LAKE CHAMPLAIN FISH AND WILDLIFE MANAGEMENT COOPERATIVE

FISHERIES TECHNICAL COMMITTEE
ANNUAL REPORT
2015 – Final

Executive Summary

Restoration efforts for native salmonids continued to be the primary focus of the Lake Champlain Fisheries Technical Committee in 2015. Landlocked Atlantic salmon (salmon) and lake trout were focal species accounting for 80% of 525,351 smolts stocked into the lake and tributaries. Highlights from native salmonid management include:

- Salmon runs remained high in the Winooski River and Boquet River with record returns in Hatchery Brook and Missisquoi River.
- The Willsboro Dam was removed in the Boquet River providing access to over 100 miles of salmon spawning and rearing habitat, however monitoring of passage at the dam removal site indicated the cascade is a major migration challenge for salmon.
- Successful natural reproduction of salmon was documented in the upper Winooski River.
- Evaluation of downstream passage for salmon smolts at three hydroelectric dams on the Winooski River indicated poor passage at Essex 19 dam and relatively good passage at the other two downstream dams.
- Deep water sampling for juvenile lake trout identified wild lake trout ranging in age from young of year to two year old. This is the first evidence of wild lake trout surviving to these older age classes since restoration programs were established in the 1970s.
- Winter and open water angler creel surveys were conducted in Lake Champlain to estimate fishing pressure, total catch and harvest of fish species, and other fishery characteristics.
- A workgroup of the Fisheries Technical Committee continued work on development of a plan to assess salmonid stocking rates.

Lampricide treatments were successfully completed on six tributaries in 2015 with a total of 37.3 miles of stream treated in New York and Vermont. Trapping efforts at 11 locations during the spring spawning run captured 997 adult sea lamprey. Sea lamprey wounding rates on salmon remain lower than the average rates observed during the 1990's experimental sea lamprey control program and lake trout wounding rates in 2015 decreased to 27 wounds per 100 fish, which is the lowest level for lake trout since long term sea lamprey control began in 2002. Sea lamprey wounding rates for sturgeon observed in the Lamole River and Winooski River were also significantly lower than those observed from 1998 to 2002.

Monitoring efforts included: forage fish assessment (program stopped in 2016); sampling stonecat, muskellunge, bass, walleye, and yellow perch populations. Research efforts included; using acoustic telemetry methods to monitor movement patterns of lake trout and sturgeon; characterizing impacts of thymine deficiency on salmonids, evaluation of broodstock sources for salmon and steelhead; and experimentation with fish rearing practices and stocking strategies to enhance salmon survival and adult returns to spawning tributaries.

Introduction

Management of the fishery resources of Lake Champlain is coordinated by the Lake Champlain Fisheries Technical Committee, which is a workgroup of the Lake Champlain Fish and Wildlife Management Cooperative. Members and advisors of the Fisheries Technical Committee includes staff from the Vermont Department of Fish and Wildlife (VTDFW), New York State Department of Environmental Conservation (NYSDEC), US Fish and Wildlife Service (USFWS), University of Vermont (UVM), Vermont Cooperative Fish and Wildlife Research Unit (VCFWRU), Quebec Ministry of Natural Resources, Lake Champlain Sea Grant, and other universities.

This report briefly summarizes fisheries management and research activities carried out on Lake Champlain during 2015. The names of Project Leaders are listed after section headings and their affiliation can be found on the Fisheries Technical Committee Membership list at the end of this document (Appendix 1). More details on specific projects can be obtained by contacting project leaders.

SALMONIDS

Stocking Summary (Shanahan)

Salmonid stockings in Lake Champlain during 2015 included approximately: 334,000 landlocked Atlantic salmon (smolt equivalents); 65,000 steelhead (smolt equivalents); 83,000 lake trout; and 44,000 brown trout (Table 1). The list includes landlocked Atlantic salmon and steelhead that were stocked in the tributaries to the lake. Also listed in Table 1 are the stocking targets for each species. Stocking numbers are presented as "stocking equivalents." Salmonids are stocked at varying sizes, from recently hatched fry that spend two years in the tributaries before migrating to the lake, to smolts and yearlings that are ready to begin life in the lake at the time of stocking. The numbers stocked are adjusted to stocking (smolt/yearling) equivalents to better represent the effective numbers stocked.

Table 1. Numbers (in stocking equivalents) of salmonids stocked in Lake Champlain during 2015, and stocking targets for the lake.

	Main Lake		Malletts Bay/Inland Sea		Total number stocked in 2015
Species	Target	2015	Target	2015	
Landlocked salmon	227,000	247,540	77,000	86,230	333,770
Lake trout	82,000	83,350	0	0	83,350
Steelhead	53,000	60,350	5,000	5,000	65,350
Brown trout	38,000	28,730	40,000	15,579	44,309
Total	400,000	419,970	112,000	106,809	525,351

Fish Passage (Staats, Shanahan, Ardren) –

Boquet River

The Willsboro (aka Saw Mill) Dam and the Willsboro Fishway on the Boquet River were both removed in late August and early September of 2015 prior to the normal operating time of the Fishway. Trap and quick set gill netting were used to monitor the salmon return to the Boquet River in the fall of 2015. Trapping was also conducted above the Willsboro cascade to monitor for evidence that salmon were able to pass above the cascade located at the former dam and fishway site. A total of 146 salmon were captured and tagged at sites below the dam removal site / cascade (Figure 1). The sex ratio was 96 male and 50 females with 97% of fish likely age 1+ lake year (based on age and length freq. data from Winooski River). Salmon migration increased after peak flows of 500 cfs on Oct. 1 (Figure 2). Salmon were captured below the cascade (Figure 1; sites 1, 5) and in resting pools within the cascade (Figure 1; sites 3, 4). No salmon were captured in the trap net above the cascade. (Figure 1; site 2). Based on combination of diagnostic fin clips and genetic tagging we determined that the origin of returning salmon was predominantly Boquet River smolt stocked (72%) and Boquet River fry stocked (22%) fish. Over 100 redds were identified below the cascade (Figure 1). No redds were observed at 7 sites surveyed above the cascade (Figure 1).

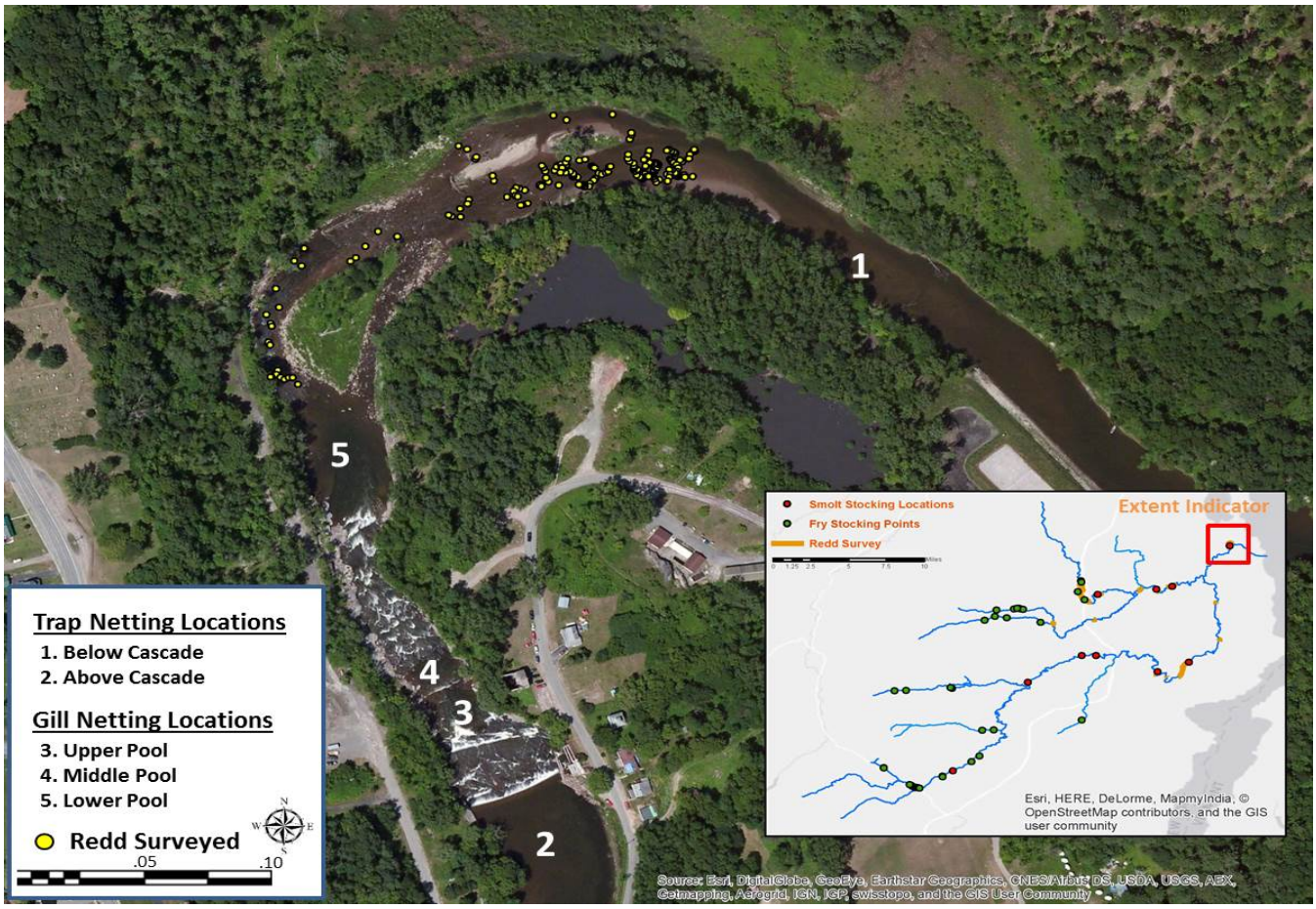


Figure 1. Adult trapping locations and observed salmon redds in the Boquet River in fall of 2015. Inset map details stocking locations and upstream redd survey locations.

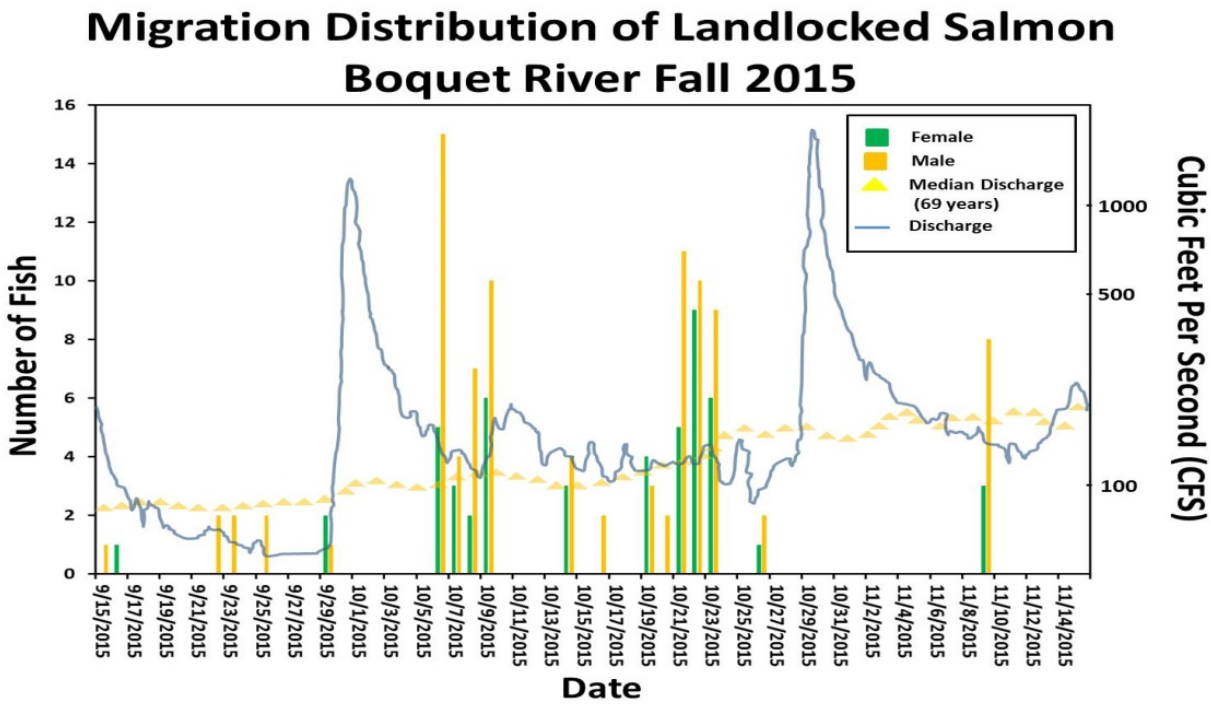


Figure 2. Relationship between river discharge and migration of landlocked salmon in the Boquet River captured below the Willsboro Cascade fall of 2015.

