SPECIES PROFILE

Dwarf Wedgemussel

Alasmidonta heterodon

Federal Listing: Endangered
State Listing: Endangered
Global Rank: G1
State Rank: S1
Author: Barry J. Wicklow, Department of Biology, Saint Anselm College

Element 1: Distribution and habitat

1.1 Habitat Description

Dwarf wedgemussels, *Alasmidonta heterodon*, are Atlantic slope species inhabiting small streams to large rivers with moderate flow. They are found in hydrologically stable areas within a variety of substrates including gravel and coarse sands, fine sands, and clays in depths from a few centimeters to several meters. Mussels are suspension and deposit feeders, subsisting on phytoplankton, bacteria, fine particulate organic matter, and dissolved organic matter (Strayer et al. 2004).

The dwarf wedgemussel's life cycle is complex. Gametogenesis occurs from May through July (Michaelson and Neves 1995). Spawning occurs in summer when sperm are released into the water column and drawn into the inhalant aperture of the female. Eggs are fertilized, undergo development, and mature in the outermost demibranchs of each gill, which function as marsupia. Well-developed glochidia are present in the Connecticut River mussels as early as late August. Dwarf wedgemussels are long-term brooders, holding glochidia through the winter until release begins in early March and continues through mid-June (Wicklow unpublished data). Glochidia must attach to a host fish in order to complete development and to facilitate dispersal. Host fish include the tessellated darter *(Etheostoma olmstedii)*, johnny darter *(Etheostoma nigrum)*, mottled sculpin *(Cottus cognatus)*, (Michaelson and Neves 1995), slimy sculpin *(Cottus cognatus)*, and juveniles and parr of the Atlantic salmon *(Salmo salar)* (B. Wicklow, Saint Anselm College, unpublished data). Due to fish range limitations, the tessellated darter, slimy sculpin, and Atlantic salmon are the only host fish available for dwarf wedgemussel glochidia in New Hampshire. The dwarf wedgemussel is the only species of *Alasmidonta* that uses a behavioral display to attract host fish (B. Wicklow, Saint Anselm College, unpublished data).

1.2 Justification

Freshwater mussels have declined dramatically in diversity, abundance, and distribution within the last 200 years and are considered the most imperiled fauna in North America (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). Historically, the dwarf wedgemussels was found from the Petitcodiac River in New Brunswick, Canada to the Neuse River in North Carolina, and was found in 15 major Atlantic slope river systems (United States Fish and Wildlife Service (USFWS) 1993). It is now extinct in Canada, extirpated in the Neuse River, and present in low densities throughout much of its former range (USFWS, 2002 Range Wide Assessment Meeting).

Only 54 populations remain; 41 of these are estimated to contain fewer than 50 individuals and of these, 32 have fewer than 10 individuals or are possibly extirpated; 8 or 9 are estimated at between 50 and 1,000 individuals; 4 are estimated at between 10,000 and 100,000 individuals. Human impacts including riparian disturbance, pollution, sedimentation, impoundments, artificial flow regimes, and stream fragmentation disrupt mussel life cycles, prevent host fish migration, block gene flow, and prohibit 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).

1.3 Protection and Regulatory Status

- Listed as endangered on Federal Endangered Species Act (listed on March 14, 1990)
- Clean Water Act-Section 404; administered by the Army Corp of Engineers and Environmental Protection Agency -- regulates discharge of dredge or fill material into "waters of the United States," including wetlands.
- Fill and Dredge in Wetlands; New Hampshire Department of Environmental Services (NHDES, RSA 482-A)- requires applicant to obtain a permit to fill or dredge jurisdictional wetland habitats, including the banks of rivers and streams.
- The Shoreland Protection Act (NHDES, RSA 483-B) limits the amount of tree removal and other activities within 250 ft of major rivers and requires a primary structure setback of at least 50 ft.
- New Hampshire Endangered Species Conservation Act (RSA 212-A)- state endangered.
- Rivers Management and Protection Program; NHDES (RSA 438) designates rivers in New Hampshire for protection of cultural or natural resources and stipulates the following: no channel alteration activities shall be allowed in rivers designated as "natural"; no dams will be built on rivers designated as natural, rural or rural community rivers; a protected instream flow level shall be established for each designated river; no motorized watercraft are allowed on designated natural rivers; ithin 15.24 m (50ft) of a stream, 50% of basal area of trees cannot be cut; for fourth order streams and higher this extends to within 45.72 m (150 ft).
- Local regulations and zoning varies considerably.

