Lake Champlain Sea Lamprey Assessment Program

Results of Sea Lamprey Assessment Activities 2007

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Summary

Sea lamprey assessment activities conducted during the spring and summer of 2007 included the trapping of migrating adult sea lamprey and electrofishing surveys of larval populations. Traps were installed on eleven streams during the spawning migration to limit reproduction or assess spawner abundance in these tributaries. Trapping of migratory phase sea lamprey was identified as a primary control method for seven streams and as part of an integrated approach on one stream in the supplemental EIS.

Quantitative electrofishing surveys (QAS) were conducted on a total of 7 streams; three currently scheduled for lampricide treatment in the fall of 2008, two potentially scheduled for lampricide treatment in the fall of 2008, one to determine if a treatment is warranted, and one to evaluate the effectiveness of continued trapping operations.

Three streams were surveyed to determine treatment effectiveness; the Ausable River, following a spring lampricide treatment in the south fork, and the Boquet River and Beaver Brook which were treated in the fall of 2007.

Presence absence surveys were conducted on a number of tributaries in northern Vermont and in Quebec on streams tributary to the Richelieu River. One new significant producer of larvae was identified through detection surveys.

1.0 Adult Trapping

The primary reason for trapping sea lamprey in Lake Champlain is to prevent them from reproducing. Small streams that lend themselves to trapping and may possess species of concern which preclude other forms of control are trapped annually. On occasion, trapping is conducted to determine if adults are using specific areas of a stream or a new stream in their migrations. These detection efforts help guide our decisions in where and how to control existing or emerging populations. Every year, the Lake Champlain Fish and Wildlife Cooperative gives trapped adult sea lamprey to researchers to help them learn more about the biology and behavior of sea lamprey. Their innovative research benefits universities by developing students and publishing research and benefits our control program by developing new techniques which may enhance the control of sea lamprey and reduce our reliance on pesticides.

1.1 Control Program

Sea lamprey spawning runs were monitored in eight streams during the spring of 2007 using portable assessment traps. A permanent trap associated with the Frog Pond Dam on the Great Chazy River has been operated since 1995 and is part of an integrated control approach. Lamprey pots were used in two streams to assess sea lamprey abundance during the spawning migration (Figure 1). Sea lamprey were removed from the traps every 2-4 days. Non-target species captured were identified, recorded, and released. Any mortality was recorded and reported to state permitting agencies.

Streams where traps were deployed included five streams in Vermont where trapping was identified as the primary control method in the supplemental EIS. A trap was set in Beaver Brook, Westport, NY, for a fourth year, to evaluate the feasibility of using traps to control the larval population there. Beaver Brook has been problematic for lampricide treatments due to low discharge and the perceived low number of lamprey killed per cost of treatment. Results of trapping operations are listed in Table 1.

Table 1. Results of migratory phase sea lamprey trapping 2006.

Stream	Date Set	Date Pulled	# Lamprey Caught	% Change from '06
Sunderland Brook	5/2/2007	6/12/2007	5	0.00%
Indian Brook	4/25/2007	6/12/2007	0	NA
Malletts Creek	4/24/2007	6/18/2007	237	39.66%
Pond Brook	4/24/2007	6/18/2007	0	0.00%
Trout Brook	4/20/2007	6/18/2007	37	-29.73%
Stone Bridge	4/20/2007	6/18/2007	128	46.09%
G. Chazy	5/2/2007	6/11/2007	383	44.65%
Beaver Brook	4/23/2007	6/14/2007	230	49.13%
Mill Brook	4/27/2007	6/14/2007	11	NA
Mullen Brook	5/3/2007	6/14/2007	11	NA
Boquet River	5/30/2007	6/14/2007	0	0.00%

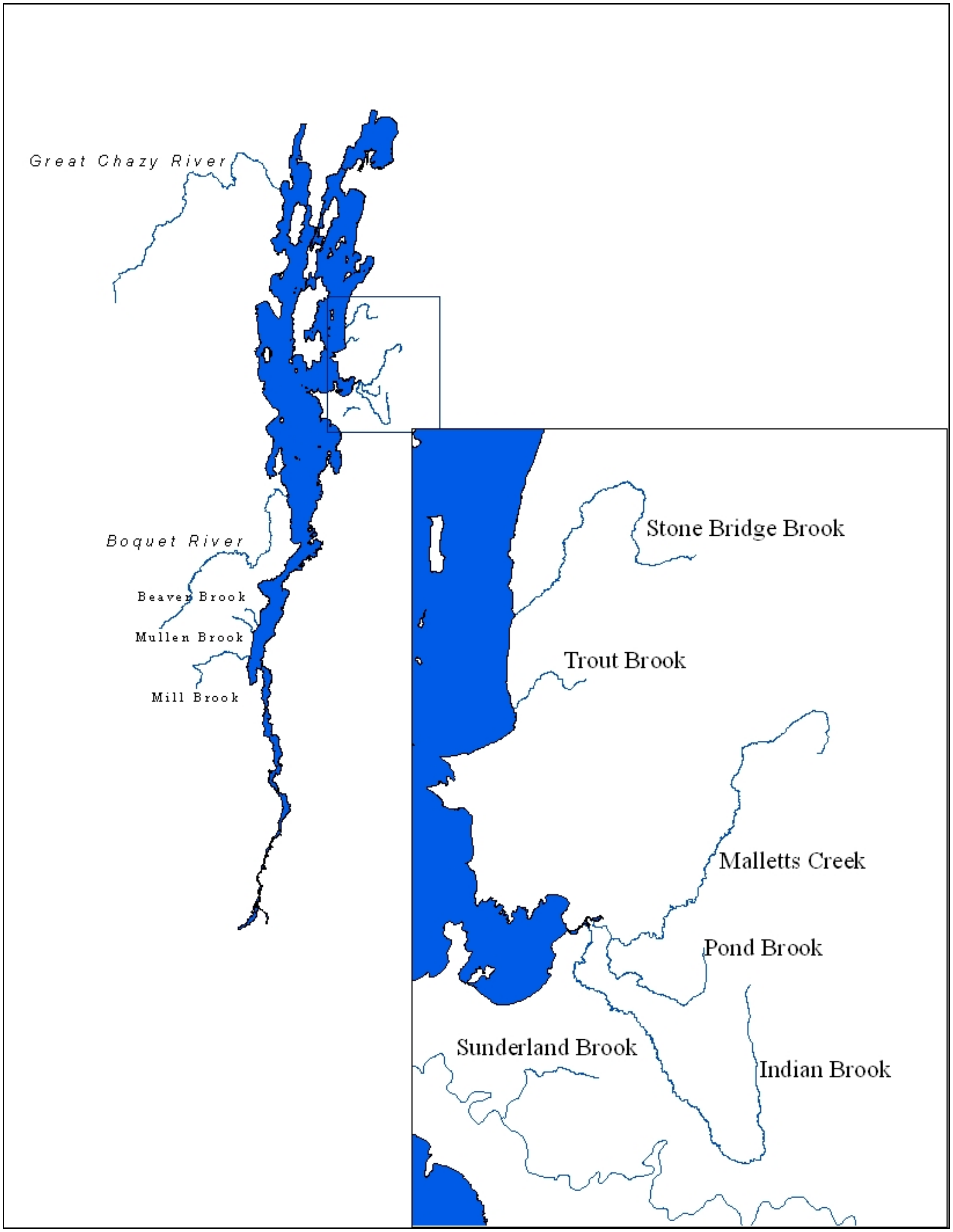


Figure 1. Location of trapping sites operated during the spring of 2007 to capture migrating adult sea lamprey.

1.2 Detection of spawning runs

Removal of the Boquet River dam in Willsboro, NY is under consideration. Removal of this dam may allow sea lamprey to access a new reach of the river. Two traps were set in the Boquet River fishway in the town of Willsboro, NY to determine if sea lamprey are able to negotiate the falls immediately downstream of the dam. No sea lamprey were captured.

Lamprey pots were deployed in two other New York streams, Mill Brook and Mullen Brook to assess the relative abundance of migratory sea lamprey. These streams are small, but flashy because they have small drainage areas. Portable assessment traps have been installed in these streams in the past and have proven very difficult to maintain. Data obtained from lamprey pots is summarized in table 2.

Table 2. Number of lamprey captured using pots .

Stream	# lamprey captured	# pot nights	CPPN
Mill Brook	11	226	0.05
Mullen Brook	11	92	0.12

1.3 Providing lampreys to researchers

Sea lamprey that are trapped are either killed on site, or more frequently, given to researchers. In 2007, the USFWS coordinated with Dr. Ellen Marsden of the University of Vermont and Dr. Donna Parish of the USGS Cooperative Fish and Wildlife Research Unit at the University of Vermont to provide them with sea lampreys necessary for research into the use of pheromones for sea lamprey control.

2.0 Larval Assessment

Larval populations are assessed by determining distribution throughout the basin and within streams and by estimating population sizes based on densities among quantified habitats. These assessments are a tool used for selecting where and how to control sea lamprey in the Lake Champlain Basin. Areas of known colonization are assessed quantitatively following the Great Lakes Fishery Commission’s (GLFC) Quantitative Assessment Sampling (QAS) protocol. Streams being monitored for signs of new colonization are sampled using a detection protocol designed to locate larvae in areas they are most probable to inhabit. Larval assessment is also done to verify the effectiveness of our adult trapping program. Surveys are done below our trapping sites to determine how many (if any) larvae were produced by spawning sea lamprey despite our trapping efforts. If larval populations are being suppressed to acceptable levels, trapping is continued. If larval populations are unacceptably high, alternative methods to trapping are considered.

2.1 Stream quantitative assessment sampling (QAS)

Larval sea lamprey populations were surveyed in five tributaries during the summer of 2007 in preparation for lampricide treatments scheduled for the fall of 2008 (Table 3). The Winooski River, Missisquoi River, Great Chazy River, and Mt. Hope Brook are currently scheduled for treatment in the fall of 2008. Mill Brook in the town of Port Henry, NY is not scheduled for a treatment at this time; however the cooperative is working toward obtaining permits to allow treatment in the fall of 2008. These surveys are needed to confirm the need for treatment and to help determine the contribution of a stream to the Lake Champlain lamprey population. A QAS survey was also conducted on Otter Creek where sea lamprey larvae were first discovered in 2003, however no sea lamprey larvae were found during the 2007 survey.

Table 3. Results of quantitative assessment surveys conducted in 2007.

Stream	Population Estimate-Ammocoetes	Population Estimate-Transformers
Great Chazy River- Reach 1	26,775	0
Great Chazy River- Reach 2	24,028	0
Great Chazy River- Reach 3	357,325	0
Mt. Hope Brook	15,894	0
Mill Brook [a]	12,683	785
Winooski River- Reach 1	174,462	0
Winooski River- Reach 2	1,532	0
Missisquoi River	63,173	0
Otter Creek	0	0
Malletts Creek	1,237	618

[a] Mill Brook survey was not done according to standard sea lamprey assessment protocols due to the short reach of stream surveyed. Crews surveyed all accessible habitat in the stream and densities were expanded across larval habitat which was surveyed at six transects.

