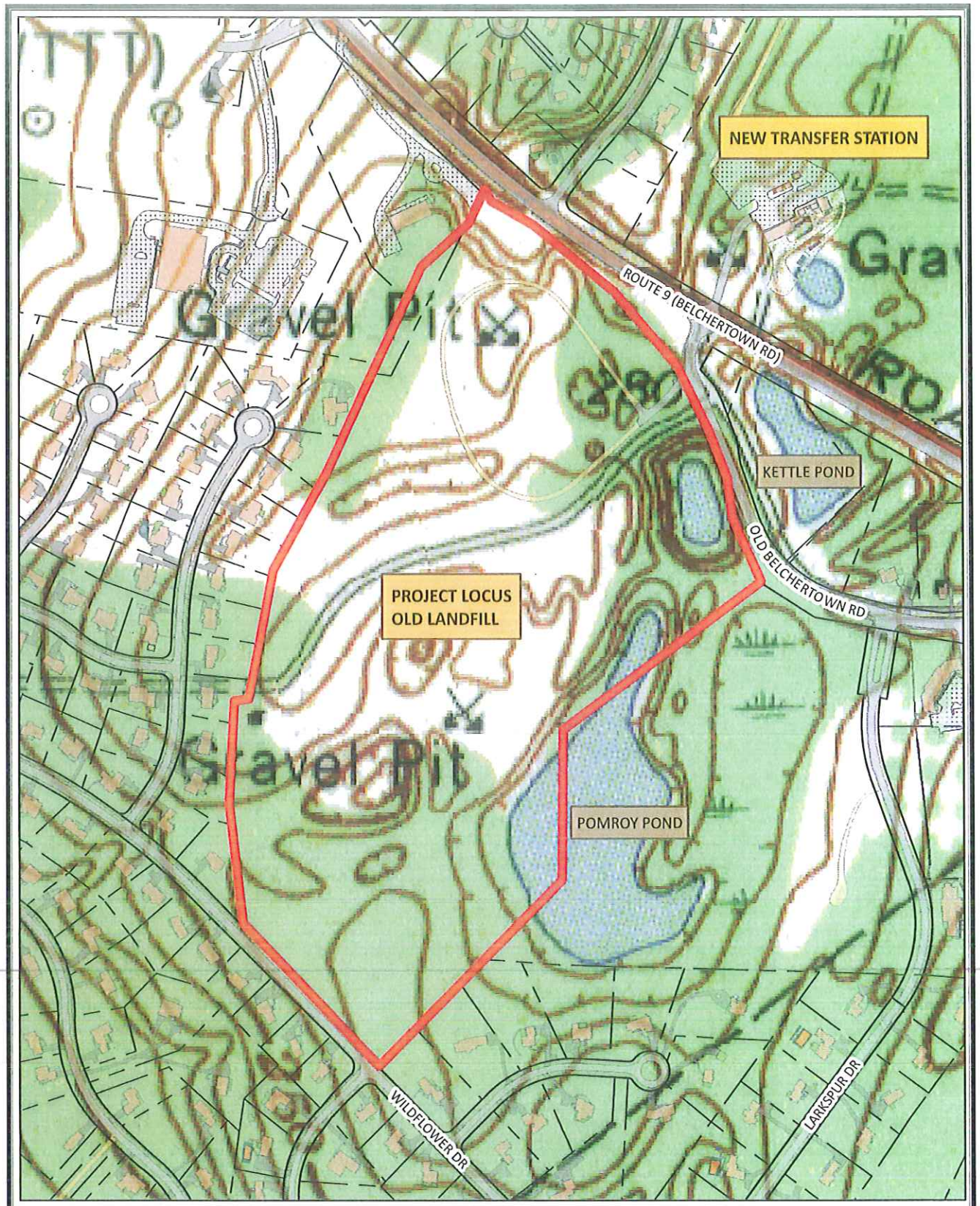
Town of Amherst
Department of Public Works

SECTION 4

Site Maps and Additional Information



USGS TOPOGRAPHICAL QUADRANGLE
OLD LANDFILL
OLD BELCHERTOWN ROAD
AMHERST, MA

SOURCE: USGS TOPOGRAPHICAL MAPS
TOWN OF AMHERST GIS

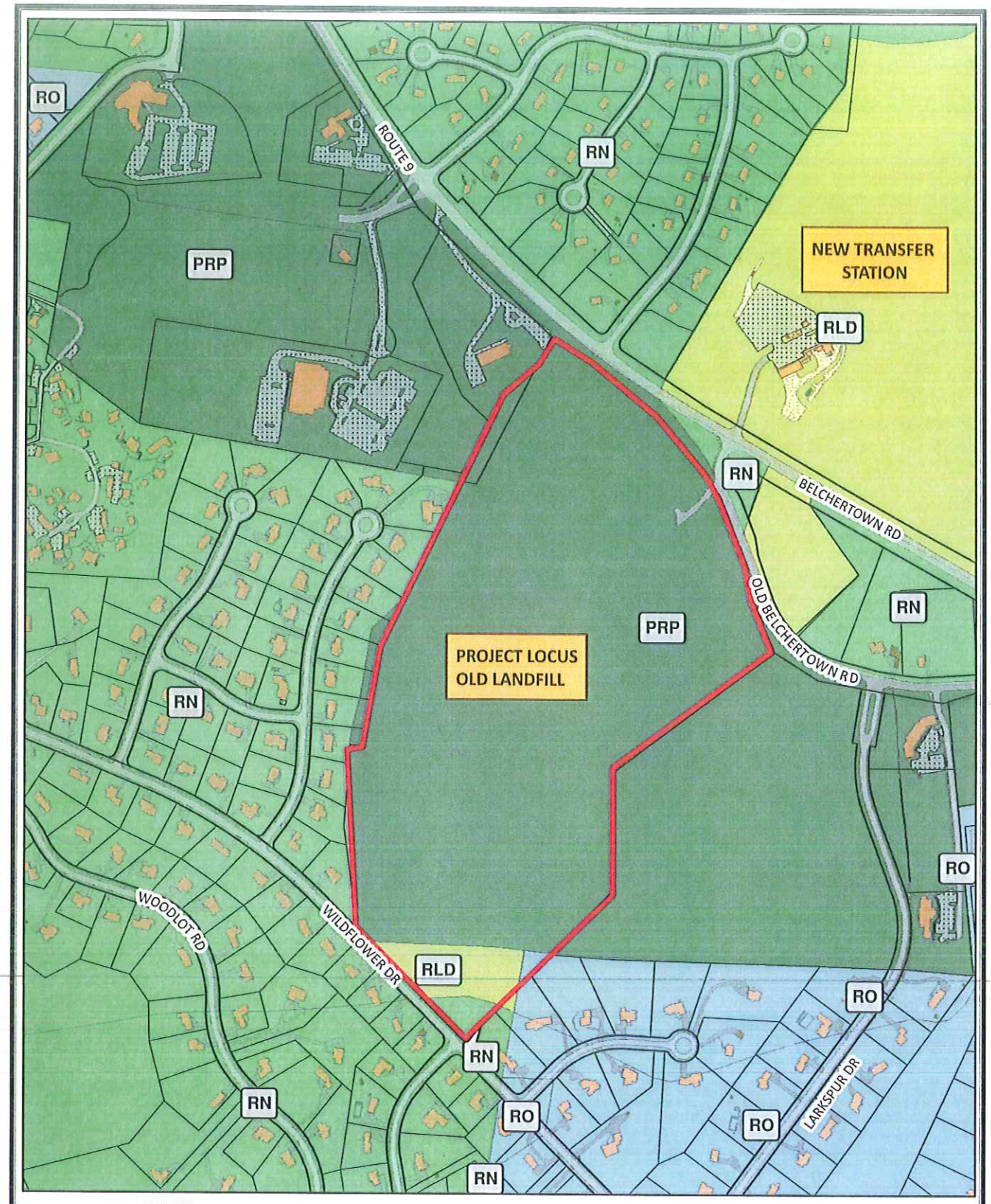
PREPARED BY THE ENGINEERING DIVISION
DEPARTMENT OF PUBLIC WORKS, AMHERST, MA
FEBRUARY 4, 2010

1 INCH = 400 FT

0 100 200 300 400
Feet

N
W E
S

AMHERST, MASSACHUSETTS
FOUNDED 1759



LEGEND

- PRP Professional Reserach Park
- RLD Low Density Residence
- NR Neighborhood Residence
- OR Outlying Residence