1.4 Population and habitat distribution

Since the extirpation in Canada, the Connecticut River drainage in New Hampshire has held the largest remaining dwarf wedgemussel populations and represents the northern limit of the distribution (USFWS, 2002 Range Wide Assessment Meeting). Nevertheless, these populations are extremely patchy, clustered in scattered mussel beds.

Dwarf wedgemussels require unpolluted streams or rivers with high dissolved oxygen, moderate current, and stable substrata within refugia (Strayer 1993b, Strayer and Ralley 1993). Stream fragmentation from dams, causeways, impoundments, channelization, and inhospitable stream segments results in spatially and genetically disjunct populations. Perhaps 50% or more of populations have densities that put them in jeopardy of extinction from catastrophes or stochastic demographic, genetic, or environmental events. Though populations range from 100 to 10,000 individuals, densities are low enough (mean = 0.01 to 0.05 per square meter, Strayer et al. 1996) to cause concern. Because mussels are broadcast spawners, populations with low densities may suffer reduced fertilization success (Downing et al. 1993, McLain and Ross 2005), which may strongly limit recruitment. Dwarf wedgemussels occupy small, linear ranges, putting populations at higher risk from impacts of pollution, habitat degradation, and disease (Strayer et al. 1996).

1.5 Town Distribution Map

A map is provided.

1.6 Habitat Map

Known occupied stretches of river are mapped in the Natural Heritage Bureau database. Future mapping efforts should identify suitable habitat that has not been surveyed.

1.7 Sources of Information

Information on the life history, habitat requirements, and distribution of dwarf wedgemussels was obtained form the scientific literature, unpublished reports, databases, expert consultation, unpublished research results, and mussel recovery meetings.

1.8 Extent and Quality of Data

Dwarf wedgemussels in the Connecticut River main stem have been surveyed and intermittently monitored since 1988. Early surveys were conducted by canoe and snorkeling in shallow water, usually within 15 meters of the bank. Later SCUBA surveys found a significant number of dwarf wedgemussels in depths greater than 1.5 meters. Most of the early monitoring efforts employed Catch Per Unit Effort (CPUE) methods. While helpful in determining presence or absence, CPUE methods are not statistically valid and therefore cannot be reliably used to determine population changes or trends.

Dwarf wedgemussels in the Connecticut River main stem have been surveyed and intermittently monitored since 1988. Dams and reservoirs divide mussels into 3 spatially and genetically disjunct populations.

1. The northern population occurs within 29-kilometer river section from Northumberland to Dalton. It was surveyed in 1996. One location in this section between Lancaster New Hampshire and Lunenburg, Vermont has been monitored regularly since 1997 when 536 dwarf wedgemussels including 87 tagged specimens were relocated 100 meters upriver as part of a bank stabilization project. Over 4,000 dwarf wedgemussels were found within the study area in 2000 (Gloria and Wicklow 2001). The Moore and Comerford dams and reservoirs separate this population from populations downstream.
2. A second population may occur in the section of river from the Comerford Dam and McIndoe Falls to the Wilder Dam impoundment. Dwarf wedgemussels were historically present and may still be extant in this section. This section is a priority for SCUBA survey.
3. The third population occurs in scattered beds within a 27-kilometer river segment between Plainfield and Charlestown. Biologists surveyed and monitored this section periodically since 1988. Strayer surveyed this section in 1994, estimating a population size of between 20,000 and 100,000 individuals (Strayer et al. 1996). Since 1991, several site-specific surveys have been conducted (Gabriel 1996, O'Brien 2001, Nedeau 2002). Between 1991 and 1995 five sites were monitored, three of the five annually (Gabriel and Strayer 1995). These three sites were monitored again in 2001 (O'Brien 2001). A 400 x 10 m area at the Charlestown Fort at Number 4 site was surveyed in 2002 (Nedeau 2003).

