Brook Floater

Alasmidonta varicosa

Federal Listing	N/A
State Listing	E
Global Rank	
State Rank	S1
Regional Status	Very High

Photo by Ethan Nedeau

Justification (Reason for Concern in NH)

Freshwater mussels are the most imperiled fauna in North America, having suffered steep declines in diversity, abundance, and distribution within the last 200 years (Richter et al. 1997, Lydeard et al. 2004). In the genus *Alasmidonta* 9 of 13 species are threatened, endangered, or extinct (Williams et al. 1992). An Atlantic slope species, the brook floater once ranged from Nova Scotia to South Carolina and was widespread throughout much of its range. Populations have since declined sharply and in many states are considered rare or are extirpated. Many populations are small, have low densities, and show little or no evidence of recruitment. Brook floaters have declined in much of the south and are critically imperiled in New Hampshire, Connecticut, Massachusetts, Maryland, and Virginia and are presumed extirpated in Rhode Island and Delaware. The range has contracted in New York, although a robust population still exists in the Neversink River (Strayer 1997, Strayer and Ralley 1991). It has disappeared from many other New York locations including the Housatonic and Passaic basin and has declined severely in the Susquehanna basin (Strayer 1997, Strayer and Fetterman 1999, O'Brien, New York Department of Environmental Conservation, personal communication). It occurs in fewer than 12 streams in Connecticut (Nedeau 2002). It is threatened in Vermont, where it is restricted to the West River (Fichtel and Smith 1995) and in Maine is a species of special concern, occurring in most rivers that historically supported Atlantic salmon (Nedeau et al. 2000). Human activity has jeopardized populations through riparian disturbance, pollution, sedimentation, dams, impoundments, and artificial flow regimes. Stream fragmentation disrupts mussel life cycles, prevents host fish migration, blocks gene flow, and prohibits recolonization resulting in reduced recruitment rates, decreased population densities, and increased probability of local extinctions (Neves et al. 1997, Watters 1999, Strayer et al. 2004).

Distribution

An Atlantic slope species, the brook floater once ranged from Nova Scotia to South Carolina and was widespread throughout much of its range. Populations have since declined sharply and in many states are considered rare or are extirpated. In New Hampshire, brook floaters occur in the Connecticut and Merrimack Rivers and coastal watersheds. Only one population occurs within the Connecticut River Watershed in NH: the North Branch of the Sugar River (Cutko 1993). Several populations are found within the Merrimack River Watershed: the Blackwater, Piscataquog, Suncook, Soucook Rivers and in Merrimack River main stem (Cutko 1993, Gabriel 1995, NHNHB 1996, Wicklow, Saint Anselm College, unpublished data). Brook floaters likely exist in very low numbers in the Nissitissit River in Hollis, Golden Brook in Windham, and Beaver Brook in Pelham where a population was first reported by

Athearn and Clarke in 1952 (Clarke 1981, Gabriel 1995). In the coastal drainage, brook floater populations are in danger of extirpation. They appear to be gone from the Exeter River and are scattered in very low numbers in the Lamprey River (Cutko 1993, Albright 1994, Gabriel 1996, Wicklow, Saint Anselm college, unpublished data, Nedeau 2011).

