Brook Floater (*Alasmidonta varicosa*) in the Pleasant River
(Gray and Windham, Cumberland County, Maine)

prepared for

Maine Department of Inland Fisheries and Wildlife
Reptile, Amphibian, and Invertebrate Group
650 State Street, Bangor, Maine

prepared by

Biodrawversity LLC
433 West Street, Amherst, Massachusetts

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The Pleasant River in the reach downstream of Windham Center Road (Site 65, Reach 5 of this report).

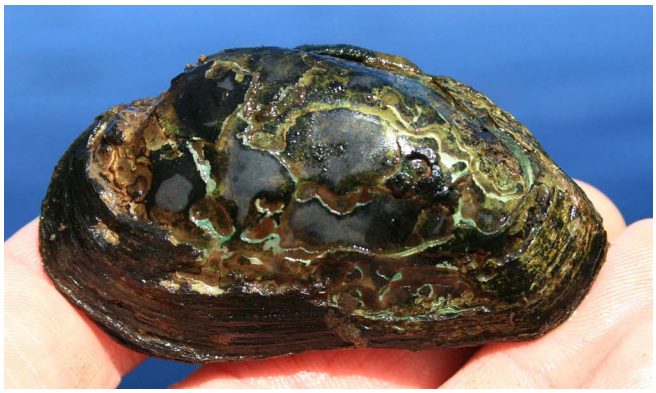
INTRODUCTION

The Brook Floater (*Alasmidonta varicosa*, hereafter referred to as *A. varicosa*), is one of the most imperiled freshwater animals in northeastern North America. It is currently listed as Endangered in Massachusetts, New Hampshire, and Connecticut; Threatened in Vermont and Maine; and extirpated in Rhode Island (Nedeau 2008). In 2007, Maine changed the status of *A. varicosa* from Special Concern to Threatened based on results of statewide qualitative surveys that indicated fragmented distribution, low population densities, and limited evidence of recruitment. There is an urgent need to determine where *A. varicosa* populations occur, assess the viability of populations, identify environmental factors that affect them, develop protection plans, and implement restoration strategies.

A. varicosa have been known to occur in the Pleasant River in Windham, particularly in the reach between Pope Road and Brand Road, for almost 20 years, but the status of this population was never adequately described. Surveys were infrequent, of short duration, and qualitative. Furthermore, they were usually conducted in small, easily accessible areas (e.g., road crossings) and there was no attempt to characterize demographics or shell condition (i.e., degree of shell erosion). During one of the more intensive surveys, conducted in 2001, two surveyors found 125 *A. varicosa* in five hours (ten person-hours) along a 0.75-mile reach between Falmouth Road and Brand Road for a catch-per-unit-effort (CPUE) of 12.5 animals/hr. Based on this survey, it was assumed that the *A. varicosa* population was stable. However, two biologists spent one full day in 2009 surveying this same reach and found only 17 live *A. varicosa* for an average CPUE of 2.8 animals/hr.

In 2009, surveyors noted dramatic bank erosion, sedimentation, and deposition of coarse woody debris and detritus throughout this reach of the Pleasant River. These phenomena were not noted in the 2001 survey. They were

Brook Floater (*Alasmidonta varicosa*) found at Site 62. This was one of the nicest (least amount of shell erosion) animals we found.



In contrast to the *A. varicosa* in good condition shown on page 1, most of the individuals found in the Pleasant River looked more like this, with a very high degree of shell erosion.

likely the result of recent severe floods, and may have been exacerbated by the large amount of agriculture and development (with inadequate forested buffers) along the river corridor. In a 2009 survey of *A. varicosa* populations in nine Maine rivers (Biodrawversity 2010), the Pleasant River had the lowest CPUE and poorest habitat. Also, the animals were in very poor condition (i.e., heavy shell erosion) and there was no evidence of recruitment. This population appeared to be critically endangered.

Based on the concerning results of the 2009 survey, MDIFW commissioned a follow-up study (this report). The objective was to describe the distribution, abundance, demographics, shell condition, and habitat of *A. varicosa* in the Pleasant River. To provide a complete assessment of the species' status in the river, it was deemed particularly important to survey remote reaches to determine if, and where, concentrations still existed. An additional objective of the study was to document existing and potential threats to *A. varicosa*. This report combines the data gathered during eight days of fieldwork from 2009 to 2011.

METHODS

Site Selection: A total of 67 sites, ranging 40–330 meters in length, were surveyed in an 18,700-meter (11.6-mile) reach of the Pleasant River in Gray and Windham, which included sites in two of the river's headwater streams (Thayer Brook and Thayer River, which converge to form

Table 1. Sites surveyed for freshwater mussels in the Pleasant River, 2009–2011.

Site	Reach	Town	Latitude	Longitude	Date
1	1	Gray	43.866734	-70.349273	9/13/10
2	1	Gray	43.864426	-70.344015	9/13/10
3	1	Gray	43.856800	-70.361220	9/13/10
4	1	Gray	43.854749	-70.362527	6/2/11
5	1	Gray	43.853435	-70.363918	6/2/11
6	1	Gray	43.852233	-70.365408	6/2/11
7	1	Gray	43.850770	-70.366957	6/2/11
8	1	Gray	43.850071	-70.367033	6/2/11
9	1	Gray	43.850211	-70.368594	6/2/11
10	1	Gray	43.848447	-70.369954	6/2/11
11	1	Gray	43.847756	-70.371815	6/2/11
12	1	Gray	43.846388	-70.372885	6/2/11
13	1	Gray	43.845739	-70.374562	6/2/11
14	1	Windham	43.844805	-70.376507	6/2/11
15	1	Windham	43.842969	-70.377551	6/2/11
16	1	Windham	43.841958	-70.378400	6/2/11
17	1	Windham	43.840514	-70.379055	6/2/11
18	1	Windham	43.839324	-70.381784	6/2/11
19	1	Windham	43.838420	-70.383453	6/3/11
20	1	Windham	43.837889	-70.385197	6/4/11
21	1	Windham	43.837126	-70.384116	6/4/11
22	2	Windham	43.835874	-70.383716	6/4/11
23	2	Windham	43.835020	-70.384410	9/13/10
24	2	Windham	43.834765	-70.384341	6/4/11
25	2	Windham	43.833866	-70.385392	6/4/11
26	2	Windham	43.833454	-70.385699	8/12/09
27	2	Windham	43.833444	-70.386345	6/4/11
28	2	Windham	43.833127	-70.388463	6/4/11
29	2	Windham	43.832590	-70.388341	6/4/11
30	2	Windham	43.831433	-70.388947	8/12/09
31	2	Windham	43.830673	-70.389769	6/4/11
32	2	Windham	43.829706	-70.391732	6/4/11
33	2	Windham	43.829471	-70.393221	8/12/09
34	2	Windham	43.828957	-70.393882	6/4/11
35	2	Windham	43.828491	-70.395091	8/12/09
36	2	Windham	43.828462	-70.395208	6/4/11
37	2	Windham	43.825873	-70.396005	6/4/11
38	2	Windham	43.824137	-70.398515	6/4/11
39	2	Windham	43.822926	-70.400694	6/4/11
40	2	Windham	43.820768	-70.403384	6/4/11
41	2	Windham	43.819185	-70.404384	6/3/11
42	2	Windham	43.818503	-70.403714	6/3/11
43	2	Windham	43.817910	-70.403908	6/3/11
44	3	Windham	43.817697	-70.404934	6/3/11
45	3	Windham	43.816252	-70.404999	6/3/11
46	3	Windham	43.814759	-70.405789	6/3/11
47	3	Windham	43.813957	-70.405362	6/3/11
48	3	Windham	43.812392	-70.405388	6/3/11
49	3	Windham	43.811017	-70.405945	6/3/11
50	3	Windham	43.810016	-70.407103	6/3/11
51	3	Windham	43.808835	-70.406350	6/3/11
52	3	Windham	43.808610	-70.407140	9/15/10
53	3	Windham	43.808291	-70.408252	6/3/11
54	3	Windham	43.806784	-70.409329	6/3/11
55	3	Windham	43.806253	-70.410237	6/3/11
56	4	Windham	43.805920	-70.411130	9/15/10
57	4	Windham	43.804853	-70.411245	6/3/11
58	4	Windham	43.803790	-70.412850	6/3/11
59	4	Windham	43.802321	-70.413225	6/3/11
60	4	Windham	43.801270	-70.414300	9/15/10
61	4	Windham	43.801147	-70.414555	6/3/11
62	4	Windham	43.798740	-70.415630	9/14/10
63	4	Windham	43.797140	-70.417120	9/14/10
64	5	Windham	43.791980	-70.419950	9/14/10
65	5	Windham	43.790810	-70.419920	9/14/10
66	5	Windham	43.789630	-70.419340	9/14/10
67	6	Windham	43.781950	-70.427180	9/14/10