The Ashuelot River population downstream of the Surry Mountain flood control dam has been periodically monitored since 1991 (Gabriel and Strayer 1995). In 2004, Nedeau conducted a quantitative survey of dwarf wedgemussels in the Ashuelot River downstream of the Surry Mountain dam. The method, described in Strayer and Smith 2003, is recommended for estimating population size, density, and spatial distribution (Nedeau 2004).

1.9 Distribution research

Quantitative, statistically valid monitoring methods in known Connecticut main stem populations are needed. Using SCUBA, additional segments of the Connecticut River main stem need to be surveyed. Of particular priority is the stretch of river from below McIndoe Falls to Lyme, New Hampshire (von Oettingen, USFWS, personal communication). Other areas include the river south of Charlestown and the northern section from Pittsburg to Colebrook.

Nedeau and Werle surveyed the Ashuelot River from Keene to Hinsdale, finding 13 individuals just upstream of Sawyer Crossing (Nedeau and Werle 2003). Dwarf wedgemussels were sparse or absent in other river segments. Although present water quality and habitat appear suitable for dwarf wedgemussel, a long history of pollution and habitat degradation decimated dwarf wedgemussels in the Ashuelot below Keene. The scattered groups of mussel found recently may have persisted in refugia or may represent a re-colonization from the source population downstream of the Surry Mountain Dam (Nedeau and Werle 2003). Dispersal distance of encysted glochidia on tessellated darters and sculpin is less than 100 meters, thus re-colonization of areas of local extinction would be slow (McLain and Ross 2005).

Element 2: Species/ habitat condition

2.1 Scale

Dams and reservoirs divide the Connecticut River main stem into 3 major segments, each containing spatially and genetically disjunct populations: 1) the northern section, upstream of the Moore and Comerford Dams, that includes the Dalton-Lancaster population, 2) a middle section downstream of the Moore and Comerford Dams that includes high potential habitat from Monroe to Lyme, and 3) a southern section downstream of the Wilder Dam that include the Plainfield-Charlestown population. Within these linear units, subpopulation exists in scattered patches that may function together as a metapopulation. Likewise, the Ashuelot River population downstream of Surry Mountain Dam is separated from the main stem by inhospitable reaches and dams. Distribution of mussels at the scale of the river reach, less than 1 kilometer, may be determined by flood stage shear stress and sediment stability (Strayer 1999b, Layzer and Madison 1995, Hastie et al. 2001).

2.2 Relative health of populations

Based on the presence of young individuals, the north and south populations on the Connecticut River main stem and the Ashuelot population appear viable. The north Connecticut River population appears to be most robust.

2.3 Populations management status

Population management has been limited to relocation initiatives stemming from bank stabilization projects, such as along Route 2 in Lunenburg, Vermont and at the Fort at Number 4 site in Charlestown, New Hampshire.

2.4 Relative quality of habitat patches

Both north and south populations in the Connecticut River main stem are estimated at between 10,000 and 100,000 individuals. These populations have been surveyed qualitatively and are in need of quantitative, statistically valid monitoring. Nevertheless, the Lancaster, New Hampshire, and Lunenburg, Vermont sites have patches of high mussel density, with all age classes present, and a high density of tessellated darter host fish (Gloria and Wicklow 2000, Nedeau 2004). This section of river is free flowing from the Murphy Dam at Lake Francis in Pittsburg to the Moore Dam Reservoir in Littleton and hosts the most vigorous, viable population known. The Ashuelot River Population, also considered among the largest populations, extends from the Surry Mountain Dam to Swanzey and is estimated at 10,000 individuals. Two sites downstream of Surry Mountain Dam were monitored quantitatively. The site closest to the dam showed an age distribution skewed toward older individuals, with little evidence of recruitment, whereas the downstream site showed a wider age distribution, with evidence of recruitment (Nedeau 2004).

2.4 Habitat patch protection status

Very little habitat protection exists. The Army Corps of Engineers operates the Surry Mountain Flood control dam and holds land downstream to the East Surry Road Bridge.