Conclusions from 2015 trapping and redd surveys in the Boquet River:

- Most spawners are hatchery-origin fish that were stocked as smolts into the upper Boquet River.
- Stocked fish are imprinting and homing back to the Boquet R.
- Willsboro cascade is a major migration challenge for salmon.
    - Dam removal caused siltation in cascade holding pools.
    - Peak flow events (>500cfs) maybe needed for salmon to pass cascade.
    - May need temporary structures to aid salmon passage in fall (i.e., boards to direct flows over sheer flow areas).
    - Spawning site below Willsboro cascade is a population sink with no juvenile rearing habitat.
    - Salmon are likely targeting upper Boquet River watershed to spawn because of stocking locations.

<u>Winooski River</u>

A total of 124 adult landlocked Atlantic salmon and 8 steelhead rainbow trout were trapped at the Winooski One fish passage facility in the fall 2015 while only 31 steelhead were processed in the spring (Figure 3)**.** There were 64 male and 57 female salmon processed at the lift. Condition factors and mean length at age of lake-age 1 males decreased slightly from 2014 (Figure 4). Salmon were transported and released upstream and subsequently, salmon redds were found in the upper Winooski River as well as the Huntington River.

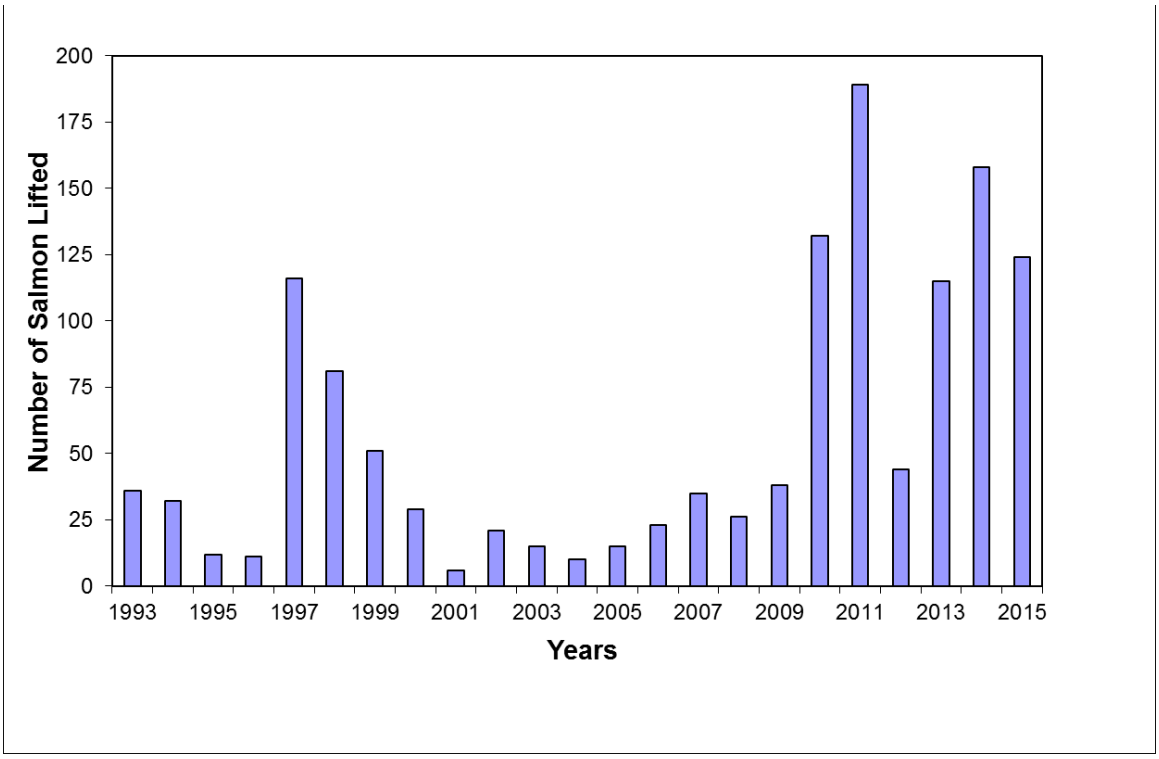


Figure 3. Summary of landlocked Atlantic salmon lifted at the Winooski One fish passage facility, 1993 – 2015.

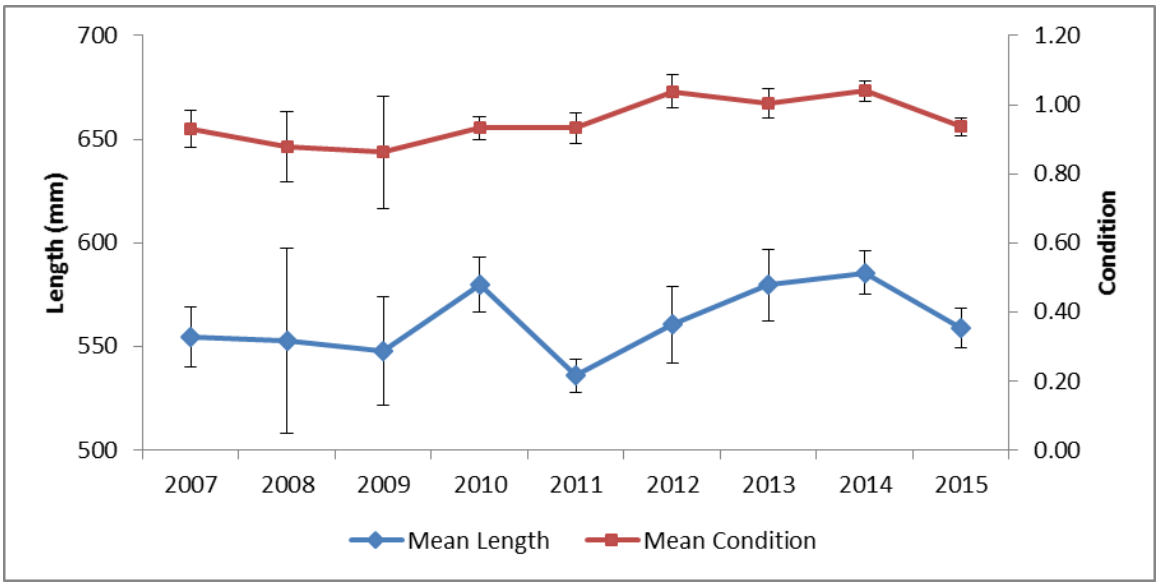


Figure 4. Comparison of mean total length (± 95 % CI) and condition factor (± 95 % CI) of lake age 1 male landlocked Atlantic salmon collected at the Winooski One fish passage facility, 2007 – 2015.

In 2014, a cooperative study was conducted by USGS-Conte Lab, Karlstad University, and USFWS to evaluate downstream fish passage for salmon smolts in the Winooski River. Dams hinder fish migration in rivers, thereby reducing connectivity between habitats; this causes fragmentation and sometimes even local extinction of migratory species. Remedial measures typically used to mitigate the negative effects of hydropower dams on downstream migrating fish include various fish passage

solutions and stocking of hatchery-reared fish. The purpose of this study was to study behavior and survival of radio-tagged wild- and hatchery-reared landlocked Atlantic salmon smolts as they migrated past three hydropower dams equipped with fish bypass solutions in the Winooski River. We found for hatchery-reared salmon that a greater proportion of early-released (early April) fish initiated downstream migration compared to those released late (late May). Early released fish also initiated downstream movement after a shorter delay than fish released late. The hatchery fish released late, however, traveled faster once they started to migrate. Throughout the river system hatchery released smolts performed similarly to fry stocked smolts (Figure 5). Dam passage rate varied between the three dams and was highest at the dam where unusually high spill levels occurred throughout the study period. Among the 50 fish that did migrate downstream, only 10% managed to reach the lake, swimming 30 km in the river, passing all three hydropower dams. Migration success was low despite the presence of bypass solutions at all three dams, underscoring the need for evaluations of remedial measures as simply constructing a fishway is not synonymous with providing fish passage.

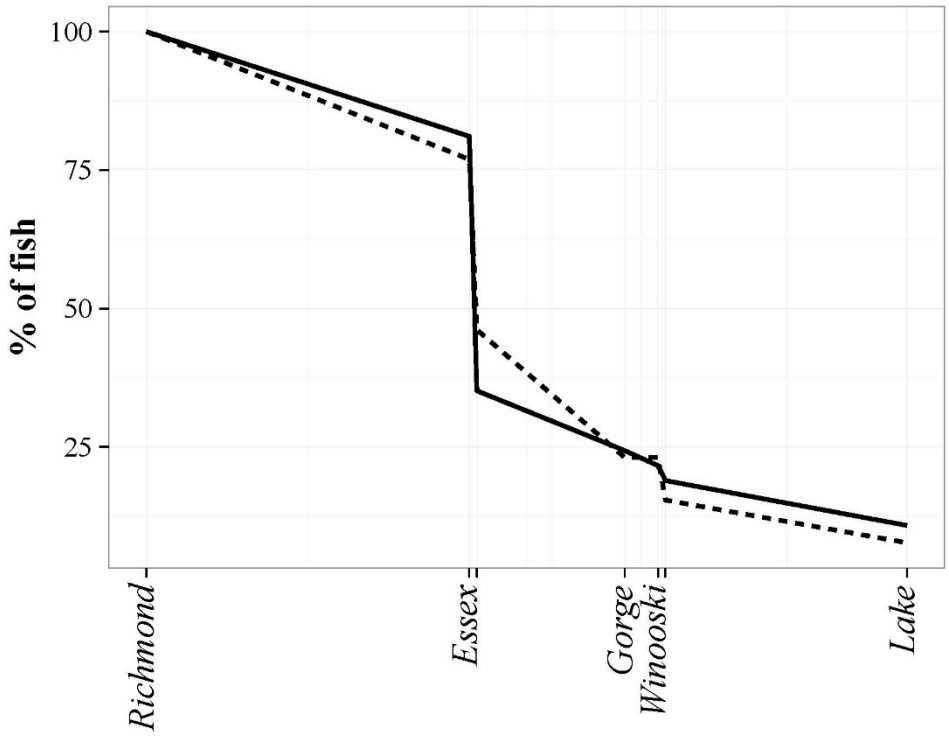


Figure 5. Accumulated survival from Richmond via the three dams (Essex, Gorge and Winooski) to the Lake Champlain for hatchery smolts (solid line) and fry stocked smolts (dashed line). The x-axis corresponds to river km and survival is assumed from radiodetections.