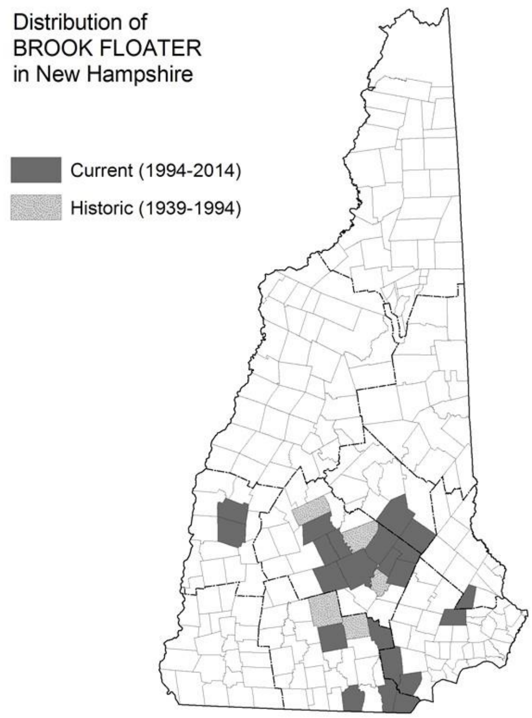
Habitat

Brook floaters are strictly riverine species inhabiting clean and well-oxygenated small streams to large rivers with high to moderate flows. They are absent in scour-prone areas of high gradient streams and avoid high velocity flow channels. Although they show no consistent substrate preference (Strayer and Ralley 1993), brook floaters in New Hampshire are often found in gravel and in sand among larger cobble in riffles, along shaded banks, and, in higher gradient streams, in sandy flow refuges behind large boulders (S. von Oettingen, USFWS, personal communication, B. Wicklow, Saint Anselm College, personal observation). They are found most often in nutrient-poor streams with low calcium levels (Strayer 1993). Mussels are suspension feeders, subsisting on phytoplankton, bacteria, fine particulate matter, and dissolved organic matter (Strayer 2004).

As in other unionid mussels, brook floaters' life cycle is complex and parasitic. Spawning occurs in summer as sperm are released into the water column, where they are drawn into the inhalent aperture of the female and into the outermost demibranchs of the gills, which function as marsupia. There the eggs are fertilized and develop and mature into larvae called glochidia. Brook floaters are long-term brooders. In New Hampshire, glochidia are held through the winter until release, which begins in mid-April and continues through May (B. Wicklow, Saint Anselm College, unpublished data). Glochidia must attach to a host fish in order to complete development and disperse.
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*, mad tom, *Noturus insignis*, and sculpin, *Cottus cognatus* (Wicklow and Wicklow, Saint Anselm College, unpublished data). Gravid female brook floaters release glochidia in loose masses that drift downstream. Transformation of encysted glochidia takes 3 to 4 weeks at 150 C. Upon release, juveniles burrow immediately into the substrate (Wicklow and Wicklow, Saint Anselm College, unpublished data).

NH Wildlife Action Plan Habitats

- Large Warmwater Rivers
- Warmwater Rivers and Streams



Distribution Map

Current Species and Habitat Condition in New Hampshire

Over 70 % of reported populations have less than 30 individuals. Stream fragmentation resulting from dams, causeways, impoundments, channelization, and inhospitable stream segments results in spatially and genetically disjunct populations. Many populations have densities that put them in jeopardy of extirpation from stochastic demographic, genetic, or environmental events. Brook floaters in New Hampshire have very small linear ranges making them especially vulnerable to human impacts. In the Connecticut River watershed, data from 2009 surveys suggest that the brook floater population in the Croydon Branch is fragmented, geriatric, and possibly declining (Nedeau 2006, Nedeau 2009). Mussel populations end abruptly at the North Branch and Sugar River confluence where water quality is low (von Oettingen, USFWS, personal communication).

Surveys in the Merrimack River watershed have been variable. The majority of the Merrimack River main stem has not been surveyed. However, relatively large numbers of brook floaters are known in the River at the Sewall’s Falls Bridge area of Concord (Nedeau 2015, Normandeau 2001), and in Franklin below the Eastman Falls dam (Kleinschmidt Group. 2014) and scattered individuals have been reported in Manchester (McLain 2004). Based on evidence of recruitment and abundance observed during CPUE surveys in 1993 and 1995, the Blackwater, Suncook, and the Soucook populations appeared to be the most robust tributaries to the Merrimack River. The Blackwater and Soucook Rivers haven't been surveyed systematically since. A large population on the Suncook River was discovered, and then lost, following an evulsion in the river that changed the course of the river (Wicklow 2008). Several other sections of the Suncook River have been surveyed in recent years associated with mussel relocation (Wicklow 2008, Nedeau 2013). Long-term monitoring of the Piscataquog River Henry Bridge population shows a decline in mussel density from 0.4 per meter squared in 1996 to 0.02 in 1999 (Wicklow, Saint Anselm College, unpublished data). A mussel bed on the South Branch of the Piscataquog River, monitored periodically since 1993, has been nearly extirpated. Brook floaters likely exist in very low numbers from the Nissitissit River in Hollis, Golden Brook in Windham, and Beaver Brook in Pelham where a population was first reported by Athearn and Clarke in 1952 (Clarke 1981, Gabriel 1995). A more recent survey on Beaver Brook found one A. varicosa near the Tallant Road Bridge in 2003 (Geiger, unpublished report, Oak Hill Environmental Services 2003).