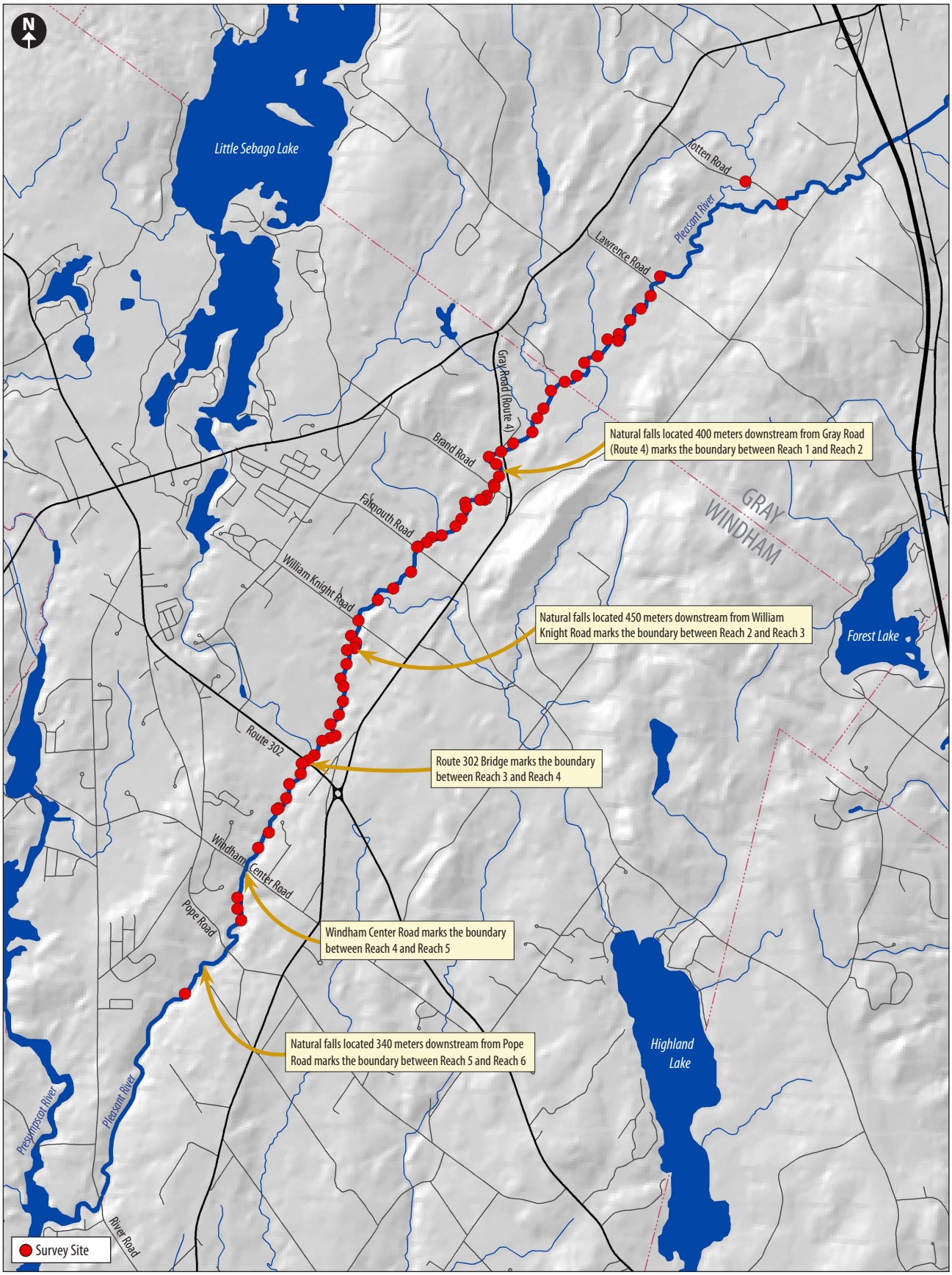


Figure 1. Reaches and survey site locations in the Pleasant River (Gray and Windham, Maine). At this scale, sites are too close together to label; see Appendix 1 for reach-scale maps with labeled survey sites.

Table 2. Level of survey effort by reach, and for all reaches combined, for mussel surveys conducted in the Pleasant River, 2009–2011.

	Reaches						
Statistic	**1**	**2**	**3**	**4**	**5**	**6**	**All**
Site Numbers	1–21	22–43	44–55	56–63	64–66	67	-
Total Sites	21	22	12	8	3	1	67
Reach Length (meters)	6,500	3,400	1,700	1,600	1,500	4,000	18,700
Total Distance Surveyed (meters)	3,217	3,505	1,640	885	280	75	9,602
Total Distance Assessed (meters)	4,200	3,400	1,700	1,600	1,200	600	12,700
Percent of Reach Surveyed	49.5	103.1	96.5	55.3	18.7	1.9	51.3
Percent of Reach Assessed	64.6	100.0	100.0	100.0	80.0	15.0	67.9
Mean Distance Per Survey Site (meters)	153	159	137	111	93	75	143
Total Survey Duration (hours)	10.00	19.56*	5.17	3.90	1.97	0.50	41.10*
Mean Survey Duration Per Site (hours)	0.48	0.66	0.43	0.49	0.66	0.50	0.54

*Includes 5 person-hours spent re-surveying two areas in August 2011, but otherwise the August 2011 surveys are not included in these statistics because they were just spot checks.

Thayer Brook (Reach 1), with poor *A. varicosa* habitat.

Pleasant River (Site 62, Reach 4), with good *A. varicosa* habitat.

the Pleasant River) (Figure 1, Table 1, Appendix 1). The Pleasant River was divided into six reaches (Figure 1), generally demarcated by natural breaks in stream gradient (e.g., waterfalls). Habitat was assessed along 12,700 meters (7.9 miles), and snorkel surveys were conducted along a combined total of 9,600 meters (6.0 miles) (Table 2). The lowermost two miles of the river, from Site 67 to its confluence with the Presumpscot River, was not surveyed, but at least half of this reach contains habitat that is clearly unsuitable for *A. varicosa* (e.g., the deep, slow-flowing, and heavily vegetated stream channel observed at the River Road bridge in Windham). The lower Pleasant River is impounded by the Gambo Dam, which is located on the Presumpscot River, approximately 1.2 miles downstream from the mouth of the Pleasant River. Toward the upstream end of the Pleasant River, all but 250 meters of the reach between Lawrence Road and Totten Road were omitted from the survey because poor habitat was observed at both ends of that reach, and aerial photographs indicated that the poor conditions extended throughout that entire reach.

Mussel surveys conducted in 2009 (August 12) and 2010 (September 13-15) were conducted within discrete sites, but habitat was also assessed both within and between survey sites. For mussel surveys, site selection was based on the presence of habitat conditions favored by *A. varicosa*. Key habitat parameters included water depth, flow velocity, and substrate types. Surveyors generally targeted areas with: water depths ranging 0.25–1.5 meters, light to moderate flow velocity (<0.3 m/s), and relatively high proportions of sand and gravel among coarser materials (e.g., cobble and boulder). Additionally, some sites were selected because they represented prevailing habitat conditions in a reach and some were selected to ensure that total survey coverage was adequate. In 2011, two biologists conducted a continuous snorkel survey (i.e., with no gaps in coverage) along a 5.2-mile section of river during June 2–4. On August 20, 2011, a survey consisted of spot-checks for presence of *A. varicosa* in areas where good habitat, but no *A. varicosa*, had been found during the June survey.

Survey Methods: At each survey site, biologists conducted semi-quantitative (i.e., timed qualitative) visual surveys by snorkeling. Mussels were counted at the surface of the sediment, and light excavation (fanning and raking sediments) was used to detect mussels that were flush with, or slightly below, the surface. The duration of each survey was recorded, but not standardized across all survey sites. Generally, more time was spent surveying high-quality habitats where *A. varicosa* were encountered, and less time was spent surveying poor-quality habitats where *A.*

Table 3. Survey effort, species counts, species CPUE for mussel species found in the Pleasant River, 2009–2011. Overall habitat suitability for *A. varicosa* indicated in the last column; see Appendix 2 for habitat data and summaries.

				Count			CPUE			
Site	Reach	Distance (m)	Time (hrs)	*E. complanata*	*A. undulata*	*A. varicosa*	*E. complanata*	*A. undulata*	*A. varicosa*	AIVa Habitat
1	1	0	0.00	-	-	-	-	-	-	POOR
2	1	0	0.00	-	-	-	-	-	-	POOR
3	1	40	0.33	24	2	0	72.0	6.0	0.0	POOR
4	1	150	0.77	19	0	0	24.8	0.0	0.0	POOR
5	1	182	0.87	36	0	0	41.5	0.0	0.0	POOR
6	1	180	0.77	73	0	0	95.2	0.0	0.0	POOR
7	1	200	0.50	27	0	0	54.0	0.0	0.0	POOR
8	1	175	0.57	37	2	0	65.3	3.5	0.0	FAIR
9	1	120	0.50	6	0	0	12.0	0.0	0.0	FAIR
10	1	180	0.50	20	S	0	40.0	0.0	0.0	POOR
11	1	200	0.57	10	S	0	17.6	0.0	0.0	POOR
12	1	170	0.53	21	0	0	39.4	0.0	0.0	POOR
13	1	150	0.57	9	0	0	15.9	0.0	0.0	POOR
14	1	200	0.40	28	0	0	70.0	0.0	0.0	POOR
15	1	220	0.43	22	0	0	50.8	0.0	0.0	POOR
16	1	150	0.47	15	0	0	32.1	0.0	0.0	POOR
17	1	170	0.43	18	0	0	41.5	0.0	0.0	POOR
18	1	260	0.47	31	0	0	66.4	0.0	0.0	POOR
19	1	190	0.43	2	0	0	4.6	0.0	0.0	FAIR
20	1	160	0.50	14	0	0	28.0	0.0	0.0	POOR
21	1	120	0.40	5	0	0	12.5	0.0	0.0	POOR
22	2	150	0.50	0	0	0	0.0	0.0	0.0	POOR
23	2	50	0.50	37	0	2	74.0	0.0	4.0	GOOD
24	2	130	0.50	28	0	0	56.0	0.0	0.0	GOOD
25	2	130	0.50	21	0	0	42.0	0.0	0.0	GOOD
26	2	240	3.40	-	-	6	-	-	1.8	GOOD
27	2	110	0.43	38	1	S	87.7	2.3	0.0	GOOD
28	2	190	0.40	18	0	0	45.0	0.0	0.0	GOOD
29	2	110	0.43	28	0	0	64.6	0.0	0.0	GOOD
30	2	90	0.73	-	-	10	-	-	13.7	GOOD
31	2	150	0.40	59	0	0	147.5	0.0	0.0	GOOD
32	2	175	0.40	34	0	0	85.0	0.0	0.0	POOR
33	2	50	1.00	-	-	1	-	-	1.0	FAIR
34	2	190	0.40	8	0	0	20.0	0.0	0.0	POOR
35	2	150	1.00	-	-	0	-	-	0.0	POOR
36	2	120	0.30	10	0	0	33.3	0.0	0.0	POOR
37	2	300	0.50	5	0	0	10.0	0.0	0.0	POOR
38	2	280	0.50	78	0	0	156.0	0.0	0.0	POOR
39	2	230	0.50	67	0	0	134.0	0.0	0.0	POOR
40	2	330	0.57	40	0	0	70.6	0.0	0.0	FAIR
41	2	160	0.50	32	0	0	64.0	0.0	0.0	FAIR
42	2	100	0.57	87	0	0	153.5	0.0	0.0	GOOD
43	2	70	0.53	8	0	0	15.0	0.0	0.0	POOR
44	3	100	0.50	25	0	0	50.0	0.0	0.0	GOOD
45	3	160	0.47	23	0	0	49.3	0.0	0.0	GOOD
46	3	170	0.63	243	0	0	383.7	0.0	0.0	FAIR
47	3	100	0.43	336	0	0	775.4	0.0	0.0	GOOD
48	3	170	0.40	73	0	0	182.5	0.0	0.0	FAIR
49	3	150	0.40	125	0	S	312.5	0.0	0.0	FAIR
50	3	140	0.40	82	0	0	205.0	0.0	0.0	POOR
51	3	140	0.40	16	0	0	40.0	0.0	0.0	POOR
52	3	50	0.50	46	0	0	92.0	0.0	0.0	FAIR
53	3	160	0.40	22	0	0	55.0	0.0	0.0	FAIR
54	3	200	0.40	45	0	0	112.5	0.0	0.0	POOR
55	3	100	0.23	7	0	0	30.0	0.0	0.0	POOR
56	4	40	0.68	73	0	3	106.8	0.0	4.4	GOOD
57	4	180	0.50	8	1	0	16.0	2.0	0.0	FAIR
58	4	180	0.43	6	0	0	13.8	0.0	0.0	FAIR
59	4	140	0.47	7	0	0	15.0	0.0	0.0	FAIR
60	4	0	0.00	-	-	-	-	-	-	POOR
61	4	170	0.40	0	0	0	0.0	0.0	0.0	POOR
62	4	75	0.75	31	0	1	41.3	0.0	1.3	GOOD
63	4	100	0.67	51	0	0	76.5	0.0	0.0	GOOD
64	5	80	0.50	1	0	0	2.0	0.0	0.0	GOOD
65	5	100	0.67	6	1	0	9.0	1.5	0.0	GOOD
66	5	100	0.80	7	1	0	8.8	1.3	0.0	FAIR
67	6	75	0.50	9	0	0	18.0	0.0	0.0	FAIR