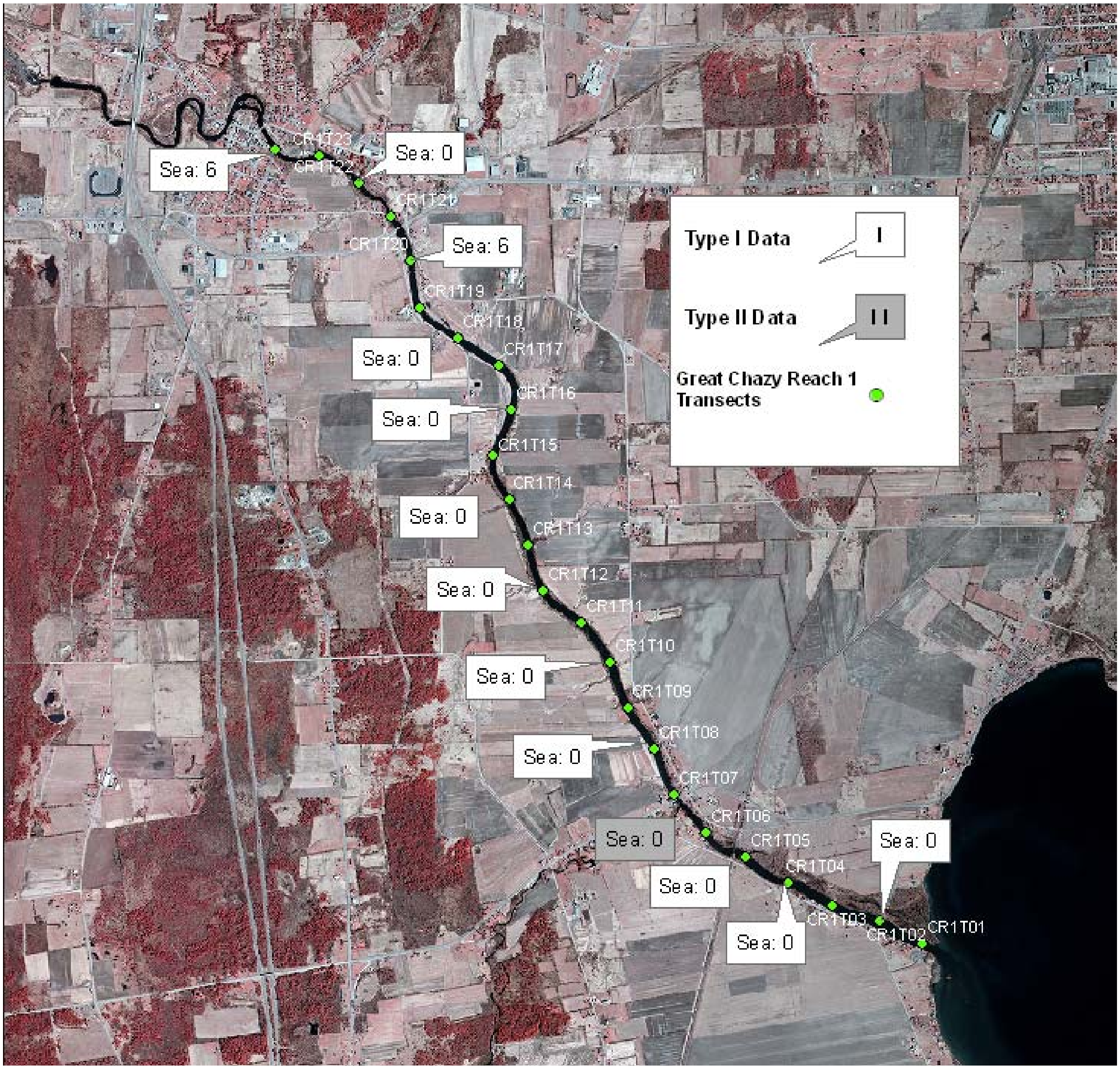


Figure 2. Great Chazy River, Reach 1, sampling locations and number of sea lamprey collected in Type I and Type II habitats.

Reach 1 of the Great Chazy River extends from its mouth to the first bridge in the village of Champlain, NY. No larvae were found downstream of transect 19. Type 2 habitat was primarily limited to the deeper mid-channel areas and was only able to be sampled at transect 6.

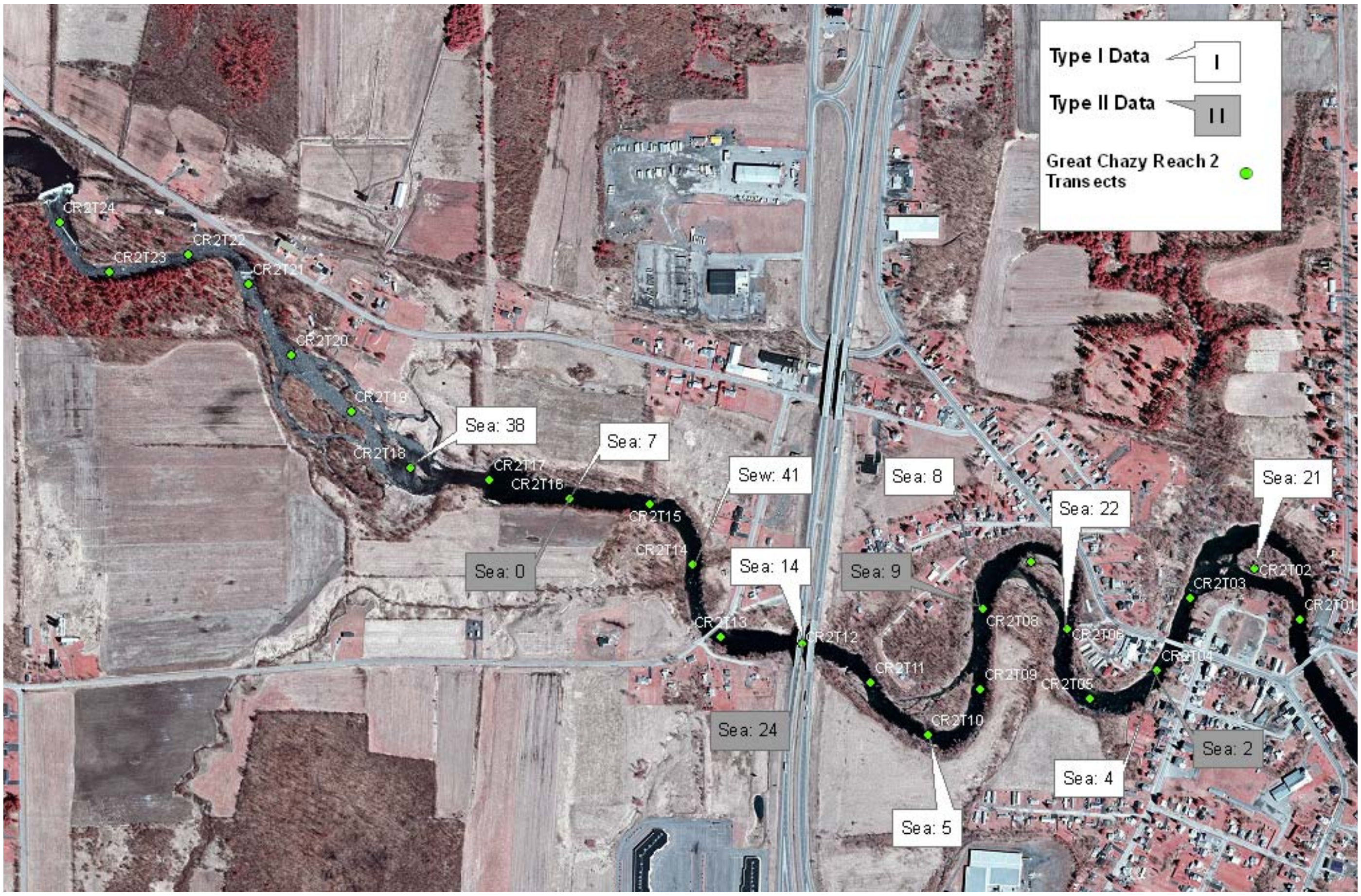


Figure 3. Great Chazy River, Reach 2, sampling locations and number of sea lamprey collected in Type I and Type II habitats.

Reach 2 of the Great Chazy River extends from the first bridge in the village of Champlain, NY upstream to the Frog Farm Dam. Limited larval habitat above transect 18 precluded electrofishing sampling.

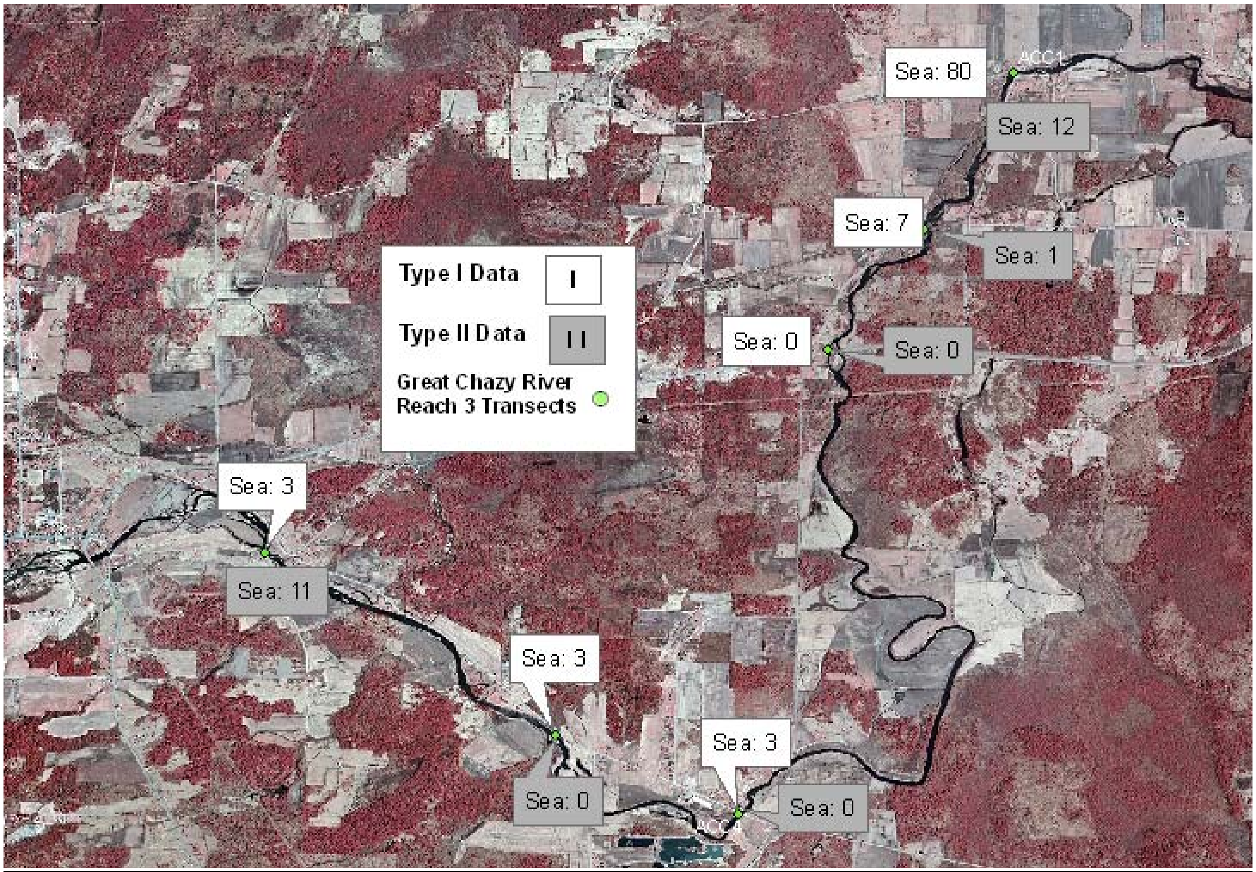


Figure 4. Great Chazy River, Reach 3, sampling locations and number of sea lamprey collected in Type I and Type II habitats.

Reach 3 of the Great Chazy River extends from the Frog Farm Dam upstream to the dam in the town of Mooers, NY which is the upper extent of sea lamprey infestation. Presence absence surveys confirmed that there are no sea lamprey larvae upstream ofg the dam in Mooers. Because of the length and relative inaccessibility of this reach, habitat transects and electrofishing samples were located at 6 access sites.