Spring and Fall Nearshore and Tributary Assessments (Chipman, Smith)

Annual fall boat electrofishing surveys for salmonids were conducted in selected Lake Champlain tributaries and nearshore areas. A fish trap was operated for the second year at Hatchery Brook (Ed Weed Fish Culture Station discharge stream) during spring and fall to capture returning salmonids in spawning runs; salmonids in Hatchery Brook were collected by electrofishing and dip netting in previous years. A trap net was deployed in Hatchery Cove to collect spawning lake trout. These sampling efforts allow for the collection of biological data including total length, weight, sex, and age information as well as lamprey wounding data. Salmonids collected in Vermont tributaries were tagged with serially numbered Floy anchor tags prior to release. The data are utilized in hatchery product and

fishery evaluations, and to monitor sea lamprey control progress through time. Numbers of fish reported below do not include same-year recaptures.

Springtime electrofishing was not conducted in 2015.

Fall nearshore salmonid sampling was focused on traditional sites in Willsboro and Whallon bays. Catches in the Whallon Bay and Willsboro Bay areas consisted of 332 lake trout, 190 salmon, 1 steelhead, and 4 brown trout. Whallon and Willsboro bay salmon catches were down from 2014, but on par with recent years. Over half of the 2015 sample was made up of fish greater than 500 mm indicating the presence of older age classes of salmon in the lake (Figure 6).

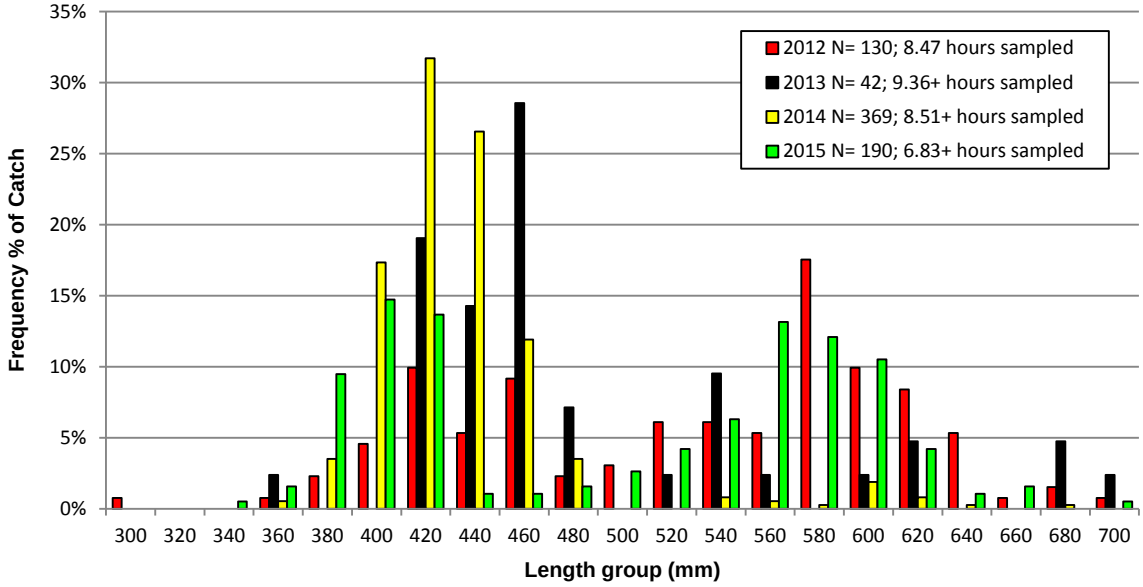


Figure 6. Length frequency distributions of landlocked Atlantic salmon collected from Willsboro and Whallon bays by electrofishing, 2012-2015.

In 2015, the Hatchery Brook trap was operated March 15-May 1 in the spring, and September 15-November 13 in the fall. The trap captured 14 steelhead during the spring season. In the fall, a record 1,494 salmon were captured and processed, which is more than double the previous record of 724 salmon captured in Hatchery Brook in 2014; 15 brown trout and one steelhead were also collected.

A total of 204 adult Sebago-strain salmon from Hatchery Brook were retained for use as broodstock at Ed Weed FCS, and 66 pairs were spawned. All of the males used for egg production were lethally sampled for disease testing, and all but 8 of the remaining salmon were released alive in Lake Champlain.

Salmon runs were also strong in other Vermont tributaries. A total of 143 salmon were collected in 11 days of electrofishing in the Lamoille River, despite low flows through much of the season limiting electrofishing boat operation in salmon holding areas. Limited sampling was conducted in two other Vermont rivers, with 54 salmon collected in five trips to Otter Creek, and 28 salmon in three trips to the Missisquoi River. The Lamoille River and Otter Creek both yielded the greatest numbers of salmon collected since 1993, and the Missisquoi River sample was the largest recorded since semi-annual sampling began there in 1990.

Length frequency distributions of Hatchery Brook and Lamoille River salmon show a marked shift to smaller sizes from 2014 to 2015 (Figure 7). Hatchery Brook salmon also continued the tendency to be larger than Lamoille River salmon (Figure 7). Aging of salmon scale samples is ongoing to enable determination of the roles of age distribution and growth rates on the spatial and temporal size structure differences.

A trap net was set in Hatchery Cove in Grand Isle for two consecutive nights in early November to sample the lake trout spawning concentration. The net was tended each day and 778 lake trout, 74 salmon, two brown trout, and one steelhead were collected. Length frequency distributions of lake trout collected by trap net in Hatchery Cove and by electrofishing in Whallon Bay are presented in Figure 8.

A workgroup of the Fisheries Technical Committee continued work on development of a plan to assess salmonid stocking rates. Fall salmonid sampling data will be used to identify potential indicators of fish condition and abundance.

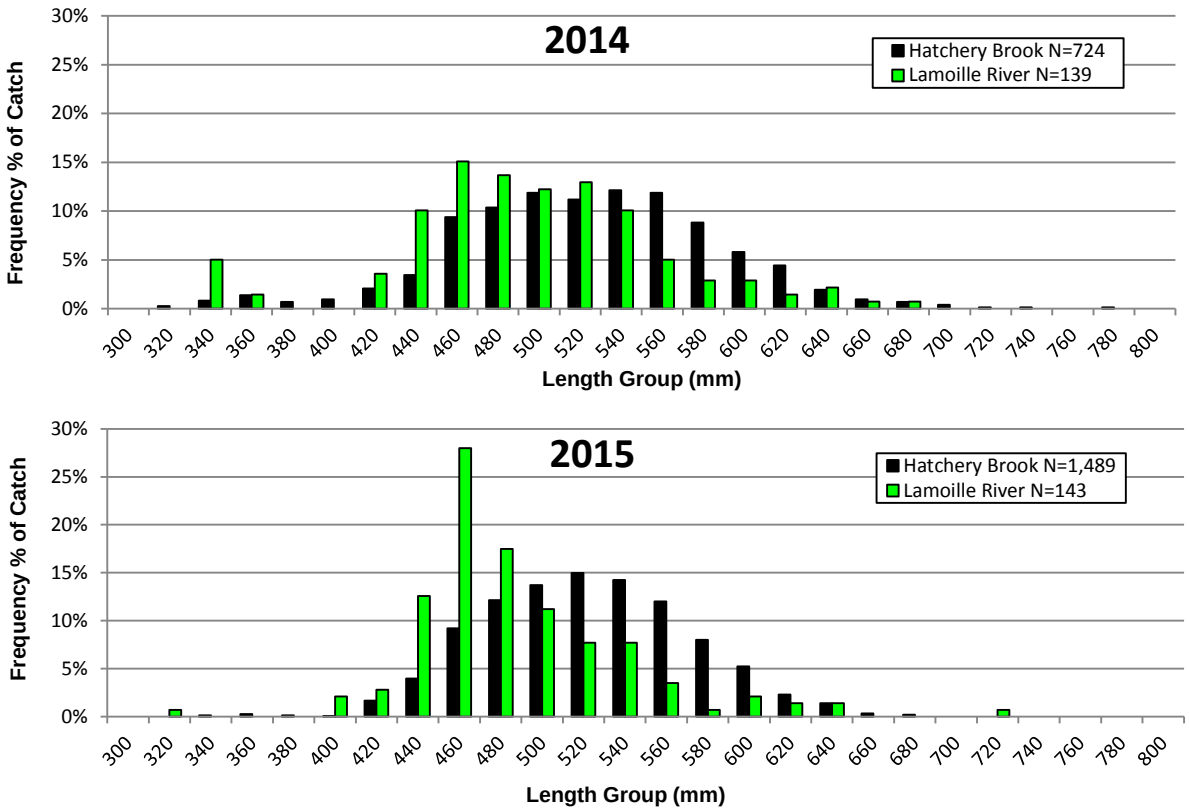


Figure 7. Length frequency distributions of landlocked Atlantic salmon collected from fall spawning runs in Hatchery Brook and Lamoille River in 2014 and 2015.

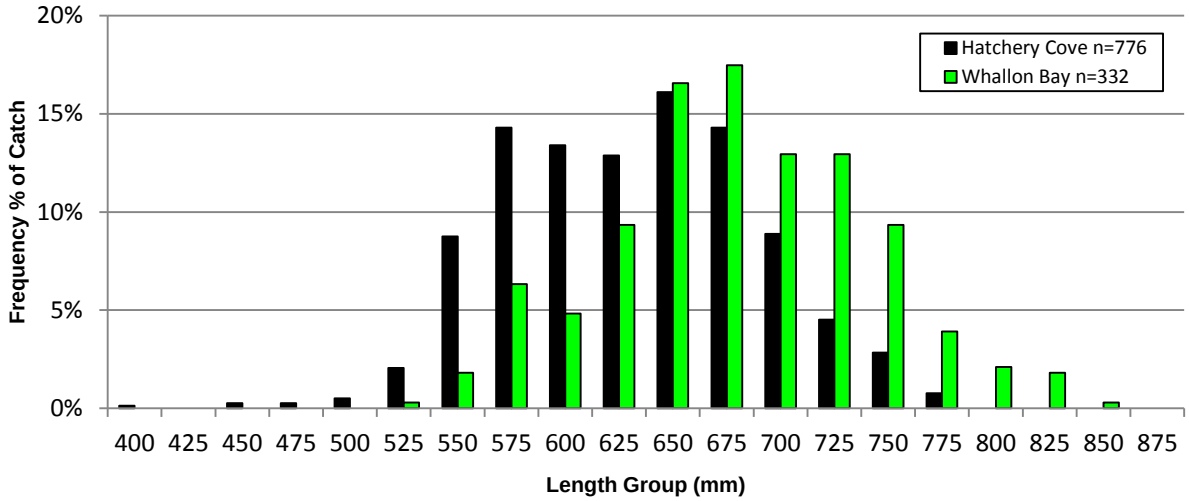


Figure 8. Length frequency distributions of lake trout collected by trap net in Hatchery Cove and by electrofishing in Whallon Bay, November 2015.

Pre-stocking Landlocked Salmon Assessments (Ardren) –

In the spring of 2015, landlocked salmon yearlings from Eisenhower NFH, Ed Weed Fish Culture Station, and Adirondack Fish Hatchery were assessed as part of a long-term monitoring database needed for managers to better understand the percentage of stocked fish that are viable smolts. Many hatchery programs that rear one year old smolts have developed a size threshold for classifying a stocked fish as a smolt. Fish that do not reach this size threshold are expected to remain as parr and will not undergo the parr-smolt transformation that year. Biologists working with anadromous Connecticut River salmon have established a smolt threshold of greater than or equal to 150 mm total length. In 2015, at least 90% of fish exceeded the 150mm size threshold for Ed Weed and Adirondack hatcheries while 83% of fish exceeded the size threshold for Eisenhower NFH (Figure 9).