varicosa were rare or not encountered. All mussels found were counted at nearly all sites, including common species; counts for each mussel species were divided by the survey duration to compute catch-per-unit-effort (CPUE; expressed as mussels/hour). Biologists also recorded the shell length, shell condition, and microhabitat (e.g., water depth and substrate) of each *A. varicosa*. Shell condition refers to the degree of shell erosion; for each animal, this was recorded as one of five numeric categories (0 = Light, 0.25 = Light/Medium, 0.5 = Medium, 0.75 = Medium/Heavy, and 1.0 = Heavy). A shell condition index ranging from 0 to 1 was then calculated as the average of these shell condition values.

Other features were also noted at each survey site, including key reach-scale and fine-scale habitat parameters, riparian condition, and adjacent land use (these features were also noted along most of the river in between survey sites). Examples of reach-scale parameters are rapids, riffles, pools, runs, and major substrate types, while examples of fine-scale parameters include water depth, flow velocity, and substrate composition. Based on a combination of instream and riverbank habitat variables, each mussel survey site was subjectively ranked as "Good", "Fair", or "Poor" habitat for *A. varicosa*. Locations of survey sites and noted habitat features were recorded with GPS and sometimes photographed.

Table 4. Summary of occurrence, count, and CPUE data for mussel species found in the Pleasant River, 2009–2011.

	Species		
Statistic	***E. complanata***	***A. undulata***	***A. varicosa***
Occurrences	58	6	6
Total Survey Sites*	60	60	64
Total Survey Duration**	30.0	30.0	41.1
Percent of Sites	96.7	10.0	9.4
Total Count	2257	8	23
Mean Count	37.62	0.13	0.36
Min Count	0	0	0
Max Count	336	2	10
Overall CPUE***	75.32	0.27	0.56
Min CPUE	0.00	0.00	0.00
Max CPUE	775.38	6.00	13.70

*Only includes actual survey (snorkel) sites where a species was counted.
**Only includes time spent at actual survey (snorkel) sites where a species was counted, and for *A. varicosa*, includes the 5 hours spent surveying in August 2011.
***Computed as the total number of animals divided by total survey duration

RESULTS

Species Distribution, Counts, and CPUE

Three mussel species were found during the surveys: *Elliptio complanata* (Eastern Elliptio), *A. varicosa*, and *A. undulata* (Triangle Floater) (Tables 3–4). During the 2010 and 2011 surveys, when surveyors counted all mussel species at each site, 2,257 *E. complanata*, six *A. varicosa* (and two shells), and eight *A. undulata* were counted. *E. complanata* comprised 99.4 percent of all mussels found. In 2009, 17 *A. varicosa* and two *A. undulata* were found, but *E. complanata* were not counted.

For all three years combined, the 23 live *A. varicosa* were found at only six (9.4 percent) of the survey sites, all of which were within either Reach 2 or Reach 4 (Tables 4–5, Figure 2). Most (19) of the live *A. varicosa* were found in a 1,200-meter (0.75-mile) reach between Falmouth Road and Brand Road (Sites 23, 26, 30, and 33), near the upstream end of Reach 2. Four live *A. varicosa* were found downstream from the Route 302 bridge (Sites 56, 62), toward the upstream end of Reach 4. In 2010 and

Table 5. Reach-level occurrence, count, CPUE, and habitat ranks for *A. varicosa* in the Pleasant River, 2009–2011.

	Reaches						
Statistic	**1**	**2**	**3**	**4**	**5**	**6**	**All**
Occurrences	0	4	0	2	0	0	6
Actual Survey Sites*	19	22	12	7	3	1	64
Percent of Sites	0.0	18.2	0.0	28.6	0.0	0.0	9.4
Total Survey Duration**	10.0	19.6	5.2	3.9	2.0	0.5	41.1
Total Count	0	19	0	4	0	0	23
Mean Count	0.00	0.90	0.00	0.57	0.00	0.00	0.37
Min Count	0	0	0	0	0	0	0
Max Count	0	10	0	3	0	0	10
Overall CPUE***	0.00	0.97	0.00	1.03	0.00	0.00	0.56
Min CPUE	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max CPUE	0.00	13.70	0.00	4.40	0.00	0.00	13.70
Percent of AIVa Habitat Ranks							
Good	0.0	45.5	25.0	37.5	66.7	0.0	26.9
Fair	14.3	13.6	41.7	37.5	33.3	100.0	23.9
Poor	85.7	40.9	33.3	25.0	0.0	0.0	49.3

*Only includes actual survey (snorkel) sites
**Only includes time spent at actual survey (snorkel) sites, and includes the 5 hours spent surveying parts of Reach 2 in August 2011.
***Computed as the total number of animals divided by total survey duration

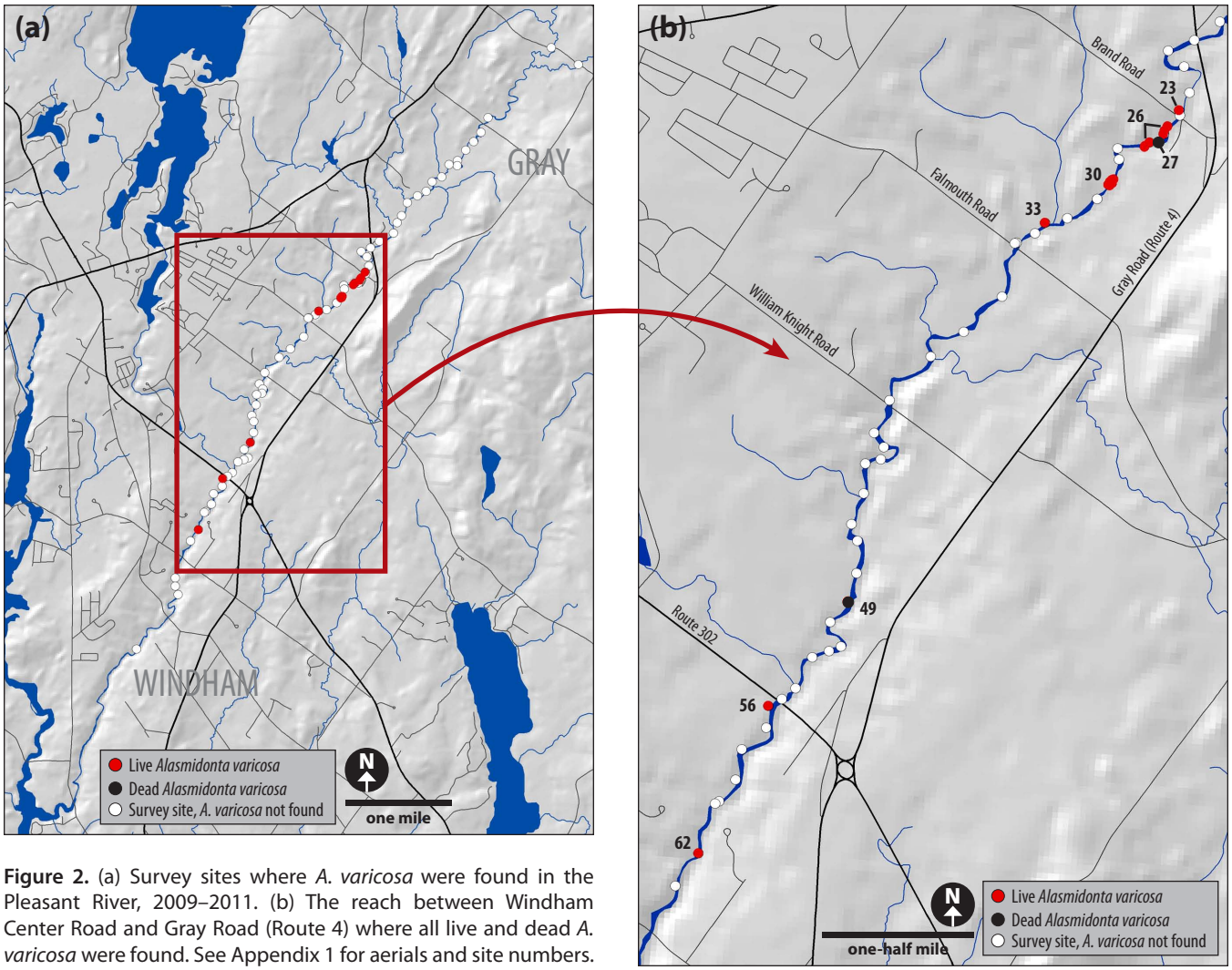


Figure 2. (a) Survey sites where *A. varicosa* were found in the Pleasant River, 2009–2011. (b) The reach between Windham Center Road and Gray Road (Route 4) where all live and dead *A. varicosa* were found. See Appendix 1 for aerials and site numbers.