2.6 Habitat management status

Currently there are no management or restoration efforts targeting dwarf wedgemussel habitat in the state. However, the Nature Conservancy, the Monadnock Conservancy, the Society for the Protection of New Hampshire Forests, and the Southwestern Regional Planning Commission have developed a conservation plan for the Ashuelot River Watershed (Zankel 2004). The Connecticut River Joint Commission is currently updating a Connecticut River Management Plan for the main stem (S. Francis, Executive Director, Connecticut River Joint Commission, personal communication). A recent USFWS initiative in riparian restoration in the Lancaster, New Hampshire to Lunenburg, Vermont reach of the Connecticut River failed due to lack of landowner cooperation (von Oettingen, USFWS, personal communication).

2.7 Sources of information

Distribution data were obtained from the New Hampshire Natural Heritage Bureau Element Occurrence Database, unpublished reports, scientific literature, and consultation with experts.

2.8 Extent and quality of data

Much of the information on the condition of dwarf wedgemussel populations and habitat is qualitative. Needed are quantitative studies to assess the physical habitat, including sediment type and hydrology, particularly shear, and water quality. Also needed are data on dwarf wedgemussel population structure, age class distribution, sex ratio, recruitment, growth rates, and migration, as well as distribution and abundance data on host fish. Studies that examine the effects of predation and competition would be helpful.

2.9 Condition ranking

To be provided by NHFG.

2.10 Condition assessment research

Research is needed to determine the biological response of dwarf wedgemussel to artificial flow regimes. Response variables include displacement of juveniles and glochidia, interference of spawning success, glochidial release patterns, and host fish attachment success. Also important are studies using micro satellite DNA markers to determine the genetic consequences of stream fragmentation on dwarf wedgemussel (King 1999). 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 for dwarf wedgemussel populations. Mussels were marked during a relocation project at the Lunenburg, Vermont bank stabilization site in 1997, and additional mussels were marked in 2003. A much larger sample size is needed to complete this study (Wicklow, Saint Anselm College, unpublished).

Element 3: Species and habitat threat assessment

3.1.1 Altered Hydrology

(A) Exposure pathway
The conversion of free-flowing rivers to highly regulated rivers has seriously affected freshwater mussels. Dams, causeways, reservoirs, gravel mining, dredging, channelization, poor land use, and municipal and industrial pollution have resulted in scattered populations. Barriers cause direct mortality, prevent dispersal, block gene flow, prohibit re-colonization of unoccupied but rehabilitated habitat, and prevent host fish migration (Layzer et al. 1993, Parmalee and Hughes 1993, Vaughn and Taylor 1999, Watters 1996).

(B) Evidence
On the Connecticut River main stem the Moore, Comerford, and Wilder Dams have divided dwarf wedgemussels into 3 populations. Dams on the Ashuelot River are also barriers to dispersal; in a survey in the Ashuelot River dwarf wedgemussels were absent below the Swanzey Dam (Nedeau and Werle 2003), and historic water and habitat degradation was apparent (Nedeau and Werle 2003). Notably, the 1968 construction of a causeway across the Petitcodiac River in New Brunswick Canada transformed a macro-tidal estuary into a shallow freshwater impoundment thereby eliminating diadromous fish including the Atlantic salmon (Locke et al. 2003), a host fish of the dwarf wedgemussel (Wicklow, unpublished data). By the 1980s, the dwarf wedgemussel had disappeared from the Petitcodiac River and in 1999 the Committee on the Status of Endangered Wildlife in Canada declared the dwarf wedgemussel officially extinct (Hanson and Locke 2000).

3.1.2 Altered Hydrology

(A) Exposure pathway
Cycles of extreme episodic flooding and dewatering use cause direct adult mortality by scouring. Extreme fluctuations in flow disrupt mussel life cycles by exposing glochidia and juveniles to flood-induced damage, mortality, or displacement to potentially unfavorable habitat downstream (Layzer et al. 1993, Richter et al. 1997). Dewatering exposes mussels to heat, desiccation, and opportunistic predators. Predator foraging efficiency increases with decreasing depth.

(B) Evidence
In 1999, Wicklow showed a correlation between presence of glochidia in stream drift samples and high flow releases from the Surry Mountain Dam on the Ashuelot River (Wicklow, Saint Anselm College, unpublished data). In addition, over 100 dwarf wedgemussel valves were collected from muskrat middens in a 15 m segment of the Ashuelot River during a period of extremely low water (von Oettingen, USFWS and Wicklow, Saint Anselm College, unpublished).