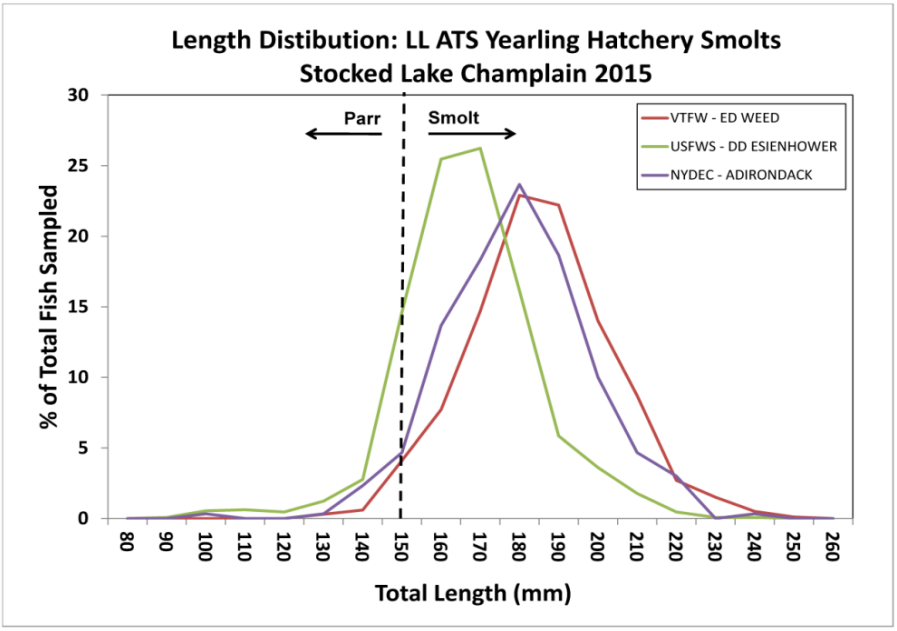


Figure 9. Total length distribution of hatchery-reared yearling landlocked Atlantic salmon stocked into the Lake Champlain Basin from three hatcheries in 2015.

Landlocked Salmon Brood Source Evaluation (Chipman) –

An experiment to compare the performance of stocked Sebago strain salmon smolts produced from domestic broodstock and feral broodstock is ongoing. Fish from each experimental group were reared under identical conditions at the Ed Weed Fish Culture Station and marked prior to stocking with fin clips specific to each group. Equal numbers of yearling smolts of each group were planned to be stocked annually from 2012 through 2015 in the Lamoille River, Missisquoi River, Inland Sea, and Hatchery Cove. Actual proportions of each group stocked over the four year period amounted to 51.2% feral and 48.8% domestic.

Returns of salmon from each brood source were recorded in annual fall nearshore, tributary, and fishway assessments. Preliminary results through 2015 show consistently increasing overall returns through the period, and substantially greater returns of feral offspring compared to domestic offspring each year (Figure 10). Evaluation sampling will continue through 2017.

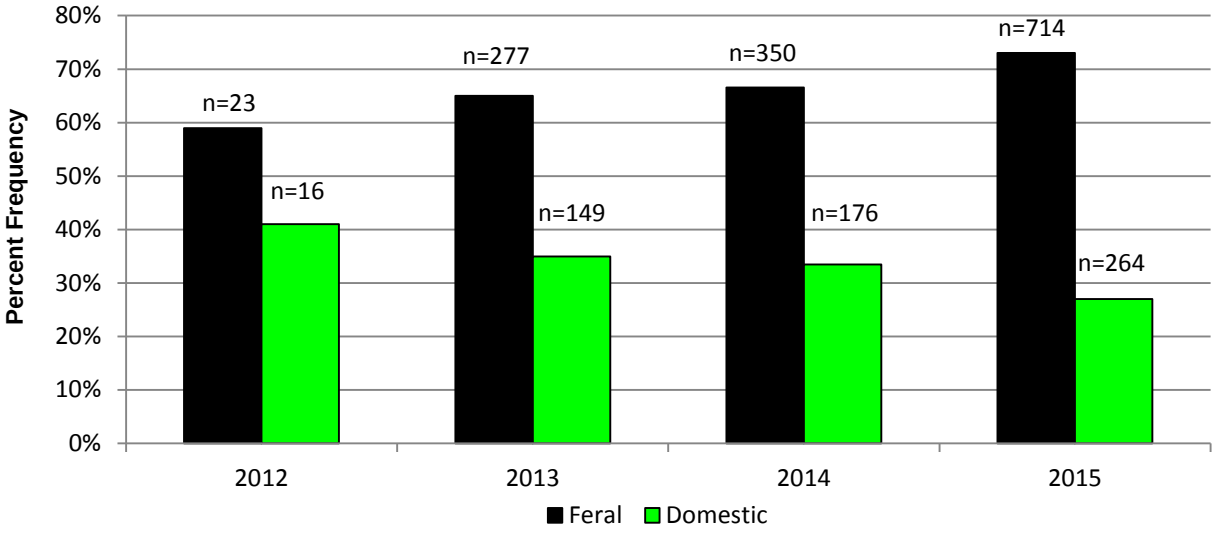


Figure 10. Returns of landlocked salmon stocked in Lake Champlain, produced from feral and domestic broodstock, 2012-2015.

Steelhead Strain Evaluation (Chipman) –

An experiment to compare the performance of Chambers Creek strain and Lake Memphremagog strain steelhead rainbow trout is ongoing. Fish of each strain were reared under identical conditions at the Ed Weed Fish Culture Station, and marked prior to stocking with fin clips specific to each group. Equal numbers of yearling smolts of each strain were planned to be stocked annually from 2012 through 2015 in Lewis Creek, LaPlatte River, Winooski River, Hatchery Cove, and Mill River. Actual proportions of each strain stocked over the four year period amounted to 53.4% Chambers Creek and 46.6% Memphremagog.

Steelhead returns from each strain were recorded in annual fall and spring nearshore, tributary, and fishway assessments. Preliminary results through fall 2015 show inconsistent overall steelhead returns from year to year, with the Chambers Creek strain returning at greater rates than the Memphremagog strain in three of the four years (Figure 11). Evaluation sampling will continue through fall 2017-spring 2018.

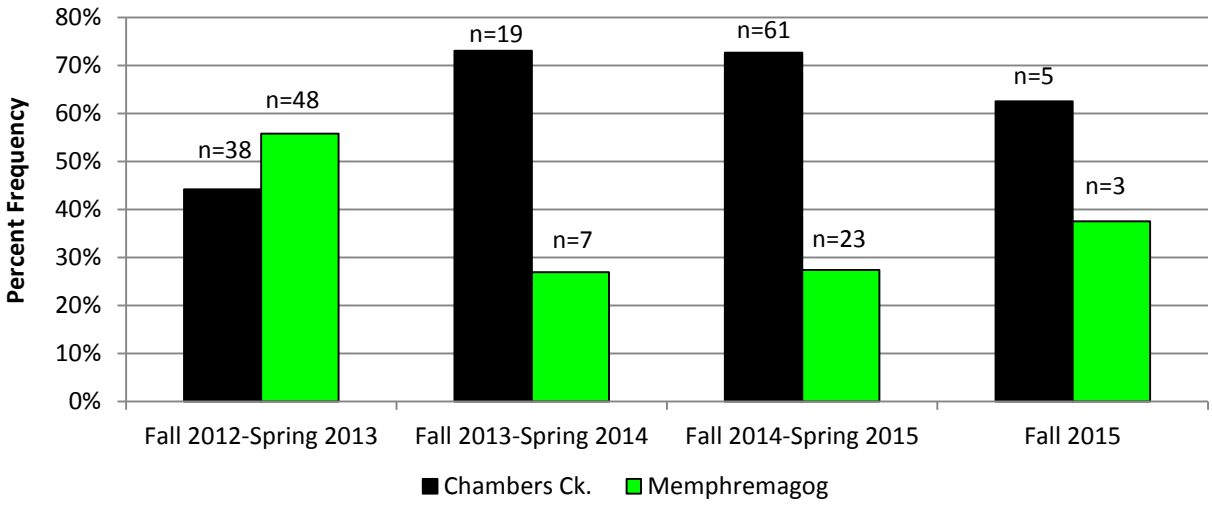


Figure 11. Returns of Chambers Creek and Lake Memphremagog strain steelhead stocked in Lake Champlain, 2012-2015.

SEA LAMPREY

The objective of the sea lamprey control program is to achieve and maintain wounding rates at or below 25 wounds per 100 lake trout, 15 wounds per 100 landlocked Atlantic salmon (salmon), and 2 wounds per 100 walleye.

Pre-treatment Quantitative Assessment Sampling (QAS) (Allaire) -

Pre-treatment QAS surveys (Table 2) were conducted in three Lake Champlain tributaries (Lamoille River, Stone Bridge Brook, and LaPlatte River) in preparation for proposed lampricide treatments in the fall of 2016. Five other Lake Champlain Tributaries (Rea Brook, Little Chazy, Malletts Creek, Pike River, and Morpion Stream), that are currently not scheduled for a TFM treatment were surveyed to evaluate their larval sea lamprey populations.

Table 2. 2015 QAS survey results and population estimates.

Stream	Sea Lamprey Larval Population Estimate	Type I Larval Density (n/m^2)	Type II Larval Density (n/m^2)	Population Estimate-Transformers
Lamoille River	0 (No Sea Larvae)	0	0	0
Stone Bridge Brook	1,019	0.039	0.014	0
LaPlatte River Reach 1	8,725	0.751	0.340	547
LaPlatte River Reach 2	4,952	0.302	0.071	0
Rea Brook	17,528	1.256	0.378	0
Little Chazy River	48,450	0.400	0.509	0
Malletts Creek	6,425	0.506	0.356	335
Pike River – Reach 2	20,523	1.767	0.878	699
Morpion Stream	72,964	1.256	0.535	4,382

Pre-treatment Ranking Survey (RS) (Allaire) -

Pre-treatment RS were conducted in the Missisquoi River in 2015 in preparation for a proposed lampricide treatment in the fall of 2016 (Table 3).

Table 3. 2015 Pre-treatment RS results.

Stream	# of M^2 Sampled	# of Sea Lamprey Collected	Larval Density (n/m^2)
Missisquoi River	225	10	.044

Post-treatment Quantitative Assessment Sampling (QAS) (Allaire) -

Post-treatment QAS surveys were conducted in four Lake Champlain tributaries (Boquet River, Lewis Creek, Ausable River, and Great Chazy River) in 2015 to evaluate the effectiveness of lampricide treatments conducted in 2014 (Table 4).

Table 4. Pre-treatment and post-treatment QAS survey results for streams treated with lampricides during the fall of 2014.

Stream	Pre-treatment (2013) population estimate	Post-treatment (2015) population estimate	Percent reduction in sea lamprey larvae
Boquet River	22,495	0	100.0%
Lewis Creek – Reach 1	172,928	2,457	98.6%
Lewis Creek – Reach 2	7,977	826	89.6%
Ausable River	870,967	57,876	93.4%
Great Chazy River - Reach 2	379	0	100.0%
Great Chazy River - Reach 3	2,375	0	100.0%

Post-treatment Ranking Survey (RS) (Allaire) -

Post-treatment RS were conducted in two Lake Champlain tributaries (Salmon River, and Little Ausable River) in 2015 to evaluate the effectiveness of lampricide treatments conducted in 2014 (Table 5).

Table 5. 2015 Post-treatment RS results.

Stream	# of M^2 Sampled	# of Sea Lamprey Collected	Larval Density (n/m^2)
Little Ausable River	78	0	-
Salmon River	90	1	.011

Detection Sampling (Allaire) -

In 2015, staff surveyed 15 tributaries in the northeastern quadrant of Lake Champlain that have historically been considered "negative" for the presence of sea lamprey. Staff spent over 9 hours of electrofishing time sampling over $360m^2$ of larval habitat investigating these 15 tributaries. No new sea lamprey populations were identified.

Delta assessment (Allaire) -

Since 2011, deepwater surveys have been conducted during the same year as scheduled delta lampricide treatments to shorten the time between assessment data and treatments. We believe this increases treatment effectiveness by limiting the amount of time for lamprey to move on the deltas between surveys and treatments. Just one delta (Mill Brook Delta), was surveyed in preparation for a possible treatment in the fall of 2015.