2011, overall CPUE of *A. varicosa* was only 0.17 animals/hour (6 animals in 35 hours of actual search time); put another way, it took an average of 5.9 hours to find one *A. varicosa*. The highest CPUE recorded in 2010 or 2011 was 4.4 animals/hour. CPUE was higher in 2009, with a maximum of 13.7 animals/hour at Site 30, but with an overall CPUE of only 2.8 animals/hour overall (17 animals in 6.1 hours of actual search time). For all years combined, overall CPUE for *A. varicosa* was 0.56 animals/hour (23 animals in 41.1 hours of actual search time).

Table 6. Shell length and shell condition statistics for *A. varicosa* found in the Pleasant River, 2009–2011.

Live Count	23		
Mean Length (mm)	55.0		
Min Length (mm)	42.0		
Max Length (mm)	66.0		
StDev Length	7.05		
Shell Condition Index	0.79		
Length Class (mm)	Count	Percent	Shell Condition Index
1 (<20)	0	0	-
2 (20.0–29.9)	0	0	-
3 (30.0–39.9)	0	0	-
4 (40.0–49.9)	5	21.7	0.70
5 (50.0–59.9)	12	52.2	0.73
6 (60.0–69.9)	6	26.1	1.00

A. varicosa Demographics and Shell Condition

Shell length and shell condition were recorded for all 23 live *A. varicosa* (Tables 6–7). The mean shell length of these animals was 55.0 millimeters and ranged from 42.0 to 66.0 millimeters. Most mussels (12, or 52.2 percent) were in the 50.0–59.9 millimeter size range and six (26.1 percent) were larger than 60.0 millimeters. The shell condition index was 0.79, which corresponds to a very high degree of shell erosion. As expected, shell condition indices were higher for larger size classes (i.e., older animals were more heavily eroded) (Table 6).

A. varicosa Habitat

Live *A. varicosa* were found at water depths ranging 0.25–1.0 meter, in light to moderate flow velocities, and in

Table 7. Location, shell length, shell condition, and microhabitat data collected for *A. varicosa* found in the Pleasant River, 2009–2011.

Site	Reach	Latitude	Longitude	Date	L/D	Length (mm)	Condition	Depth (ft)	Substrate*
23	2	43.835020	-70.384410	9/13/10	Live	64.5	1.00	0.80	S/G/C
23	2	43.835020	-70.384410	9/13/10	Live	65.0	1.00	1.25	S/G/C
26	2	43.834021	-70.385351	8/12/09	Live	43.0	0.25	3.00	G/C
26	2	43.833221	-70.386651	8/12/09	Live	44.5	1.00	1.00	G/C
26	2	43.834211	-70.385171	8/12/09	Live	50.0	0.50	1.50	G/C
26	2	43.833261	-70.386641	8/12/09	Live	52.0	1.00	1.00	G/C
26	2	43.833851	-70.385431	8/12/09	Live	55.0	1.00	2.00	G/C
26	2	43.834241	-70.385141	8/12/09	Live	59.0	1.00	1.50	G/C
27	2	43.833444	-70.386345	6/4/11	Dead	-	-	-	-
30	2	43.831631	-70.388681	8/12/09	Live	42.0	1.00	1.50	S/G/C
30	2	43.831361	-70.389041	8/12/09	Live	46.0	1.00	1.50	S/G/C
30	2	43.831461	-70.388771	8/12/09	Live	53.0	1.00	1.50	S/G/C
30	2	43.831501	-70.388931	8/12/09	Live	54.5	1.00	1.50	S/G/C
30	2	43.831521	-70.388811	8/12/09	Live	58.0	1.00	1.50	S/G/C
30	2	43.831431	-70.388781	8/12/09	Live	58.0	1.00	1.50	S/G/C
30	2	43.831481	-70.388901	8/12/09	Live	59.0	1.00	1.50	S/G/C
30	2	43.831331	-70.388951	8/12/09	Live	60.0	1.00	1.50	S/G/C
30	2	43.831601	-70.388801	8/12/09	Live	62.0	1.00	1.50	S/G/C
30	2	43.831471	-70.388771	8/12/09	Live	63.0	1.00	1.50	S/G/C
33	2	43.829471	-70.393221	8/12/09	Live	66.0	1.00	1.50	S/G/C
49	3	43.811017	-70.405945	6/3/11	Dead	(55.0)	-	-	-
56	4	43.805920	-70.411130	9/15/10	Live	49.0	0.25	1.50	S/G
56	4	43.805920	-70.411130	9/15/10	Live	51.0	0.00	1.50	S/G
56	4	43.805920	-70.411130	9/15/10	Live	55.0	0.25	1.50	S/G
62	4	43.798740	-70.415630	9/14/10	Live	56.0	0.00	1.00	S

*S = Sand, G = Gravel, C = Cobble

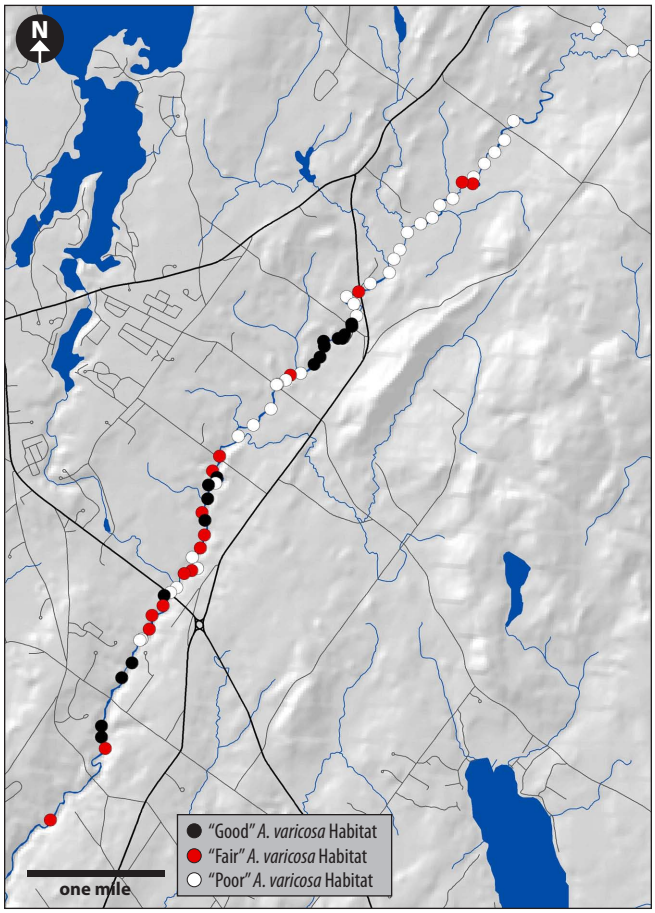


Figure 3. Habitat suitability map for *A. varicosa* in the Pleasant River. See Appendix 1 for maps, and Appendix 2 for descriptions.

sand and gravel substrates (often with embedded cobble nearby) (Table 7, Appendix 2). They were not found in fast-flowing areas dominated by cobble and boulder/bedrock, nor were they found in the slow-flowing or stagnant areas dominated by clay, silt, sand, and detritus. Extensive emergent and submerged macrophytes, usually characteristic of the more open and low-gradient areas of the river, seemed to preclude the presence of *A. varicosa*. Large amounts of woody debris (e.g., roots, trunks, and branches) were noted throughout many sections of the river and usually were associated with large amounts of sand, silt, and detritus (Appendix 2); these areas were typically not suitable for *A. varicosa*. Some of these accumulations may have actually occluded pre-existing *A. varicosa* habitat.

Almost 50 percent of the survey sites were given an *A. varicosa* habitat rank of "Poor," with near equal amounts of "Fair" and "Good" habitat making up the rest (Table 5, Figure 3). In Reach 1, 85.7 and 14.3 percent of the sites were ranked Poor or Fair, respectively, and Good habitat was not found. In Reach 3, 33.3 and 41.7 percent of the sites were ranked Poor or Fair, respectively, and only 25 percent was ranked as Good. Reaches 2, 4, and 5 had proportionately more Good habitat, at 45.5, 37.5, and 66.7 percent, respectively. The correlation between presence of *A. varicosa* and habitat rank was not compelling; the six sites where *A. varicosa* were found were either ranked as Good (5) or Fair (1), but there were also 13 Good sites, and 15 Fair sites where *A. varicosa* were not found.

One of several areas where good *A. varicosa* habitat was observed (here, Reach 5) but no *A. varicosa* were found.

DISCUSSION

The one-day survey in the Pleasant River in 2009, between Falmouth Road and Brand Road, raised serious concern about the *A. varicosa* population (Biodrawversity 2010), based primarily on a CPUE that was almost 90 percent lower than what was reported in 2001 for the same reach. Furthermore, this reach seemed to be decimated by fresh deposition of sand, detritus, and coarse woody debris. An important question was whether this high level of habitat degradation and low *A. varicosa* density were localized, or indicative of the entire river. Follow-up studies conducted in 2010 and 2011 suggest the latter may be true; unsuitable and highly degraded stream habitat was observed throughout the river, only six live *A. varicosa* were found, and *A. varicosa* were not found in many areas that appeared to contain suitable habitat. Overall, evidence points toward an aging population of unhealthy (i.e., heavily eroded) animals, with no evidence of recruitment. Furthermore, a sparse distribution and low density together raise serious doubt about fertilization success.

Among the more than 40 rivers that Biodrawversity has intensively surveyed for *A. varicosa* in the last decade, the Pleasant River ranks among the lowest for CPUE of *A. varicosa* as well as a second species, *A. undulata*. The low species diversity (3) in the Pleasant River, and data that suggest that both *A. varicosa* and *A. undulata* are critically endangered, are cause for significant concern. These results may put the Pleasant River's *A. varicosa* population on par with populations in five rivers in Connecticut (Shetucket River, Bungee Brook, Natchaug River, Stony Brook, and Jeremy River) and one in New Hampshire (Lamprey River) that have all been characterized as either critically endangered or terminal (Biodrawversity 2010, 2011). It would be unfortunate to lose the Pleasant River population, as it is Maine's southernmost population, and it is geographically isolated from the nearest populations in the Sheepscot River and tributaries of the Kennebec River. There are no other *A. varicosa* populations known to occur in the Presumpscot River watershed.