3.1.3 Non-Point Source Pollution

(A) Exposure pathway
As development increases and riparian vegetation buffers decrease, the effects of pollution on the biota in the Connecticut River and tributaries will increase. Runoff from municipalities, industrial waste, sewage outfalls, golf courses, poor agricultural and silviculture land contributes to sedimentation, organic pollution, and general water quality degradation (Poole and Downing 2004). Mussels are sensitive to toxins, such as chlorine and ammonia, and to heavy metals introduced through runoff and atmospheric deposi-

tion (Naimo 1995, Augsburger et al. 2003). Glochidia and juveniles are the most sensitive to pollutants, juveniles because they burrow into and feed within the sediments. Thus sediment, particularly when low in pore-water oxygen and high in toxins, may be a major contamination pathway for infaunal juveniles, as well as for adults, who may also deposit feed (Newton et al. 2003, Poole and Downing 2004).

(B) Evidence
The effect of acute pollution on freshwater mussels is well documented (Neves et al. 1997). Chemical and agricultural waste spills cause direct mussel mortality. The most widely reported sources of pollution are poor agriculture practices (Neves et al. 1997, Poole and Downing 2004)); 20 dwarf wedgemussels and hundreds of other mussel species were killed by waste runoff from a small farm in the Connecticut River Watershed (USFWS 2002). The effect of sediment toxicity is not well understood. However, recent toxicity tests for total residual chlorine showed that juvenile mussels are much more sensitive to toxins than are glochidia (Cherry et al. 2005).

3.1.4 Introduced Species

Adult zebra mussels are transported from basin to basin while attached to boats, and larvae may be transported in bilge and bait bucket water. Zebra mussels compete with native freshwater mussels for food and may reduce food concentration to levels that cannot support native species (Caraco et al. 1997, Strayer 1999). Larvae of zebra mussels require calcium levels between 8 and 20 ppm in order to complete development, well within the levels in the Connecticut River (Michelle Babione, Wildlife Biologist, Silvio O. Conte National Wildlife Refuge, personal communication). Because zebra mussels tend to infest rivers greater than 30 meters wide, the Ashuelot River is at lower risk of invasion.

After their initial discovery in Lake Saint Clare in 1988, zebra mussels quickly spread throughout many regions of the United States and parts of Canada. Their effect on the decline of freshwater mussels in the Hudson River is well documented (Caraco et al. 1997, Strayer 1999). Zebra mussels are present in Lake Champlain in Vermont. Recently a zebra mussel was detected on a boat in a boatyard at Lake Winnipesaukee. This underscores our need to intensify boat ramp surveys, particularly at high-use boating areas and priority biological sites, such as dwarf wedgemussel habitat. High boat use lakes, such as Sunapee Lake, that connect to biologically sensitive areas and have the potential for further zebra mussel spreading should be targeted (Michelle Babione, Wildlife Biologist, Silvio O. Conte National Wildlife Refuge, personal communication).

3.2 Sources of Information

Information was gathered from the scientific literature, reports, consultation with experts, and personal research.

3.3 Extent and quality of data

Whereas not all threats have been documented specifically for dwarf wedgemussels and their habitat, there is documentation for threat effects on other unionid mussels. The synergistic and long-term effect of the multiple kinds of chronic stresses on freshwater mussels is not known.

3.4 Threat assessment research

Expand research to determine phylogeographic relationships of New Hampshire populations of dwarf wedgemussels, using micro satellite DNA sequences (King et al., unpublished data). Further elucidate the life history of the dwarf wedgemussel. Determine the effect of hydrology on the life history of dwarf wedgemussels. Compare patterns of glochidial release observed in the mussels in the Ashuelot River prior to and after the change to “run of the river” flow management at the Surry Mountain Dam. Continue USFWS toxicity testing of glochidia and juvenile mussels (Cherry et al. 2005). Establish long-term monitoring sites on the Connecticut River that include geomorphologic, hydrological, and water quality assessments. Identify the physical characteristics of dwarf wedge mussel habitat and survey potential habitats for the presence of dwarf wedgemussel. Investigate the potential for relocation strategies.