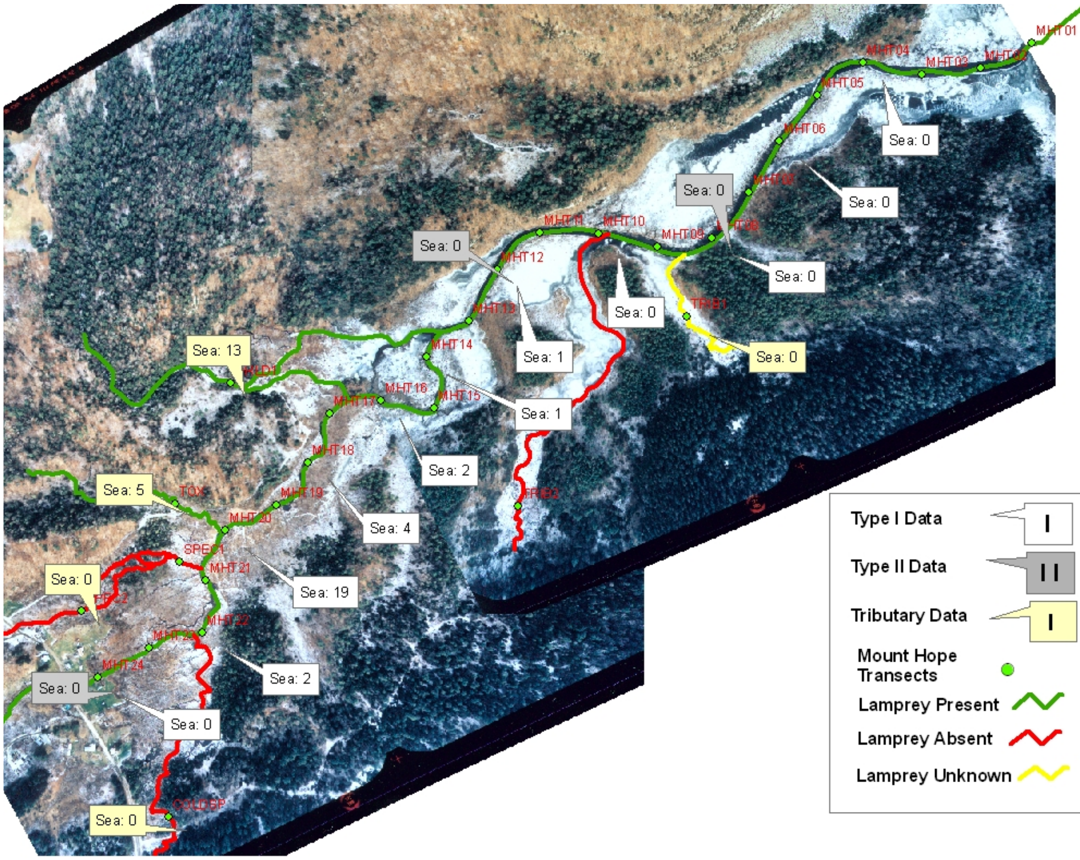


Figure 5. Mount Hope Brook sampling locations and number of sea lamprey collected in Type I and Type II habitats.

The reach sampled in Mount Hope Brook was limited to extend from the mouth up to the bridge in the hamlet of South Bay. Previous surveys indicated that above the bridge was primarily spawning habitat and cobble/boulder substrates, containing few if any larvae. Several tributaries to Mount Hope Brook were also sampled to determine the need for inclusion into treatment planning. Surveys in the lowermost unnamed tributary (TRIB 1 in Figure 5), Cold Spring Brook, and Spectacle Brook did not locate any sea lamprey larvae. Surveys in Greenland Brook and an unnamed tributary near where the toxicity test trailer has historically been located for lampricide treatments (TOX in Figure 5) were positive for sea lamprey larvae.

Figure 6. Winooski River Reach 1 sampling locations and numbers of sea lamprey collected in Type I and Type II habitats.

Reach 1 of the Winooski River extends form the mouth upstream to the large island downstream of the railroad bridge in the town of Winooski. Sea lamprey larvae were found as far downstream as the Rt 127 bridge.

Figure 7. Winooski River Reach 2 sampling locations and numbers of sea lamprey collected in Type I and Type II habitats.

Reach 2 of the Winooski River extends from the island below the railroad bridge to the rapids just below the Salmon hole in the town of Winooski.

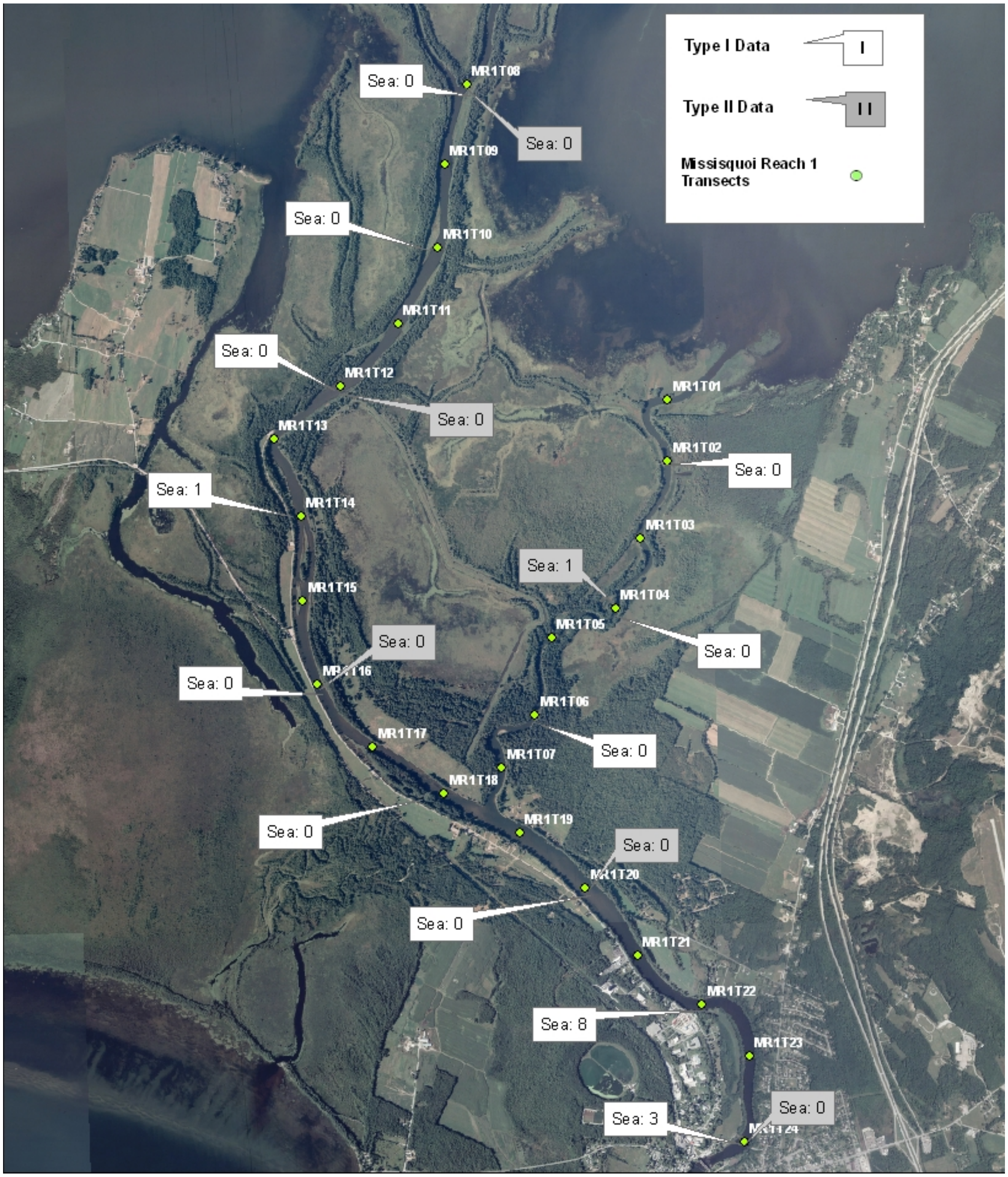


Figure 8. Missisquoi River, sampling locations and numbers of sea lamprey collected in Type I and Type II habitats.

The reach sampled on the Missisquoi River extended from the upstream tip of Shad Island upstream to the dam in the town of Swanton and included the Dead Creek distributary. As seen in previous surveys the downstream extent of the sea lamprey population appears to be in the vicinity of Mac's Bend.

2.2 Detection sampling

Annually the Service investigates "negative streams" where sea lamprey populations are not known to exist, but where there may be suitable habitat. The lake basin is divided into quadrants which are rotated annually so that all streams are surveyed on a four year cycle. Investigations consist of a site visit to determine if there is the potential for a sea lamprey population and electrofishing sampling if conditions are favorable. Many of these streams are seasonal in nature and dry at the time of site visits. If there is available habitat, electrofishing samples are taken to determine presence / absence of sea lamprey larvae. In 2007, presence absence surveys were conducted in the northern Vermont quadrant and several other streams of interest. Site visits were conducted on several tributaries of the Richelieu River in Quebec. No sea lamprey were collected during any negative stream surveys. Tables 4 and 5 contain the results of site visits and electrofishing surveys where they were conducted.

Table 4. List of Northern Vermont negative streams investigated in 2007. Also includes sampling above dam in Mooers, NY.

Date	Location	Habitat Type Sampled	Area Sampled (m^2)	Number of Larvae Collected	Notes
6/26/07	Rock River, Boat launch on Rt. 7	I	30	0	Suitable larval habitat. Large amount of submergent vegetation, most of the substrate covered in plant matter.
6/26/07	Saxe Brook, Ballard Rd crossing	I	3.3	0	Larval habitat very limited. Mostly type III, no spawning habitat.
6/26/07	Saxe Brook, St. Armond Rd crossing	I	15	0	Suitable larval habitat. Culvert under road is higher than stream by 0.5m, may act as an upstream barrier.
6/26/07	Carmen Brook, Rt. 7 crossing	I & II	28.5	0	Suitable larval habitat. Poor visibility downstream of Rt. 7.
6/26/07	Stevens Brook, Kellogg Rd crossing	N/A	N/A	N/A	No suitable larval or spawning habitat. Did not sample at this location. Small falls upstream, may act as barrier.
6/26/07	Stevens Brook, Newton Rd crossing	I	16.2	0	Suitable larval habitat. Large amount of silty sediment. Slow, consistent water flow. Brook flows through 2 dairy farms.
6/26/07	Jewett Brook, Dunsmore Rd crossing.	N/A	N/A	N/A	No suitable larval or spawning habitat. Stagnant backwater with duckweed. Did not sample at this location.
6/26/07	Jewett Brook, Newton Rd (Rt 38) crossing	N/A	N/A	N/A	No suitable larval or spawning habitat. Little to no water flow, very vegetated. Some type III habitat. Did not sample at this location.
7/5/07	Mill River, downstream of Georgia Shore bridge, below falls	I & II	27	0	Suitable larval habitat. More type II than type I. Appropriate water flow.
7/5/07	Allen Brook, Coon Hill Rd crossing	I	25	0	Plenty of suitable larval habitat. Appropriate water flow.

7/5/07	Niquette State Park, "Trout Brook" near bridge on Muhley Trail	I & II	27	0	Suitable larval habitat upstream and downstream of bridge. Suitable water flow.
7/5/07	Unnamed tributary to Mallets Bay off Rt 127 (Peppin's Garage)	I	16	0	Suitable larval habitat. Slightly turbid, slow moving water.
7/5/07	Unnamed tributary to Mallets Bay, Williams Rd crossing	I	30	0	Suitable larval habitat, mostly type II.
7/5/07	Munroe Brook, Bay Rd crossing	I	9.5	0	Limited larval habitat, mostly type III.
8/2/07	Munroe Brook, at Longmeadow crossing, entrance to housing development	I	2	0	Plenty of Type I, brook dries up downstream of road. Very low flow.
8/2/07	Holmes Creek, Above covered bridge at Lake Rd crossing	N/A	N/A	N/A	Mostly type III, stagnant pool cut off from lake by low water level. Unsuitable habitat, did not sample at this location.
8/2/07	Thorp Brook, East Thompson Point Road crossing	N/A	N/A	N/A	Unsuitable habitat, did not sample at this location. Stagnant pool, channel dry on upstream end of culvert.
8/2/07	Kimball Brook, Greenbush Rd crossing	N/A	N/A	N/A	Unsuitable habitat, stagnant pool, low water level. Did not sample at this location.
8/2/07	Little Otter Creek, below falls at Little Chicago Rd	I	30	0	Turbid water, only sampled along banks.
8/23/07	Great Chazy River, Reach 4. Up and downstream of Tappin Rd in Mooers	I	26.6	0	Very little type I, mostly bedrock.

The Richilieu tributaries listed in table 5 were scouted by land and evaluated for their potential as lamprey streams. The most likely candidate was the Lacolle River. This was the only tributary in Quebec that was electrofished and it yielded no lamprey. Based on habitat characteristics, proximity to the lake, and the absence of a population in the Lacolle River, we are satisfied that no sea lamprey populations would exist north of the Lacolle River.

Table 5. List of streams tributary to the Richeleiu River surveyed in 2007.