The greatest uncertainty about the conclusions in this report stems from very poor water clarity observed on every day of the survey in each of the three years, which impeded thorough visual surveys. Turbidity was thought to be due to the prevalence of clay in the basin, ongoing sedimentation from eroding streambanks and grazing cattle, and perhaps algal productivity. Some areas of the Pleasant River, especially in Reaches 1–3, could not be surveyed effectively because visibility was less than 10 centimeters. Areas up to one meter deep could be surveyed visually, by snorkeling, but with a greatly limited field of view. Areas deeper than one meter were even more challenging to sur-

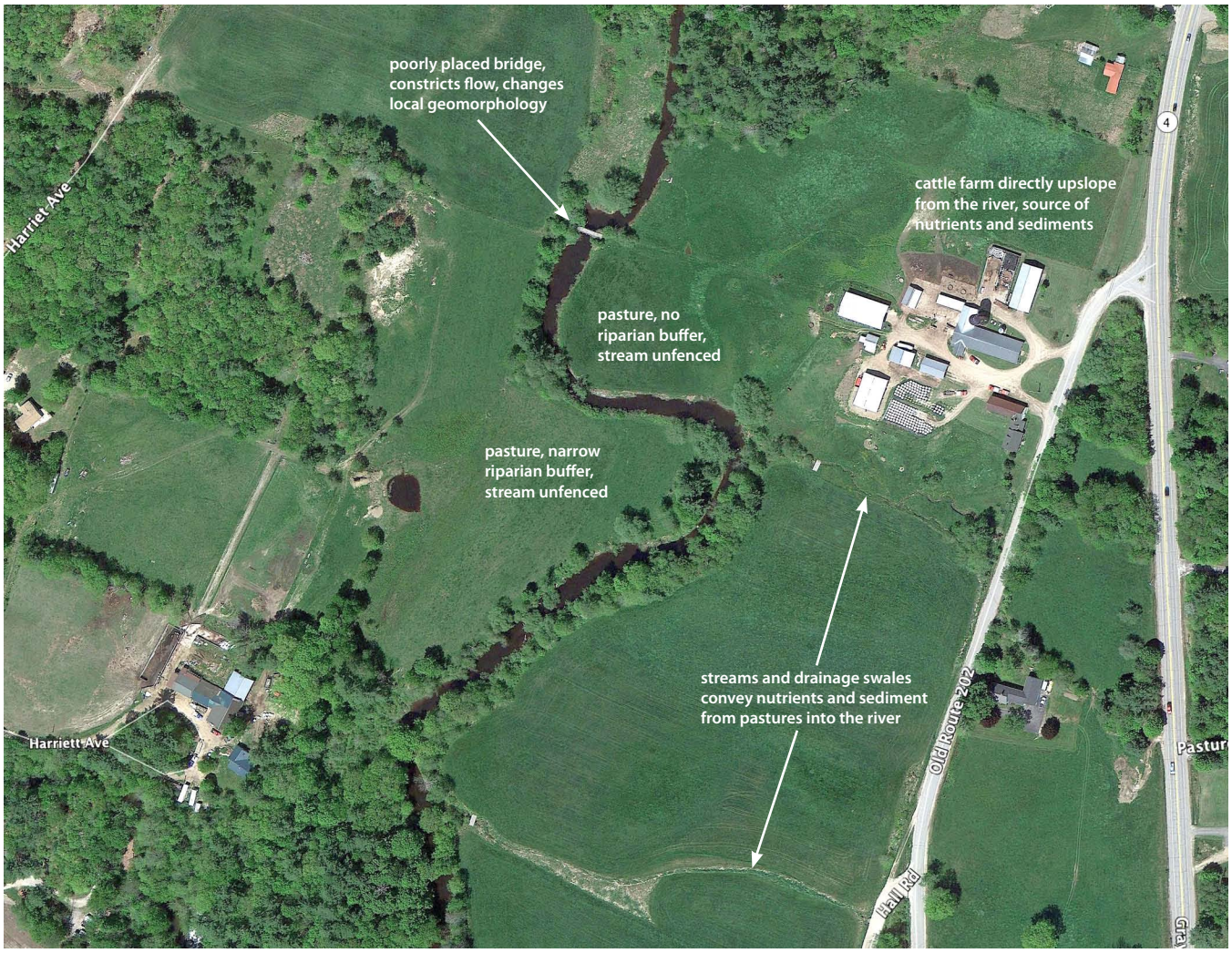


Figure 4. One of several examples of multiple threats to habitat quality and water quality in the Pleasant River, in close proximity to each other. Here, toward the downstream end of Reach 3 (upstream from the Route 302 Bridge, intensive agricultural and grazing lands in the river corridor, combined with an inadequate forested buffer, contribute to the export of nutrients and sediment to the Pleasant River, trampling of the bottom and banks of the river by cattle, among other threats.

vey. It was interesting to find three live *A. varicosa* at Site 56, which was the first survey site downstream of Ditch Brook, where the inflow of clear water immediately improved clarity in the Pleasant River. Adding an additional degree of uncertainty is the fact that it was impossible to survey beneath accumulations of coarse woody debris, especially where water was deep. In short, it is possible, though unlikely, that the *A. varicosa* population in the Pleasant River is larger and more widely distributed than what we have documented. However, habitat quality and water clarity (and perhaps water quality) in the Pleasant River is worse than we have observed in any other river in New England where *A. varicosa* have been documented, except perhaps the Exeter River (New Hampshire) where these conditions were worse and, incidentally, *A. varicosa* are considered extirpated (Biodrawversity 2011).

As mentioned throughout this report, there are numerous anthropogenic threats to mussels and aquatic habitat along the Pleasant River. Agricultural lands, including for row crops (mainly corn) and livestock, comprise

Cattle pasture near Site 51 (same area shown on Figure 4).

One of many areas in the Pleasant River where very significant bank failure is occurring. Areas like this contribute an enormous amount of sediment, nutrients, and coarse woody material to the river.

a significant proportion of land cover in the reach from about 0.25 miles upstream of Windham Center Road up to Brand Road. In many cases, a forested riparian buffer is either absent or inadequate, and bank erosion is threatening the few remaining trees that provide shade and stability. Livestock have access to the river in several locations; they trample the bottom and banks of the river and defecate in the water. Throughout these open lands, there are many small intermittent streams and swales where surface runoff concentrates; these may convey large amounts of nutrients, sediment, and bacteria to the river during winter snowmelt and periods of heavy rain. In one case, a farm's barns, manure piles, and feeding areas are only 100 meters upslope from the river, and there was no buffer to intercept surface runoff (Figure 4). Where larger streams and drainage swales enter the Pleasant River, we usually observed problems such as headcutting, extensive alluvial fans, significant bank erosion, and accumulation of large woody debris and detritus.

One of many areas in the Pleasant River with significant instream accumulations of large woody debris.

There is also quite a lot of residential development in the watershed, resulting in impervious surfaces and new sources of nutrients/contaminants that ultimately reach the river via tributaries or surface runoff. Many of the bridges and culverts that we observed were undersized relative to the size of the river, especially its size during flood events, and there were usually telltale signs of channel instability near these undersized crossings.

Even in areas that were far from agricultural lands, residential development, or road crossings, we observed tremendous amounts of bank erosion and slope failure, both close to and well away from the river. The large volume of sediment and coarse woody debris that has slid

into the river during floods of the last five years seemed to have had an enormous effect on stream geomorphology, in some cases causing the river to cut new channels altogether. The cumulative effect of all of these factors is that there is very little high-quality *A. varicosa* habitat left in the Pleasant River. What remains is highly fragmented, and it continues to be threatened. Considering both the degraded habitat quality and the results of the mussel survey, we are not optimistic that the *A. varicosa* population in the Pleasant River can persist.

If additional studies are going to be planned for the Pleasant River, we suggest that they focus on areas identified as having Good or Fair habitat, especially in parts of Reaches 2–5 that have a relatively intact riparian forest and that have not been decimated by eroding streambanks, deposition of coarse woody debris, and sedimentation. It would be beneficial to monitor water clarity throughout the year and only conduct the surveys when water is clearest.

REPORTS CITED

Biodrawversity. 2010. Brook Floater (*Alasmidonta varicosa*) Population Assessments in Nine Maine Rivers. Report submitted to the Maine Department of Inland Fisheries and Wildlife.

Biodrawversity. 2011. Freshwater Mussel Survey in the Lamprey and Exeter River Watersheds of Southeastern New Hampshire. Report submitted to the New Hampshire Fish and Game Department.