The coastal watershed populations are at high risk of extirpation with only a few scattered individuals remaining from the Lamprey River (Nedeau 2011).

Population Management Status

Mussels are surveyed and occasionally relocated during bank stabilization, bridge replacement, or other projects with potential to harm species (e.g., Nedeau 2015). During extensive flooding in May of 2006, a section of the Suncook River in Epsom, NH breeched a glacial ridge to cut a new channel leaving a dewatered stretch where a large population of brook floater mussels, *Alasmidonta varicosa*, was discovered. Approximately 1100 brook floater mussels were collected then held for 3 months at the National Fish Hatchery, Nashua NH, for tagging and measurement. Mussels were then relocated to an upstream section of the Suncook River in North Chichester, NH. At the relocation site, one of the largest known brook floater populations range-wide was discovered. Both resident and relocated brook floaters were marked, measured, and mapped in 2 experimental plots.

Regulatory Protection (for explanations, see Appendix I)

- Endangered Species Conservation Act (RSA 212-A)
- Fill and Dredge in Wetlands - NHDES
- Rivers Management and Protection Program - NHDES
- Comprehensive Shoreland Protection Act - NHDES
- Alteration of Terrain Permitting - NHDES

Quality of Habitat

Very little habitat information exists. Historically robust sites in the Lamprey River are nearly gone with only a few scattered individuals detected, potentially at least partially resulting from large sediment deposits on mussel beds following major flood events (Nedeau 2011). Brook floaters appear to be in decline within the Croydon branch of the Sugar River, the only occupied tributary in the Connecticut River watershed within New Hampshire. Much of the Merrimack River watershed has not been surveyed for brook floaters nor has the habitat been assessed. A detailed habitat assessment was conducted at the Suncook River relocation site in Chichester and data supported a high quality riparian and within stream habitat (Wicklow 2008).

Habitat Protection Status

Riparian habitat protection varies among and within rivers, and some riparian habitat is protected by the NH Comprehensive Shoreland Protection Act. See Appendix B: Aquatic habitat profiles: Large warmwater rivers and warmwater rivers and streams for summary of habitat protection.

Habitat Management Status

There is no known management specifically for the purposes of benefitting brook floater mussels. Several dams have been removed in waterbodies where brook floater mussels previously occurred in the vicinity (e.g., Bunker pond dam, Lamprey River).

Threats to this Species or Habitat in NH

Threat rankings were calculated by groups of taxonomic or habitat experts using a multistep process (details in Chapter 4). Each threat was ranked for these factors: Spatial Extent, Severity, Immediacy, Certainty, and Reversibility (ability to address the threat). These combined scores produced one overall threat score. Only threats that received a "medium" or "high" score have accompanying text in this profile. Threats that have a low spatial extent, are unlikely to occur in the next ten years, or there is uncertainty in the data will be ranked lower due to these factors.

Habitat degradation and mortality from dams that alter hydrology upstream and downstream (Threat Rank: High)

The conversion of free-flowing rivers to highly regulated rivers has seriously affected freshwater mussels (Locke et al. 2003, Watters 1996, Watters 1999). Barriers cause direct mortality, prevent dispersal, block gene flow, prohibit recolonization of rehabilitated habitat, and prevent host fish migration (Layzer et al. 1993, Parmalee and Hughes 1993, Vaughn and Taylor 1999, Watters 1996). Cycles of extreme episodic flooding and dewatering use cause direct adult mortality by scouring. Extreme fluctuations in flow disrupt mussels by exposing glochidia and juveniles to flood-induced damage, mortality, or displacement to unfavorable habitat downstream (Layzer et al. 1993, Layzer and Madison 1995, Hardison and Layzer 2000). Dewatering exposes mussels to heat, desiccation, and opportunistic predators. Predator foraging efficiency increases with decreasing depth.

Dams have separated brook floater populations in every river system they inhabit. Barriers decrease the size of linear ranges. Isolated mussel populations are more susceptible to pollution and habitat degradation (Strayer et al. 1996). In 1999, Wicklow showed a correlation between presence of glochidia and high flow releases from the Surry Mountain Dam on the Ashuelot River (Wicklow, Saint Anselm College, unpublished data). During a period of low water in 1997, 163 brook floaters in a population downstream from the Gregg Falls Hydroelectric Dam on the Piscataquog River were lost to predation (Wicklow, Saint Anselm College, unpublished data). In addition, over 100 dwarf wedgemussel valves were collected from muskrat middens in a 15-meter segment of the Ashuelot River during a period of extremely low water (von Oettingen, USFWS and Wicklow, Saint Anselm College, unpublished).