Element 4 - Conservation actions

4.1.1 Restoration and management

(A) Stream fragmentation, altered flow regimes, pollution, riparian disturbance, invasive species

(B) Justification
Reducing stream fragmentation by removing barriers such as nonfunctional dams and by rehabilitating degraded river reaches will increase dispersal and re-colonization of dwarf wedgemussels. As barriers to dispersal are removed, gene flow is enhanced and heterozygosity increases.

Pollution may render stream reaches uninhabitable. Destruction and transformation of riparian corridors accelerates erosion, bank sloughing, and runoff, leading to higher temperatures, toxin levels, and sediment levels. Dam impoundments and reservoirs have a higher probability of zebra mussel colonization than do free-flowing river segments. Greater attention should be paid to areas of high risk. More intense boat ramp surveys, particularly at high-use boating areas and priority biological sites are warranted.

Dispersal increases the potential for persistence of species in patchy, unstable habitats such as rivers and streams. As mussels are established in new suitable habitat patches, linear range, population size, and likelihood of re-colonization increase. Protection of riparian corridors through fee simple land acquisition, conservation easements, and private landowner cooperation will reduce pollution runoff and sedimentation in the Connecticut River main stem and the Ashuelot River.

Removal of a small dam on the Ashuelot River will open kilometers of new habitat. Ultimately the Ashuelot River may be free of barriers through to the Connecticut River main stem. Riparian protection and restoration will improve downstream water quality and habitat.

Mussels found below a dam removal site or in 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.

(C) Conservation performance objective: The performance objective is to restore the Ashuelot River to a free flowing condition free of physical barriers and inhospitable degraded river segments within 5 to 10 years. The performance indicator is the presence of dwarf wedgemussels downstream of former barriers. The number of reproducing subpopulations of dwarf wedgemussel will indicate the success of the program. The performance indicator for protected or restored riparian corridors is 25 to 35% additional riparian protection along the Ashuelot River in 10 years and 15 to 20% additional riparian protection along the Connecticut River main stem in 10 to 20 years.

(D) Performance monitoring: The Ashuelot River was surveyed from Keene to Hinsdale between 2001 and 2003 (Nedeau and Werle 2003). Surveys in subsequent years are intended first to detect mussels. Then, as populations enlarge, mussel sites should be surveyed using quantitative, statistically valid methods. Water quality monitoring stations upstream of dwarf wedgemussel populations must be established.

(E) Ecological response objective: The habitat restoration response objective is to increase size and density of dwarf wedgemussel subpopulations downstream from Keene to Hinsdale and the mouth of the Connecticut River main stem. Decades may be needed to achieve the desired ecological response. Monitoring should indicate water quality improvement within 5 to 10 years. Additional survey and monitoring data is needed for the Connecticut River main stem before response objectives can be quantified.

(F) Response monitoring: The initial response will be monitored with qualitative surveying. As mussel populations increase in size, quantitative methods will be used (Strayer and Smith 2003).

(G) Implementation: In 2000 the NHDES helped establish the New Hampshire River Restoration Task Force with the objective, in part, of exploring possible dam removal in order to restore rivers. The Task Force includes state and federal agencies, conservation organizations, towns, and other interest groups. The Task Force facilitated the removal of two dams on the Ashuelot River: the McGoldrick Dam in Hinsdale in 2001 and the Winchester Dam in 2002. Two dams remain: the Homestead Woolen Mill Dam in West

Swanzey and the Fiske Mill Dam in Hinsdale. The Homestead Woolen Mill Dam is under consideration for removal; however, the Fiske Mill Dam was under consideration for removal but was purchased recently for hydroelectric power use (Loiselle, River Restoration Coordinator, NHDES). In addition, The Nature Conservancy has begun implementing a land conservation plan for the Ashuelot River (Zankel, 2004).

(H) Feasibility: Dam removal projects are feasible. However, the Town of Swanzey has not yet decided to remove the Homestead Dam. In 1998 the owner of Homestead Woolen Mills applied to breach the dam, though he is now willing to convey ownership to the town. Issues that may favor the town taking ownership of the dam include the historic covered bridge just upstream of the dam that may suffer scour damage without the dam and the influence of decreased water levels on fire department access. The selectmen are soliciting comment prior to an August 2005 meeting to reach a consensus. A final decision may require a warrant article for town meeting, March 2006 (Sara Carbonneau, Swanzey Town Planner, personal communication).