1 INCH = 500 FEET

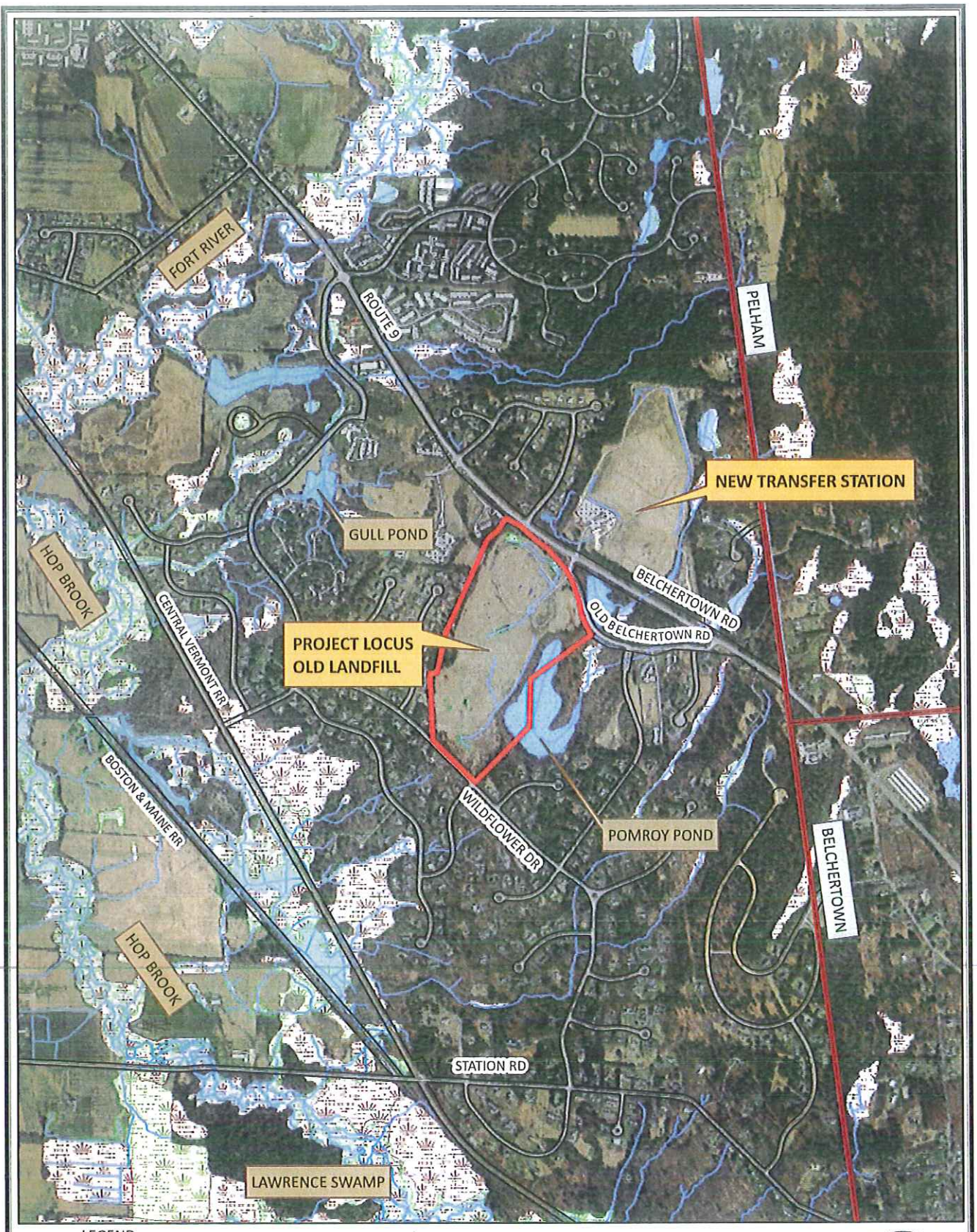
0 250 500 750 1,000 Feet

ZONING MAP
OLD LANDFILL
OLD BELCHERTOWN ROAD
AMHERST, MA

N W E S

SOURCE: TOWN OF AMHERST GIS

PREPARED BY THE ENGINEERING DIVISION
DEPARTMENT OF PUBLIC WORKS, AMHERST, MA
FEBRUARY 16, 2010



LEGEND

- Marsh
- Open Water
- Wooded Swamp

1 INCH = 1/4 MILE

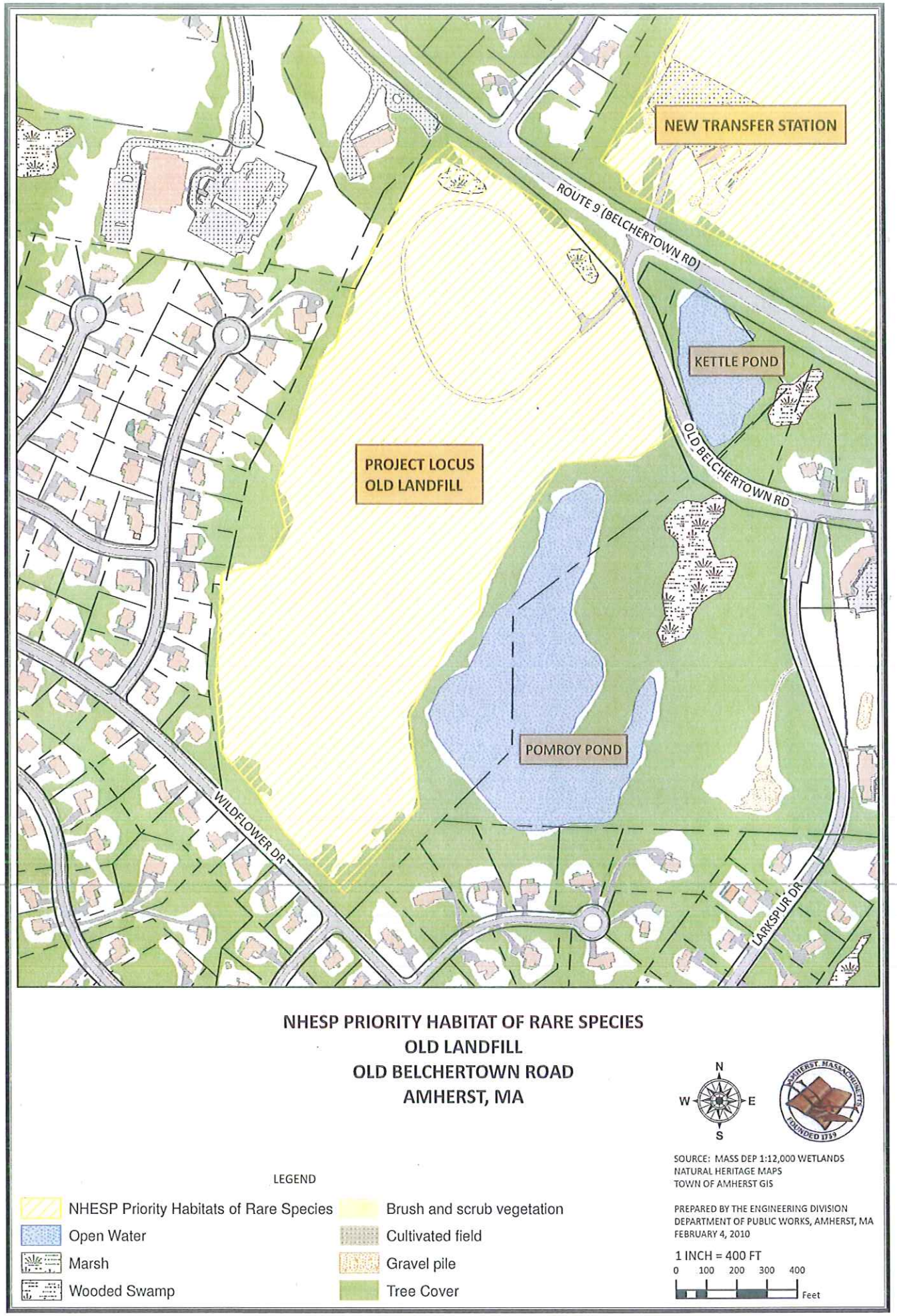
0 0.25 0.5 Miles

U. S. WATERWAYS
OLD LANDFILL
OLD BELCHERTOWN ROAD
AMHERST, MA

N W E S

SOURCE: MASS DEP 1:12,000 WETLANDS
2009 AMHERST ORTHOPHOTO
TOWN OF AMHERST GIS

PREPARED BY THE ENGINEERING DIVISION
DEPARTMENT OF PUBLIC WORKS, AMHERST, MA
FEBRUARY 4, 2010



NHESP PRIORITY HABITAT OF RARE SPECIES
OLD LANDFILL
OLD BELCHERTOWN ROAD
AMHERST, MA

N
W E
S

SOURCE: MASS DEP 1:12,000 WETLANDS
NATURAL HERITAGE MAPS
TOWN OF AMHERST GIS

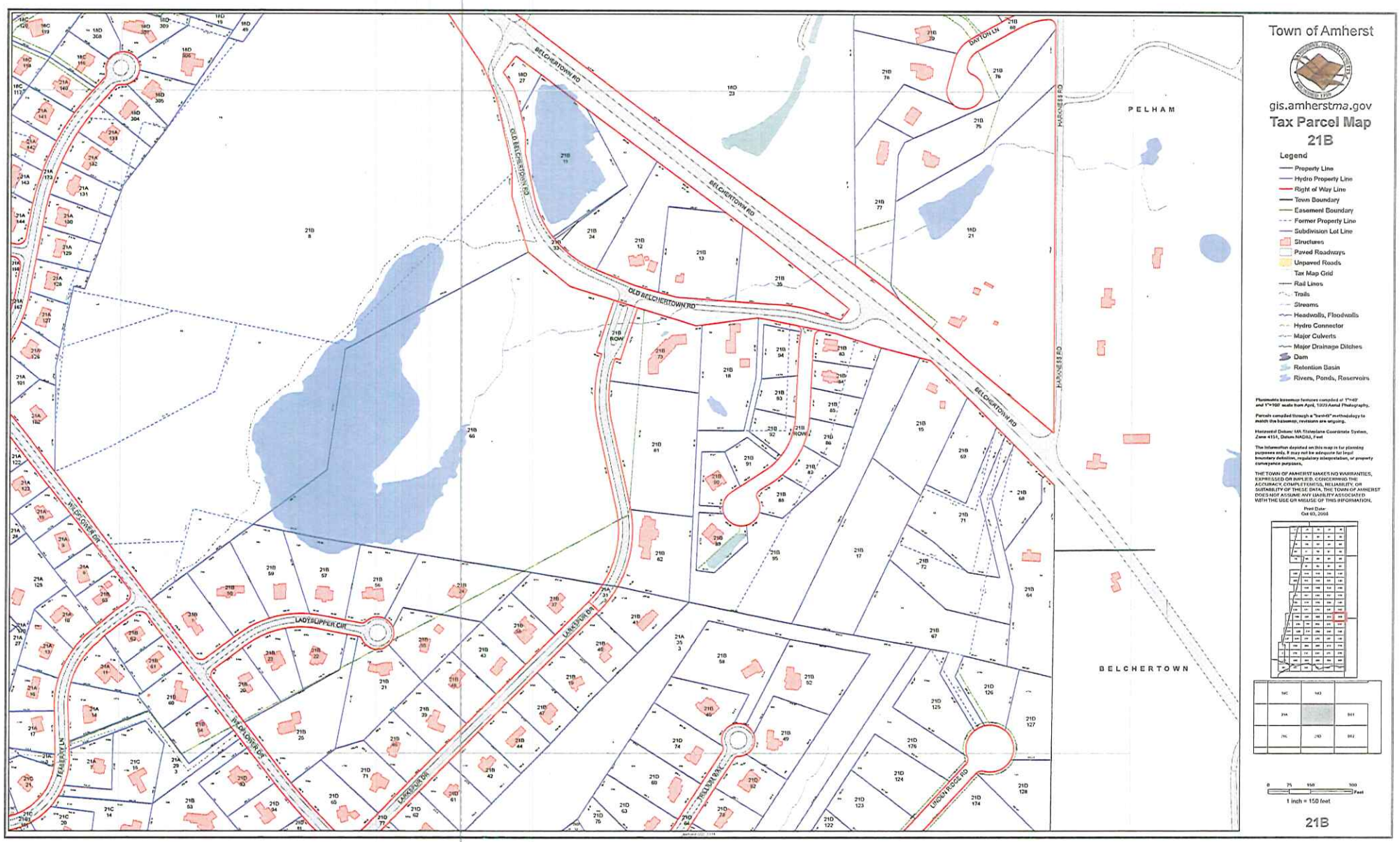
PREPARED BY THE ENGINEERING DIVISION
DEPARTMENT OF PUBLIC WORKS, AMHERST, MA
FEBRUARY 4, 2010

1 INCH = 400 FT

0 100 200 300 400
Feet

LEGEND

- NHESP Priority Habitats of Rare Species
- Open Water
- Marsh
- Wooded Swamp
- Brush and scrub vegetation
- Cultivated field
- Gravel pile
- Tree Cover



Town of Amherst

gis.amherstma.gov

Tax Parcel Map

21B

Legend

- Property Line
- Hydro Property Line
- Right of Way Line
- Town Boundary
- Easement Boundary
- Former Property Line
- Subdivision Lot Line
- Structures
- Paved Roadways
- Unpaved Roads
- Tax Map Grid
- Rail Lines
- Trails
- Streams
- Headwalls, Floodwalls
- Hydro Connector
- Major Culverts
- Major Drainage Ditches
- Dam
- Retention Basin
- Rivers, Ponds, Reservoirs

Planimetric basemap features compiled at 1"=40' and 1"=100' scale from April, 1999 Aerial Photography.

Parcels compiled through a "bench" methodology to match the basemap, revisions are ongoing.

Horizontal Datum: MA State plane Coordinate System, Zone 4101, Datum NAD83, Feet

The information depicted on this map is for planning purposes only. It may not be adequate for legal boundary definition, regulatory interpretation, or property conveyance purposes.

THE TOWN OF AMHERST MAKES NO WARRANTIES, EXPRESSED OR IMPLIED, CONCERNING THE ACCURACY, COMPLETENESS, RELIABILITY, OR SUITABILITY OF THESE DATA. THE TOWN OF AMHERST DOES NOT ASSUME ANY LIABILITY ASSOCIATED WITH THE USE OR MISUSE OF THIS INFORMATION.

Print Date:
Oct 03, 2008

0 75 150 300 Feet

1 inch = 150 feet

21B

Property Location: BL...ERT ... RD Map ID: 21B/... Bldg Name: State Use: 903...

Vision ID: 5150 Account # Bldg #: 1 of 1 Sec #: 1 of 1 Card 1 of 1 Print Date: 12/11/2009 15:03

CURRENT OWNER	TOPO.	UTILITIES	STRT./ROAD	LOCATION
TOWN OF AMHERST				
TOWN HALL				
AMHERST, MA 01002				
Additional Owners:				

SUPPLEMENTAL DATA

Other ID:	OLD LANDFILL	Precinct	
Calc Frontag	2050.5	Vote At	
Owner Occupi		SCHOOL	
		PARENT	
		CREATED	
GIS ID: 21B-8		ASSOC PID#	

CURRENT ASSESSMENT

Description	Code	Appraised Value	Assessed Value
EXM LAND	9030	93,300	93,300
		Total	93,300	93,300

601
AMHERST, MA

VISION

RECORD OF OWNERSHIP

RECORD OF OWNERSHIP	BK-VOL/PAGE	SALE DATE	q/u	v/i	SALE PRICE	V.C.
TOWN OF AMHERST	4014/ 332	08/17/1992			0	
FLOWER, JEFFREY W	2619/ 67	09/13/1985			0	
TOWN OF AMHERST	2536/ 21	02/15/1985			0	
AMHERST, TOWN OF	1676/ 123	12/12/1972			24,000	
AMHERST, TOWN OF	1543/ 545	01/01/1968			0	
AMHERST, TOWN OF	1543/ 545	01/01/1968			0	

PREVIOUS ASSESSMENTS (HISTORY)

Yr.	Code	Assessed Value	Yr.	Code	Assessed Value	Yr.	Code	Assessed Value
2010	9030	93,300	2009	9030	93,300	2008	9030	93,300
	Total:	93,300		Total:	93,300		Total:	93,300

EXEMPTIONS

Year	Type	Description	Amount
		Total:	

OTHER ASSESSMENTS

Code	Description	Number	Amount	Comm. Int.

This signature acknowledges a visit by a Data Collector or Assessor

APPRAISED VALUE SUMMARY

Appraised Bldg. Value (Card)	0
Appraised XF (B) Value (Bldg)	0
Appraised OB (L) Value (Bldg)	0
Appraised Land Value (Bldg)	93,300
Special Land Value	0
Total Appraised Parcel Value	93,300
Valuation Method:	C
Adjustment:	0
Net Total Appraised Parcel Value	93,300

ASSESSING NEIGHBORHOOD

NBHD/ SUB	NBHD NAME	STREET INDEX NAME	TRACING	BATCH
AW/A				

NOTES

CLOSED MUNICIPAL LANDFILL
FY98-ADD PART OF 21A-100,
& 21B-68 & ALL OF 18D-21,
21B-32,6,10,26 & 21A-31.

BUILDING PERMIT RECORD

Permit ID	Issue Date	Type	Description	Amount	Insp. Date	% Comp.	Date Comp.	Comments

VISIT/ CHANGE HISTORY

Date	Type	IS	ID	Cd.	Purpose/Result
7/21/1986			A		

LAND LINE VALUATION SECTION

B #	Use Code	Use Description	Zone	D	Frontage	Depth	Units		Unit Price	I. Factor	S.A.	Acre Disc	C. Factor	ST. Idx	Adj.	Notes- Adj	Special Pricing	Adj. Unit Price	Land Value
1	9030	MUNICPAL V	RN20		915		51.83	AC	10,000.00	0.90	0	0.2000	1.00	AW	1.00			1,800.00	93,300
Total Card Land Units:							51.83	AC	Parcel Total Land Area:			51.83 AC						Total Land Value:	93,300

...rty Lo... t: B... ERT RD M... :21B Bldg : St... ...2:903...

Vision ID: 5150 Account # Bldg #: 1 of 1 Sec #: 1 of 1 Card 1 of 1 Print Date: 12/11/2009 15:03

CONSTRUCTION DETAIL

Element	Cd.	Ch.	Description
Model	00		Vacant

CONSTRUCTION DETAIL (CONTINUED)

Element	Cd.	Ch.	Description

MIXED USE

Code	Description	Percentage
9030	MUNICPAL V	100

COST/MARKET VALUATION

Adj. Base Rate:	0.00
Section. RCN:	0
Net Other Adj:	0.00
Replace Cost	0
AYB	
EYB	0
Dep Code	
Remodel Rating	
Year Remodeled	
Dep %	
Functional Obslnc	
External Obslnc	
Cost Trend Factor	1
Condition	
% Complete	
Overall % Cond	
Apprais Val	
Dep % Ovr	0
Dep Ovr Comment	
Misc Imp Ovr	0
Misc Imp Ovr Comment	
Cost to Cure Ovr	0
Cost to Cure Ovr Comment	

OB-OUTBUILDING & YARD ITEMS(L) / XF-BUILDING EXTRA FEATURES(B)

Code	Description	Sub	Sub Descript	L/B	Units	Unit Price	Yr	Gde	Dp Rt	Cnd	%Cnd	Apr Value

BUILDING SUB-AREA SUMMARY SECTION

Code	Description	Living Area	Gross Area	Eff. Area	Unit Cost	Undeprec. Value
	Ttl. Gross Liv/Lease Area:	0	0	0		

No Photo On Record

Town of Amherst
Department of Public Works

SECTION 5

Information Request Response Letter from NHESP and Species Fact Sheets

Commonwealth of Massachusetts

Division of Fisheries & Wildlife

MassWildlife

Wayne F. MacCallum, *Director*

February 25, 2010

Paul Dethier
Amherst Department of Public Works
586 South Pleasant St
Amherst MA 01002

RE: Project Location: 740 Belchertown Road
Town: AMHERST
NHESP Tracking No.: 10-27804

To Whom It May Concern:

Thank you for contacting the Natural Heritage and Endangered Species Program ("NHESP") of the MA Division of Fisheries & Wildlife for information regarding state-listed rare species in the vicinity of the above referenced site. Based on the information provided, this project site, or a portion thereof, is located **within** *Priority Habitat* and *Estimated Habitat* as indicated in the *Massachusetts Natural Heritage Atlas* (13th Edition). Our database indicates that the following state-listed rare species have been found in the vicinity of the site:

Priority Habitat 697 & 698 (PH 697 & 698), Amherst Landfill:

Scientific name	Common Name	Taxonomic Group	State Status
Ammodramus savannarum	Grasshopper Sparrow	Bird	Threatened

Priority Habitat 1337 (PH 1337) and *Estimated Habitat 76* (EH 76), Fort River:

Scientific name	Common Name	Taxonomic Group	State Status
Glyptemys insculpta	Wood Turtle	Reptile	Special Concern
Alasmidonta undulata	Triangle Floater	Mussel	Special Concern
Alasmidonta heterodon	Dwarf Wedgemussel	Mussel	Endangered
Strophitus undulatus	Creeper	Mussel	Special Concern
Ligumia nasuta	Eastern Pondmussel	Mussel	Special Concern
Stylurus scudderi	Zebra Clubtail	Dragonfly	Special Concern

The species listed above are protected under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) and its implementing regulations (321 CMR 10.00). State-listed wildlife are also protected under the state's Wetlands Protection Act (WPA) (M.G.L. c. 131, s. 40) and its implementing regulations (310 CMR 10.00). Fact sheets for most state-listed rare species can be found on our website (www.nhesp.org).

Please note that projects and activities located within Priority and/or Estimated Habitat **must** be reviewed by the NHESP for compliance with the state-listed rare species protection provisions of MESA (321 CMR 10.00) and/or the WPA (310 CMR 10.00).