Habitat degradation and mortality from increased flooding that destroys mussel beds (Threat Rank: High)

Excessive flood events can transport mussels downriver and or bury them in sediment, resulting in mortality to individuals. Extreme weather events can change river courses and sediment transport.

A population of brook floater mussels was discovered in the Soucook River following the mother's day floods in 2006. The Soucook River changed course and left a stretch of river and associated mussels stranded. Alive brook floater mussels were collected and maintained in a USFWS hatchery until they could be relocated upstream. A flood event in 2007, followed by a drought resulted in additional mortality to transported and resident mussels (Wicklow 2008). Surveys of the Lamprey River indicated a near extirpation of the species. Historically robust populations in the Lamprey river were apparently buried in several feet of sediment during flood events and associated eroding river banks (Nedeau 2011).

Habitat degradation and mortality from impervious surface run-off that contains excess nutrients, sediment and toxins (Threat Rank: High)

Runoff from municipalities, industrial waste, sewage outfalls, golf courses, and poorly managed agricultural and silvicultural land contributes to water quality degradation, increasing sedimentation and organic pollution. As development increases, impervious surfaces increase the volume and velocity of runoff, causing erosion, sedimentation, and high levels of toxins in rivers and streams. Riparian vegetation is critical in retarding these effects. Mussels are sensitive to heavy metals introduced through runoff and atmospheric deposition, as well as to toxins, such as chlorine and ammonia (Naimo 1995, Augsburger et al. 2003). Glochidia and juveniles are most sensitive to pollutants. Because juveniles and adults burrow into and feed within the sediments, oxygen-poor and toxin-rich sediment may be a major pathway for contamination (Newton et al. 2003, Poole and Downing 2004).

The effect of acute pollution on freshwater mussels is well documented (Neves et al. 1997). The most widely reported sources of pollution are poor land use practices (Neves et al. 1997, Poole and Downing 2004). For example, hundreds of mussels were killed, including federal and state listed species, by waste runoff from a small farm in the Connecticut River Watershed (USFWS 2002). Chemical and agricultural waste spills also cause direct mussel mortality, though the effect of sediment toxicity is not well understood. However, recent toxicity tests for total residual chlorine showed that juvenile mussels are more sensitive to toxins than glochidia (Cherry et al. 2005).

Habitat impacts and disturbance from development of riparian habitats that increases stream temperature (Threat Rank: Medium)

Increased water temperatures and associated reduced oxygen availability were predicted to adversely impact mussel populations.

Thresholds for these stressors need further evaluation.

Habitat impacts (fragmentation) from dams that cause inhospitable stream conditions (Threat Rank: Medium)

See 'Habitat degradation and mortality from dams that alter hydrology upstream and downstream' threat summary.

Mortality from recreational activities within a stream that can crush mussels (Threat Rank: Medium)

Brook floater mussels are thin shelled and easily crushed when stepped on. Human recreation (swimming, fishing, boat access, vehicle crossing streams) in streams can result in killed mussels and reduced population densities.

There are anecdotal reports of mussels crushed at high use recreation sites. A sizable number of tidewater mucket mussels, another thin-shelled mussel species, were found dead along lakefront properties in a Massachusetts pond and densities of tidewater muckets were greater in an undisturbed private beach compared to a busy public beach, suggesting trampling of mussels may be impacting those populations (Nedeau 2009).

Species impacts from reduction or loss of host fish from degraded habitat and species composition changes (Threat Rank: Medium)

Freshwater mussels require specific fish species as hosts for glochidia development. As such, reductions in fish densities or species available to host glochidia for brook floater mussels will adversely impact reproduction of brook floater populations.

However, brook floaters use a variety of fish species as hosts so the likelihood of this threat needs further evaluation.