Name	**Bank**	**Coordinates**	**Description**
"Leech Creek"	West	45°00.226' N 73°21.842' W	In New York, Similar to Youngman Brook. Access by Lincoln Blvd. in Rouses Point or by boat at its mouth near Fort Blunder.
Ruiss Bisaillon	West	45°01.921'N 73°21.066'W	Approx 1 mile in length.
Boyce – Gervais/Patenaude	West	N/A	Lake level, no spawning. Bay – like.
Boyce – Gervais	West	N/A	Short drainage ditch.
Patenaude	West	45°01.829'N 73°22.269'W	Small. Spawning and larval habitat.
LaColle River	West	45°04.156'N 73°20.502'W	Larval and spawning. Large river, similar to Great Chazy.
Pir-Vir	West	45°05.469'N 73°19.088'W	Similar to Mallets, spawning and larval habitat.
Unnamed Ditch	West	45°05.663'N 73°18.895'W	North of Pir-Vir.
Gamache	West	45°06.242'N 73°18.354'W	Ditch.
Paquette	West		Intermittent farm ditch.
LeGrande Ruisseau (near mouth)	West	45°07.534'N 73°16.942'W	Lake effect, wide, deep, channel.
LeGrand Ruisseau (upstream)	West	45°07.778'N 73°19.417'W	Larval and spawning habitat. Similar to Stonebridge.
Marais	West		Intermittent.

Ruisseau Jackson	West	45°08.657'N 73°16.447'W	Similar to Morpion.
Bleury	West		Trickle.
Haut des Terres	West		Ditch.
Cloutier – Perrier	West		Ditch.
Savage	West	45°10.770'N 73°16.311'W	Ditch.
Milieu et du Trait Carre	West		Ditch.
Bernier	West	45°11.839'N 73°16.024'W	Larval and spawning habitat.
Barbotte	East	45°16.304'N 73°13.801'W	Similar to Mallets. Deep channel, must access upstream.
Vingt Decharge	East	45°12.490'N 73°13.784'W	Larval and spawning habitat. Similar to Stonebridge.
Sud River	East	45°08.181'N 73°10.593'W	Deep and muddy. Like Poultney. Larval habitat, no spawning habitat.

2.3 Verification of trapping program

A QAS survey was conducted on Malletts Creek to determine the effectiveness of our ongoing spring trapping program. Traps have been used annually since 2001 to block spawning runs of sea lamprey in an effort to limit their reproduction. Table 6 lists the population estimates of sea lamprey ammocoetes and transformers and *Ichthyomyzon spp.* (most likely northern brook lamprey).

Table 6. Population estimates of sea lamprey ammocoetes and transformers and *Ichthyomyzon spp.* larvae (most likely northern brook lamprey) for surveys conducted in Malletts Creek 2001-2007.

	Sea Lamprey		*Ichthyomyzon*
Year	Ammocoetes	Transformers	All larvae
2001	21,223	2,996	21,120
2005	4,100	342	2,798
2007	1,237	618	2,956

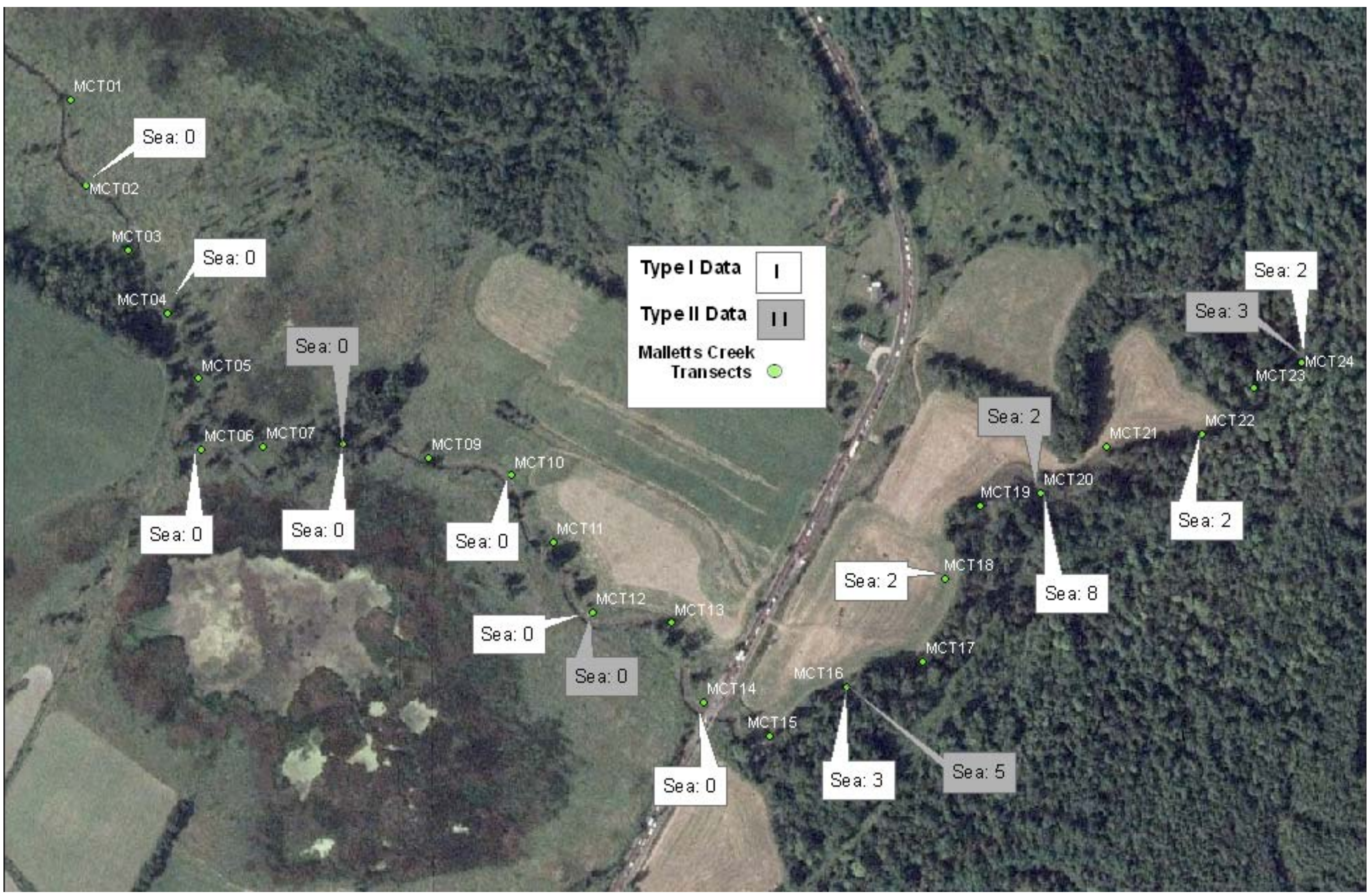


Figure 9. Malletts Creek sampling locations and number of sea lamprey collected in Type I and Type II habitats.

The reach sampled on Malletts Creek extends from a point approximately 1000 meters downstream of the Rt. 7 bridge upstream to the falls which act as a barrier to lamprey migration.

2.4 Post-treatment larval assessment

Post treatment surveys from the fall of 2006 indicated that the initial treatment of the South Fork in September 2006 was not successful. A spring treatment was conducted in late May 2007 to kill remaining larvae. Surveys were conducted in the South Fork of the Ausable River to assess the spring TFM treatment of that river segment.

Backpack electrofishing (Figure 10) and deep-water electrofishing samples (Figure 11) were taken in June of 2007 to evaluate treatment success. Pre-treatment backpack data for the south fork of the Ausable River are from surveys conducted in the fall of 2006 following the full river lampricide treatment. All transects were sampled during the spring 2007 post treatment survey to obtain better data on the effectiveness of the treatment. Unlike the backpack electrofishing surveys, the pre-treatment deep-water data were collected during the summer of 2006 prior to the initial full river treatment.

Figure 10. Ausable River south fork backpack electrofishing sampling locations and numbers of sea lamprey captured prior to and following a spring lampricide treatment in 2007.

Figure 11. Ausable River South fork deep-water electrofishing sample locations and number of lamprey captured.

Post-treatment electrofishing surveys were conducted on Beaver Brook (Figure 12) and the Boquet River (Figure 13) following fall lampricide treatments in 2007. The Poultney River was not surveyed following its lampricide treatment in 2007 due to the late date at which the treatment was conducted. Poultney River post treatment surveys will be conducted early in the summer of 2008.

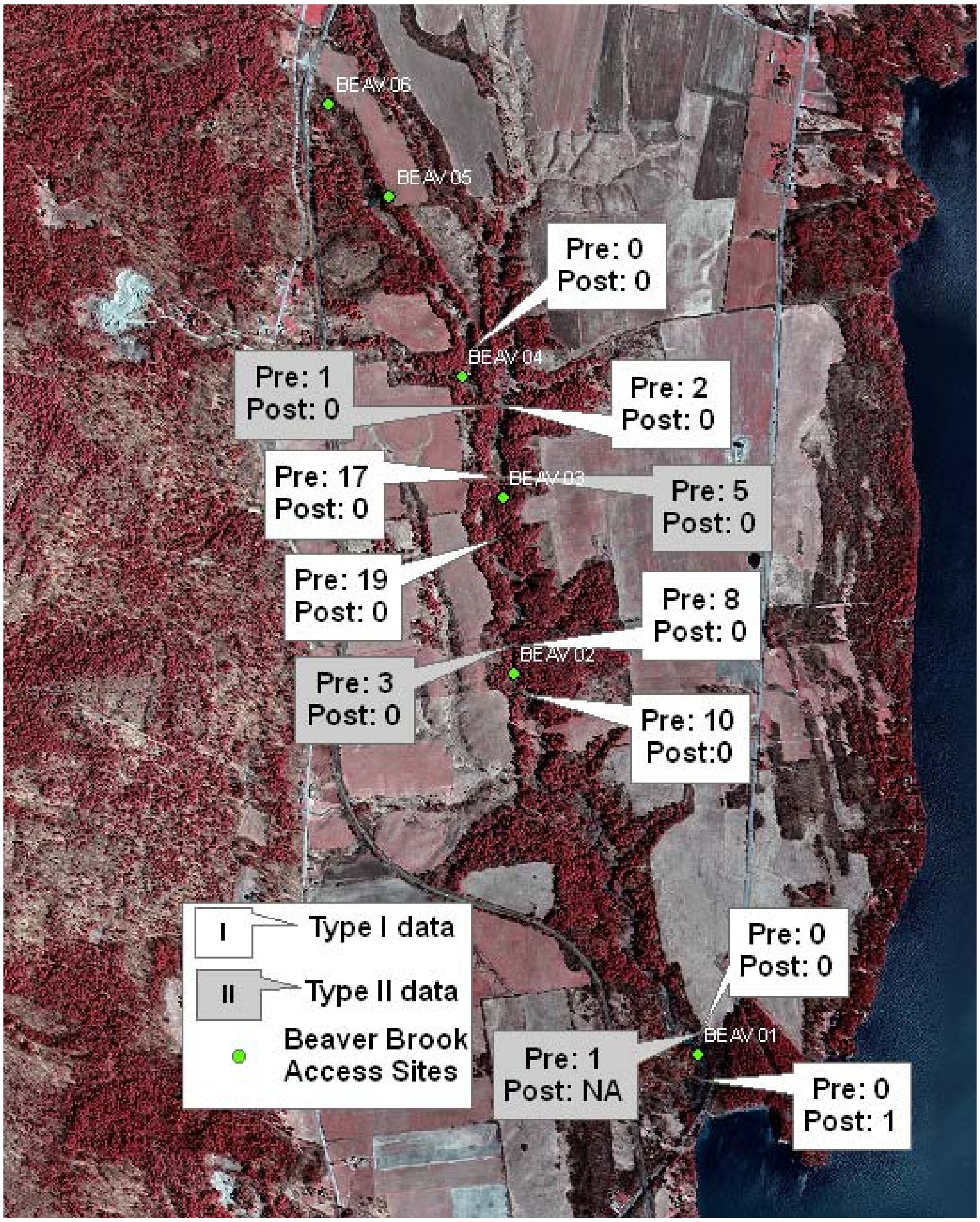


Figure 12. Beaver Brook access sites and numbers of sea lamprey captured prior to and following the 2007 fall lampricide treatment.