Wetlands Protection Act (WPA)

Division of Fisheries and Wildlife
Field Headquarters, North Drive, Westborough, MA 01581 (508) 389-6300 Fax (508) 389-7891
An Agency of the Department of Fish and Game

If the project site is within Estimated Habitat and a Notice of Intent (NOI) is required, then a copy of the NOI must be submitted to the NHESP so that it is received at the same time as the local conservation commission. If the NHESP determines that the proposed project will adversely affect the actual Resource Area habitat of state-protected wildlife, then the proposed project may not be permitted (310 CMR 10.37, 10.58(4)(b) & 10.59). In such a case, the project proponent may request a consultation with the NHESP to discuss potential project design modifications that would avoid adverse effects to rare wildlife habitat.

A streamlined joint MESA/WPA review process is now available. When filing a Notice of Intent (NOI), the applicant may now file concurrently under the MESA on the same NOI form and qualify for a 30-day streamlined joint review. For a copy of the revised NOI form, please visit the MA Department of Environmental Protection's website: http://www.mass.gov/dep/water/approvals/wpaform3.doc.

MA Endangered Species Act (MESA)

If the proposed project is located within Priority Habitat and is not exempt from review (see 321 CMR 10.14), then project plans, a fee, and other required materials must be sent to NHESP Regulatory Review to determine whether a probable "take" under the MA Endangered Species Act would occur (321 CMR 10.18). Please note that all proposed and anticipated development must be disclosed, as MESA does not allow project segmentation (321 CMR 10.16). For a MESA filing checklist and additional information please see our website: www.nhesp.org ("Regulatory Review" tab).

We recommend that rare species habitat concerns be addressed during the project design phase prior to submission of a formal MESA filing, as avoidance and minimization of impacts to rare species and their habitats is likely to expedite endangered species regulatory review.

This evaluation is based on the most recent information available in the Natural Heritage database, which is constantly being expanded and updated through ongoing research and inventory. If you have any questions regarding this letter please contact Amy Coman, Endangered Species Review Assistant, at (508) 389-6364.

Sincerely,

Thomas W. French

Thomas W. French, Ph.D.
Assistant Director

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Silvio O. Conte
National Fish and Wildlife Refuge
At the Great Falls Discovery Center
38 Avenue A
Turners Falls, MA 01376

J- 413- 863-0209

November 19, 1996

Mr. Noel Ryan, Director
Department of Public Works
South Pleasant Street
Amherst, Massachusetts 01002

Dear Mr. Ryan:

I know you are curious about what we found on the old landfill during the grassland bird survey last summer. I was having trouble finding time to take a close look at the data and apologize for the delay. Fortunately, a wonderful volunteer, Melissa Handley, took the time to do this for me. Many thanks to Melissa!

The inventory work was conducted by Bonnie MacCulloch, an intern with the Massachusetts Audubon Society who was doing similar work elsewhere in the state as well. Harvey Allen, a dedicated birder from Amherst, assisted Bonnie. I'd like to recognize and thank Harvey for his help.

The study was conducted from May 20, 1996 to July 7, 1996. Twenty-two survey points were established in the ten fields of cooperators. Each point was visited six times in the early morning. Six species of grassland birds were found nesting in the surveyed fields: the bobolink, the red-winged blackbird, the eastern meadowlark, the song sparrow, the savannah sparrow and the grasshopper sparrow. Each field was also checked once in the early evening for owls, but none were found (inconclusive).

The number of individuals of each species seen inside and outside of a 100 meter radius circle during a ten minute period was recorded. In analyzing the data to make it a little more "user friendly," Melissa figured out the overall average per point (inside the 100 m) per day and then gave each target species at each site a ranking of "low", "medium" or "high". This ranking is comparative, and shows how the average of this property compares with that of the other properties that participated in the study. The rankings were based upon natural breaks in the data.

Also noted were other species that were observed using each field. These species were divided into groups of common or uncommon, based on the number of days each was seen.

The landfill had three inventory points, indicated on the attached copy of an aerial photo. The landfill was remarkable in that it was one of only two properties surveyed on which all six grassland species

were observed. This property had the highest average of both the savannah sparrow and the grasshopper sparrow. Both of these birds prefer sparse grasses or some bare ground. It also was one of three properties with the highest average of eastern meadowlarks. In addition to the grassland species, 31 other species were observed.

I hope you find this information interesting. It shows that your current management practices, combined with the characteristics of your site, are providing some of the best grassland bird habitat in town. I really appreciate this contribution! The inventory provides a good baseline and will allow us to compare bird use over the years and note changes caused by changing vegetation or management practices. I look forward to continuing this inventory on the old landfill next year. Thank you again for your participation in this study.

Sincerely,

Beth Goettel

Beth Goettel
Wildlife Biologist

cc: Pete Westover

Table 1: Grassland bird species observed at the old landfill (1996)

Species	Average for point 1 (#/day)	Average for point 2 (#/day)	Average for point 3 (#/day)	Overall Av. (#/point/day)	Ranking
Bobolink	0	1.6	2.6	1.4	low
Red-winged Blackbird	10.6	3.2	3.7	5.8	medium
Eastern Meadowlark	0.2	0.8	1.4	0.8	medium
Song Sparrow	0	0	0 .2	0.1	low
Savannah Sparrow	0	1.0	0.8	0.6	high
Grasshopper Sparrow	0	0	0.2	0.1	high

Table 2: Other species observed at the old landfill (1996)

Common	Uncommon
Brown-headed Cowbird	Wood thrush
American Goldfinch	Eastern Pewee
American Crow	Tufted Titmouse
Common Yellowthroat	American Robin
Mourning Dove	Gray Catbird
	Killdeer
	Rose-breasted Grosbeak
	Great-crested Flycatcher
	Towhee
	Starling
	House Wren
	Yellow Wren
	Eastern Kingbird
	Cerulean Warbler
	Yellow Warbler
	Carolina Wren
	Kestrel
	Scarlet Tanager
	Black-and-white Warbler
	Common Grackle
	Blue Jay
	Tree Swallow
	Pileated Woodpecker
	Northern Cardinal
	Northern Oriole
	Indigo Bunting

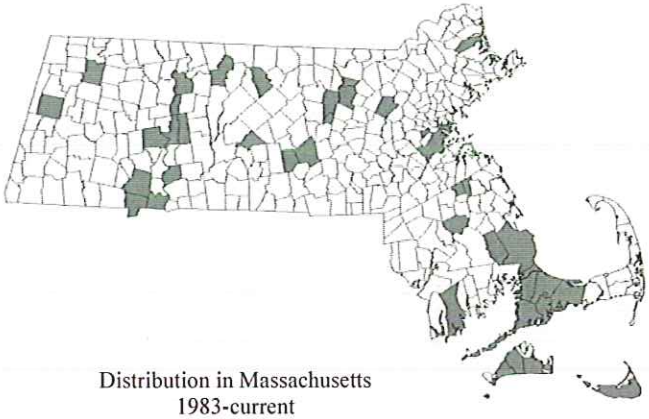
Natural Heritage
& Endangered Species
Program
Massachusetts Division of Fisheries & Wildlife
1 Rabbit Hill Road, Westborough, MA 01581
tel: (508) 389-6360, fax: (508) 389-7891
www.nhesp.org

Grasshopper Sparrow

Ammodramus savannarum

State Status: **Threatened**
Federal Status: **None**

DESCRIPTION: The Grasshopper Sparrow is a small sparrow of open fields. It is 4.5 to 5.5 in (11-13 cm) long with a narrow short tail. Each feather of the tail tapers to a point giving it a ragged appearance. It has a flat head which slopes directly into the bill. The upperparts have reddish streaks with contrast with the intervening gray. The dark brown crown is divided by a thin cream-colored center stripe. A yellowish spot extends from the bill in front and below the eye. The sexes are similar. The typical song, often mistaken for the song of a grasshopper, consists of two chip notes followed by "tsk tsick tsurrrr". Breeding birds also sing a complicated song with many squeaky and buzzy notes intermixed in a long phrase.



Distribution in Massachusetts
1983-current
Based on records in Natural Heritage Database

SIMILAR SPECIES: Young birds resemble adult Henslow's Sparrows but have dusky brown streaks or spots on the buffy breast and flanks. Adult Grasshopper Sparrows can be distinguished from the Field Sparrow by the latter's pinkish bill, rusty cap and white eye ring. Other species similar in appearance and also found in the same type of habitat include the Vesper Sparrow, Savannah Sparrow and Song Sparrow but Grasshopper Sparrow differ from these by its buffy unstreaked throats and breast and the yellowish area around the eye. However, its distinctive call best distinguishes it from all other birds.

ECOLOGY/BEHAVIOR: Grasshopper Sparrows eat, sleep and nest on the ground. When flushed, it usually flies up from the grass, flutters rather low and erratically for a short distance and drops into the grass again. On the ground it either hops or runs.

HABITAT IN MASSACHUSETTS: It is found in the sandplain grasslands, pastures, hayfields and airfields characterized by bunch grasses (rather than sod-forming grasses). It is also found in open knolls, sandplains within Pine Barrens and coastal heathlands. It requires a patchy grassland habitat with bare ground and bunch grasses such as poverty grass (*Danthonia spicata*), bluestem (*Andropogon* spp.) and fescue (*Fescue* spp.). Preferred habitat is characterized by relatively low stem densities and limited accumulation of ground litter. This species is generally absent from fields with over 35% cover in shrubs. Bare ground is especially important, as Grasshopper Sparrows behave much like field mice in their habit of running along the ground to escape predators and to forage for invertebrates.

MIGRATION: The Grasshopper Sparrows arrive in Massachusetts in late May. The male lays claim to a 1-4 acre exclusive non-overlapping territory by singing the "grasshopper" song all day from a tall weed, fence post, haystack, etc. During the non-breeding season both the male and female sing. Grasshopper Sparrows migrate to the wintering grounds by mid-September.

BREEDING HABITS: Grasshopper Sparrows produce one brood each summer in Massachusetts. The well-hidden nests are walled, domed structures of grasses built at the base of clumps of grass. Only the female incubates the eggs, which take an estimated 12 days to hatch. The usually 3-5 eggs are white with spots or blotches of brown to reddish brown which are concentrated on the larger end of the egg. The young, which are wholly dependent on the mother at hatching, leave the nest after 9 days and follow the parent on the ground until they fledge. If found on the nest, the mother flutters through the grass feigning lameness. Though the male does not care for the young, he does react to predators near the nest. Nests may be parasitized by cowbirds. Breeding activity diminishes by mid-August after which the families disperse.

FEEDING HABITS: This species is largely insectivorous. Patches of bare ground are critical to this sparrow's foraging behavior as grasshoppers, a primary food item, are most often pursued on or near the ground. Grasshopper Sparrows also feed on spiders, myriapods, snails, earthworms, weed and grass seeds.

RANGE: The Grasshopper Sparrow can be found from New Hampshire to California, and south to South Carolina to Mexico, Cuba, the Bahamas and Guatemala. It winters from southern California to El Salvador, and the West Indies.

POPULATION STATUS: The Grasshopper Sparrow is classified as a Threatened Species in Massachusetts, where it is known to nest at fewer than 20 sites. Many of the current locations are in fields adjacent to air fields. This sparrow formerly was abundant on Nantucket, Martha's Vineyard, and in eastern Massachusetts. Loss of appropriate habitat to land development, changes in agricultural practices (early harvesting and fewer fallow fields), and natural succession (abandoned fields growing up to shrubs and woods) appears to be the primary factor in its decline. Openings created by forest fires once provided habitat but these are now rare.

Updated August 2008

Natural Heritage
& Endangered Species
Program

Massachusetts Division of Fisheries & Wildlife
Route 135, Westborough, MA 01581
tel: (508) 389-6360; fax: (508) 389-7891
www.nhesp.org

Wood Turtle

Glyptemys insculpta

State Status: **Species of Special Concern**
Federal Status: None

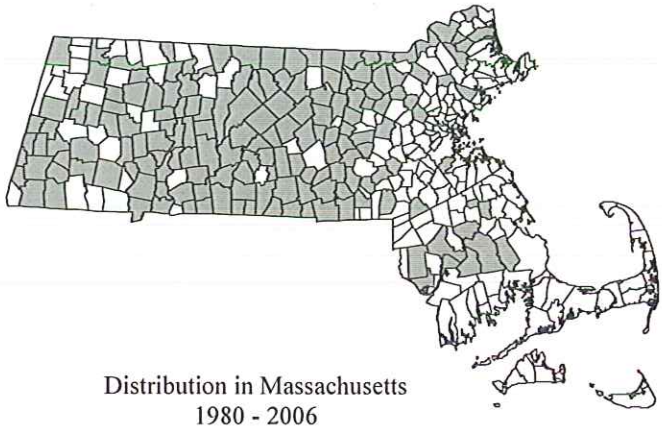
Photo by Mike Jones

DESCRIPTION: The Wood Turtle is a medium-sized turtle (14-20 cm; 5.5-8 in) that can be recognized by its sculpted shell and orange coloration on the legs and neck. The carapace (upper shell) is rough and each scale (scute) rises upwards in an irregularly shaped pyramid of grooves and ridges. The carapace is tan, grayish-brown or brown, has a mid-line ridge (keel) and often has a pattern of black or yellow lines on the larger scutes. The plastron (lower shell) is yellow with oblong dark patches on the outer, posterior corner of each scute. The head is black, but may be speckled with faint yellow spots. The legs, neck, and chin can have orange to reddish coloration. Males have a concave plastron, thick tail, long front claws, and a wider and more robust head than females. Hatchlings have a dull-colored shell that is broad and low, a tail that is almost as long as their carapace and they lack orange coloration on the neck and legs.

SIMILAR SPECIES: The habitat of the Eastern Box Turtle (*Terrapene carolina*) and the Blanding's Turtle (*Emydoidea blandingii*) may overlap that of the Wood Turtle, but neither has the Wood Turtle's pyramidal shell segments. Unlike the Wood Turtle, the Box and Blanding's Turtle have hinged plastrons into which they can withdraw or partially withdraw if threatened. The Northern Diamond-backed Terrapin (*Malaclemys terrapin*) has a shell similar to that of the Wood Turtle. However, its skin is grey and it lives only near brackish water, which the Wood Turtle avoids.

RANGE: The Wood Turtle can be found throughout New England, north to Nova Scotia, west to eastern Minnesota, and south to northern Virginia. The Wood Turtle appears to be widespread in Massachusetts. However, it should be kept in mind that little is known about the status of local populations associated with the majority of these sightings. Most of the towns have fewer than 5 known occurrences.

HABITAT IN MASSACHUSETTS: The preferred habitat of the Wood Turtle is riparian areas. Slower moving mid-sized streams are favored, with sandy bottoms and heavily vegetated stream banks. The stream bottom and muddy banks provide hibernating sites for overwintering, and open areas with sand or gravel substrate near the streams edge are used for nesting. Wood Turtles spend most of the spring and summer in mixed or deciduous forests, fields, hay-fields, riparian wetlands including wet meadows, bogs, and beaver ponds. Then they return to the streams in late summer or early fall to their favored overwintering location.



Distribution in Massachusetts
1980 - 2006
Based on records in Natural Heritage Database

LIFE CYCLE & BEHAVIOR: The Wood Turtle typically spends the winter in flowing rivers and perennial streams. Full-time submersion in the water begins in November, once freezing occurs regularly overnight, and continues until temperatures begin to increase in spring. It may hibernate alone or in large groups in community burrows in muddy banks, stream bottoms, deep pools, instream woody debris, and abandoned muskrat burrows. The Wood Turtle may make underwater movements in the stream during the winter; however, extended periods of activity and emergence from the water do not occur until mid-March or early April.