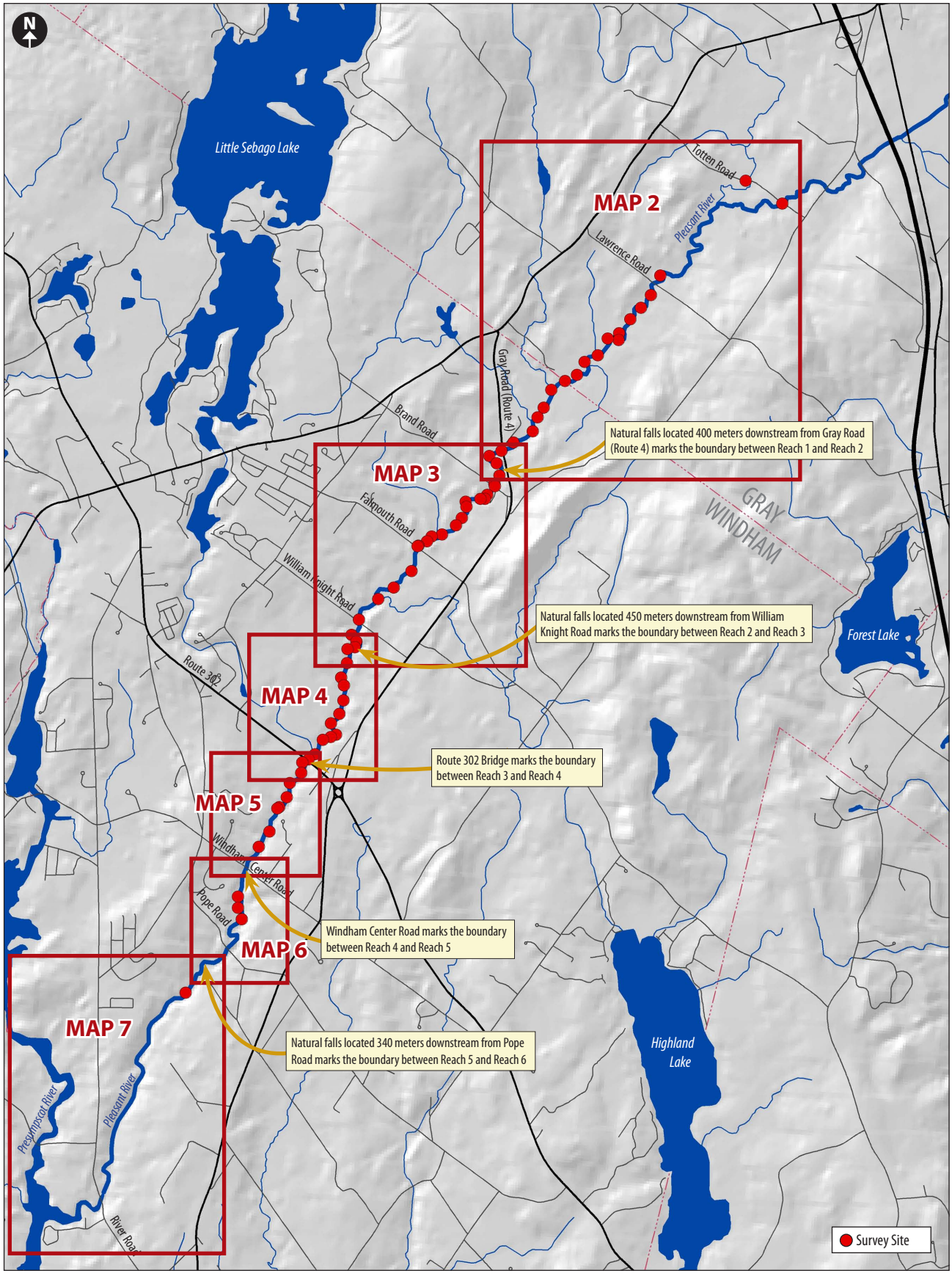
Nedeau, E.J. 2008. *Freshwater Mussels and the Connecticut River Watershed*. Connecticut River Watershed Council, Greenfield, MA.

APPENDIX 1

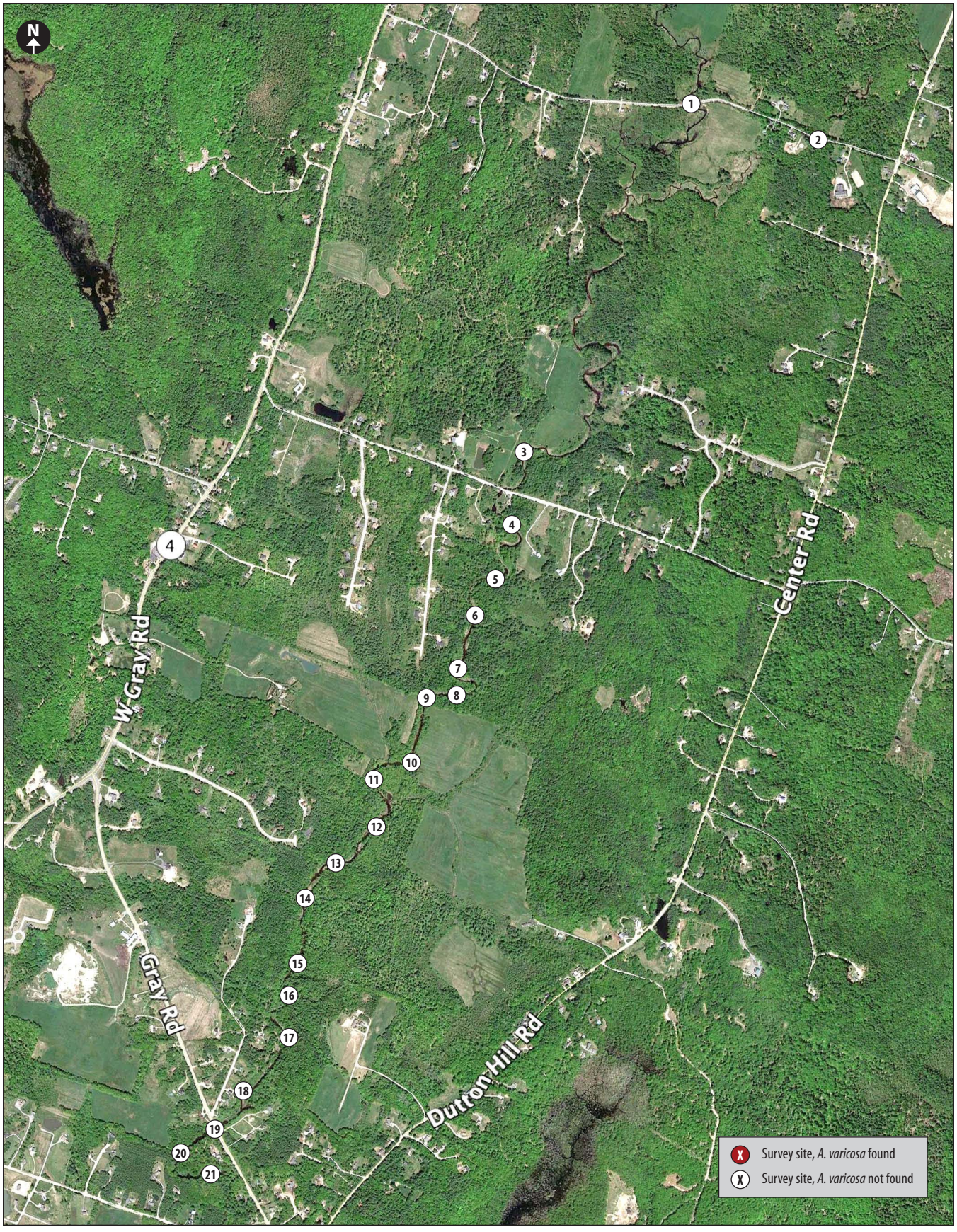
Aerial Images Showing the Pleasant River, Its Surrounding Landscape, and Survey Sites

APPENDIX 1, MAP 1

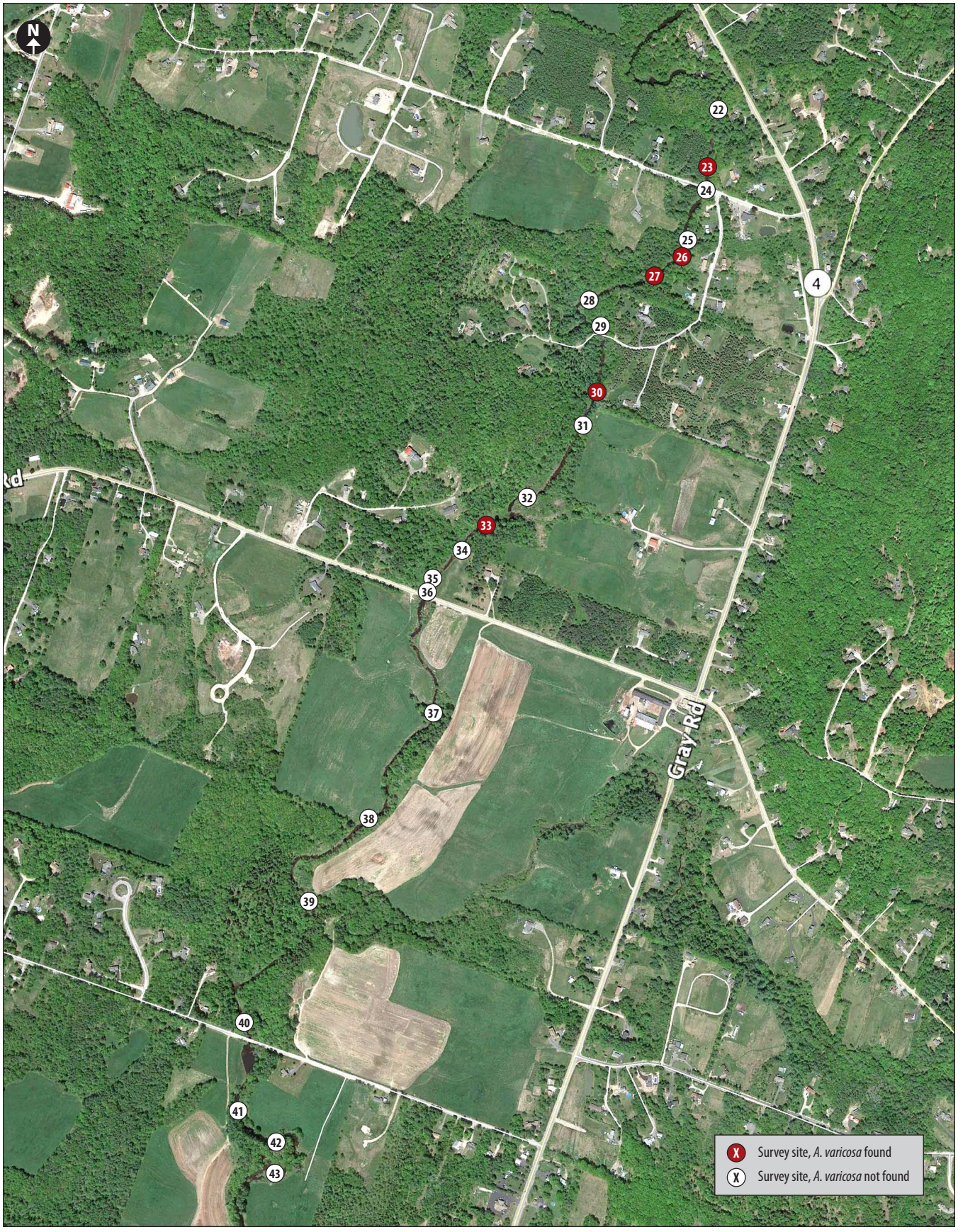
Overview of survey sites and reaches, and locator for maps 2-6