The Nature Conservancy's land protection initiative will begin in 2006 (Aldridge, The Nature Conservancy, personal communication). In addition, The Nature Conservancy's Connecticut River Program, in partnership with the United States Geological Survey, the University of Massachusetts, and Dartmouth College and the Army Corps of Engineers will hire a postdoctoral student to assess and implement trial flow regimes and determine their ecological responses in the Ashuelot River (Lutz, Director, The Connecticut River Program, The Nature Conservancy, personal communication).

4.2 Conservation action research:

In addition to removal of McGoldrick and Winchester Dams on the Ashuelot River, the Cuddebackville Dam on the Neversink River, New York, was successfully removed without apparent impairment of the downstream dwarf wedgemussel population (Strayer, Institute for Ecosystem Studies, Millbrook, New York, personal communication).

Element 5: References

5.1 Literature

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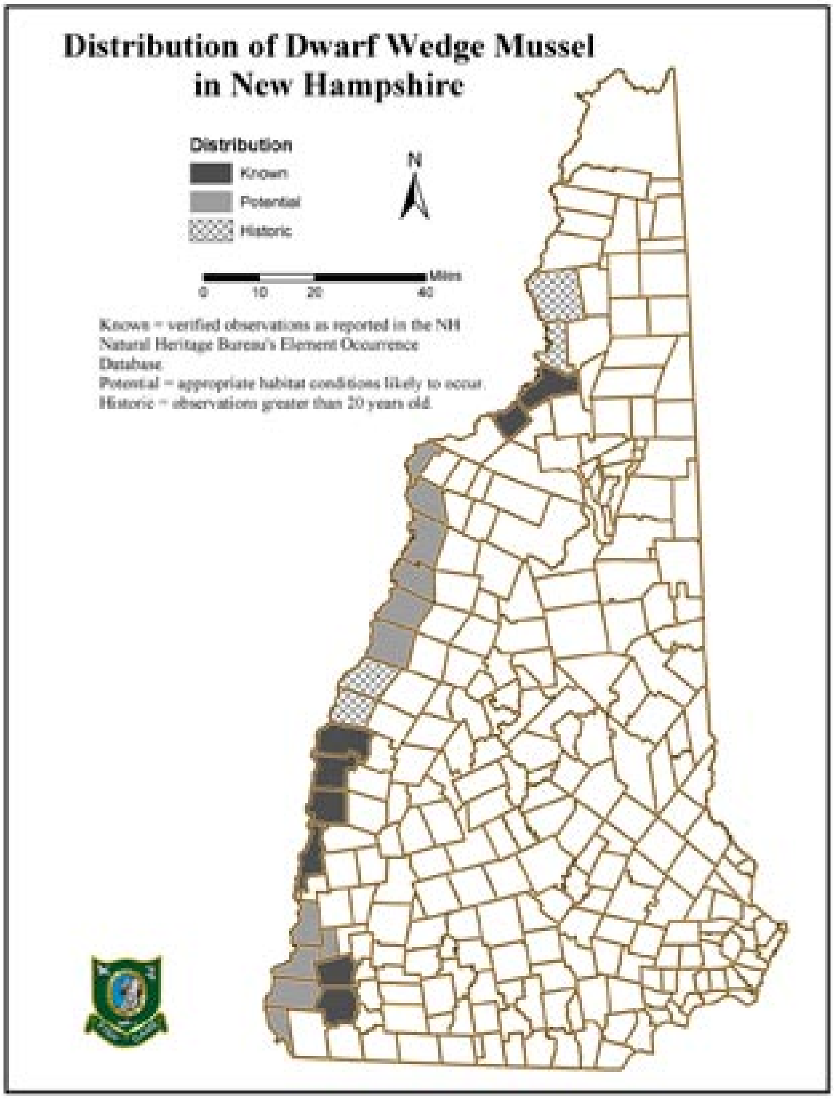

Distribution of Dwarf Wedge Mussel in New Hampshire
Distribution
Known
Potential
Historic
N
Miles
0
10
20
40
Known = verified observations as reported in the NH Natural Heritage Bureau's Element Occurrence Database.
Potential = appropriate habitat conditions likely to occur.
Historic = observations greater than 20 years old.