List of Lower Ranking Threats:

Habitat degradation and mortality from streambank stabilization

Mortality from the introduction and spread of problematic diseases and parasites

Species impacts from introduced or invasive animals that result in competition, predation, and reduced habitat quality

Habitat impacts from introduced or invasive plants

Actions to benefit this Species or Habitat in NH

Direct swimming and fishing access points away from mussel beds

Primary Threat Addressed: Mortality from recreational activities within a stream that can crush mussels

Specific Threat (IUCN Threat Levels): Human intrusions & disturbance

Objective:
Reduce mortality of mussels from recreational activities within a stream, river or pond.

General Strategy:
As additional information on mussel occurrences is collected and mapped, managers should consider ways to direct recreational activities away from sensitive mussel beds. This can include strategically placing docks, boat launches, parking areas, beaches, and trails away from documented mussel beds. This will help reduce disturbance to mussels, reduce the potential for direct mortality, and help reduce pollution and sedimentation into mussel habitat. Targeted outreach to fishermen may occur coinciding with this effort, advising that mussels not be cracked open and used for bait. This has been commonly observed during mussel surveys.

Political Location:
Belknap County, Hillsborough County, Merrimack County, Rockingham County, Strafford County, Sullivan County

Watershed Location:
Lower CT Watershed, Merrimack Watershed, Coastal Watershed

Review projects that have potential to cause harm to brook floater populations.

Primary Threat Addressed: Habitat degradation and mortality from streambank stabilization

Specific Threat (IUCN Threat Levels): Natural system modifications

Objective:
Review projects that have potential to harm brook floater mussels and develop guidance for minimizing impacts.

General Strategy:
Brook floater mussels are listed as endangered in New Hampshire. As such, NHFG will review any proposed activities (residential, commercial, road construction and maintenance, recreation, dam licensing) that has the potential to harm brook floater mussels. NHFG will work with applicants and permitting staff from other state and federal agencies, primarily Department of Environmental Services (Wetlands Bureau) and U.S. Army Corps of Engineers, to identify avoidance and minimization conditions for permit applicants. NHFG will develop guidelines for consistent and effective review of projects potentially impacting brook floater mussels. Guidelines will consider scenarios where impacts should be avoided and scenarios where impact minimization of mitigation may be appropriate. Pre- and post- construction monitoring of brook floater mussels and associated habitat should be considered as a component of project review.

Political Location:
Belknap County, Hillsborough County, Merrimack County, Rockingham County, Strafford County, Sullivan County

Watershed Location:
Lower CT Watershed, Merrimack Watershed, Coastal Watershed

Regional Coordination

Objective:
Participate in regional efforts to conserve the species.

General Strategy:
A status assessment is underway for the brook floater in the northeast (Regional Conservation Need grant). NHFG will continue to participate in these regional discussions and meetings to further the conservation purposes of brook floater mussels.

Political Location:
Belknap County, Hillsborough County, Merrimack County, Rockingham County, Strafford County, Sullivan County

Watershed Location:
Lower CT Watershed, Merrimack Watershed, Coastal Watershed

Evaluate conservation actions for stream reaches.

Primary Threat Addressed: Habitat degradation and mortality from increased flooding that destroys mussel beds

Specific Threat (IUCN Threat Levels): Climate change & severe weather

Objective:
Evaluate whether species augmentation, translocation, or reintroduction feasible.

General Strategy:
Determine whether species active management techniques are warranted for certain stream reaches. Coordinate with USFWS and regional biologists on priority stream reaches for management and/or restoration. Evaluate husbandry, augmentation, and translocation techniques.

Political Location:
Northeast, Statewide

Watershed Location:
Statewide

Restoration and management of streams and rivers, with an emphasis on reducing stream fragmentation and restoring natural flow regimes, reducing pollution and riparian disturbance

Primary Threat Addressed: Habitat degradation and mortality from dams that alter hydrology upstream and downstream

Specific Threat (IUCN Threat Levels): Natural system modifications

Objective:
Restoration of fragmented rivers will allow increased dispersal, increasing the overall potential for persistence of mussels. As mussels are established in new habitat, linear range, re-colonization, and population size increase.