Mill Brook Delta: Just one sea lamprey larvae and 3 silver lamprey larvae were collected during the Mill Brook Delta survey. Based on survey results the Mill Brook Delta was not treated in the fall of 2015.

Trapping and Barriers (Allaire) -

Adult sea lamprey were trapped in 11 streams during the spring of 2015 to prevent or limit reproductive success (Table 6). 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.

In 2014, the U.S. Fish and Wildlife Service began operation of a removable barrier on Morpion Stream in Quebec. A portable assessment trap was also placed in McKenzie Brook in Port Henry, NY for the first time in 2014.

Baited pots were deployed above trap sites in Malletts Creek and Trout Brook to capture sea lamprey which had made it past the downstream weir. We collected 2 adult sea lamprey in Trout Brook (6.9% of total catch) and 16 adult sea lamprey (9.1% of catch) in Malletts Creek using these pots. We will continue to use pots in areas where we are unable to deploy traps, as well as above traps to gauge the amount of escapement past trap sites.

We saw a significant decrease in the number of adult lamprey captured in many of our adult traps in 2015, including just 54 at the Frog Farm Dam on the Great Chazy, which was a record low. We only saw an increase at three trap sites, including McKenzie Brook that increased by a single lamprey. We saw a significant increase at the new Morpion barrier, as expected following the installation of a new floor prior to the 2015 trapping season that prevented lamprey escapement.

Table 6. Results of adult sea lamprey trapping in 2015.

Date Trap Set	State / Province	Stream	Date Trap Removed	% of Days Trap Operational	Lamprey Captured **(2014)**	Lamprey Captured **(2015)**	% Change From 2014
4/7/15	NY	Beaver Brook	6/25/15	96.1%	203	235	+15.8%
4/16/15	VT	Trout Brook	6/24/15	67.2%	47	29	-38.3%
4/15/15	VT	Stone Bridge Brook	6/15/15	84.7%	15	14	- 6.7%
4/28/15	VT	Malletts Creek	6/17/15	73.5%	215	175	-18.6%
5/5/15	NY	Great Chazy River	6/17/15	100.0%	241	54	-77.6%
4/14/15	VT	Pond Brook	6/11/15	80.8%	121	72	-40.5%
4/15/15	NY	Rea Brook	6/17/15	77.0%	128	63	-50.8%
4/14/15	VT	Sunderland Brook	6/22/15	77.9%	63	60	-4.8%
4/6/15	NY	Mullen Brook	6/25/15	71.3%	65	41	-36.9%
4/6/15	NY	McKenzie Brook	6/12/15	60.9%	5	6	+20.0%
5/1/15	QC	Morpion	6/29/15	80.0%	134	248	+85.1%
				TOTAL	**1237**	**997**	-19.4%

Lampricide Control (Smith) -

Lampricide treatments were completed on six tributaries in 2015 (Table 7). Control status of Lake Champlain tributaries is presented in Appendix 2. A treatment history and schedule of future treatments is presented in Appendix 3.

Table 7. Summary of 2015 lampricide applications in tributaries to Lake Champlain.

Stream or delta	Date treated	Flow (CFS)	TFM (lbs. active ingredient)	Area treated	Niclosamide (lbs. active ingredient)
Ausable River South Mouth	May 20	170	468	1.8 mi.	-
Mt. Hope Brook	Oct 6	3.0	56	2.6 mi.	-
Poultney River	Oct 14	83	1,284	10.6 mi.	-
Hubbardton River	Oct 14	2.5	33.5	2.3 mi.	-
Lewis Creek	Oct 20	18	339	9.5 mi.	-
Winooski River	Nov 3	900	2,658	10.5 mi.	32.1
		Totals:	**4,839**	**37.3 mi.**	**32.1**

Wounding Rates (Chipman, Smith) -

Sea lamprey wounding rates calculated for lake trout collected in 2015 decreased to 27 wounds per 100 fish, which is the lowest level achieved for lake trout since sea lamprey control began in 1990, but still slightly above the program objective (Figure 12). The wounding rate for Main Lake salmon collected in 2015 increased to 19 wounds per 100 fish after being at or below the program objective in the previous two years (Figure 13). Inland Sea-Malletts Bay salmon continued to show a higher wounding rate than Main Lake salmon, but it declined for the second consecutive year to 25 wounds per 100 fish (Figure 13). Both salmon and lake trout wounding rates in 2015 remained substantially lower than the average rates observed during the 1990's experimental sea lamprey control program, (Table 8).

The sea lamprey wounding rate for walleye (534 to 634 mm TL) collected in spring 2015 from the Winooski River was 5 wounds per 100 fish, which is above the Cooperative's lamprey wounding rate objective for walleye of 2 wounds per 100 walleye.

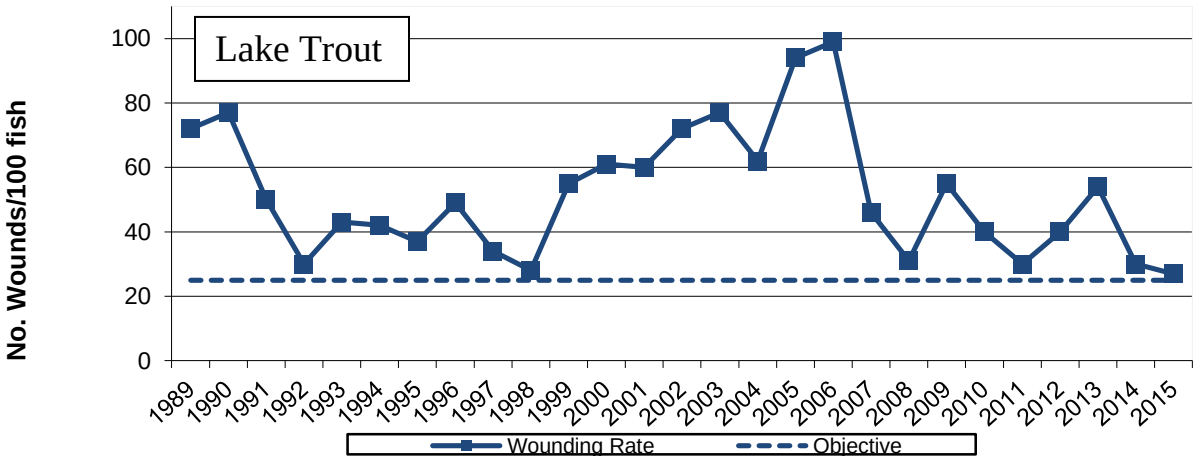


Figure 12. Type A1-A3 sea lamprey wounds (fresh and healing) per 100 lake trout (533-633 mm total length) from fall sampling in the Main Lake basin, 1989-2015. The target wounding rate of 25 wounds per 100 fish is also presented for reference (dashed line).

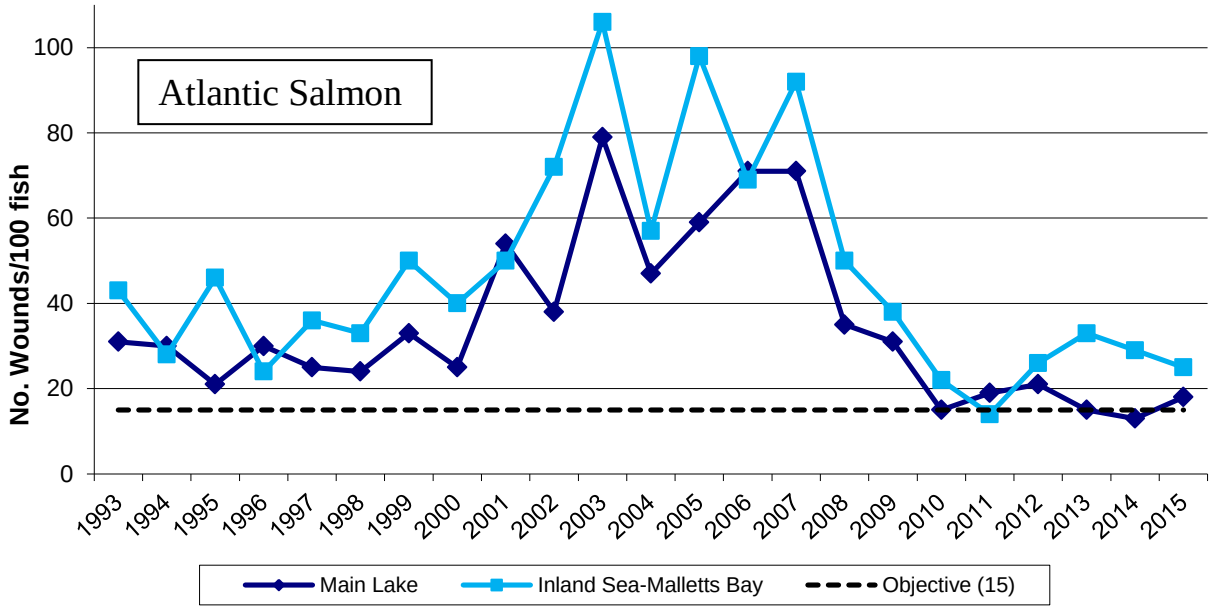


Figure 13. Type A1-A3 sea lamprey wounds (fresh and healing) per 100 salmon (432-533 mm total length) from fall sampling in the Main Lake and Inland Sea-Malletts Bay basins, 1993-2015. The target wounding rate of 15 wounds per 100 fish is also presented for reference (dashed line).

Table 8. Sea lamprey wounding rates on Lake Champlain lake trout and Atlantic salmon during 2015, compared with pre-control and eight-year experimental control program results.

	Number of type A1-A3 lamprey wounds per 100 fish			
	Objective	Pre-control	Experimental control	2015
Lake Trout[a] (Main Lake)	25	55	38	27
Atlantic Salmon[b] (lake-wide)	15	32	31	19
Atlantic Salmon[b] (Main Lake)	15	34	27	18
Atlantic Salmon[b] (Malletts Bay-Inland Sea)	15	32	39	25

[a] Lake trout in the 533-633 mm (21.0-24.9 inches) length interval. For lake trout, pre-control included 1982 - 92, while experimental control includes 1993 - 97.
[b] Salmon in the 432-533 mm (17.0-21.0 inches) length interval. For salmon, pre-control included 1985 - 92, while experimental control includes 1993 - 98.

FORAGE FISH (This program was discontinued in 2016)

Smelt (Staats) -

Eighteen midwater trawls for rainbow smelt were conducted in late summer, 2015 (Table 9). Mean catch per 55 minute trawl (CPUE) in the main lake was above the long-term average except at Valcour Island while Malletts Bay and the Northeast Arm numbers remain low (Figure 14). Preliminary analysis suggests the main lake stations were dominated by age 1 smelt. Older ages are better represented in the Malletts Bay and Northeast Arm samples, however in the Northeast Arm, less than a quarter of the usual numbers of smelt were collected from this station for age analysis.