One sea lamprey transformer was collected at the lowermost access site on Beaver Brook indicating that the duration of lethal concentration of lampricide may not have been adequate to kill sea lamprey larvae. No sea lamprey larvae were found upstream of access site 4 during pretreatment surveys. As such, the application point for the lampricide treatment was located just upstream of this site, and post treatment surveys were limited to the lower 4 access sites.

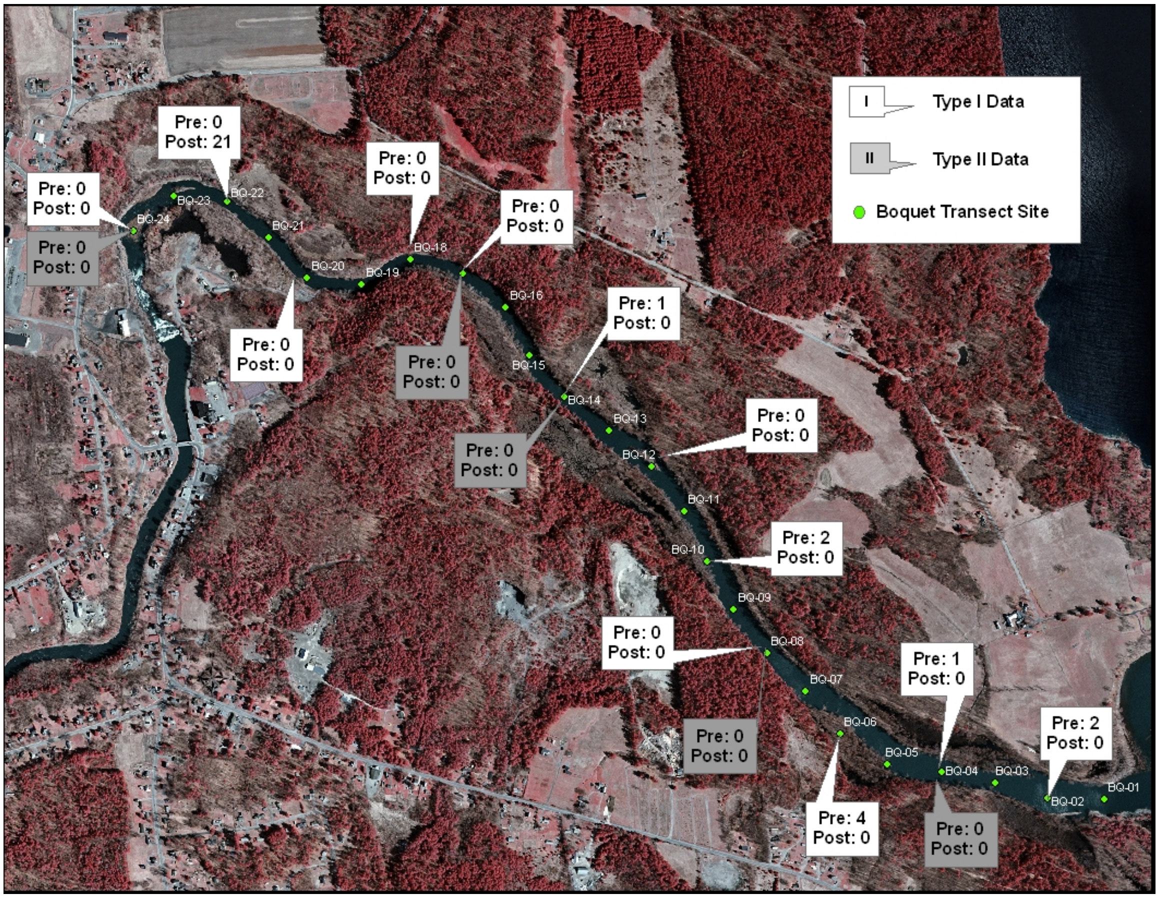


Figure 13. Boquet River sampling locations and numbers of sea lamprey captured prior to and following the 2007 fall lampricide treatment.

The reach sampled on the Boquet River extends form the mouth upstream to the dam in the town of Willsboro, NY. During post-treatment surveys, 21 sea lamprey larvae were collected from a small pool where fresh water seeped from the bank near transect 22. All other sampling locations were negative for sea lamprey larvae following the treatment indicating that the treatment was effective.

3.0 Larval Assessment – Deltas and Deepwater

Deepwater assessment is another critical piece of our larval sampling program. Larval populations are known to exist on the deltas of up to nine NY tributaries and possibly some in VT. Assessing the presence and abundance of these deepwater populations guides our decisions of where to control these deepwater populations in the face of a limited supply of Bayluscide.

During the spring of 2007, the USFWS modified the approach to sampling delta populations of larval sea lamprey. In the past, deltas were divided into grids based on UTM coordinates. Deepwater electrofishing samples were collected at the intersection of grids. Habitat was defined as the area in the grids. This year the decision was made to adopt the GLFC Deep Water Quantitative Assessment Sampling Technique (DQAS) to assess lentic larval populations. Under the new system, the delta is predefined by analyzing bathymetry data with a GIS program. Once the delta has been defined, the sampling effort can be systematically distributed across the delta using GIS software. A new GPS chartplotting system installed on the deepwater sampling boat was then used to guide the boat to sampling locations. This method allows for delta habitat to be measured and a density of larvae to be calculated from electrofishing samples. The density along with habitat data can be used to calculate a population estimate in a similar fashion to our stream QAS surveys.

3.1 Deep-water quantitative assessment sampling (DQAS)

Larval sea lamprey populations were assessed on two river deltas during the summer of 2007 in preparation for Bayluscide treatments scheduled for the fall of 2008 (Table 7). These surveys are needed to confirm the need for treatment and to delineate spatial population distributions to make treatments more efficient. This year, for the first time, a DQAS method used on the deltas will allow for the delta population estimates to be compared to stream estimates to evaluate relative contributions to the Lake Champlain lamprey population.

All of the deltas surveyed in 2007 were in the New York waters of Lake Champlain. The deltas surveyed were: Saranac River (Figure 14) and Boquet River (Figure 15).

Table 7. Results of quantitative assessment sampling surveys conducted during the summer of 2007.

Delta	Population estimate-ammocoetes
Saranac River	258,074
Boquet River	6,714

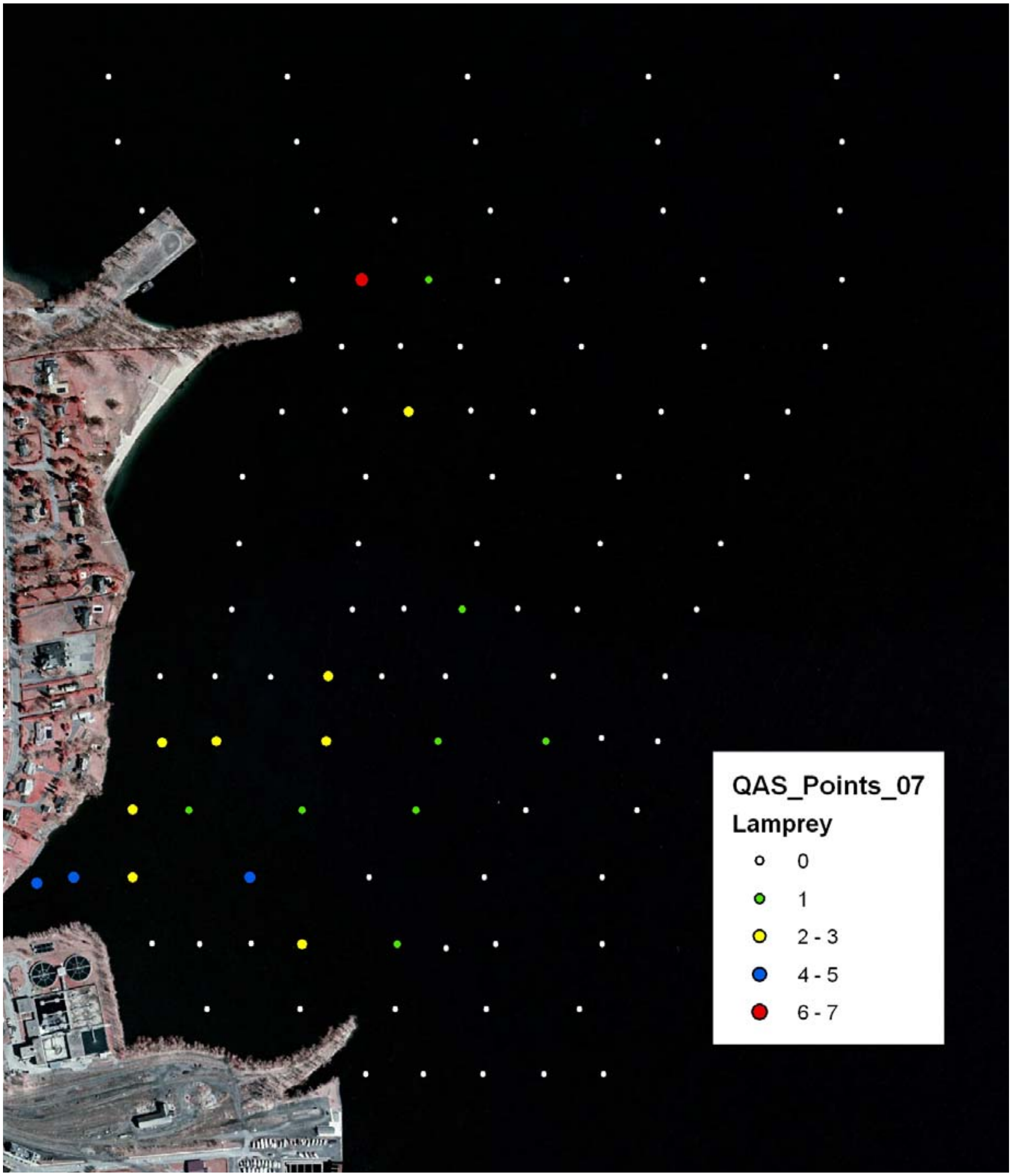


Figure 14. Saranac River deep-water electrofishing sample locations and number of lamprey captured during 2007.