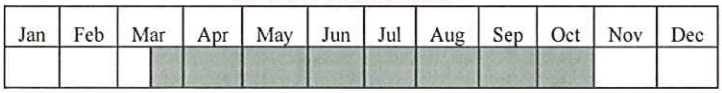
In spring, Wood Turtles are active during the day and are usually encountered within a few hundred meters from the stream banks. They have relatively linear home ranges that can be ½ a mile in length in Massachusetts (M. Jones, unpubl data). They will use emergent logs or grassy, sandy, and muddy banks to soak up the spring sun. During the summer months they feed in early successional fields, hayfields, and forests.

Wood Turtles are opportunistic omnivores; their diet consists of both plant and animal matter that is consumed on land and in the water. The Wood Turtle occasionally exhibits an unusual feeding behavior referred to as "stomping." In its search for food, this species will stomp on the ground alternating its front feet, creating vibrations in the ground resembling rainfall. Earthworms respond, rising to the ground's surface to keep from drowning. Instead of rain, the earthworm is met by the Wood Turtle, and is promptly devoured.

Although the peaks in mating activity occur in the spring and fall, Wood Turtles are known to mate opportunistically throughout their activity period. Males have been observed exhibiting aggressive behavior such as chasing, biting, and butting both during the mating season and at other times. A courtship ritual "dance" typically takes place at the edge of a stream or brook for several hours prior to mating. The dance involves the male and female approaching each other slowly with necks extended and their heads up. Before they actually touch noses, they lower their heads, and swing them from side to side. Copulation usually takes place within the water. Courting adults may produce a very subdued whistle that is rarely heard by observers. A female may mate with multiple individuals over the course of the active season.

In Massachusetts, most nesting occurs over a four-week period, primarily in June. Nesting sites may be a limited resource for Wood Turtles. Females are known to travel long distances in search of appropriate nesting habitat (average straight line distance of 244 m; 800 ft). Once they have arrived at a suitable nesting area, there may be multiple nesting attempts or false nests that occur over the course of several days, prior to laying eggs. They abort attempts when disturbed (e.g. by human activities) early in the process or hit a large rock while digging. Female Wood Turtles lay one clutch a year and often congregate in a good nesting area. Clutch size in Massachusetts averages 7 eggs (Jones, 2004, pers. comm.). Hatchling emergence occurs from August through September. The life span of the adult Wood Turtle is easily 46 years and may reach as much as 100 years.

ACTIVE PERIOD



THREATS: Hatchling and juvenile survival is very low and the time to sexual maturity is long. These characteristics are compensated by adults living a long time and reproducing for many years. Adult survivorship must be very high to sustain a viable population. These characteristics make Wood Turtles vulnerable to human disturbances. Population declines of Wood Turtles has likely been caused by hay-mowing operations, development of wooded stream banks, roadway casualties, incidental collection of specimens for pets, unnaturally inflated rates of predation in suburban and urban areas, forestry and agricultural activities and pollution of streams.

MANAGEMENT RECOMMENDATIONS: Using a turtle habitat model developed by UMass and NHESP records, Wood Turtle habitat needs to be assessed and prioritized for protection based on the extent, quality, and juxtaposition of habitats and their predicted ability to support self-sustaining populations of Wood Turtles. Other considerations should include the size and lack of fragmentation of both riverine and upland habitats and proximity and connectivity to other relatively unfragmented habitats, especially within existing protected open space. This information will be used to direct land acquisition and to target areas for Conservation Restrictions (CRs), Agricultural Preservation Restrictions (APRs) and Landowner Incentive Program (LIP) projects.

Mowing and nest site creation guidelines developed by NHESP should be followed on properties managed for Wood Turtles. These practices will be most practical on state-owned conservation lands. However, these materials are available to town land managers and private landowners.

Alternative wildlife corridor structures should be considered at strategic sites on existing roads. In particular, appropriate wildlife corridor structures should be considered for bridge and culvert upgrade and road-widening projects within or near Wood Turtle habitat. Efforts should be made to inform local regulatory agencies of key locations where these measures would be most effective for Wood Turtle conservation.

Educational materials are being developed and distributed to the public in reference to the detrimental effects of keeping our native Wood Turtles as pets (an illegal activity that reduces reproduction in the population), releasing pet store turtles (which could spread disease), leaving cats and dogs outdoors unattended (particularly during the nesting season), mowing of fields and shrubby areas, feeding suburban wildlife (which increases the number of natural predators to turtles), and driving ATVs in nesting areas from June-October. People should be encouraged, when safe to do so, to help Wood Turtles cross roads (always in the direction the animal was heading); however, turtles should never be transported to "better" locations. They will naturally want to return to their original location and likely need to traverse roads to do so.

Increased law enforcement is needed to protect our wild turtles, particularly during the nesting season when poaching is most frequent and ATV use is common and most damaging.

Forestry Conservation Management Practices should be applied on state and private lands to avoid direct turtle mortality. Seasonal timber harvesting restrictions apply to Wood Turtle habitat and to upland habitat that occurs up to 600 ft (183 m) beyond the stream edge. Motorized vehicle access to timber harvesting sites in Wood Turtle habitat is restricted to times when the Wood Turtle is overwintering. Bridges should be laid down across streams prior to any motorized equipment crossing the stream in order to maintain the structural integrity of overwintering sites.

Finally, a statewide monitoring program is needed to track long-term population trends in Wood Turtles.

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Zebra Clubtail Dragonfly

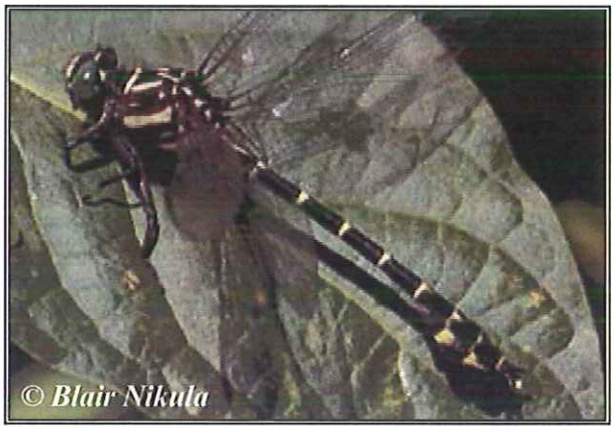
Stylurus scudderi

State Status: **Endangered**
Federal Status: None

DESCRIPTION: The Zebra Clubtail (*Stylurus scudderi*) is a large insect belonging to the order Odonata, sub-order Anisoptera (the dragonflies), and family Gomphidae (clubtails). Clubtails are a distinctive group of dragonflies that generally inhabit flowing waters, though they can be found at a variety of habitats, including ponds and lakes. Clubtails also have the distinction of being the only group of dragonflies in Massachusetts to have widely separated eyes. The name clubtail refers to a swelling in the distal segments of these dragonflies' abdomens, creating a form not unlike a club that varies in width from species to species. The Zebra Clubtail possesses a rather wide club, nearly as wide as the thorax (section behind the head), which includes the seventh, eighth, and ninth segments (dragonflies and damselflies have ten abdominal segments). The Zebra Clubtail is a very striking insect with black and yellow patterning (which prompted its naming) and bright green eyes. The face is green with black cross stripes. The dark brown thorax has two large buff white stripes on each side. The black abdomen is marked with pale yellow rings. Abdominal segments eight and nine have a large yellowish spot located laterally on each side, while segment seven has a smaller spot in the same location. The three pairs of powerful legs are jet black and lined with spines which aid in catching the small aerial insects these insects feed on. Zebra Clubtails perch horizontally on rocks, logs, vegetation or the ground with their wings held horizontal, like those of an airplane.

Adult Zebra Clubtails range from 2 to 2.3 inches (52 to 59 mm) in length. Although male and female Zebra Clubtails appear similar in their coloration, the female is slightly larger with a reduced "club."

SIMILAR SPECIES: Although many of the clubtails are similar in appearance, the Zebra Clubtail is a large and distinctively marked species. A combination of factors, including its ringed abdomen, green eyes, terminal abdominal appendages (males), hamules (males) and vulvar lamina (females), help to easily distinguish this species from all other dragonflies in Massachusetts (Needham *et al.* 1999). The nymphs can be distinguished by characteristics of the abdominal segments and palpal lobes as shown in the keys in Walker (1958) and Soltesz (1996).



HABITAT: Zebra Clubtails inhabit medium-sized forested streams which usually have some intermittent rapids. These streams are generally sandy-bottomed with slow to moderate flow. Elsewhere within its range, the Zebra Clubtail has occasionally been found on large lakes.

LIFE-HISTORY/BEHAVIOR: The Zebra Clubtail is a late flying species. Emergence in Massachusetts probably occurs in early July. Following maturation, which may take a week, Zebra Clubtails can be seen at breeding habitat from mid-July through early September.

Dragonflies are an understudied group of insects. As a result there has been little published on their habits and general life histories. This is true for the Zebra Clubtail, for which there is a paucity of published material. However, information that has been published on other related species is most likely applicable.

During their complete life cycle, dragonflies go through two distinct stages, a nymph stage where they are wholly aquatic, and an aerial adult stage. Zebra Clubtail nymphs spend much of their time buried in the sand at the bottom of their stream habitat where they wait to ambush almost any animal that is a suitable size.

ZEBRA CLUBTAIL FLIGHT PERIOD

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Please allow the Natural Heritage & Endangered Species Program to continue to conserve the biodiversity of Massachusetts with a contribution for 'endangered wildlife conservation' on your state income tax form as these donations comprise a significant portion of our operating budget.

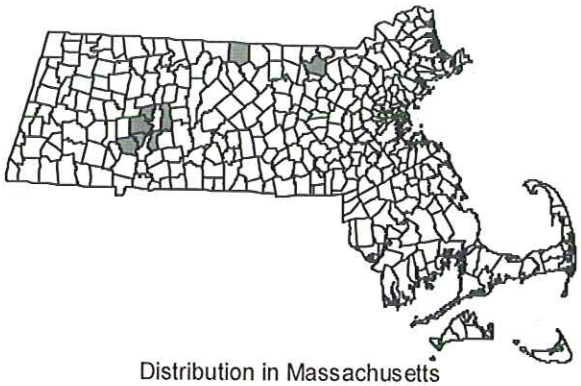
Dragonfly and damselfly nymphs are unique in their mode of prey capture. They have a hinged labium (lower lip) which can be extended rapidly to secure their prey. The victim can then be moved back to the mandibles to be eaten. The wide variety of prey includes aquatic insects, small fish, and tadpoles. While in the nymph stage, the dragonflies will molt up to 10 times, growing each time. When the nymph reaches a certain size, they enter the last developmental stage. Although it is not known how long it takes for Zebra Clubtail nymphs to fully develop, in similarly sized dragonflies it takes about a year.

The final stage of development in dragonflies is emergence from the nymph to the flying adult. The nymph of the Zebra Clubtail generally emerges on the bank of the stream no more than 3 feet above the surface of the water. Although most dragonflies emerge during the early morning, or at night, the Zebra Clubtail has often been found emerging during the middle part of the day. Most dragonflies do not emerge at this time, apparently because predation may be highest during these hours. Upon reaching a secure location, the adult pushes out of the nymphal skin. During the first few hours following emergence, the adult dragonfly is very soft and thus vulnerable to predators. To avoid predation, the newly emerged adults will disperse into surrounding woodlands where they will spend a week or more. This time of wandering is spent maturing and feeding. Dragonflies are aerial predators that feed on small flying insects such as flies and mosquitoes. When not feeding, Zebra Clubtails spend most of their time resting, sitting horizontally on the surfaces of leaves.

Zebra Clubtails breed in late summer, mostly from mid-July through August, though sometimes continuing into September. Male Zebra Clubtails patrol the stream, flying low and quickly over the surface of the water in search of females. They frequently land on the bank, logs, rocks and occasionally shoreline vegetation. When a female is found, the males grabs her and secures her with his terminal abdominal appendages which fit into special grooves in back of her eyes. The female swings the tip of her abdomen, where her reproductive organs are located, towards the male's hamules, located on the under side of the second abdominal segment, forming the "wheel position" with the male on top and the female below. When a male Zebra Clubtail secures a female, the pair leaves the stream and flies up into forest, usually to the tops of the trees, to mate. Oviposition occurs after mating has been completed. Female Zebra Clubtails oviposit alone by rapidly flying over the surface of the water and dipping the tip of her abdomen into the water every few feet. Her flight is very erratic, which may help protect her from potential predators during this time of vulnerability.

RANGE: The Zebra Clubtail is found throughout much of the eastern United States. It ranges from Nova Scotia west to Ontario and south to Georgia, Tennessee and Michigan. The Zebra Clubtail has been found in every New England state, though it appears to be absent from the southeast coastal plain.

POPULATION STATUS IN MASSACHUSETTS: The Zebra Clubtail is listed as an Endangered Species in Massachusetts. As with all species listed in Massachusetts, individuals of the species are protected from take (picking, collecting, killing, etc…) and sale under the Massachusetts Endangered Species Act. The species is known from only a few rivers in the state. The secretive habits of this species have undoubtedly kept it from being found at more sites. However, the Zebra Clubtail has been found at very low densities at all known sites. Thus, this species deserves careful study and monitoring.



Distribution in Massachusetts
1977 - 2002
Based on records in Natural Heritage Database

MANAGEMENT RECOMMENDATIONS: As for many rare species, the exact management needs of Zebra Clubtails are not known. Water quality certainly is a primary concern. Potential threats to the water quality of the rivers in which this species lives include industrial pollution from businesses located along the river, salt and other road contaminant run-off, and siltation from construction or erosion. The disruption of natural flooding regimes by dams and water diversion projects also may have a negative impact on odonate populations. Extensive use of the river by power boats and jet skis is a serious concern, particularly during the mid- to late-summer emergence period of Zebra Clubtails. Many species of clubtails and other riverine odonates undergo emergence near the water on exposed rocks or vegetation, or exposed sections of the river bank, where they are imperiled by the wakes of high speed watercraft. Low-level recreational use from fisherman and canoeists probably has little impact on odonate populations, but should be monitored. The upland borders of these river systems are also crucial to the well-being of odonate populations as they are critical for feeding, resting, and maturation. Development of these areas should be discouraged and preservation of the remaining undeveloped upland bordering the river should be a top priority.