Alewives (Pientka) -

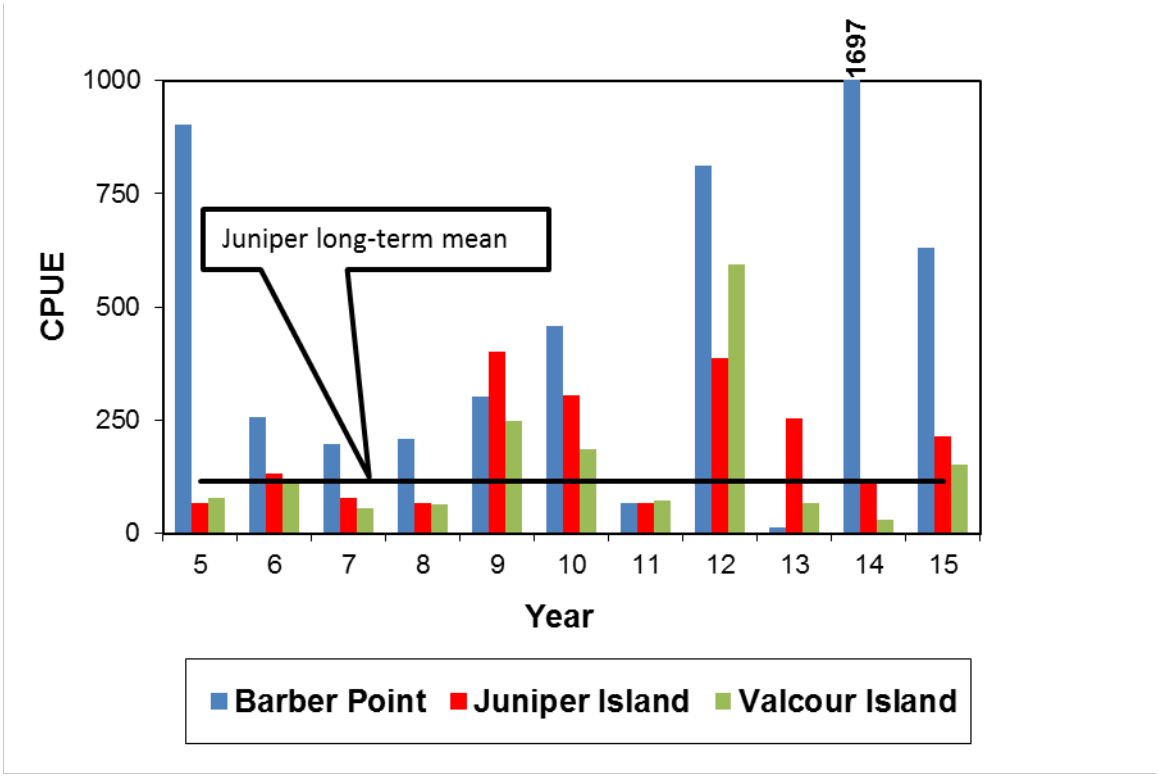
Alewives were first discovered in Lake Champlain in 2004 and their numbers have increased since. Since 2008, floating gill nets have been utilized to collect alewife samples for age and growth analysis. In 2015, both young-of-year and older alewife were collected at most sampling stations. The north main lake station recorded the greatest CPUE of adult alewife at 34 fish per 4 hour set. Nets in the Northeast Arm had the greatest catch of YOY alewife while catching the fewest number of adults.

Hydroacoustics (Pientka) -

Hydroacoustic assessment of Northeast Arm, Malletts Bay and Main Lake was conducted between July 28 and August 18, 2015 following the same procedures as prior years. The 2015 assessment transects covered 12.9 nautical miles in the Northeast Arm, 7.8 nautical miles in Malletts Bay and 57.8 nautical miles in the Main Lake. Along with the acoustic transects, targeted trawls and temperature profiles were performed to confirm species compositions. In 2015, 4 tucker trawls, 12 midwater trawls and 21 temperature profiles were performed. Processing of the acoustic data is currently ongoing.

Table 9. Mean catch per 55 minute trawl (CPUE with 95% confidence interval) of rainbow smelt in 2015 and comparison to pre- (1990-2004) and post-alewife invasion mean CPUE (2005-2015).

Station	Number of trawls	CPUE	Pre-Alewife Mean	Post-Alewife Mean	N years
Main Lake					
Barber Point	2	631 ± 2471	206	504	22
Juniper Island	4	214 ± 80	180	190	26
Valcour Island	4	153 ± 39	423	152	16
Malletts Bay					
Malletts Bay	4	60 ± 13	1124	395	26
Inland Sea					
Northeast Arm	4	15 ± 5	1363	181	26



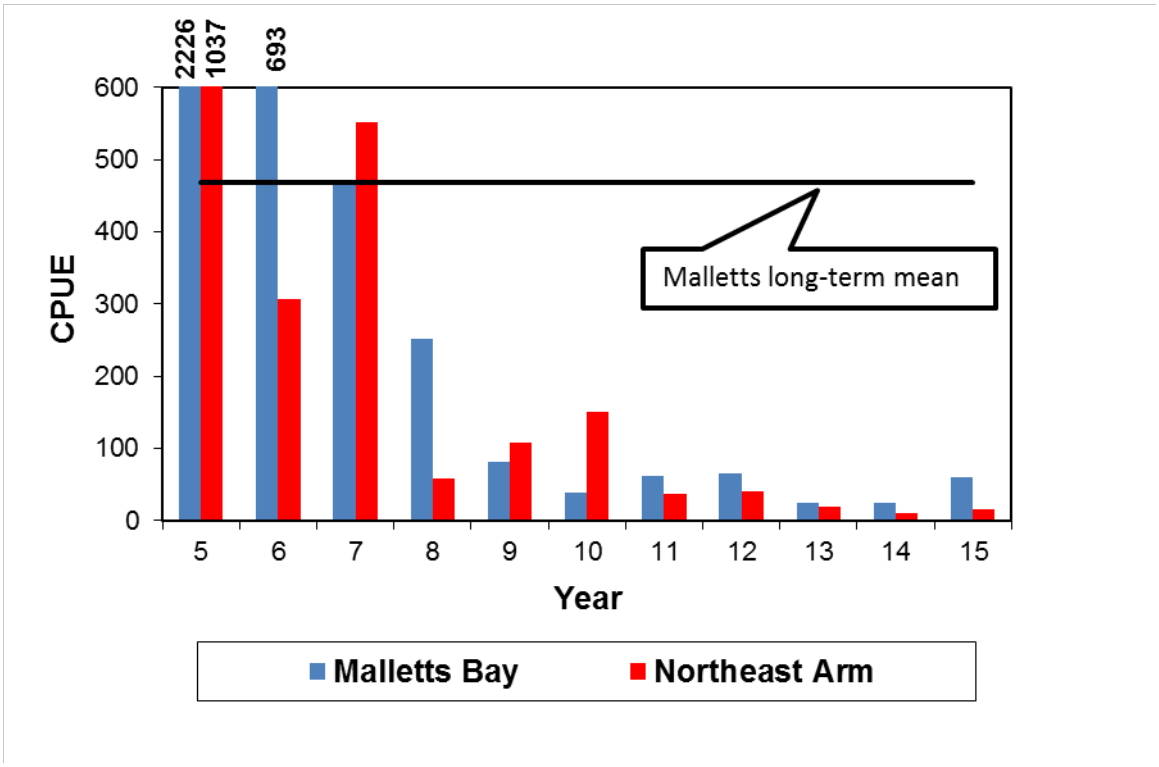


Figure 14. Mean catch per 55-minute trawl for rainbow smelt in Lake Champlain, 2005-2015.

PERCIDS

Yellow Perch (Pientka) -

Experimental gillnets are set overnight at multiple locations in order to monitor the Lake Champlain fish community. While these nets are not specifically targeting yellow perch they do give insight into relative abundance. In 2015, the sampling occurred between June 29th and July 15th. Yellow perch catch per overnight set (CPUE) at Shelburne Bay and St. Albans Bay were the highest in the past 7 years of sampling (Figure 15). Sampling will continue in 2016.

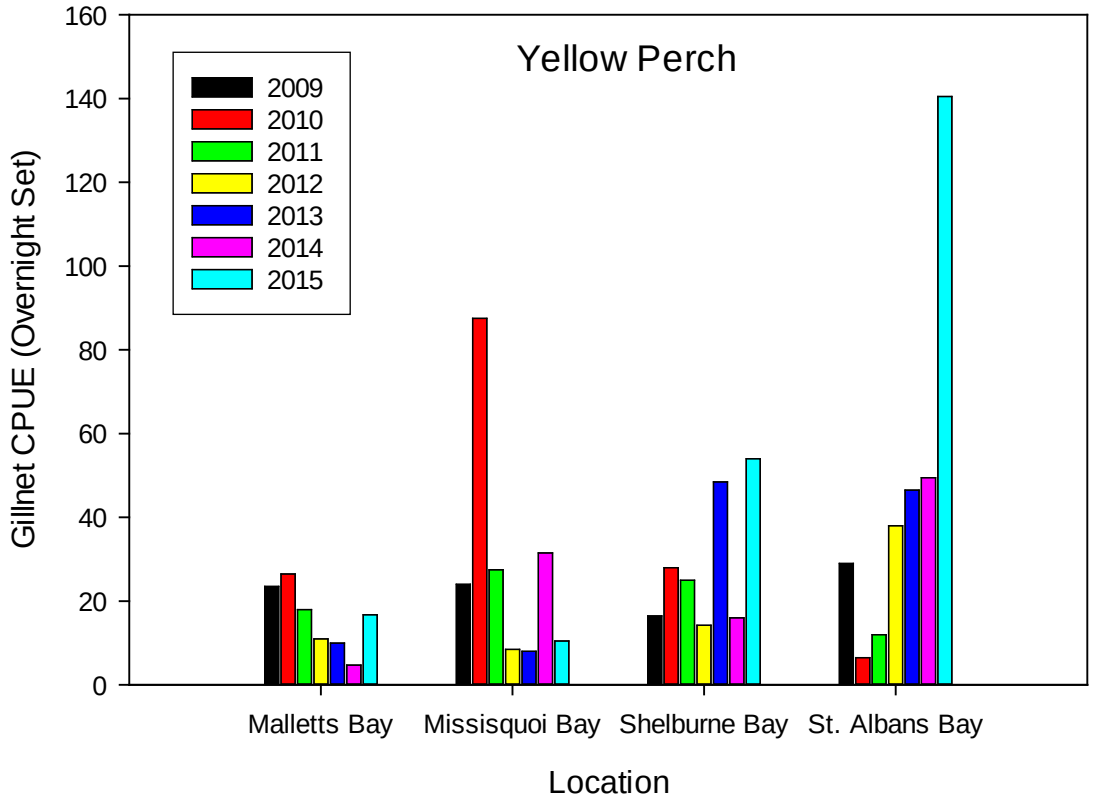


Figure 15. Yellow Perch CPUE for 2009-2015 at four Lake Champlain Locations

Walleye (MacKenzie, Pientka) -

Walleye management activities on Lake Champlain included monitoring adult walleye returning to spawn in the Winooski River, seining for walleye at the Sandy Point, collection of brood stock for the fish culture and stocking program, evaluation of the contribution of stocked walleye to spawning populations and summarizing the data on sauger abundance in Lake Champlain to provide technical assistance to the Vermont Fish & Wildlife Board during their review of sauger regulations on Lake Champlain..

Three hundred and forty six walleye (230 males, 96 females) were collected from the Winooski River. Twenty four pairs were spawned resulting in 4.67 million eggs. Eggs were hatched at the Ed Weed Fish Culture Station (FCS) in Vermont. Fingerlings were reared in the intensive culture system located at the Ed Weed FCS and in 4 ponds managed by the Lake Champlain Walleye Association. All fry and fingerlings were marked with OTC prior to stocking. Fifty age-3 males were collected for evaluation of the contribution of stocked fish to the spawning run in the Winooski River.

A total of 46 walleye were collected by seining in 2015. This resulted in a total CPUE of 1.59 walleye per seine haul, which is one of the higher values we have seen in recent years. Including walleye, a total of 15,178 fish of 27 different species were collected during the 2015 seining operation.

Information on the abundance of sauger in Lake Champlain was summarized due to concerns that sauger numbers in Lake Champlain have declined significantly. After review of the available information a proposal to change the regulations on sauger was presented to the Vermont Fish & Wildlife Board. The Board adopted a new regulation prohibiting the harvest of all sauger after reviewing the information and public comments. The new regulation requiring no-kill will be implemented in 2016.

CENTRARCHIDS

Largemouth and Smallmouth Bass (Good, Pientka) -

Angling for largemouth and smallmouth bass in Lake Champlain continues to increase in popularity. The lake is frequently named as one of the top 5 bass fishing destinations in the country by numerous popular national fishing magazines. It not only attracts and supports a high level of recreational fishing pressure, but multiple professional bass fishing tournament trails have added Lake Champlain as an annual stop. In 2015, Vermont issued 105 Bass Tournament permits for Lake Champlain. For the FLW Outdoors Series, results indicate that tournament catches have remained very consistent since their first tournament was held on Lake Champlain in 2002 (Figure 16). Both major U.S. professional bass fishing tournament series, Bassmaster and Forrest L. Wood (FLW) Outdoors, have held regular events on the lake.