General Strategy:
Stream fragmentation, and attendant gene flow restrictions, will be reduced by removing barriers such as nonfunctional dams, where feasible, by operating dams at “run of the river” flow regimes, and by rehabilitating degraded river reaches. These measures will increase dispersal and recolonization of mussels into rehabilitated river reaches. Mussel populations and habitats must be assessed prior to implementation. Mussels found below a dam removal site or rehabilitated river reach may appear within 3 to 5 years, but 10 to 20 years or more may be necessary to establish a viable population. Riparian protection and restoration will be a long-term effort. As additional water quality and habitat assessment information is collected, efforts can be redirected or expanded. Pollution may render stream reaches uninhabitable. Destruction and transformation of riparian corridors accelerates erosion, bank sloughing, and runoff leading to increased levels of stream toxins, sediment, and higher stream temperatures. Education should be provided to adjacent landowners about practices that contribute pollutants into nearby rivers, streams, and ponds. Protection of riparian corridors through fee simple land acquisition, conservation easements, and private landowner cooperation will reduce pollution runoff and sedimentation. Properly sized culverts will reduce sedimentation and mass mortality of mussel beds. Surveys are needed to choose long-term, quantitative monitoring sites in occupied rivers and streams to assess patterns of disturbance and pollution. Following riparian disturbance mitigation or efforts to decrease pollution, the initial response of mussel populations should be monitored with qualitative surveying. As mussel populations increase in size, quantitative methods will be used (Strayer and Smith 2003). As additional water quality and habitat assessment information is collected, efforts can be redirected or expanded. The number of reproducing

subpopulations of mussels will indicate the success of the program.

Political Location:
Belknap County, Hillsborough County, Merrimack County, Rockingham County, Strafford County, Sullivan County

Watershed Location:
Lower CT Watershed, Merrimack Watershed, Coastal Watershed

Monitor mussel populations

Objective:
Conduct surveys to detect mussel populations and collect additional land use data in mussel-occupied habitats is needed to better inform management decisions and create conservation plans for the species.

General Strategy:
General distribution surveys should be focused on historic sites and areas where data is lacking. Data on population structure, age class distribution, sex ratio, recruitment, growth rates, and migration is needed, as well as distribution and abundance data on host fish. Studies may also examine the effects of predation and competition. Research is needed to determine the biological response of mussels to artificial flow regimes. Response variables include displacement of juveniles, interference of spawning success, larval release patterns, and host fish attachment success. Villella et al. used mark-recapture techniques to estimate survival, recruitment, and population growth of freshwater mussels (Villella et al. 2004), and this technique could provide valuable demographic information. Currently, much of the information on the condition of mussel populations and habitat is qualitative. Needed are quantitative studies to assess the physical habitat, including sediment type and hydrology, particularly shear, and water quality. As actions are initiated and populations potentially enlarge, mussel sites should be monitored using quantitative, statistically valid methods. Water quality monitoring stations upstream of mussel populations must be established.

Political Location:
Belknap County, Hillsborough County, Merrimack County, Rockingham County, Strafford County, Sullivan County

Watershed Location:
Lower CT Watershed, Merrimack Watershed, Coastal Watershed

References, Data Sources and Authors

Data Sources
Information on the life history, habitat, and distribution of brook floaters was obtained from the scientific literature, unpublished reports, databases, expert consultation, and unpublished research results.
Distribution data were obtained from the New Hampshire Natural Heritage Bureau Element Occurrence Database, unpublished reports, scientific literature, and consultation with experts. Several targeted brook floater surveys were initiated by NHFG in the previous 10 years (Nedeau 2006, Nedeau 2009, Nedeau 2011, Wicklow 2008). B. Wicklow summarized the status of NH brook floater

population in a draft report for a regional status assessment funded by the Regional Conservation Need grant program (State Wildlife Grants). The threat assessment was conducted by Michael Marchand (NHFG), Barry Wicklow (St. Anselms), and Susi von Oettingen (USFWS).

Data Quality

Most information on brook floater populations is qualitative and was acquired in the mid-1990s or earlier. Early surveys efforts employed Catch Per Unit Effort (CPUE) methods, and while helpful in determining presence of absence, these methods are not statistically valid and therefore cannot be reliably used to determine population changes or trends. In 1996, Wicklow began a 10-year quantitative study of the brook floater population in the main stem of the Piscataquog River in Goffstown. The population was monitored in 1996, 1997, 1999, 2004, and will be monitored again in 2005 and 2006 (Wicklow, Saint Anselm College, unpublished).

2015 Authors:

Michael Marchand, NHFG

2005 Authors:

Barry J. Wicklow, Saint Anselm College

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