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Updated May 2003

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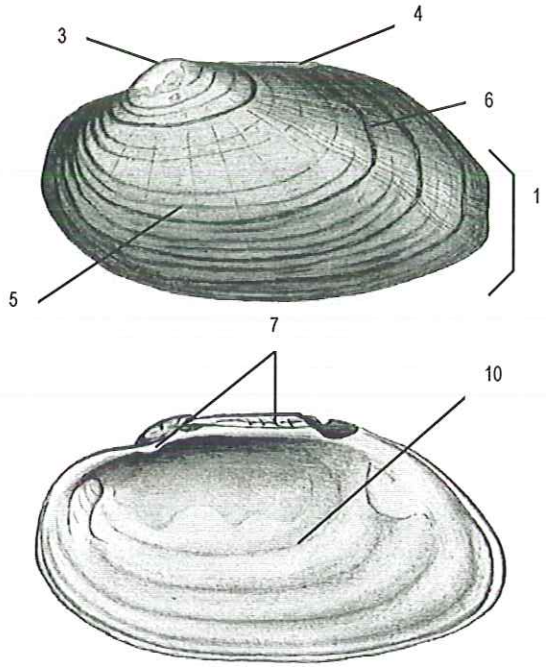
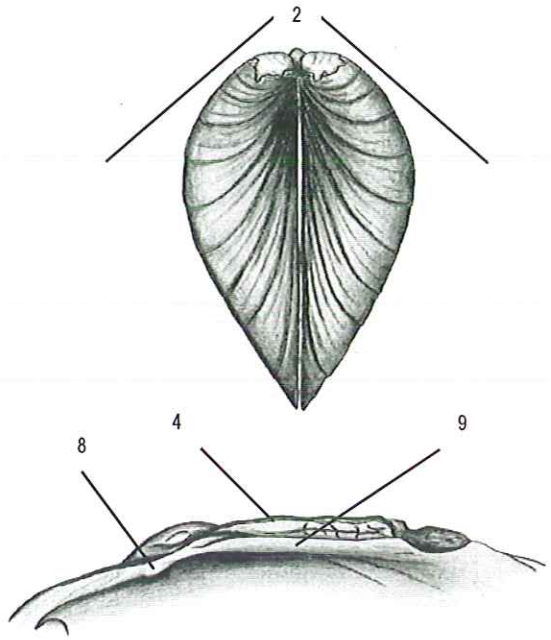
Creeper
Strophitus undulatus

State Status: **Species of Special Concern**
Federal Status: None

Description: The creeper is a small freshwater mussel that rarely exceeds three inches (75mm) in length. The shape is subovate to subtrapezoidal and usually has a blunt posterior end (1). The shells are slightly inflated (2), thin, and fragile. Beaks (3) are barely elevated above the hinge line (4). Sculpturing on the beak is usually coarse and prominent, but this feature is often only evident in animals with little shell erosion. The surface of the shell is often rough due to prominent growth lines. The periostracum (5) may be yellow or greenish-brown in young animals, and brown or black in older animals. Fine green shell rays may be evident toward the posterior slope (6), particularly in young animals or light-colored adults. Hinge teeth (7) are almost entirely absent—pseudocardinal teeth (8) appear as an indistinct swollen area of the nacre below the beak. Lateral teeth (9) are absent. The nacre (10) is white or bluish-white, and it is dull-yellow or greenish toward the beak cavity. Feet may be a very pale orange color but this trait is variable.

Similar Species in Massachusetts: Shells (dead animals) are usually easy to distinguish because they lack hinge teeth and have a distinct color pattern on the nacre. However, these features cannot be used when identifying live animals. The novice will often have difficulty discerning between live animals of the creeper, eastern elliptio, brook floater, dwarf wedgemussel, triangle floater, alewife floater, and eastern floater. Greatest difficulty arises when trying to identify juveniles, animals with excessive shell erosion, or animals whose periostracum is darkly stained or covered with algae. A common error is to confuse the creeper with young eastern elliptio, which unlike the creeper have very strong, thick shells. An expert should be consulted to identify the species because it is listed as a Species of Special Concern in Massachusetts and because it can be confused with three other state or federally protected species (brook floater, triangle floater, and dwarf wedgemussel).





Illustrations by Ethan Nedeau

Text contributed by Ethan Nedeau, December 2007, Creeper Fact Sheet.

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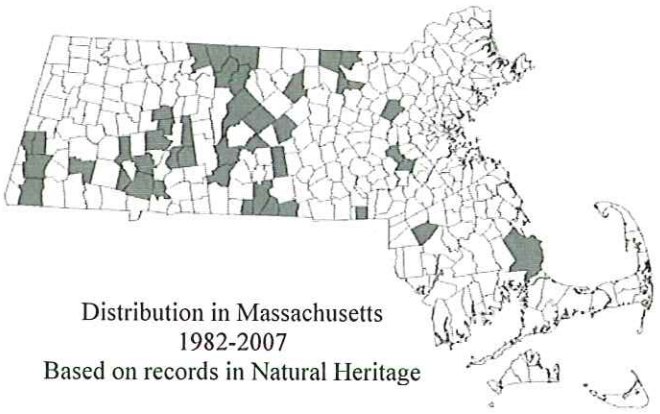
Range: The creeper is widely distributed in North America. It occurs in most Atlantic coastal drainages from Florida to Newfoundland and occurs west of the Appalachian Mountains to Texas and Saskatchewan (including the St. Lawrence River system, Great Lakes basin, and the Ohio and Mississippi River systems). In Massachusetts, the creeper is present in 13 sub basins located mostly in the western two-thirds of the state.

Habitat: In northeastern North America, the creeper inhabits small to large rivers. Preferred habitats include low-gradient river reaches with sand and gravel substrates and low to moderate water velocities, although they can occur within a broader range of habitat conditions (Nedeau *et al.* 2000). While the creeper has not been reported from lakes in the Northeast, they often inhabit small impoundments of run-of-river dams that retain some amount of flow. Streams and rivers that are productive, cool to warm-water environments with diverse fish assemblages are most likely to support the species. Creepers are generally sparse or absent in headwater streams and high-gradient river reaches. They occur most frequently with eastern elliptio, triangle floater, dwarf wedgemussel, and brook floater but have a far broader distribution than the latter two species.

Biology: Freshwater mussels are essentially sedentary filter feeders that spend most of their lives anchored to the bottoms of rivers, streams, lakes, and ponds by their muscular foot. Gills circulate water through their shells via incurrent and excurrent openings, siphoning nutrients to be absorbed by the digestive system. This filtering process is also critical for successful reproduction (Figure 1). Like all freshwater mussels, larvae (called glochidia) of the creeper must attach to the gills or fins of a vertebrate host (mainly fish) to develop into juveniles (for a review, see Nedeau *et al.* 2000). This parasitic phase is the only period during which mussels can disperse long distances. Fertilization occurs in the summer and glochidia are released the following spring. Studies have identified many vertebrate hosts, including a suite of species common in cool to warm-water streams in Massachusetts such as largemouth bass, fallfish, longnose dace, blacknose dace, common shiner, golden shiner, slimy sculpin, bluegill, rock bass, and even two-lined salamanders and red-spotted newts (Nedeau *et al.* 2000, Gray *et al.* 2002). Gray *et al.* (2002) found a low degree of host specificity for the creeper—its glochidia successfully metamorphosed into juveniles on 15 of the 22 species examined. Because the creeper will parasitize such a broad range of native and non-native fish species in Massachusetts, its viability may be less reliant on specific fish as compared to other mussel species, such as the dwarf wedgemussel, which is highly host-specific. Lefevre and Curtis (1911) found that glochidia of the creeper could transform into juveniles without a fish host, a trait that is rare among freshwater mussels. This observation has not been confirmed.



Distribution in Massachusetts
1982-2007
Based on records in Natural Heritage

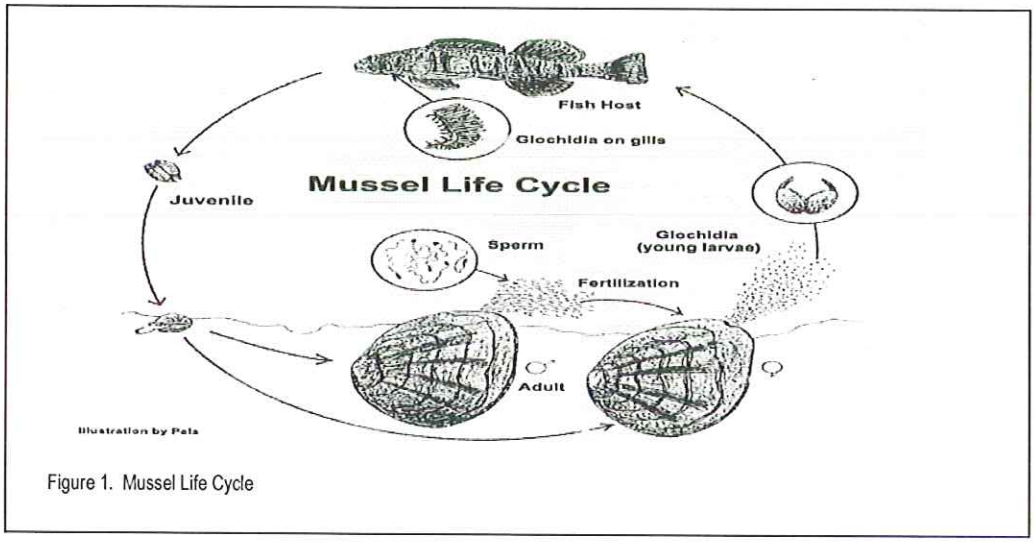


Figure 1. Mussel Life Cycle

Text contributed by Ethan Nedeau, December 2007, Creeper Fact Sheet.

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Population Status in Massachusetts: As of October 2007, there were 58 occurrences of the creeper in 13 sub basins and 42 towns in Massachusetts. Of these 58 occurrences, 38 were represented by live animals and 20 by spent shells only (dead shell remnants). Only 12 of the 38 live occurrences were comprised of 10 or more individuals. Although the creeper is widely distributed in Massachusetts, it is never abundant and the long-term viability of low-density populations is poorly understood. Therefore, the creeper is listed as a Species of Special Concern in Massachusetts pursuant to the Massachusetts Endangered Species Act (MG.L. c.131A) and its implementing regulations (321 CMR 10.00). Maine lists the creeper as a Species of Special Concern for similar reasons as Massachusetts (Nedeau *et al.* 2000), and there is concern for the species in Rhode Island even though it receives no formal protection (Raithel and Hartenstine 2006).

Threats: Because creepers are essentially sedentary filter feeders, they are unable to flee from degraded environments and are vulnerable to the anthropogenic alterations of waterways. Some of the many threats to the creeper and its habitat in Massachusetts include: nutrient enrichment, sedimentation, point-source pollution, alteration of natural flow regimes, water withdrawal, encroachment of river corridors by development, non-native and invasive species, habitat fragmentation caused by dams and road-stream crossings, and a legacy of land use that has greatly altered the natural dynamics of river corridors. In addition, the long-term effects of regional or global problems such as acidic precipitation, mercury, and climate change are considered severe but little empirical data relates these stressors to mussel populations. As local populations of creepers decline and/or become extirpated in response to these threats, dispersal distances between populations increase, weakening overall reproductive success and ultimately genetic diversity (Vaughn 1993).

Conservation & Management Recommendations: Discovery and protection of viable mussel populations is essential for the long-term conservation of freshwater mussels. Currently, much of the available mussel occurrence data are the result of limited presence/absence surveys conducted at road crossings or other easily accessed points of entry. In addition, regulatory protection under MESA only applies to rare species occurrences that are less than twenty-five years old. Surveys are critically needed to monitor known populations, evaluate habitat, locate new populations, and assess population viability at various spatial scales (e.g., river, watershed, state) so that conservation and restoration efforts, as well as regulatory protection, can be effectively targeted. The NHESP has produced the *Freshwater Mussel Habitat Assessment and Survey Guidelines* and maintains a list of experts qualified to conduct surveys. Other conservation and management recommendations include:

- Maintain naturally variable river flow and limit water withdrawals
- Identify, mitigate, or eliminate sources of pollution to rivers
- Identify dispersal barriers (e.g., dams, impassable culverts) for host fish, especially those that fragment the species range within a river or watershed, and seek options to improve fish passage or remove the barrier
- Maintain adequate vegetated riparian buffers
- Protect or acquire land at high priority sites

Further Reading

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Updated: 12/01/07

Text contributed by Ethan Nedeau, December 2007, Creeper Fact Sheet.

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Eastern Pondmussel
Ligumia nasuta

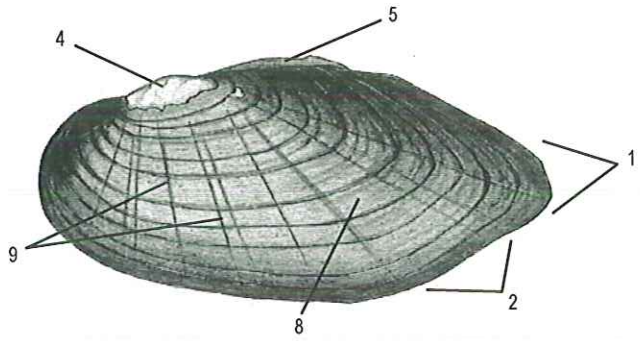
State Status: **Species of Special Concern**
Federal Status: None

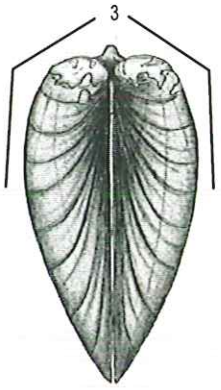
Description: The eastern pondmussel is a medium-sized to large mussel that may exceed six inches (150 mm) in length. The shape is distinctly elongate or elliptical and the posterior end tapers to a blunt point (1). Shells of sexually mature females may be slightly more rounded toward the posterior ventral margin (2) than males or adolescent females. Shells are laterally compressed (3), and despite being thin, they are quite strong. Beaks are low (4) and barely extend beyond the line of the hinge (5). Hinge teeth are well developed but delicate—the left valve has two pseudocardinal teeth and two lateral teeth, and the right valve has two pseudocardinal teeth (6) and one lateral tooth (7). The periostracum (8) is yellowish or greenish-black in young individuals, but usually dark brown or black in older specimens. Shell rays (9) are sometimes evident on those individuals with a light-colored periostracum. The nacre (10) is usually purple, pink, or silvery-white.

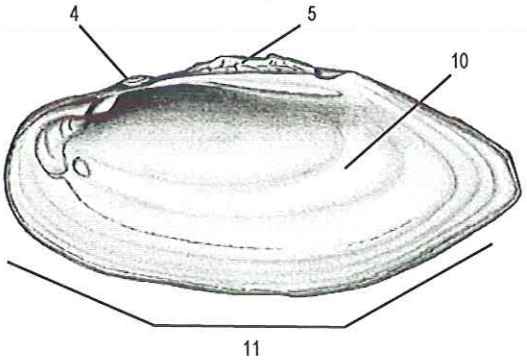
Similar Species in Massachusetts: Due to its elongate shape (11), pointed posterior end (1), and laterally compressed shell (3), the eastern pondmussel is easy to distinguish from all other species in Massachusetts.

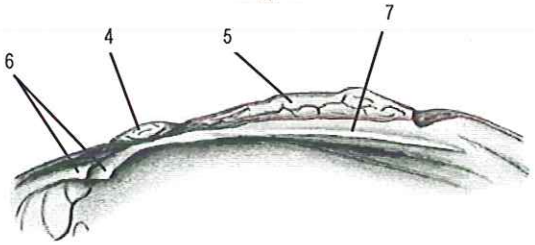
Range: The eastern pondmussel is distributed throughout Atlantic coastal drainages from Virginia to New Hampshire and in the eastern Great Lakes region. It is most abundant in southeastern Massachusetts, particularly in large coastal plain ponds on the mainland and on Cape Cod. Small populations also occur in the central Connecticut River Valley, especially in low-gradient sections of several tributaries to the Connecticut River

Habitat: The eastern pondmussel inhabits streams, rivers, and small to large lakes and ponds. It exhibits no distinct preference for substrate, depth, or flow conditions. It has been found at relatively high densities at depths of 15-25 feet in coastal ponds where the substrate was primarily mud (Nedeau and Low 2008), and in shallow rivers with relatively strong currents and a substrate of gravel and cobble (Nedeau 2008). In the Connecticut River watershed, populations are known primarily from streams









Illustrations by Ethan Nedeau

Text contributed by Ethan Nedeau, December 2007,Eastern Pondmussel Fact Sheet.