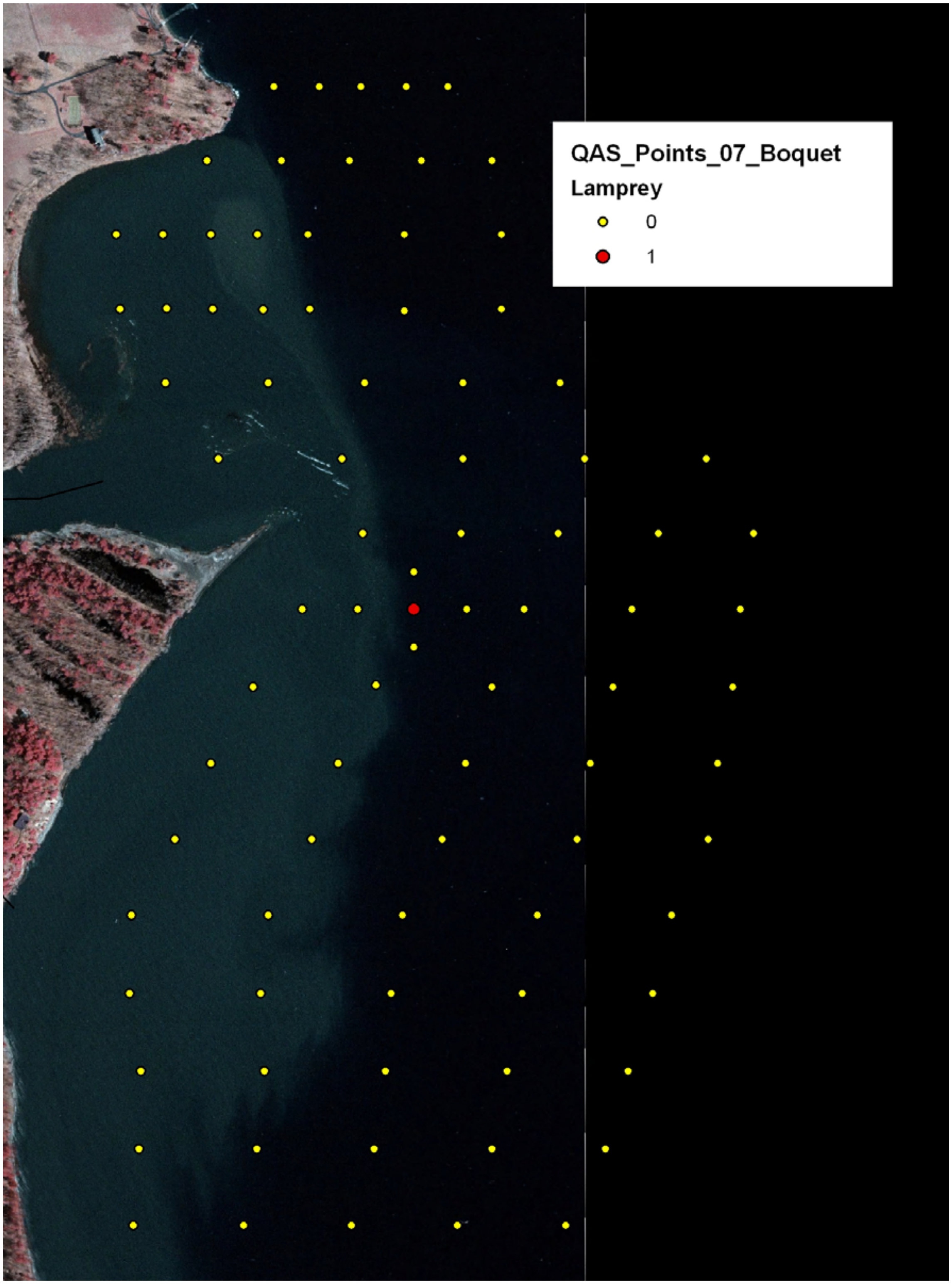


Figure 15. Boquet River deep-water electrofishing sample locations and number of lamprey captured during 2007.

3.2 Additional Deep-water Larval Sampling

A partial DQAS survey was conducted on Putnam Creek delta to determine if a population was present (Figure 16). No lamprey were collected on the Putnam Creek delta in 56 samples.

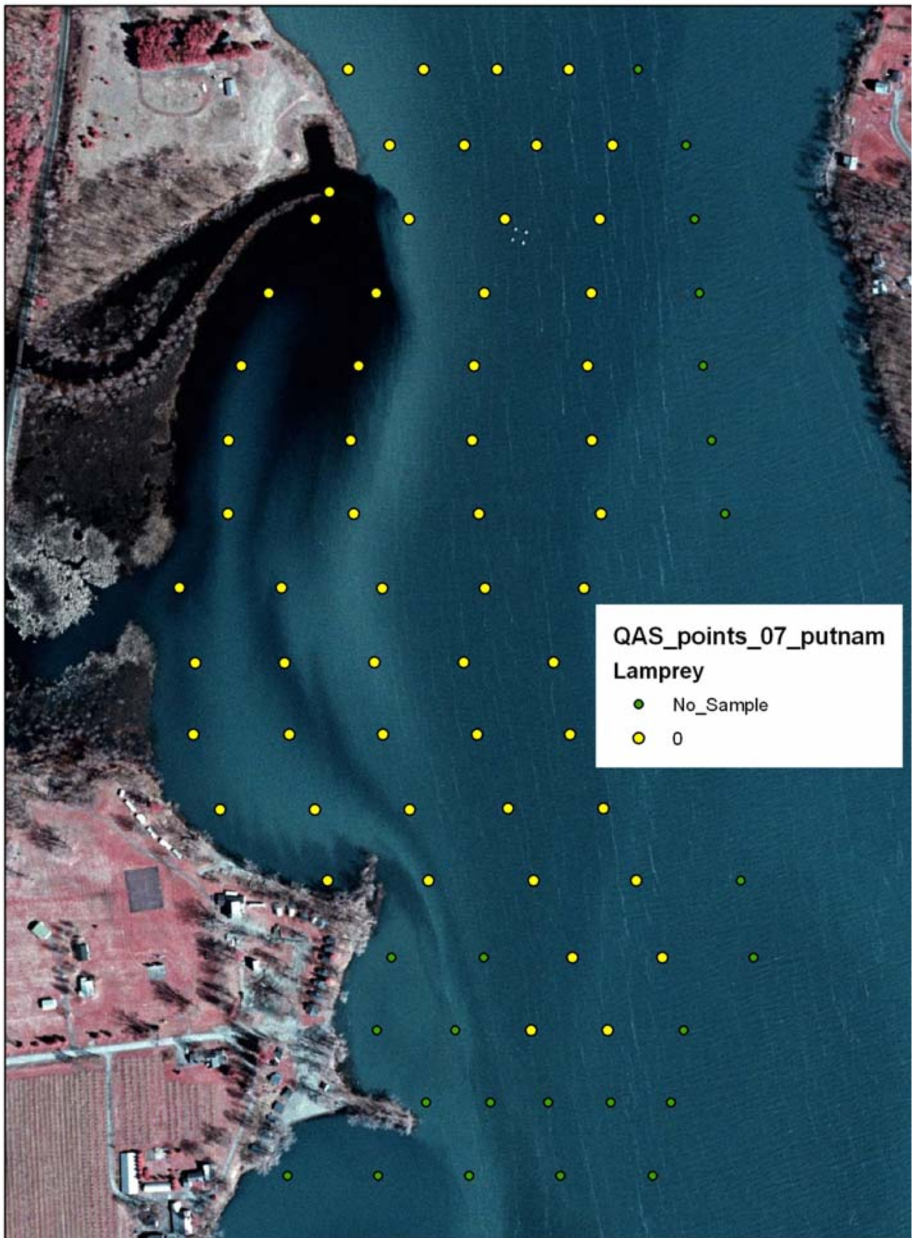


Figure 16. Putnam Creek deep-water electrofishing sample locations and number of lamprey captured during 2007.

Deep-water sampling on the Mill Brook delta was initiated in 2006. Sampling conducted in 2006 indicated that the population did not extend to the south beyond the breakwall on the south side of the mouth. Samples collected in 2007 (Figure 17) confirm results from 2006 that identify the existence of a delta population. Data do not indicate a large population, but a population certainly exists.

Figure 17. Mill Brook deep-water electrofishing sample locations and number of lamprey captured during 2007.

4.0 Ausable River Delta Treatment

On September 4, the day prior to treatment, treatment advisory buoys were placed on the perimeter of the treatment area. Individual treatment zones and collection plots within the zones were marked with corner buoys using GPS coordinates (Figure 18). At 1600 hours a pre-treatment briefing occurred to familiarize all staff involved with the treatment plan. This was the first Bayluscide treatment that was conducted without the aid of guidance buoys. An advanced GPS/Chart-plotting unit was purchased and installed on one of the application boats to guide treatments. Pre-determined treatment routes were created based on analysis of population surveys using GIS software and transferred to the chart-plotter.

Application boats and ammocoete collection boats motored out onto the delta at approximately 0630 hours on Wednesday 5 September. Calibration of application boat velocity was conducted by feeding measured amounts of Bayluscide through the spreaders over a know area. Calibration transects indicated target treatment velocity to be ~9.5 mph as measured by GPS. Treatment of Zone 1 was initiated at approximately 0700 hours. Target speeds were maintained whenever possible. Lake level had declined approximately 1.2 feet as measured at the Rouses Point USGS gauging station between treatment planning and the treatment date. This resulted in some untreatable areas near sandbars in treatment zones. Treatment was not possible in areas were boats were unable to navigate at target speed (Figure 18). The weather on treatment day was nearly perfect, sunny with a light Northeasterly breeze. Treatment proceeded all day until Zone 4 was completed at approximately 1630 hours. In the future backpack blowers and small boats may prove useful in accessing these areas to ensure all infested areas are treated.

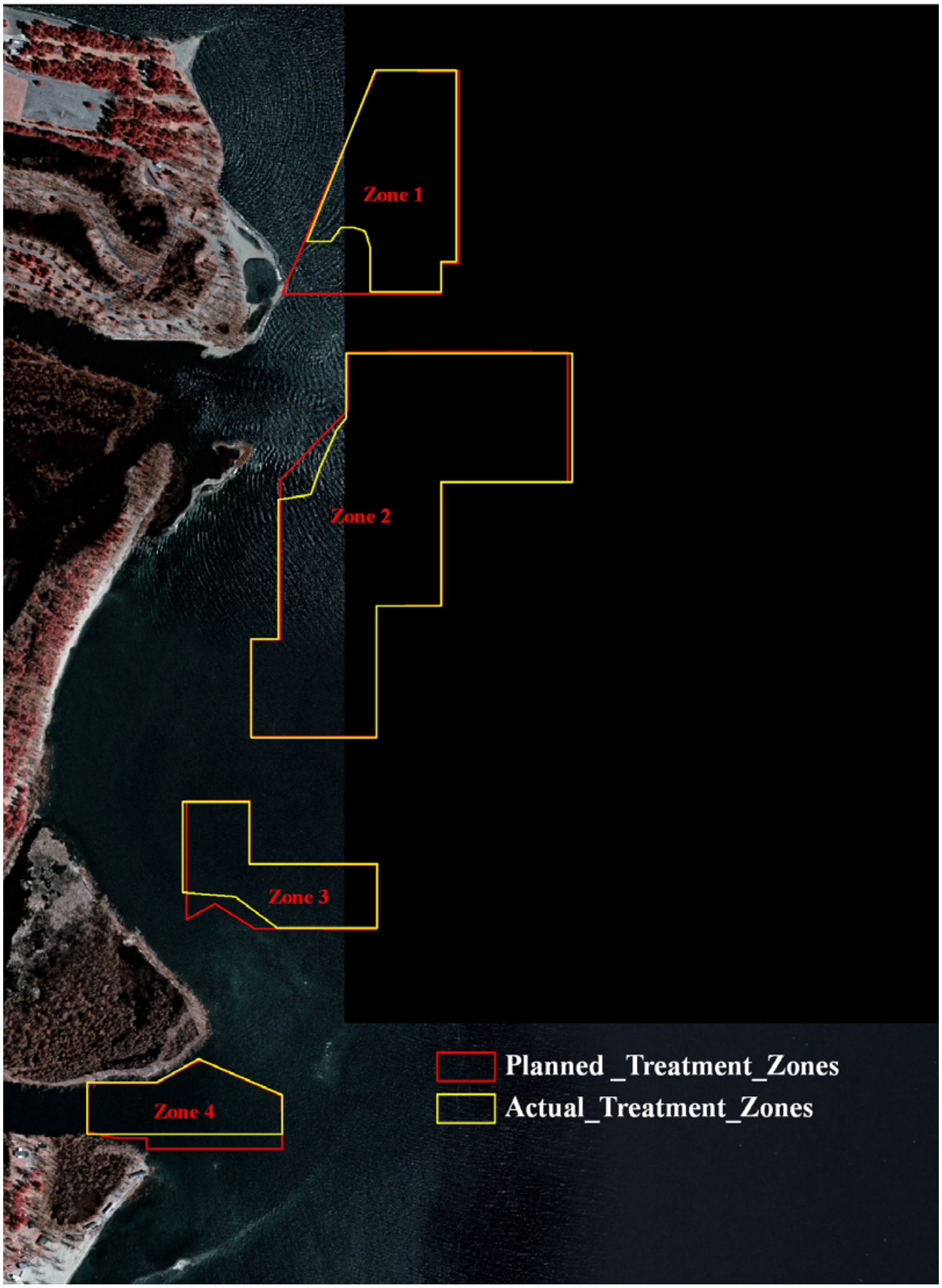


Figure 18. Ausable River delta treatment area.

4.1 Ammocoete Collections

Ammocoete collections occurred on 8 plots located throughout the 4 treatment Zones (Figure 19) according to the GLFC SOP for DQAS sampling with granular bayluscide. Ammocoete collection allowed calculation of lamprey density and estimation of the total number of lamprey killed during treatment (Table 8). Zone 1 collections showed an ammocoete density of 0.025 ammocoetes/m², Zone 2- 2.9 ammocoetes/m², Zone 3- 0.46 ammocoetes/m², and Zone 4- 1.46 ammocoetes/m². Gull numbers and feeding activity appeared consistent with ammocoete collection numbers.