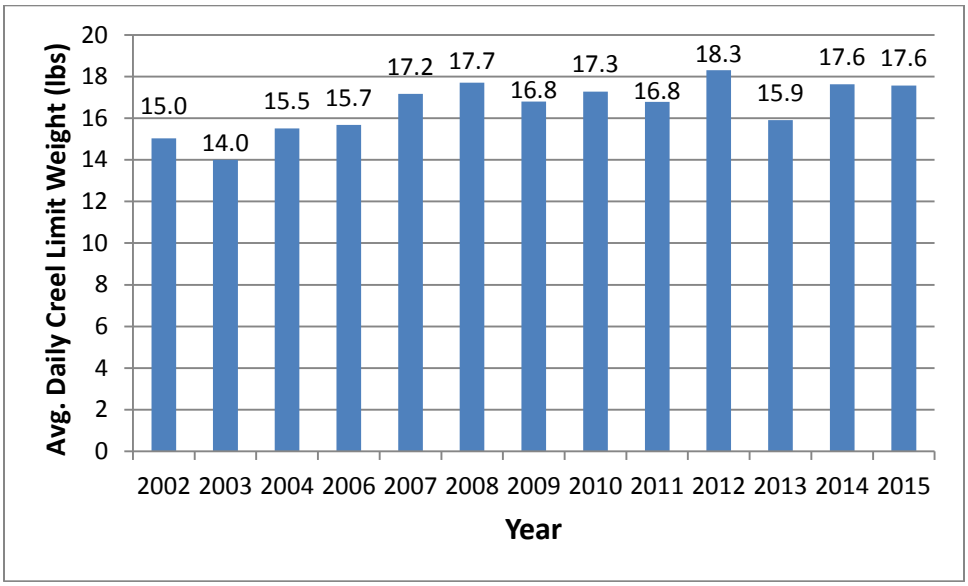


Figure 16. Average daily creel limit weights for the Top 10 anglers from each of the 14 professional-level FLW Outdoors tournaments held on Lake Champlain since 2002.

Favorable weather and lake levels in 2015 allowed for springtime bass sampling to occur, which better targets smallmouth bass when they are located nearshore and more vulnerable to electrofishing. Surveys at 20 standardized sampling stations on the South Lake captured 309 largemouth bass and 235 smallmouth bass in 9.4 hours of electrofishing in 2015. Largemouth bass ranged in size from 5.7 to 20.6 inches total length and smallmouth bass ranged in size from 3.5 to 21.1 inches total length.

Summertime electrofishing surveys at 20 standardized sampling stations on the South Lake captured 452 largemouth bass and 227 smallmouth bass in 8.8 hours of electrofishing in 2015. Largemouth bass ranged in size from 1.9 to 20.6 inches total length and smallmouth bass ranged in size from 2.1 to 18.4 inches total length.

During the spring of 2015, electrofishing surveys were also conducted on northern Lake Champlain. This was the first year of sampling, with the primary purpose of locating potential transects to be used for future standardized bass sampling. Two areas were selected and a total of 9 transects were sampled. A total of 3.8 hours of electrofishing were completed and 126 black bass were collected.

ESOCIDS

Muskellunge (Good, Pientka) -

In 2015, VTDFW stocked 5,540 muskellunge into the lower Missisquoi River and Missisquoi Bay, including Campbell's Bay (Table 8). As in 2013 and 2014, approximately 2,000 of the muskellunge were also stocked above the Swanton Dam. The location above Swanton Dam has been stocked recently because of several potential benefits – there is abundant forage and a relative lack of predation and competition. Muskellunge may grow readily and have good survival rates. Fish are likely to then migrate downstream into the lower river and Lake Champlain at a size where predation would be low and survival high in the Champlain fish community.

Table 10. Muskellunge stocking numbers for Lake Champlain, 2008-2015.

Date	Strain	Source	Number Stocked	Length (Inches)	Wt. (Lbs.)	Life Stage	Stocking Location
2008	Chautauqua	NYSDEC	250	6.10	4.35	Summer Fingerling	Missisquoi River & Bay
2009	Chautauqua	NYSDEC	10,000	5.04	174	Summer Fingerling	Missisquoi River & Bay
2011	Chautauqua	NYSDEC	5,150	5.00	95.5	Summer Fingerling	Missisquoi River & Bay
2012	Chautauqua	NYSDEC	8,800	5.40	185	Summer Fingerling	Missisquoi River & Bay
2013	Chautauqua	NYSDEC	7,580	5.32	155	Summer Fingerling	Lower Missisquoi R & Bay, Upper Missisquoi R. (Swanton to Highgate)
2014	Chautauqua	NYSDEC	7,000	5.24	137	Summer Fingerling	Lower Missisquoi R & Bay, Upper Missisquoi R. (Swanton to Highgate)
2015	Chautauqua	NYSDEC	5,540	4.83	85	Summer Fingerling	Lower Missisquoi R & Bay, Upper Missisquoi R.

Sampling was conducted on October 28, 2015 on the upper Missisquoi River between Swanton and Highgate dams, targeting the three year classes stocked there in 2013 (Age 2+), 2014 (Age 1+) and 2015 (Age 0+). Although muskellunge are also stocked below the dam and in Missisquoi Bay, the upper Missisquoi River is more conducive to collecting stocked fish because of the ease of targeting potential habitat, versus the vast areas of habitat in the lower river and bay. A total of seventeen muskellunge were captured. Sixteen were from the August 2015 stocking and ranged in size from 169mm to 231mm (6.7" – 9.1"). One larger muskellunge (550mm, 21.7") was collected, likely originating from the 2013 stocking.

Young-of-year muskellunge appeared to be relating primarily to eel grass (*Vallisneria americana*) in depths less than 2-feet, while the larger muskellunge was captured in 4 to 5 feet of water relating to submerged wood. Size-at-capture of the young-of-year indicated a very high rate of growth from size-at-stocking in August.

Lake Sturgeon **(MacKenzie) –**

Sampling for lake sturgeon returning to spawn in the Lamoille and Winooski rivers in May, 2015 resulted in the capture of 16 sturgeon in the Winooski River and one in the Lamoille. Total lengths ranged from 48.6 inches to 54.7 inches with weights ranging from 20 to 40 pounds. Sea lamprey wounding rates were significantly lower than those observed from 1998 to 2002.

Acoustic tags were surgically implanted in ten sturgeon captured in the Winooski river and sturgeon movements were monitored in the river and in Lake Champlain. All 10 tagged fish were located near or on the Winooski River delta on multiple occasions.

Lake sturgeon were distributed across the delta during the summer (Figure 17) but congregated in a smaller area for the winter (Figure 18).

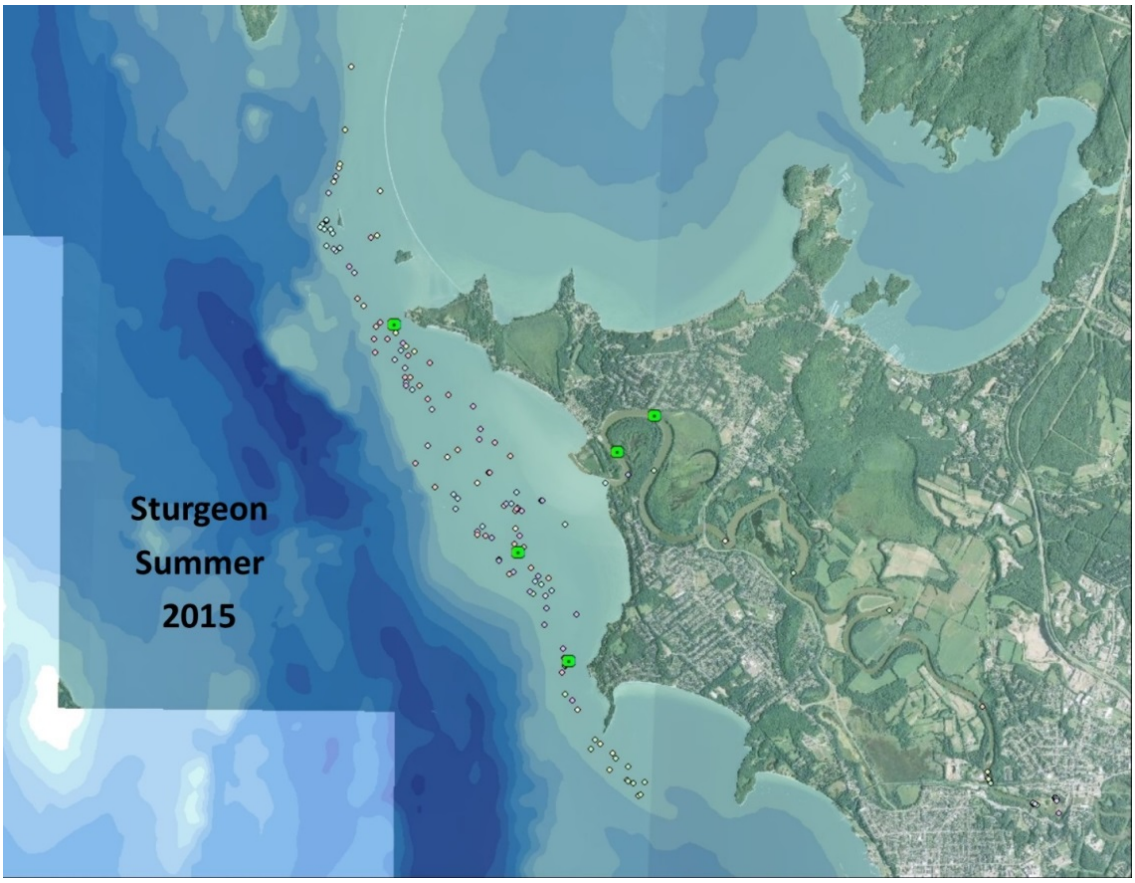


Figure 17. Lake sturgeon locations on the Winooski Delta as determined by acoustic tracking, June thru October, 2015