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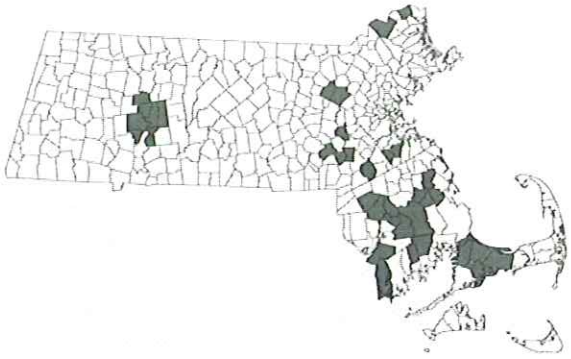
and rivers (Nedeau 2008), but in eastern Massachusetts, including Cape Cod, there are more lake and pond populations.

Biology: Eastern pondmussels are essentially sedentary filter feeders that spend most of their lives partially burrowed into the bottoms of rivers, streams, lakes, and ponds. Eastern pondmussels, like all freshwater mussels, have larvae (called glochidia) that must attach to the gills or fins of a vertebrate host to develop into juveniles. Sexually mature female eastern pondmussels use papillae along their mantle margins to lure potential host fish; this behavior was described by Corey *et al.* (2006). Displaying females tend to migrate toward the surface of the sediment, and may even lie fully on the surface of the sediment (unburied) to increase their visibility to fish. They will also part their valves widely, exposing more of the mantle edge. Host fish(es) for this species have not yet been determined, though the mussel's range suggests that its hosts have some affinity for coastal areas. Closely related species have been reported to parasitize centrarchids (sunfishes and bass) as well as the banded killifish. These fish species occur throughout the eastern pondmussel's range in Massachusetts and southern New England. Little else is known about the biology of the eastern pondmussel.

Population Status in Massachusetts: The eastern pondmussel is a species of special concern in Massachusetts, as well as Connecticut and New Hampshire. A few sizeable populations exist in coastal plain ponds of eastern Massachusetts, however, riverine populations in the state are generally sparse with the exception of a couple tributaries to the Connecticut River. The species is currently known from 24 lakes/ponds and 13 rivers, however, less than ten of these sites support

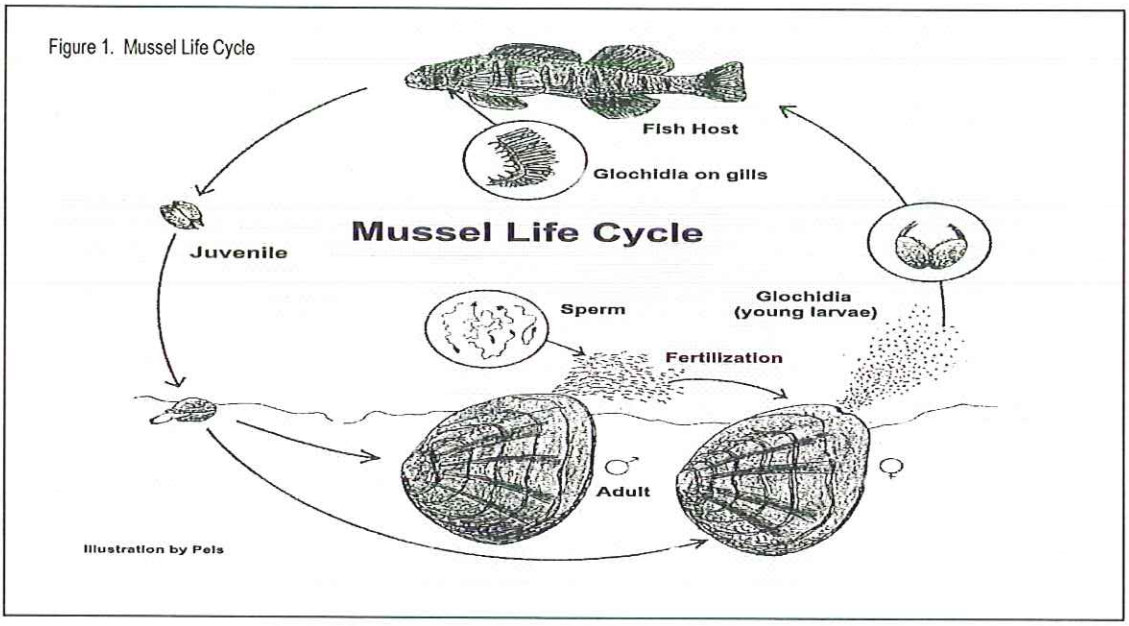


Distribution in Massachusetts
1984-2009
Based on records in Natural Heritage Database

sizeable populations. There are an additional 34 historic occurrences that have not been documented in the last 25 years and therefore are not subject to MESA protection. Surveys of historic sites and a careful status review are needed.

Threats: Because eastern pondmussels are essentially sedentary filter feeders, they are unable to flee from degraded environments and are vulnerable to the alterations of water bodies. Eastern pondmussels occur in lakes and rivers, and the threats in these two habitats are slightly different. Overlapping threats include nutrient enrichment, sedimentation, non-native and invasive species, and the many consequences of urbanization. River populations of eastern pondmussels are threatened by alteration of natural flow regimes, encroachment of river corridors by development, habitat fragmentation caused by dams and road-stream crossings, and a legacy of land use that has greatly altered the natural dynamics of river

Figure 1. Mussel Life Cycle



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corridors (Nedeau 2008). Lake populations are challenged by intense development, modification, and recreational use of sensitive shoreline habitats, and by increasing eutrophication. Dams and other stream barriers in the rivers that connect lakes to coastal waters may also affect lake populations of eastern pondmussels. Invasive plants and animals, such as European milfoil and Asian clams, are having severe impacts on the fragile ecology of coastal plain ponds. The ultimate consequences on eastern pondmussels and other native species are not completely known, but the prognosis is bleak. In addition, the long-term effects of regional or global problems such as acidic precipitation, mercury, and climate change are considered severe but little empirical data relates these stressors to mussel populations.

Conservation and Management Recommendations: Discovery and protection of viable mussel populations is critical for the long-term conservation of freshwater mussels. Currently, much of the available mussel occurrence data are the result of limited presence/absence surveys. In addition, regulatory protection under MESA only applies to rare species occurrences that are less than 25 years old. Surveys are critically needed to monitor known populations, evaluate habitat, locate new populations, and assess population viability so that conservation and restoration efforts, as well as regulatory protection, can be effectively targeted. Coastal plain ponds are critical to the long-term viability of the eastern pondmussel in Massachusetts, and these habitats are also experiencing intense development pressure and recreational use. Understanding this threat and developing conservation and management strategies is a high priority for NHESP. The NHESP has produced *Freshwater Mussel Habitat Assessment* and *Survey Guidelines* and has been working with qualified experts to conduct surveys. Other conservation and management recommendations include:

- Understand the effects of shoreline development and recreational use of lakeshores
- Maintain naturally variable river flow and limit water withdrawals
- Identify, mitigate, or eliminate sources of pollution to water bodies
- Identify dispersal barriers for host fish, especially those that fragment the species range within a river or watershed, and seek options to improve fish passage or remove the barrier
- Maintain adequate vegetated riparian buffer along rivers and lakes
- Protect or acquire land at high priority sites

Further Reading

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Updated: 08/01/09

Text contributed by Ethan Nedeau, December 2007,Eastern Pondmussel Fact Sheet.

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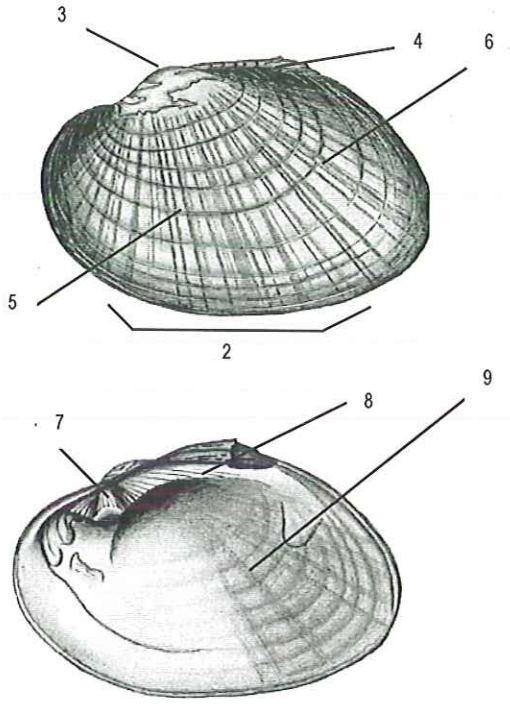
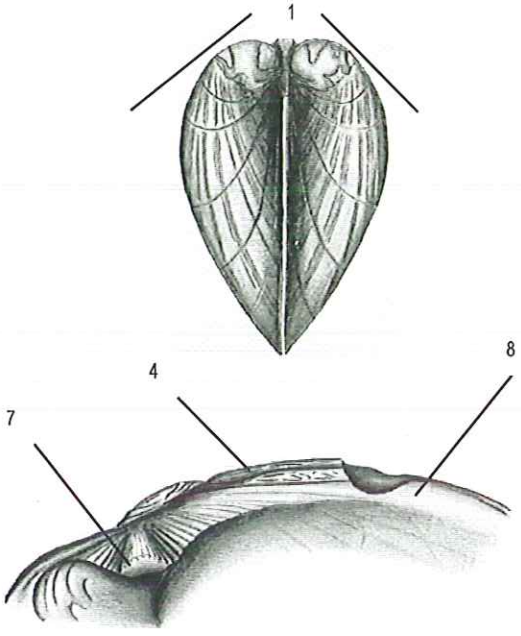
Triangle Floater
Alasmidonta undulata

State Status: **Species of Special Concern**
Federal Status: None

Description: The triangle floater is a small freshwater mussel that rarely exceeds three inches (75mm) in length. The shape is subovate to almost triangular and has a somewhat "squat" appearance (it is short, wide, and fat(1)). The ventral margin is rounded (2), so that the shell rocks evenly when placed on a flat surface. Beaks (3) are prominent and raised above the hinge line (4). Sculpturing on the beak is uneven and coarse, although this feature is more readily observed in young animals with little shell erosion. The periostracum (5) is smooth and shiny, and ranges in color from yellowish-green to nearly black. The periostracum has green shell rays (6) that are prominent on all but very old, stained, or eroded animals. Pseudocardinal teeth (7) are a triangular shape and very prominent; the pseudocardinal teeth are buttressed by a thick portion of the nacre. Lateral teeth are absent (8). The nacre (9) is distinctively bicolored: the posterior half of the shell is thin and an iridescent bluish-pink color, and the anterior half of the shell is substantially thicker and a white or pinkish color. The foot is usually white.

Similar Species in Massachusetts: The hinge teeth morphology, shell shape, and distinctly bicolored nacre make the shells (dead animals) of the triangle floater unmistakable from other species in Massachusetts. However, internal features cannot be used when identifying live animals. Live animals can often be confused with the brook floater, creeper, and dwarf wedgemussel. Greatest difficulty arises when trying to identify juveniles, animals with excessive shell erosion, or animals whose periostracum is darkly stained or covered with algae. The triangle floater is distinct from the brook floater because it lacks prominent ridges on the dorso-posterior slope and its ventral margin is curved rather than straight. In addition, triangle floater feet are white and brook floater feet are usually cantaloupe colored. Compared to the creeper, the triangle floater is more laterally inflated (1), has prominent beaks (3), and has a stronger shell. Young triangle floaters can be confused with dwarf wedgemussels that are more ovate than the typical wedge shape; usually the coarse uneven beak





Illustrations by Ethan Nedeau

Text contributed by Ethan Nedeau, December 2007,Triangle Floater Fact Sheet.

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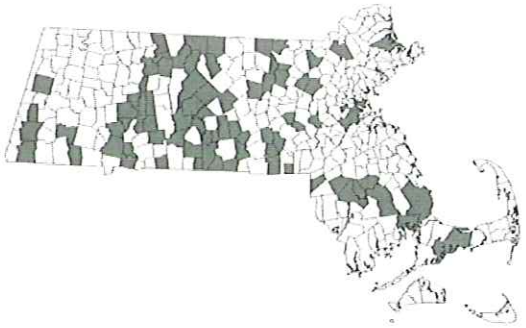
sculpture of the triangle floater and the size and shape of the animals will enable accurate identification. An expert should be consulted to identify the species because it is listed as a Species of Special Concern in Massachusetts and because it can be confused with three other state or federally protected species (brook floater, creeper, and dwarf wedgemussel).

Range: The North American range of the triangle floater extends from North Carolina northward to Nova Scotia and New Brunswick. It occurs in most Atlantic coastal drainages throughout that range. It also occurs in tributaries of the lower St. Lawrence River in Quebec. The triangle floater has the broadest range of any state-listed mussel in Massachusetts; it is present in 18 sub basins from the Housatonic River in western Massachusetts to coastal plain ponds of Cape Cod.

Habitat: In northeastern North America, the triangle floater inhabits small to large rivers and lakes. It is more commonly found in flowing water, where it occupies a wide range of substrate and flow conditions. Preferred habitats include low-gradient river reaches with sand and gravel substrates and low to moderate water velocities. It has been found in streams smaller than five meters wide and rivers wider than 100 meters. The triangle floater is the only species in the genus *Alasmidonta* that inhabits lakes; it occurs in both natural lakes and reservoirs occasionally in Massachusetts and in Maine, although at lower population densities than in rivers. Its ability to tolerate standing water makes this species less sensitive to the effects of dams than other species, such as the brook floater. In fact, at times it is as abundant in small impoundments of run-of-river dams as it is in free-flowing portions of rivers. Like most other mussel species, triangle floaters are sparse or absent in headwater streams and high-gradient river reaches. Because they are widespread in Massachusetts and inhabit a wide range of habitats, they share habitat with almost every other mussel species.



Distribution in Massachusetts
1982-2007
Based on records in Natural Heritage Database

However, they are most abundant in rivers that support eastern elliptio, eastern lampmussel, creeper, brook floater, and dwarf wedgemussel.