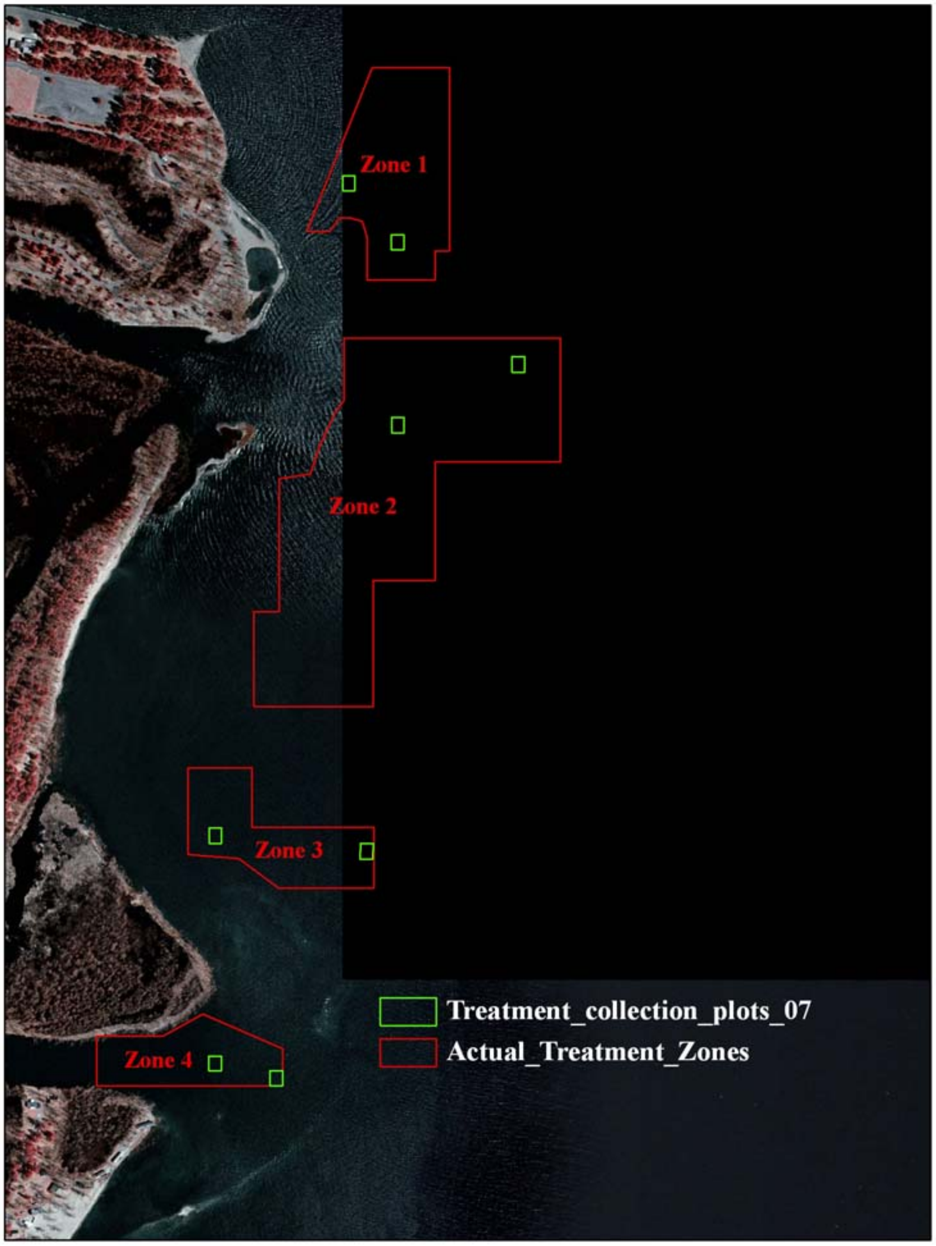


Figure 19. Zones targeted for Bayluscide treatment and larval collection areas.

Table 8. Sea lamprey density and estimated population for each treatment zone on the Ausable River delta calculated according to the Great Lakes protocol for estimating deepwater populations using granular Bayluscide.

	Ammocoetes		Transformers	
	Density	Zone estimate	Density	Zone estimate
Zone 1	0.025	1,764	0	0
Zone 2	2.9	479,858	0.025	4,137
Zone 3	0.4625	17,494	0	0
Zone 4	1.4625	47,198	0.8	25,818
Total for Treatment Area		546,314		29,955
Estimated total kill			576,269	

4.2 Non-Target Observations

Ammocoete collection boats recorded non-target mortality when encountered. A shoreline walk was also conducted after treatment on the evening of September 5th. See table 9 for summary.

Table 9. Non-target organisms collected or noted during and following treatment of the Ausable River delta.

Species	Number Dead	Observer	Location
yellow perch (*Perca flavescens*)	1	collection boat	treatment Zone 3
tessellated darter (*Etheostoma olmstedi*)	7	collection boat	treatment Zone 4
slimy sculpin *(Cottus cognatus)*	1	collection boat	treatment Zone 4
unidentified fish (*cyprinidae spp*.)	6	collection boat	treatment Zone 2
yellow perch*(Perca flavescens)*	1	application boat	treatment Zone 2
slimy sculpin *(Cottus cognatus)*	1	shore walk	between North and South mouth
tessellated darter (*Etheostoma olmstedi*)	1	shore walk	between North and South mouth
unidentified fish (*cyprinidae spp*.)	56	shore walk	between North and South mouth
killifish *(Fundulus diaphanus)*	1	shore walk	between North and South mouth
unidentified fish	12	shore walk	between North and South mouth
unidentified fish *(escocidae spp.*)	1	shore walk	between North and South mouth
American brook lamprey *(Lampetra appendix)*	74	collection boat	treatment zone 2,3,4

4.3 Problems

No major problems occurred which stopped treatment for a prolonged period. The biggest problems appeared to be associated with operation the outboard motors in shallow sandy-bottom areas. The water cooling pump became plugged on one application boat, but was able to be flushed with assistance from the chemical ferry which was equipped with a hose. In the future the chemical ferry should carry a portable pressure washer to clean the spreaders thoroughly when treatment is complete each day.

5.0 Missisquoi River Geomorphic Assessment

During the summer of 2007 the Service, with the help of the VTDEC's River Management Program, collected and provided geomorphic profile and elevation data to Applied Science Associates (ASA) to complete a TFM transport model for the Missisquoi River and Missisquoi Bay. The data from this model is needed to assist with determining water use advisory boundaries and planning of a lampricide treatment on the Missisquoi River scheduled for the fall of 2008.

6.0 Proposed Fieldwork for 2008

Assessment fieldwork in 2008 will be led by Wayne Bouffard and Steve Smith. These two field supervisors will share one temporary 8-month technician

6.1 Trapping

Malletts Creek
Pond Brook
Trout Brook
Stonebridge Brook
Great Chazy River
Beaver Brook
Willsboro Fishway
Potential to place pots in Winooski, Saranac, Ausable, Lewis, or Laplatte as a pilot project for a proposed adult assessment project

6.2 Stream Sampling

- Great Chazy River tributaries- to determine the need for and optimal locations of chemical blocks and identify any additional streams that may require individual full treatment. The results may force amending applications prior to the scheduled fall lampricide treatment.
- The LaPlatte River (QAS)- Sea Lamprey were discovered above the falls for the first time in 2007. These falls were thought to be the barrier to spawning migrations of sea lamprey. We plan on conducting a QAS upstream of the falls to estimate the extent and size of the sea lamprey population.
- Lamoille River (QAS)- in preparation for a 2009 lampricide treatment.
- Pike River and Morpion Stream (QAS)- to obtain baseline data for evaluation of the planned barrier and trap.
- Cyclical detection surveys will be conducted in streams in the southern Vermont quadrant of the Lake Champlain Basin plus Pond, Indian, and Sunderland brooks.

6.3 Delta sampling

- Ausable Delta- to assess Bayluscide treatment of 2007
- Saranac Delta- to define areas of infestation
- Mill Brook- to further define areas of infestation

6.4 Post treatment assessment

- Poultney River
- Hubbardton River
- Great Chazy and appropriate tributaries
- Winooski River
- Missisquoi River
- Mt. Hope Brook and appropriate tributaries

Appendix 1.

Comparison of natural features which limit or prevent lamprey migration in select Lake Champlain Streams

I. Background

The Boquet River dam in the village of Willsboro, NY is in eminent need of repair, replacement, or removal. Recent movement has tended toward removal which would restore approximately 214 kilometers of the Boquet River to its natural unimpeded state. The dam currently serves as an effective barrier to sea lamprey which spawn in the Boquet River below the dam where only a very limited amount of spawning habitat is present. Great concern surrounds the implications of dam removal and the potential for an expanded sea lamprey population: both in number and distance. Sea lamprey, while poor swimmers, are able to use their suction mouth to slowly inch their way over steep terrain and fast-flowing waters. The natural falls below the existing dam are a formidable challenge for sea lamprey at present. Though it is possible that lamprey could navigate up through and over the falls if the dam were no longer present, no clear data are available to use in making a decisive judgment. Trapping operations at the fishway located above the falls have been unproductive thus far during lamprey spawning season, but will be improved and repeated.

II. Purpose

To accompany the trapping data, an assessment of similar rivers in the Lake Champlain Basin with sea lamprey populations was proposed. Fall-line features in these rivers without barriers could be measured and compared to the Boquet River. Lamprey data do exist on the other three rivers surveyed and can be used to show what lamprey are capable of elsewhere and how that compares to the measured attributes of the Boquet River falls.

III. Methods

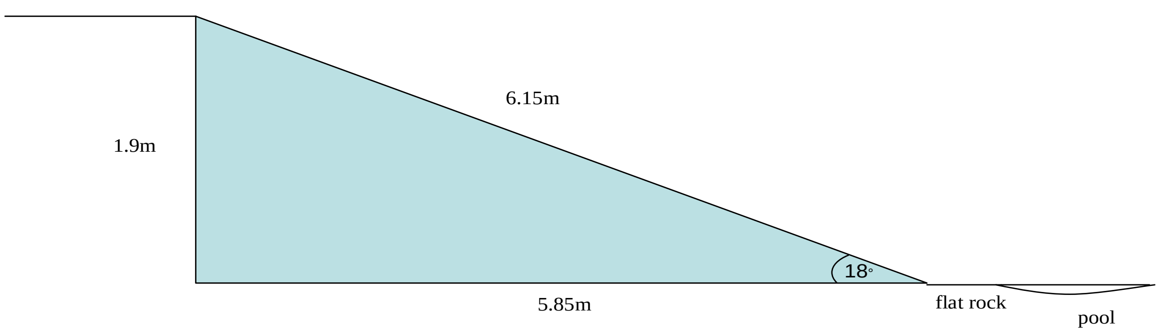
Height and horizontal distance of falls were measured in the field using a 15-ft. telescoping measuring pole, a sight/surface level, and a 50-m measuring tape. The telescoping measuring pole was held vertically at the base of the falls at the water surface. The base of the falls was defined as the interface of falling white water and the plunge pool. An observer viewed the height on the measuring pole through a sight/surface level at the top of the falls. The height from the top of the falls to the observer's standing eye level was subtracted from the measurement viewed on the pole to calculate actual falls height. When height calculation was limited by the length of the measuring pole, measurements were taken in smaller increments along the falls.
The horizontal distance of falls was measured using a 50 meter measuring tape. One end of the tape was held at the top of the falls, while the other end was held level atop the pole at the base of the falls. The maximum angles that occurred at each falls were estimated by multiple observers. A maximum angle of 90° was indicative of at least one vertical face that lamprey encounter while migrating.

All measurements were converted to the metric system. The slope distance from the top of the falls to the base was calculated using the Pythagorean Theorem. The horizontal distance, height, and slope distance measurements were diagrammed as a right triangle. The average angle of the slope was calculated using the arctangent function and the ratio of the two non-hypotenuse sides. The two non-hypotenuse sides included the height and horizontal distance of the falls.

IV. Field Measurements

The falls on Lewis Creek in North Ferrisburg were measured on 6 August 2007. According to the USGS gaging station, the stream discharge on that date was 14cfs.