APPENDIX 1, MAP 2
Aerial Image of the Study Area: Reach 1, Sites 1-21



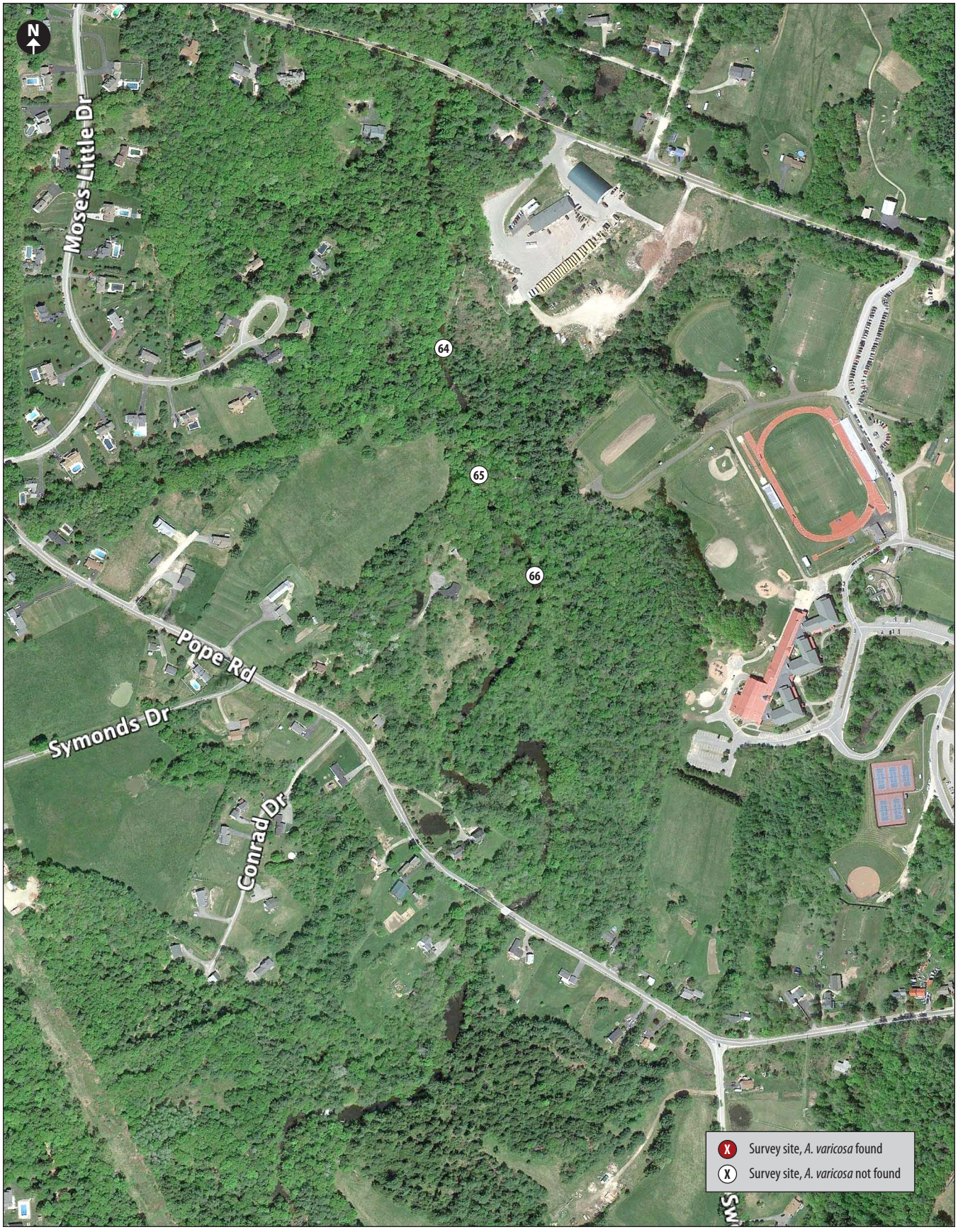
APPENDIX 1, MAP 3
Aerial Image of the Study Area: Reach 2, Sites 22-43



APPENDIX 1, MAP 4
Aerial Image of the Study Area: Reach 3, Sites 44-55

APPENDIX 1, MAP 5
Aerial Image of the Study Area: Reach 4, Sites 56-63

APPENDIX 1, MAP 6
Aerial Image of the Study Area: Reach 5, Sites 64-66



APPENDIX 1, MAP 7
Aerial Image of the Study Area: Reach 6, Site 67

APPENDIX 2
Habitat Data Recorded at Each Survey Site

Abbreviations: B/Bed = Boulder/bedrock, LWD = Large woody debris, AIVaHab = subjective evaluation of whether habitat was Good, Fair, or Poor for A. varicosa. Flow (i.e., water velocity): 0 = Stagnant, 1 = Slow, 2 = Moderate, 3 = Fast.

		Mean		Substrate								
Site	Reach	Depth (ft)	Flow	Clay	Silt	Sand	Gravel	Cobble	B/Bed	LWD	AIVAHAB	Habitat Description
1	1	3.0	0.0	X	X	X	0	0	0	0	POOR	Slow-flowing/stagnant channel meandering through low-lying wetland; emergent and submerged vegetation abundant, water clarity very poor.
2	1	0.5	3.0	0	0	0	X	X	X	0	POOR	Small, narrow, high-gradient stream channel with fast water, shallow depth, and rocky substrate. Not suitable for any mussel species.
3	1	2.0	0.5	X	X	X	X	0	0	0	POOR	Slow-flowing/stagnant channel meandering through low-lying wetland; emergent and submerged vegetation abundant, water clarity very poor. Mostly clay, silt, and sand substrate.
4	1	2.5	0.0	X	X	0	X	0	0	X	POOR	Bank intact, with little erosion; riparian zone with small trees; woody debris abundant, especially in pools.
5	1	2.0	1.5	X	X	X	0	0	0	X	POOR	Bank heavily eroded; riparian zone with low vegetation; woody debris abundant along the stream bottom and bank.
6	1	2.0	1.5	X	X	X	X	0	0	0	POOR	Bank not described; riparian zone forested; woody debris not described; better mussel habitat present behind upstream beaver dam.
7	1	2.0	1.5	X	X	0	0	0	0	X	POOR	Bank with erosion; riparian zone with forest and brush; woody debris abundant.
8	1	2.0	1.0	X	X	X	X	X	0	X	FAIR	Bank with erosion; riparian zone forested, with shrubs and grasses present; woody debris abundant.
9	1	2.0	1.0	X	X	0	X	X	0	X	FAIR	Bank with erosion; riparian zone vegetated partly forested, with a field present; woody debris abundant.
10	1	2.0	1.0	0	0	0	0	0	0	0	POOR	Bank with minor erosion; riparian zone forested; woody debris less abundant than in previous sections; more plant material, such as leaves and twigs.
11	1	2.0	1.0	X	X	0	0	0	0	X	POOR	Bank with erosion in steep areas; riparian zone partly forested, partly open; woody debris less abundant than in upstream sections.
12	1	3.0	0.5	X	X	0	0	0	0	X	POOR	Bank intact, with little erosion; riparian zone forested with some open areas; woody debris very abundant on river bottom and along banks; log jam present. Mucky swamp.
13	1	2.5	0.5	X	X	0	0	0	0	X	POOR	Bank partly intact, partly with erosion; riparian zone forested, though some trees are washing out along bank; woody debris abundant, both instream and along bank.
14	1	2.5	0.5	X	X	0	0	0	0	X	POOR	Bank with erosion; riparian zone forested, with abundant herbaceous vegation along the bank; woody debris abundant.
15	1	2.0	0.5	X	X	X	0	0	0	X	POOR	Bank with erosion and downed trees; riparian zone forested; woody debris abundant, with other organic material.
16	1	2.0	1.0	X	X	X	0	0	0	X	POOR	Bank with erosion and downed trees; riparian zone forested; woody debris abundant instream and along banks.
17	1	1.5	1.5	X	X	X	0	0	0	X	POOR	Bank with erosion; riparian zone forested, with downed trees present; woody debris abundant upstream of tribuary, less downstream.
18	1	2.0	1.5	X	0	X	X	0	0	X	POOR	Bank with erosion; riparian zone with some forest and some early succession cover; woody debris abundant.
19	1	2.0	1.0	X	X	X	X	0	0	X	FAIR	Bank with erosion; riparian zone forested along steep banks; woody debris abundant. One short gravelly riffle in middle of section.
20	1	2.5	0.5	X	X	X	0	0	0	X	POOR	Bank with erosion 2-3 ft above the water line; riparian zone forested, with dense, shading canopy; woody debris abundant, especially downstream of the pool.
21	1	3.0	1.0	X	X	0	0	0	X	X	POOR	Bank with minor erosion; riparian zone forested with dense, shading canopy; woody debris abundant in muck.
22	2	2.0	3.0	X	X	0	0	X	X	0	POOR	Bank with minor erosion; riparian zone forested with dense, shading canopy; woody debris scarce; trail present, used by anglers.
23	2	1.5	2.0	0	X	X	X	X	0	0	GOOD	Pool-glide-run habitat located upstream from the bridge. Banks with minor to moderate erosion, large woody debris scarce. Became shallower upstream, perhaps too shallow/rocky for mussels.
24	2	2.0	2.5	0	0	X	X	X	0	0	GOOD	Bank with erosion in a large area along the steep bank upstream of bridge; riparian zone forested; woody debris scarce, composed of small branches; high quality mussel habitat present.
25	2	2.0	--	0	0	X	X	X	0	X	GOOD	Bank with heavy erorsion, mostly in the middle of the section; riparian zone primarily forested with a 50-100 m buffer, but some residences present; woody debris abundant in middle of section; high quality mussel habitat present.

APPENDIX 2
Habitat Data Recorded at Each Survey Site (continued)

Abbreviations: B/Bed = Boulder/bedrock, LWD = Large woody debris, AIVaHab = subjective evaluation of whether habitat was Good, Fair, or Poor for A. varicosa. Flow (i.e., water velocity): 0 = Stagnant, 1 = Slow, 2 = Moderate, 3 = Fast.