Biology: Freshwater mussels are essentially sedentary filter feeders that spend most of their lives anchored to the bottoms of rivers, streams, lakes, and ponds by their muscular foot. Gills circulate water through their shells via incurrent and excurrent openings, siphoning nutrients to be absorbed by the digestive system. This filtering process is also critical for successful reproduction (Figure 1). Like all freshwater mussels, larvae (called glochidia) of the triangle floater must attach to the gills or fins of a vertebrate host (mainly fish) to develop into juveniles (for a review, see Nedeau *et al.* 2000). This parasitic phase is the only period during which mussels can disperse long distances. Fertilization occurs in the summer and glochidia are released the following spring. Studies have identified several hosts that are common in coldwater and warmwater environments in Massachusetts, such as the common shiner, blacknose dace, longnose dace, white sucker, pumpkinseed sunfish, fallfish, largemouth bass, slimy sculpin, and several species not found in the state

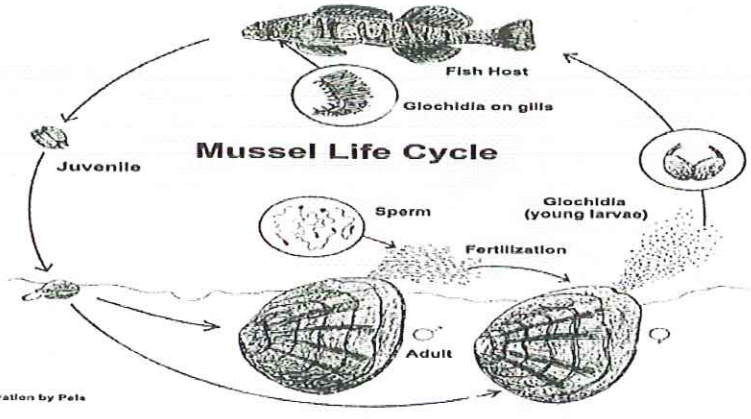


Figure 1. Mussel Life Cycle

Text contributed by Ethan Nedeau, December 2007, Triangle Floater Fact Sheet.

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(Nedeau *et al.* 2000, Wicklow 2004). The triangle floater uses a broader variety of host fish than the closely related dwarf wedgemussel. Following the parasitic period, juveniles drop to the bottom of the lake or river, burrow into the sediment, and spend the rest of their lives as free-living animals. Longevity is unknown, but given their size and the longevity of closely related species (dwarf wedgemussel and brook floater), the triangle floater likely lives for eight to 20 years in Massachusetts. During that time, they may only move a few meters within a water body.

Population Status in Massachusetts: As of October 2007, there were 92 recent occurrences (<25 years old) of the triangle floater in 18 sub basins and 79 towns in Massachusetts. Of the 92 recent occurrences, 76 consisted of live animals (versus dead animals) and only 31 of these were comprised of ten or more individuals. Data acquired from recent surveys indicate that the triangle floater is widely distributed in Massachusetts, however, many populations are sparse and recruitment status is unknown. The long-term viability of low-density populations is poorly understood, therefore, the triangle floater is listed as a Species of Special Concern in Massachusetts pursuant to the Massachusetts Endangered Species Act (MG.L. c.131A) and its implementing regulations (321 CMR 10.00). The triangle floater is faring well in other New England states and is not listed as state-protected; Maine removed it from their list of Special Concern Species in 2006 after a careful status review. The triangle floater is one of three species in Rhode Island, along with eastern elliptio and eastern floater, considered widespread (Raithel and Hartenstine 2006). A careful status review is needed to assess the long-term viability of triangle floater populations in Massachusetts.

Threats: Because triangle floaters are essentially sedentary filter feeders, they are unable to flee from degraded environments and are vulnerable to the anthropogenic alterations of waterways. Some of the many threats to the triangle floater and its habitat in Massachusetts include: nutrient enrichment, sedimentation, point-source pollution, alteration of natural flow regimes, water withdrawal, encroachment of river corridors by development, non-native and invasive species, habitat fragmentation caused by dams and road-stream crossings, and a legacy of land use that has greatly altered the natural dynamics of river corridors. In addition, the long-term effects of regional or global problems such as acidic precipitation, mercury, and climate change are considered severe but little empirical data relates these stressors to mussel populations. As local populations of triangle floaters decline and/or become extirpated in response to these threats, dispersal distances between populations increase, weakening overall reproductive success, and ultimately genetic diversity (Vaughn 1993).

Conservation & Management Recommendations: Discovery and protection of viable mussel populations is essential for the long-term conservation of freshwater mussels. Currently, much of the available mussel occurrence data are the result of limited presence/absence surveys conducted at road crossings or other easily accessed points of entry. In addition, regulatory protection under MESA only applies to rare species occurrences that are less than twenty-five years old. Surveys are critically needed to monitor known populations, evaluate habitat, locate new populations, and assess population viability at various spatial scales (e.g., river, watershed, state) so that conservation and restoration efforts, as well as regulatory protection, can be effectively targeted. The NHESP has produced the *Freshwater Mussel Habitat Assessment and Survey Guidelines* and maintains a list of experts qualified to conduct surveys. Other conservation and management recommendations include:

- Maintain naturally variable river flow and limit water withdrawals
- Identify, mitigate, or eliminate sources of pollution to rivers
- Identify dispersal barriers (e.g., dams, impassable culverts) for host fish, especially those that fragment the species range within a river or watershed, and seek options to improve fish passage or remove the barrier
- Maintain adequate vegetated riparian buffers
- Protect or acquire land at high priority sites

Further Reading

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Updated: 12/01/07

Text contributed by Ethan Nedeau, December 2007, Triangle Floater Fact Sheet.

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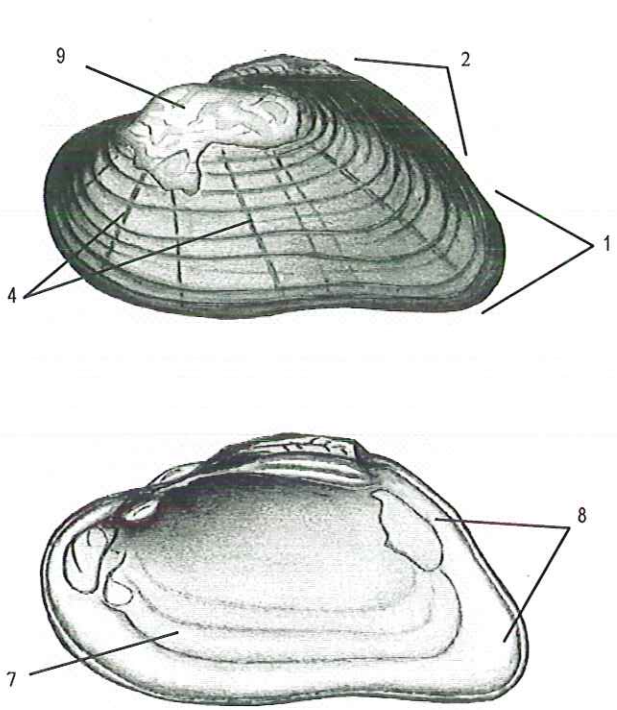
Dwarf Wedgemussel
Alasmidonta heterodon

State Status: **Endangered**
Federal Status: **Endangered**

Description: The dwarf wedgemussel is a small species that rarely exceeds 1.75 inches (45 mm) in length; the largest known specimens came from a New Hampshire river and were 2.2 inches (56 mm) long. The shell is triangular or trapezoidal. The posterior end of the shell tapers to a rounded point (1) and has been described as "wedge-shaped," although this distinctive shape varies with the size and gender of an individual. There is a prominent rounded ridge along the dorso-posterior slope (2). The valves are usually laterally compressed to slightly inflated (3); mature females tend to be more inflated than males. The shell is smooth and may be yellowish-brown, olive-brown, or brownish-black in color. Faint greenish rays (4) are evident on the shells of juveniles and light-colored adults. Hinge teeth are present but delicate. This is the only species in North America that has two lateral teeth (5) on the right valve and one lateral tooth on the left valve (all other species with lateral teeth have the opposite configuration). The dwarf wedgemussel also has pseudocardinal teeth—two on the left valve and one (6) on the right valve. The color of the nacre (7) is bluish-white and often iridescent along the posterior margin (8). The foot is often a pale beige or slightly orange color.

Similar Species in Massachusetts: The small size, wedge shape, and hinge tooth morphology of this species make shells easily distinguishable from all other species in New England. None of the species it might be confused with (brook floater, triangle floater, and creeper) has lateral teeth. However, live animals, which are often identified based on variable features such as shape or color, can sometimes be difficult to distinguish from a young brook floater, triangle floater, or creeper. Unlike the brook floater, the dwarf wedgemussel lacks corrugations along the dorso-posterior slope and its feet are not cantaloupe colored. The triangle floater is more subovate and laterally inflated than the dwarf wedgemussel and has coarse uneven beak sculpturing (9). To the novice, it is most difficult to distinguish between dwarf wedgemussels and young creepers because their shape and color are



Illustrations by Ethan Nedeau

Text contributed by Ethan Nedeau, December 2007,Eastern Pondmussel Fact Sheet.

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similar. The dwarf wedgemussel is a federally endangered species and it is imperative that animals are not harmed or removed from the water. Furthermore, commonly confused species are also protected in Massachusetts and an expert should always be consulted.

Range: The historic range of the dwarf wedgemussel included 70 locations in 15 major Atlantic coastal watersheds from North Carolina to eastern New Brunswick. By the early 1990s, its range was thought to have shrunk to approximately 20 locations in eight watersheds (USFWS 1993). In the last 15-18 years, biologists have rediscovered populations that were considered extirpated and discovered entirely new populations (Nedeau 2006). It is currently known from 70 locations in 15 major watersheds, with the largest populations in the Connecticut River watershed (Nedeau 2008). In Massachusetts, live animals have been found in only three water bodies in the Connecticut River watershed in the last 25 years.

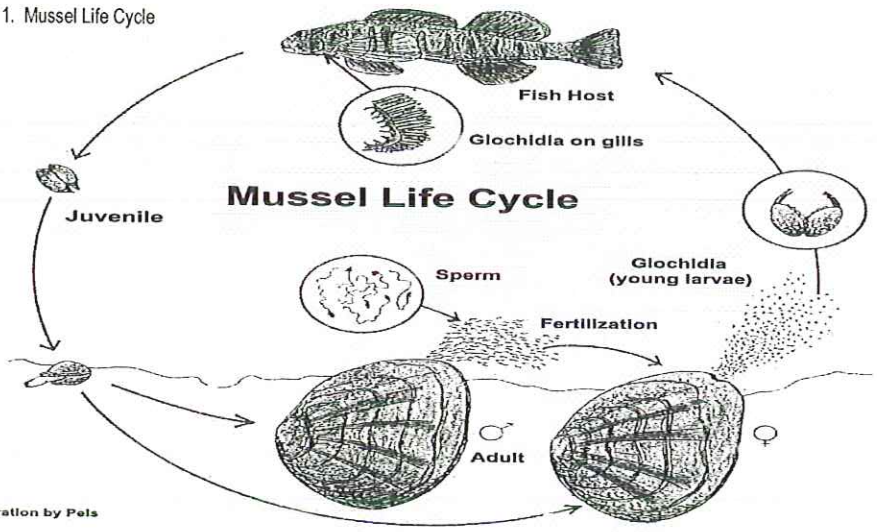
Habitat: The dwarf wedgemussel is a generalist in terms of its preference for stream size, substrate, and flow conditions (Nedeau 2008). It inhabits small streams less than five meters wide to large rivers more than 100 meters wide. It is found in a variety of substrate types including clay, sand, gravel, and pebble, and often in areas of rivers with large amounts of silt (e.g., depositional areas and near banks). The dwarf wedgemussel inhabits very shallow water along streambanks and can move laterally or horizontally in the substrate as water levels fluctuate, but they have also been found at depths of 25 feet in the Connecticut River. The dwarf wedgemussel does not inhabit lakes or reservoirs but may occur in small impoundments created by run-of-river lowhead dams, beaver dams, or by natural landforms that create deep and stable stream reaches. An increasing number of published

Distribution in Massachusetts
1984-2009
Based on records in Natural Heritage Database

studies and field observations suggest that stable flow and substrate are critical for this species (reviewed in Nedeau 2008). Dwarf wedgemussels are often patchily distributed in rivers, especially those with highly variable physical habitat and fragmenting features such as dams and culverts. Identifying and protecting these patches are critical for conserving the species.

Biology: Dwarf wedgemussels are essentially sedentary filter feeders that spend most of their lives partially burrowed into the bottoms of rivers and streams. Like all freshwater mussels, larvae (called glochidia) of the dwarf wedgemussel must attach to the gills or fins of a vertebrate host to develop into juveniles. The tessellated darter is considered the primary host in the Connecticut River watershed and its range is most congruent with that of the dwarf wedgemussel, but several other fish (e.g., Atlantic salmon) have been identified as potential hosts (Nedeau 2008). Tessellated darters do not move very far—usually less than 100 meters during their short lives—thus the

Figure 1. Mussel Life Cycle



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dispersal ability of dwarf wedgemussels may be low and the rate at which they might recolonize former habitat is slow (McLain and Ross 2005). The life span of a dwarf wedgemussel is considered less than 12 years (Michaelson and Neves 1995), which is young compared with many other freshwater mussel species in the Northeast. Short life spans, low fecundity, high degree of host specificity, limited dispersal ability of its primary host, and low population densities likely all contribute to the endangered status of the dwarf wedgemussel.

Population Status in Massachusetts: The dwarf wedgemussel is one of the most endangered mussels in all of northeastern North America. It is listed as endangered in Massachusetts and protected under the Massachusetts Endangered Species Act (MG.L. c.131A) and its implementing regulations (321 CMR 10.00), and is the only federally endangered mussel in the state. In Massachusetts, it was historically known from the mainstem Connecticut River, several of its tributaries, and four other rivers in the southeastern and northeastern parts of the state. It is now believed extirpated from most of these sites (USFWS 1993) and recent (<25 years) records are confined to just a four water bodies within the Connecticut River watershed. Dwarf wedgemussels occur discontinuously within these river systems and usually at low population densities, raising concern about the viability of the populations.

Threats: Because dwarf wedgemussels are essentially sedentary filter feeders, they are unable to flee from degraded environments and are vulnerable to the alterations of waterways. Some of the many threats to the dwarf wedgemussel and its habitat in Massachusetts include: nutrient enrichment, sedimentation, point-source pollution, alteration of natural flow regimes, water withdrawal, encroachment of river corridors by development, non-native and invasive species, habitat fragmentation caused by dams and road-stream crossings, and a legacy of land use that has greatly altered the natural dynamics of river corridors (Nedeau 2008). Bacterial pathogens and nitrogenous wastes can cause problems downslope and downstream of agricultural lands; ammonia-nitrogen is considered particularly toxic to mussels. In 2001, runoff from a small farm killed more than 25 dwarf wedgemussels and hundreds of other mussels in a river in Massachusetts. Livestock allowed access to streams can severely damage mussel communities by trampling mussels, causing sedimentation, destabilizing streambanks, and defecating in the water. In addition, the long-term effects of regional or global problems such as acidic precipitation, mercury, and climate change are considered severe but little empirical data relates these stressors to mussel populations. As local populations of dwarf wedgemussels decline and/or become extirpated in response to these threats, dispersal distances between populations increase, weakening overall reproductive success, and ultimately genetic diversity.

