

- If results of this survey accurately reflect the status of the brook floater in the Lamprey River, it might be too late for quantitative population monitoring. Nevertheless, some species are more common and long-term monitoring of these species might provide important insight into the health of the mussel fauna in the river. Details of this research and monitoring plan should be determined via discussions with the New Hampshire Fish and Game Department.
- We recommend exploring the use of different set of indicator species altogether, such as fish or benthic macroinvertebrates, to establish a meaningful long-term ecological monitoring program for the Lamprey River.

FURTHER READING

Nedeau, E.J. 2008. Freshwater Mussels and the Connecticut River Watershed. Connecticut River Watershed Council, Greenfield, MA.