		Mean		Substrate								
Site	Reach	Depth (ft)	Flow	Clay	Silt	Sand	Gravel	Cobble	B/Bed	LWD	AIVAHAB	Habitat Description
26	2	1.5	2.0	0	X	X	X	X	X	0	GOOD	Mix of pools, glides, and deep runs; bottom firm (sand, gravel, cobble, some bedrock) but hard to see due to poor water clarity. Minor to moderate bank erosion, some large accumulations of woody debris.
27	2	2.0	2.5	0	0	X	X	X	X	0	GOOD	Bank with heavy erosion in areas; riparian zone mostly forested, but with a residence in the middle; woody debris not described.
28	2	1.5	2.5	0	0	X	X	X	0	0	GOOD	Bank with erosion; riparian zone forested, with some shrub cover; woody debris scarce. Would be good habitat, but quite shallow.
29	2	2.0	2.0	0	0	X	X	0	0	X	GOOD	Bank with moderate erosion; riparian zone primarily forested, with some open areas; woody debris abundant in areas.
30	2	1.5	1.5	0	X	X	X	X	0	0	GOOD	Pool-run habitat downstream of a riffle, steep bank with bedrock on left side of the river, long sand bar with silt/ detritus along the right side. Bank erosion minor to moderate at this site, but more prevalent both upstream and downstream. Trash (scrap metal, old bottles, etc.) on te riverbank and in the river.
31	2	2.0	2.0	0	0	X	X	X	0	X	GOOD	Bank with erosion, with some flood debris; riparian zone primarily forested with some open areas; woody debris present only at lower end; high quality mussel habitat present.
32	2	1.5	1.0	0	X	X	0	0	0	X	POOR	Bank with heavy erosion; riparian zone vegetated with shrubs and sparse tree cover; woody debris abundant.
33	2	1.5	1.5	X	X	X	X	X	0	X	FAIR	Banks with moderate to heavy erosion; riparian zone forested, woody debris present throughout yet some suitable mussel habitat occurs mid-channel.
34	2	2.0	2.0	0	0	X	X	0	0	X	POOR	Bank with heavy erosion, with many snags, and sand in the streams; riparian zone vegetated with shrubs and sparse tree cover; woody debris abundant, mixed with sand; snags forming small impoundments.
35	2	1.5	2.0	X	X	X	X	0	0	X	POOR	Bank with heavy erosion, with many snags, and sand in the streams; riparian zone vegetated with shrubs and sparse tree cover; woody debris abundant, mixed with sand; snags forming small impoundments.
36	2	2.0	2.0	0	0	X	X	0	0	X	POOR	Bank with erosion, with sand; riparian zone open; woody debris abundant, mixed with sand; snags forming small impoundments.
37	2	2.5	1.5	X	X	X	X	0	0	X	POOR	Bank with heavy erosion; riparian zone with open fields and no forested buffer; woody debris abundant, with many snags.
38	2	2.0	2.5	0	0	0	0	0	0	0	POOR	Bank with moderate erosion; riparian zone with forested buffer of variable width in some areas, and open fields in other areas; woody debris moderate to scarce.
39	2	2.0	1.5	X	X	X	0	0	0	X	POOR	Bank with heavy erosion, with silt and sand in the stream; riparian zone forested; woody debris abundant.
40	2	2.5	2.0	X	X	X	X	X	0	X	FAIR	Bank with erosion; riparian zone forested; woody debris present.
41	2	3.0	2.0	X	X	X	X	0	0	X	FAIR	Bank with minor erosion; riparian zone with forested buffer and fields beyond; woody debris present but not abundant.
42	2	1.5	2.0	0	0	X	X	X	0	X	GOOD	Bank with minor erosion; riparian zone forested with buffer 50-100 m wide, and partly open field; woody debris moderate, mostly in sandy and eroded areas.
43	2	2.5	2.0	0	0	0	0	X	X	0	POOR	Bank with erosion, sediment in the stream; riparian zone partly forested, and partly open field; woody debris scarce.
44	3	2.0	2.5	0	0	0	X	X	0	0	GOOD	Bank with erosion; riparian zone with forested buffer on one bank , and with open field and no buffer on the other bank; woody debris scarce; high quality mussel habitat present.
45	3	1.0	2.5	0	0	X	X	X	X	0	GOOD	Bank with erosion; riparian zone with fields on both sides, and sparse tree cover; woody debris scarce.
46	3	2.0	2.5	0	0	X	X	0	0	0	FAIR	Bank with erosion; riparian zone mostly with forested buffer but partly open with a field; woody debris scarce.
47	3	2.0	2.0	0	0	X	X	0	0	0	GOOD	Bank with erosion; riparian zone with forest; woody debris scarce, present in sandy areas near banks; high quality habitat present.
48	3	2.0	2.0	0	0	X	X	X	X	0	FAIR	Bank with erosion, 2-3 ft above the water line; riparian zone vegetated with forest; woody debris scarce.

APPENDIX 2

Habitat Data Recorded at Each Survey Site (continued)

Abbreviations: B/Bed = Boulder/bedrock, LWD = Large woody debris, AIVaHab = subjective evaluation of whether habitat was Good, Fair, or Poor for A. varicosa. Flow (i.e., water velocity): 0 = Stagnant, 1 = Slow, 2 = Moderate, 3 = Fast.

		Mean		Substrate								
Site	Reach	Depth (ft)	Flow	Clay	Silt	Sand	Gravel	Cobble	B/Bed	LWD	AIVAHAB	Habitat Description
49	3	2.0	2.0	0	X	X	X	0	0	0	FAIR	Bank with erosion; riparian zone with a forested buffer; woody debris not described.
50	3	3.0	2.0	X	X	0	0	0	X	X	POOR	Bank with erosion; riparian zone mostly open, with sparse tree cover; woody debris abundant from rail bridge.
51	3	2.5	2.0	X	X	X	0	X	0	X	POOR	Bank with heavy erosion in areas with steep banks; riparian zone with open fields (with cattle) and brush; woody debris abundant throughout.
52	3	2.0	1.0	X	X	X	X	X	0	X	FAIR	Bank with moderate to severe erosion; very steep on the left side. Riparian zone with a narrow forested buffer on both sides, with fields beyond. Woody debris abundant. Water clarity very poor, difficult to see the bottom even in less than a foot of water.
53	3	3.0	1.5	X	X	X	0	X	0	X	FAIR	Bank with erosion1-2 ft above the water line; riparian zone with a narrow forested buffer on both sides, and fields beyond; woody debris abundant, with snags on the stream bottom.
54	3	3.5	1.0	X	X	X	0	0	0	X	POOR	Bank with erosion; riparian zone with wide forested buffer of on one side, and a narrow forested buffer on the other side; woody debris abundant.
55	3	2.5	1.0	X	X	X	0	X	0	X	POOR	Bank with erosion; riparian zone with buffer of deciduous trees; woody debris moderate.
56	4	2.0	2.0	0	0	X	X	X	0	0	GOOD	Glide located between the scour pool below the 302 Bridge and a rapids/riffle section farther downstream. Banks with light to moderate erosion, mostly open canopy, some woody debris in the channel. Better water clarity due to clear water coming in from upstream tributary. Excellent flow and substrate conditions for A. varicosa.
57	4	2.0	2.5	0	X	X	X	0	0	X	FAIR	Bank with erosion, 6-7 ft above the water line; riparian zone with mixed forest buffer 50-100 m wide; woody debris moderate.
58	4	2.5	2.5	0	0	0	X	X	0	X	FAIR	Bank with heavy erosion near upstream limit; riparian zone with mixed forest buffer of variable width; woody debris moderate.
59	4	4.0	2.5	X	0	0	X	X	0	X	FAIR	Bank with heavy erosion, with areas in which clay has fallen from the bank; riparian zone forested on one side, and with an open field on the other side; woody debris abundant, with large pieces.
60	4	3.0	1.0	X	X	X	X	0	0	X	POOR	Bank with heavy erosion, with areas in which clay has fallen from the bank; riparian zone forested on one side, and with an open field on the other side; woody debris abundant, with large pieces.
61	4	3.0	2.0	X	X	X	X	0	0	X	POOR	Bank with erosion; riparian zone with narrow forested buffer through much of section; woody debris moderate.
62	4	1.0	1.5	0	0	X	X	X	X	0	GOOD	Riffle-glide-pool habitat located in a forested reach, though pastures located upslope on the right side of the river. Banks with minor to moderate erosion. Channel with some woody debris, recent sedimentation, but overall there is good amounts of gravel and cobble, and depth/flow conditions suitable for A. varicosa.
63	4	1.5	2.0	0	0	X	X	X	X	0	GOOD	Pool-run-rapids habitat, with sand, gravel, cobble, and boulder habitat. Relatively deep water, good flow conditions. Minor bank erosion, some large woody debris in the river. Forested streambank and uplands on both sides of the river.
64	5	1.5	2.0	0	0	X	X	X	X	0	GOOD	Banks with minor erosion, little woody debris in the channel. Mainly a pool-run habitat located upstream from a series of ledges, substate mix of sand-gravel-cobble-boulder. Seems like ideal habitat for A. varicosa.
65	5	1.5	1.5	0	0	X	X	X	X	0	GOOD	Minor to moderate bank erosion, some woody debris in the channel. Mainly a pool-run habitat at lower end, became riffle-rapids toward the upper end, especially near a series of ledges. Shallow water, variable substrate, overall good for A. varicosa.
66	5	1.5	2.0	0	0	X	X	X	X	0	FAIR	Minor to moderate bank erosion, some woody debris along the sides of the channel, banks forested on both sides. Substrate primarily gravel and cobble. sand sparse. Shallow, moderate to strong flow velocity. Only fair for A. varicosa because of shallow water, stronger flows, and rocky substrate.
67	6	1.5	1.0	0	X	X	X	X	X	X	FAIR	Walked a long distance from Pope Road to below the powerlines to find suitable habitat to survey. Here, long run-pool with shallow depth, light to moderate flow velocity, and mixed substrate with gravel and cobble dominant. Bank with minor erosion, heavily forested on both sides.