Conservation and Management Recommendations: Discovery and protection of viable mussel populations is critical for the long-term conservation of freshwater mussels. Currently, much of the available mussel occurrence data are the result of limited presence/absence surveys at road crossings or other easily accessed points of entry. Regulatory protection under MESA only applies to rare species occurrences that are less than 25 years old. Surveys are critically needed to monitor known populations, evaluate habitat, locate new populations, and assess population viability at various spatial scales (e.g., river, watershed, state) so that conservation and restoration efforts, as well as regulatory protection, can be effectively targeted. The NHESP has produced *Freshwater Mussel Habitat Assessment* and *Survey Guidelines* and has been working with qualified experts to conduct surveys. Other conservation and management recommendations include:

- Maintain naturally variable river flow and limit water withdrawals
- Identify, mitigate, or eliminate sources of pollution to rivers
- Identify dispersal barriers (e.g., dams, impassable culverts) for host fish, especially those that fragment the species range within a river or watershed, and seek options to improve fish passage or remove the barrier
- Maintain adequate vegetated riparian buffer
- Protect or acquire land at high priority sites

Further Reading

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Updated: 11/01/09

Text contributed by Ethan Nedeau, December 2007,Eastern Pondmussel Fact Sheet.

Please allow the Natural Heritage & Endangered Species Program to continue to conserve the biodiversity of Massachusetts with a contribution for 'endangered wildlife conservation' on your state income tax form as these donations comprise a significant portion of our operating budget.

Town of Amherst
Department of Public Works

SECTION 6

Final Comprehensive Site Assessment, Prepared by Tighe and Bond (Section 7 Conclusions and Recommendations)

Section 7
FCSA Conclusions & Recommendations

7.1 Summary of FCSA Findings

The CSA study of the Old Amherst Landfill was conducted to assess and characterize potential landfill impacts to human health, public safety and the environment and to determine if corrective actions are required to mitigate potential site risks or impacts. Findings from this study include:

7.1.1 Hydrogeologic Characterization

Twelve groundwater monitoring wells and two gas monitoring wells were installed for the FCSA Study at eight locations. Monitoring wells were installed upgradient of the site, directly downgradient of the site at the landfill perimeter and adjacent to downgradient groundwater discharge areas. Groundwater monitoring wells were installed at shallow (water table) and deep locations within the surficial aquifer, confining layer (where present) and confined aquifer (where present), and at two locations into the underlying bedrock.

Underlying soils at the landfill site are characterized as very fine to coarse sands and gravels above bedrock. A confining layer of glaciolacustrine very fine sand, silt and clay is present below grade to the west of the site along the Hop Brook flood plain. The confining layer is underlain by a thin confined aquifer (where present) consisting of fine to coarse sands, underlain by glacial till and/or bedrock. Bedrock is characterized as arkosic sandstone. The confined aquifer is under artesian conditions at the #6-08/#7-08 monitoring well cluster location.

Groundwater flow beneath and downgradient of the site is generally to the west, discharging to the Hop Brook flood plain and associated wetland areas. Groundwater flow velocities beneath and downgradient of the site in the surficial aquifer vary with groundwater gradient and aquifer hydraulic conductivity. Shallow groundwater flow rates in the surficial aquifer at the landfill site vary from about 1 foot per day (ft/day) beneath the northern and central portions of the landfill site to about 3 ft/day beneath the southern portion of the site. Downgradient shallow groundwater flow velocities were estimated at about 0.4 ft/day or 150 feet per year.

Surface water flow in the vicinity of the site is east to west towards the Hop Brook flood plain and associated wetland areas located west of the Old Amherst Landfill site. Hop Brook flows south to north in its flood plain and discharges to the Fort River at a location approximately 1-mile northwest of the landfill. The primary drainage area for Hop Brook is the Lawrence Swamp basin located approximately 1-mile south of the landfill site. This basin is the primary groundwater supply source for the Town of Amherst where a series of high-yield water supply wells were developed in a confined aquifer of permeable sands and gravel. The confined aquifer in the Lawrence Swamp basin underlies thick glaciolacustrine deposits of very fine sands, silts and clays and is under artesian conditions at various locations. The "Zone II" limit for these wells is located south and east of the landfill site.

Wetland areas affected by the discharge of contaminated groundwater were identified in the area of Gull Pond (station SW-1), the KC Trail wetland (stations SW-6 and SW-14)

and the SW-15 wetland located at the intersection of Old Farm Road and Hop Brook Drive. The wetlands, in particular the KC Trail wetland and the inlet to Gull Pond, are visually impacted by the presence of reddish-brown discolored sediments.

7.1.2 Environmental Monitoring & Contaminant Characterization

The FCSA Report is based on two rounds of site-wide environmental monitoring, one round conducted in November 2005 for the Interim CSA Report and one round conducted in October 2008 for the FCSA study. The CSA environmental monitoring program included the collection of groundwater, surface water and sediment samples for the analytical parameters listed in *Massachusetts Solid Waste Regulation 310 CMR 19.132(1)h*. Additional sediment and surface water samples were collected and analyzed for a limited number of analytical parameters as part of the FCSA study. Potential "Contaminants of Concern (COCs)" were identified in each media by comparison to applicable standards or guidelines.

1) **Groundwater:** Potential landfill groundwater quality impacts include moderate elevated (>500 umhos/cm) to elevated (>1,000 umhos/cm) specific conductance, elevated levels (>500 mg/L) of total dissolved solids (TDS) and low <3.0 mg/L) levels of dissolved oxygen. Metals detected in the groundwater included low levels arsenic (As), and elevated levels of the metals iron (Fe) and manganese (Mn). A few volatile organic compounds (VOCs) were detected infrequently in various groundwater samples at trace to low concentrations. While detected, individual compounds were not found to be wide ranging in the surficial, confined or bedrock aquifers or frequently detected at high concentrations.

   Groundwater contaminants of concern (COCs) identified in the FCSA analytical data are the metals arsenic (As) at trace to low concentrations, and iron (Fe) and manganese (Mn) at elevated concentrations. Other metals such as barium (Ba), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg) and zinc (Zn) were either detected at low frequencies and low concentrations, also detected in the groundwater upgradient of the site, or were detected during total metals analysis and not during dissolved metals analysis and are therefore not considered COCs. No VOCs are identified as COCs in the groundwater.

2) **Surface Water:** Potential surface water quality impacts include moderate elevated (200-500 umhos/cm) specific conductance, alkalinity (100-300 mg/L), chemical oxygen demand (COD) above 100 mg/L, moderated elevated TOS (200-500 mg/L), pH less than 6.5 standard units, trace levels of cyanide, low <3.0 mg/L) levels of dissolved oxygen Metals detected in the surface water included trace levels of arsenic (As) and trace to low levels of lead (Pb), and elevated levels of iron (Fe) and manganese (Mn). Very few target VOCs and non-target compounds were detected in the surface water samples at trace concentrations; none were found to be frequently detected.

   The one surface water COC is the metal lead (Pb) at the SW-15 wetland area. Other contaminants such as cyanide which was were detected in one of three samples at the KC Trail wetland area and two of five samples at the SW-15 wetland area was detected low concentrations and low frequencies and therefore was not identified as a COC for surface water at these locations. No VOCs are identified as COCs in the surface water.

3) **Sediments:** Potential landfill sediment quality impacts include cyanide was identified in one of two samples at the KC Trail wetland, the metals arsenic (As), cadmium (Cd), mercury (Hg) and elevated levels of iron (Fe). The elevated metals concentrations in the sediments are the likely result of groundwater discharge to the downgradient wetland areas. Very few target VOCs and non-target compounds were detected in the sediment samples at trace to low concentrations.

   Sediment COCs are arsenic (As) at the Gull Pond inlet station, arsenic (As) and cadmium (Cd) at the KC Trail wetland area, and mercury (Hg) at the SW-15 wetland area. No VOCs are identified as COCs in sediment.

4) **Soil Air:** Potential landfill gas impacts to soil air on-site and adjacent to the site include methane, carbon dioxide and trace levels of hydrogen sulfide gas. These gases are generated in the landfill and may migrate off-site in the subsurface through unsaturated soils and potentially impact abutting properties and subsurface utilities such as drainage lines and catch basins. A low oxygen level is also identified as a potential landfill gas impact to soil air.

7.1.3 Baseline Risk Assessment

The qualitative risk assessment for the Old Amherst Landfill site identified five potential exposure pathways for human health, public safety and environmental impact:

1) **Groundwater:** Groundwater exposure pathways are limited to downgradient groundwater discharge areas for the aquifer underlying the site. These exposure pathways include contaminant transport and discharge to downgradient wetlands and surface waters. Direct exposure to contaminated groundwater in the surficial, confined, or bedrock aquifer was not identified as a significant exposure pathway.

2) **Surface Water:** Environmental monitoring of surface waters in streams, ponds and wetlands downgradient and adjacent to the site indicate that there are few significant water quality impacts to surface water that could be attributed to the landfill site at concentrations less than drinking water standards or guidelines.

3) **Sediment:** Analytical results from sediment samples collected from the KC Trail wetland (As and Cd) located between Hop Brook Drive and Old Farm Road, from the inlet of Gull Pond (As) and from the SW-15 wetland area (Hg) indicate that a potential human exposure pathway to impacted sediments exists. Based on the sediment data, the MassDEP required that a "Focused Risk Characterization" be conducted for the KC Trail wetland and the Gull Pond inlet locations.

   KC Trail Wetland: Results of the focused quantitative risk assessment indicate that a condition of No Significant Risk to human health exists for fall victims and neighborhood children who engage in recreational or trespassing activities within the KC Trail wetland area located between Hop Brook Drive and Old Farm Road.

   Gull Pond Inlet: Results of the focused quantitative risk assessment indicate that a condition of No Significant Risk to human health exists for fall victims and neighborhood children who engage in recreational activities or trespassing at the Gull Pond inlet.

   SW-15 Wetland Area: A focused quantitative risk assessment was not conducted for the SW-15 wetland area. However, this wetland area is a forested wetland that

is not readily accessible to the general public and therefore was not considered a significant human health or public safety exposure risk. No additional assessment or evaluation is recommended for this wetland area.

4) **Environmental Risk:** Sediment the KC Trail wetland (for arsenic (As) and cadmium (Cd)), the inlet of Gull Pond (for arsenic (As)) and the SW-15 wetland area (for mercury (Hg)) are considered contaminant exposure pathways for environmental receptors, specifically for local terrestrial and aquatic biota:

   KC Trail Wetland: Arsenic (As) and cadmium (Cd) were detected at concentrations exceeding the MassDEP Screening Criteria of 33 mg/kg and 5.0 mg/kg, respectively. Concentrations were highest in the central portion of the wetland and less than MassDEP threshold levels along the edges of the wetland. Iron (Fe) levels exceeded Ontario Guidelines for "Severe Effect Levels" (SELs) for iron (Fe) of 40,000 mg/kg in four of four samples. The Ontario SEL is defined as the concentration that would be detrimental to the majority of benthic species.

   Gull Pond Inlet: Arsenic (As) was detected at concentrations exceeding the MassDEP Screening Criteria of 33 mg/kg in four of six samples. Iron (Fe) concentrations in two of two samples exceeded the Ontario Guideline SEL for iron (Fe) of 40,000 mg/kg.

   SW-15 Wetland Area: Mercury (Hg) was detected in four of four samples at concentrations exceeding MassDEP Screening Criteria of 0.18 mg/kg.

5) **Landfill Gases:** Off-site subsurface migration of landfill gases in the soil air represents a human health and public safety risk. Although methane or other landfill gases were not detected at levels exceeding regulatory threshold concentrations during soil gas monitoring conducted for the Interim CSA study and FCSA study, landfill gases generated through the decomposition of wastes represents a diminishing human health and public safety risk into the future as waste decomposition slows over time and the landfill gas generation decreases.

7.2 FCSA Recommendations

The following recommendations are provided based on the results of the Interim CSA and Final CSA studies:

1) **Additional Assessment Activities:** The environmental monitoring data collected and evaluated for the CSA Report is adequate to characterize environmental impacts from the Old Amherst Landfill. No further assessment activities are warranted.

   No additional assessment work is warranted at the site and a Corrective Action Alternatives Analysis (CAAA) is not recommended based on the data evaluated for the CSA study. The site was closed in the early 1980s using a 2-foot soil final cover system and has been adequately maintained by the Town of Amherst.

2) **Post-CSA Environmental Monitoring Program:** A post-CSA environmental monitoring program is recommended for the Old Amherst Landfill site as required under *Massachusetts Solid Waste Regulations 310 CMR 19.142(5)*.

The landfill has been inactive since the early 1980s when waste disposal ceased on-site and site was closed and covered with a 2-foot soil final cover system. Environmental monitoring data collected at the site indicates a stabilized condition relative to contaminant concentrations in downgradient groundwater. Based on this data, a annual post-closure monitoring program is recommended that focuses on monitoring downgradient water quality in the surficial and confined aquifers.

a) **Groundwater Monitoring:** The proposed groundwater monitoring program is focused on evaluating potential landfill contaminant impacts to the surficial and confined aquifers downgradient of the site and includes the following monitoring wells:

#01-08	**Surficial Aquifer - Upgradient Monitoring Well**
#6-08	**Confined Aquifer - Downgradient Monitoring Well**
#8-08	**Surficial Aquifer - Downgradient Monitoring Well**
#9-08	**Confined Aquifer - Downgradient Monitoring Well**
#10-08	**Confined Aquifer - Downgradient Monitoring Well**
#11-08	**Surficial Aquifer - Downgradient Monitoring Well**
#1-03	**Surficial Aquifer – Cross-gradient Monitoring Well**
#12-08	**Confining Layer - Cross-gradient Monitoring Well**

Recommended monitoring parameters are those required under Massachusetts Solid Waste Regulations 310 CMR 19.132(1)h. Metals analysis should be by dissolved metals to limit the effect of turbidity and suspended sediments on the analyses.

b) **Surface Water Monitoring:** The proposed surface water-monitoring program is focused on monitoring potential landfill contaminant impacts to the downgradient surface waters as follows:

SW-1	**Gull Pond Inlet**
SW-2	**Gull Pond**
SW-6	**KC Trail Wetland Area**
SW-15	**SW-15 Wetland Area**

Monitoring parameters are those listed under Massachusetts Solid Waste Regulations 310 CMR 19.132(1)h. Analysis for "dissolved" metal concentrations is recommended.

c) **Perimeter Soil Gas Monitoring:** Semi-annual monitoring of gas monitoring wells for the parameters listed under Massachusetts Solid Waste Regulations 310 CMR 19.132(4) including percent combustible gas, percent oxygen and hydrogen sulfide gas at the parts per million (ppm) level.

3) **Surface Cover Improvements**: Field observations of the surface cover at the Old Amherst Landfill indicate that the Town has adequately maintained the site since closure in accordance with *Massachusetts Solid Waste Regulations 310 CMR 19.000*. However, differential settlement of the landfill surface since site closure in the early 1980s has resulted in scattered areas of poor surface drainage that result in the ponding of runoff on capped areas of the site. Based on these observations, Tighe & Bond recommends the following maintenance actions be undertaken:

a) **Landfill Surface Maintenance:** Undertake a maintenance program to re-establish 2 percent minimum landfill surface slopes to the perimeter of the site or to storm water drainage swales and retention areas by the placement of additional soil or alternative soil materials. Areas of surface ponding should be filled and eliminated. Areas disturbed by the placement of soils should be provided with a 6-inch minimum layer of vegetative support material (topsoil or equivalent) and reseeded to establish a grass vegetative cover.

b) **Storm Water Management Systems:** Check the slope of drainage swales and correct any areas of ponding in the swales and/or remove obstructions. Remove silt accumulations from the bottom of retention basins to promote storm water infiltration, as necessary.

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