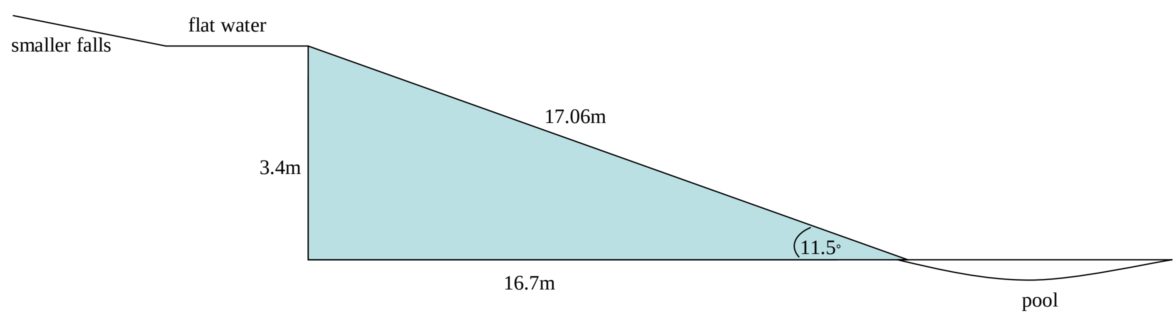
Lewis Creek Falls



The average angle of the falls on Lewis Creek is 18°, the height is 1.9m, and the horizontal distance is 5.85m. The slope distance was calculated to be 6.15m. The maximum angle is 90°. Water spills onto a flat lip of rock before falling into the pool. The eastern edge of the face of the falls is a more gradual slope than the main area of the falls which consists of steeper ledge drop-offs.

The falls on Little Ausable River were measured on 15 August 2007. According to the USGS gaging station, the stream discharge on that date was 8.1 cfs. Heading downstream on Lapham Mills Road from its junction with Fuller Street, ½ mile down is a large pool, accessible by a pull off. Downstream of that pool about 100 m is the falls that were measured [44° 35.87'N, 73° 29.07'W (WGS84)].

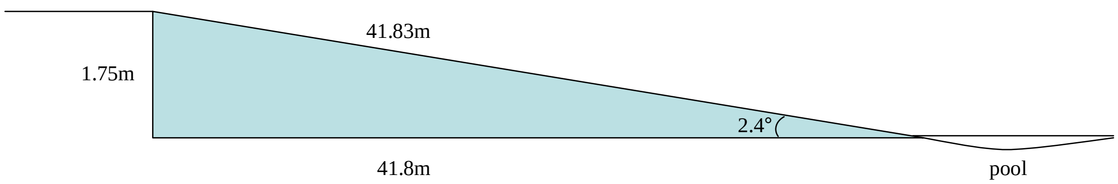
Little Ausable River



The average angle of the falls on Little Ausable River is 11.5°, the height is 3.4m, and the horizontal distance is 16.7m. The slope distance was calculated to be 17.06m. The maximum angle is 90°. The falls consist of a series of stair-step drop-offs. There is a pool below these falls and a smaller falls upstream of them that were not measured.

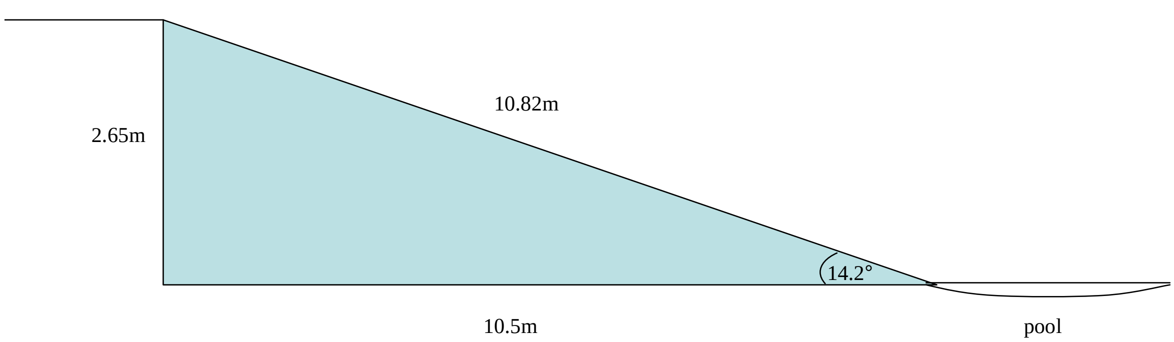
Two separate falls were measured on the Salmon River. The lower falls are upstream of the route 9 bridge and the upper falls are downstream of the route 22 bridge. Both falls were measured on 15 August 2007.

Salmon River Lower Falls



The average angle of the lower falls on Salmon River is 2.4°, the height is 1.75m, and the horizontal distance is 41.8m. The slope distance was calculated to be 41.83m. The maximum angle is 50°. The slope of the falls is very gradual (no vertical faces) and there is a pool directly below falls.

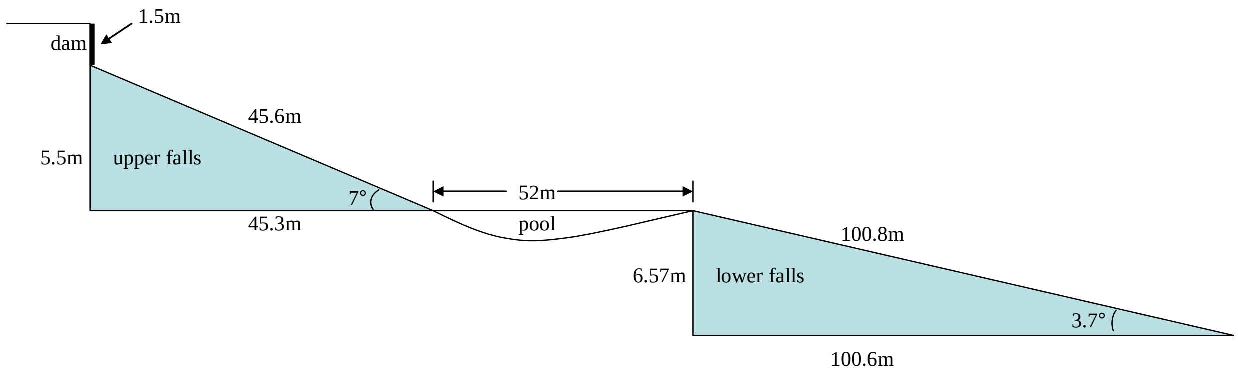
Salmon River Upper Falls



The average angle of the upper falls on Salmon River is 14.2°, the height is 2.65m, and the horizontal distance is 10.5m. The slope distance was calculated to be 10.82m. The maximum angle is 90°. The falls are a series of stair-step ledges, and there is a pool directly below.

The falls on Boquet River were measured on 18 September 2007. According to the USGS gaging station, the river discharge on that date was 53 cfs.

Boquet River



The falls on the Boquet River are below the dam in the town of Willsboro. The height of the wooden dam face is 1.5m. The falls consist of two distinct cascades separated by a pool that is 52m long. The average angle of the upper falls is 7°, the height is 5.5m, and the horizontal distance is 45.3m. The slope distance was calculated to be 45.6m. The average angle of the lower falls is 3.7°, the height is 6.57m, and the horizontal distance is 100.6m. The slope distance was calculated to be 100.8m. The maximum angle of the falls at both sites is 90°.

V. Conclusions

Sea lamprey have been seen to negotiate the different falls, measured above, with differing degrees of success. We can classify the ability of these falls to block lamprey migration into three categories. First, some falls serve as ***no*** barrier and have no measureable impact on sea lamprey migration. Second some falls serve as a ***partial*** barrier where sea lamprey have been documented to migrate above the falls, yet the larval population size and year class abundances above the barrier are inconsistent. This indicates that migration above the falls is either annually dependent on requisite stream discharges or substantially reduced by the falls acting as a barrier and physically preventing the migration of most lamprey. Third, some falls are a ***complete*** barrier and can be identified as such because no migrating adults or larval lamprey have ever been documented upstream of the site. Sea lamprey may be physically capable of migrating above the barrier, but for any number of reasons they do not. The reasons for their failure to migrate above these barriers may be physically obvious (e.g. the Ausable Chasm Falls) or not. Regardless of the reasons, these falls have been shown through repeated data collections to function as effective barriers to lamprey migration.

The Lewis Creek falls are a partial barrier. The population of sea lamprey above the falls is only a fraction of the population below, but the above-falls population size and age-class structure varies widely as measured in our quadrennial surveys.

The Little Ausable falls are a complete barrier. Although the falls do not have an obvious appearance of being a complete barrier, sea lamprey adults and larvae have never been found upstream of this site. This is despite adequate spawning and rearing habitat available above the falls. The combination of slope, length, and spring discharge apparently present an obstacle that is too great for lamprey to migrate past.

The lower Salmon falls are serve as no barrier. This is not surprising considering their relatively gentle slope. Sea lamprey have no problem passing these falls as evidenced by their numbers above the site.

We are unsure of the blocking effectiveness of the upper Salmon falls. Adults have been reported above the falls, however no larvae have been collected in that stretch despite repeated efforts and adequate spawning and rearing habitat. As with any partial barrier, the potential to migrate past the falls may depend on discharge at the time of migration.

Unfortunately the Boquet falls in Willsboro cannot be classified definitively as any one of the three types of barriers. The average slopes of the two sets of falls are less steep than all measured falls except the lower Salmon which act as no barrier. However, the Boquet falls are more than five times the length, just in the section below the pool, of the Little Ausable falls. Any lamprey migrating up the Boquet falls would have a long journey through rough rapids in the spring.

Based on our measurements, the physical attributes of the Boquet falls are most consistent with other partial barriers in Lake Champlain Basin. There is the potential for at least some lamprey to migrate past the falls if the dam were not in place. The migration potential would likely be affected by springtime discharges. There are two potential results of allowing a limited number of sea lamprey above the falls as illustrated by two cases in other Lake Champlain streams. 1) A partial barrier on Lewis Creek allows limited numbers of sea lamprey to surmount the falls described above. The ability of sea lamprey to negotiate the falls seems dependent on discharge during the migratory period. The larval population above the falls is a fraction of the population found below the falls and has annually inconsistent sizes and age-class structures. 2) An ineffective barrier on the Great Chazy River allows a limited number of sea lamprey upstream where they have access to approximately 23 kilometers of stream which contains adequate spawning and larval habitat. Surveys conducted in 2007 (see Section 2.1) show that the population above the dam far exceeds the population below the barrier.

Unfortunately, our attempts to capture sea lamprey at the fishway and our characterization of the falls are both inconclusive. There is a large disparity between potential larval population levels depending on which of the above scenarios results from dam removal. If scenario 1 results, the population expected to be found above the falls may be inconsequential because the Boquet River has a relatively small population of sea lamprey larvae (less than 4,000) below the dam. If scenario 2 results, there could be a large population of sea lamprey larvae above the falls. If a sizable new stretch of spawning and larval habitat was made available to migrating sea lamprey, the Boquet, nestled amongst many large producers of sea lamprey (Ausable River, Beaver Brook, Mill Brook, Putnam Creek) could become a large producer itself. The point being that perhaps the shortage of spawning habitat has prevented sea lamprey from realizing their reproductive potential in the Boquet River.

VI. Recommendations

- Additional trapping- We recommend continuing trapping operations at the Boquet Fishway. Trapping should also be done at other locations along the length of the falls (e.g. in the pool midway up the falls) to better determine the ability of sea lamprey to negotiate the falls.
- More detailed examination of falls profiles- Since our data on the slopes and lengths of falls are inconclusive, it may be worthwhile to revisit the falls we surveyed and obtain more detailed information on the slopes and heights of vertical faces (if present). More detailed information on the physical attributes of the falls may allow us to better judge the potential for sea lamprey to migrate past the falls on the Boquet River.
- Habitat reconnaissance- To better estimate the potential size and distribution of a sea lamprey population above the dam, we recommend a limited habitat survey to characterize the habitat that would be made accessible by removing the dam.
- Contingency plan- Prior to removing the dam the cooperative should develop a contingency plan for addressing an expanded sea lamprey population. Factors to consider should include the cost of a full river lampricide treatment and the feasibility of some type of augmentation to the falls which would ensure that it remains a barrier to sea lamprey passage.