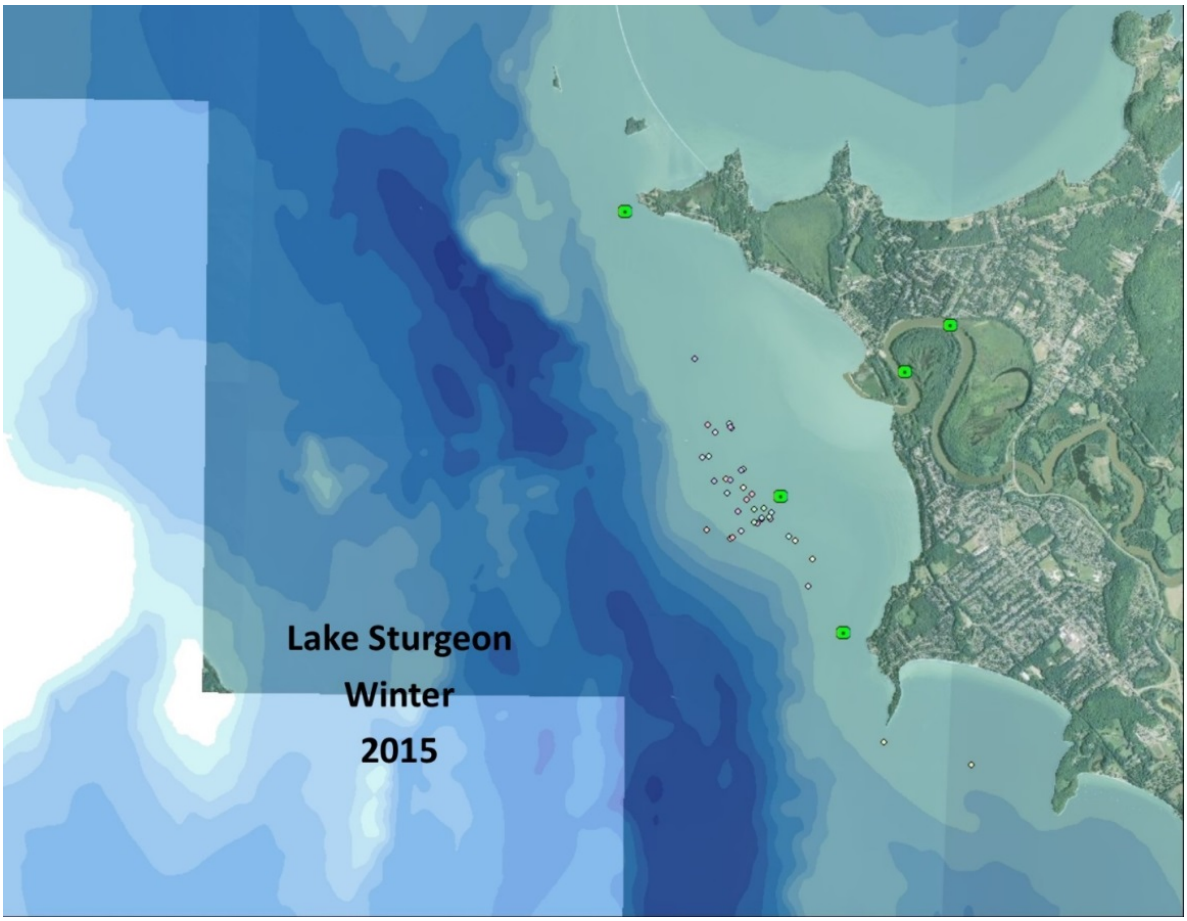


Figure 18. Lake sturgeon locations on the Winooski Delta as determined by acoustic tracking, November and December, 2015

ANGUILLIDS

American eel (Staats) -

In 1997, an eel ladder was constructed at the Richelieu River dam in Chambly, Quebec and in 2001 a fish ladder and an eel ladder were built at the St Ours dam on the Richelieu. These facilities reopened connectivity for eel migration from the St. Lawrence River to Lake Champlain. Faune Québec, in cooperation with a commercial fishing union and Hydro-Québec, initiated an eel stocking program in 2005 in the Richelieu River to further enhance eel recruitment. In order to monitor the success of these stocking efforts and new passage facilities, Québec asked members of Fisheries Technical Committee to monitor eel in Lake Champlain.

No eel sampling was scheduled for 2015. Eel sampling was conducted in 2014 and numbers of eels collected or observed were similar or greater relative to sampling efforts in 2012 (Table 11). However, eels were collected during annual spring adult sea lamprey trapping operations (Table 12). The majority of which were larger eels (>600 mm), but some smaller eels were also handled (300-450 mm) (Anthony Curtis, USFWS, personal communication).

Table 11. Summary of American eel stocking in the upper Richelieu River and the number of eels caught in Lake Champlain by electrofishing in 2007, and 2010 to 2014.

Year	Number of glass eels stocked	Number of eels collected (observed but not collected)			
		Keeler Bay	Paradise Bay	Converse Bay	Grand Isle shoreline
2005	600,000	----	----	----	----
2006	1,000,000	----	----	----	----
2007	425,500	0	0	0	1
2008	746,000	----	----	----	----
2010	0	1	1 (1)	25 (17)	14 (3-5)
2012	0	1 (13)	2 (4)	57 (98)	21 (12)
2014	0	12 (12)	17 (18)	54 (39)	Not sampled

Table 12. Summary of American eel captured during annual sea lamprey trapping conducted in the spring, 2010-2015.

Stream	2015	2014	2013	2012	2011	2010
Main Lake						
Great Chazy River, NY	5	7	0	0	1	1
Sunderland Brook, VT	1	0	2	1	---	0
Potash Brook, VT	---	---	---	0	---	---
Mullen Brook, NY	0	0	0	0	0	0
Beaver Brook, NY	1	1	0	0	0	0
Rea Brook, NY	0	0	1	0	---	----
McKenzie Brook, NY	0	0	---	---	---	---
Inland Sea, VT						
Stone Bridge Brook	10	5	24	12	11	2
Trout Brook	0	0	0	1	0	0
Morpion Stream (QC)	0	2	---	---	---	---
Malletts Bay, VT						
Malletts Creek	0	0	0	0	0	0
Pond Brook	0	0	1	0	3	0
Indian brook	---	---	---	5	---	---

RECREATIONAL FISHERY MONITORING

Angler Surveys (Pientka, Good, Chipman)-

Winter and open water angler creel surveys were conducted in selected areas of Lake Champlain to estimate fishing pressure, total catch and harvest of fish species, and other fishery characteristics.

During the winter of 2015 roving ice angler surveys were completed on portions of the southern and northern ends of Lake Champlain (Figure 19). The southern survey ran from January 1 to March 29, 2015, and the northern survey ran from January 1 to April 2, 2015. A total of 4,101 angler interviews were completed and 9,846 fish were measured during the winter surveys. Yellow Perch was most frequently targeted by interviewed ice anglers (44% in the northern survey and 31% in the southern survey).

An open water roving angler survey was completed on the major portion of the Main Lake basin from April 18 (ice-out) to October 15 (Figure 19). A total of 1,182 parties (2,446 anglers) were interviewed, and 68% of interviewed parties were targeting salmonids.

Angler survey data processing is underway and major findings will be presented in the 2016 annual report.

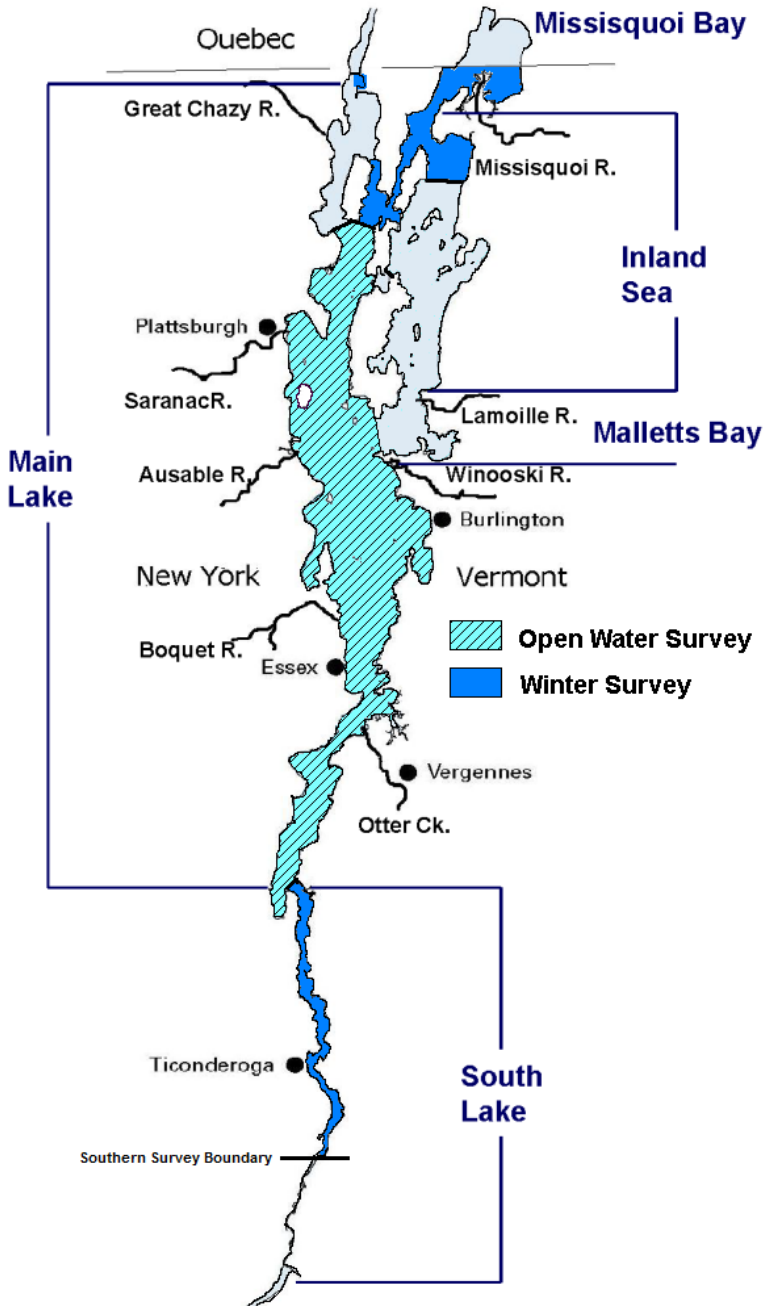


Figure 19. Lake Champlain angler survey areas in 2015.

RESEARCH

Acoustic telemetry (Tori Pinheiro, Ellen Marsden, UVM)
Twenty-seven acoustic receivers have been deployed between Crown Pt and Rouses Pt, allowing detection of tagged fish year-round. To date, 15 walleye and 93 lake trout have been tagged for UVM studies; the acoustic array is also contributing to an acoustic telemetry study of lake sturgeon conducted by VTDFW. Preliminary analysis of walleye movements indicates that fish tended to remain in the basin (Main Lake, or Northeast Arm) in which they were tagged; a single fish that traveled extensively appeared to be impeded by the Sandbar and Isle LaMotte causeways. Male and female lake trout both traveled to multiple spawning sites between 2 and 56 km apart within a spawning season, but selected a single preferred spawning site where they spent the majority of the spawning season; males spent more time on spawning sites than females. Of the lake trout that were detected during multiple spawning seasons, 57% of females and 74% of males showed homing behavior to the same site.

Lake trout thiamine study (Carrie Kozel, Ellen Marsden, UVM)
Catch per unit effort of wild lake trout fry in Lake Champlain has not declined since the introduction of alewife, despite a steady decline in the amount of thiamine in lake trout eggs since 2004. We hypothesize that wild fry may ameliorate thiamine deficiency by consuming thiamine-rich prey within one or two weeks of hatching. Eggs were collected from 53 lake trout and analyzed for thiamine content using HPLC; thiamine levels were lower than in 2013 (3.4 ± nmol/g). Forty families of eggs, with a range from low to high thiamine, were reared at the Rubenstein Ecosystem Science Laboratory at UVM; each family was split into two groups, and one group from each family was treated with thiamine. After hatching, half of each of the treated and untreated groups was fed live zooplankton throughout development, and half were starved. Approximately two weeks after the yolk sacs were fully adsorbed, a sample of fry from all treatments were analyzed for thiamine content. All groups appeared to have increased their thiamine content between the egg and hatching stages. The experiment was repeated in 2015 with attention to potential confounding factors, and thiamine analysis of the hatched, fed and unfed fry will occur in 2016.

Lake trout recruitment (Ellen Marsden, Carrie Kozel, Steve Cluett, UVM)
The lake trout population in Lake Champlain is largely supported by stocking Stocked lake trout spawn lake-wide, and fry are abundant on spawning reefs in spring, but there has been little to no recruitment of wild fish into the population. Lake trout are assessed annually in fall to look for unclipped (wild) spawners, but no juvenile surveys have been conducted. In 2015 we began focused sampling in deep water to look for juvenile lake trout. We collected over 258 individuals, of which 23% were unclipped; these wild fish appear to comprise at least three age classes (young-of-year, age-1, and age-2, based on size distribution). In 2016 we will sample for juvenile lake trout throughout the lake to describe the spatial, seasonal, and depth distribution of wild lake trout juveniles, evaluate abundance of wild juveniles by comparing catch per unit effort relative to catches of stocked lake trout, and determine whether stocked juvenile lake trout are competing with the wild juveniles for food.

Status of Stonecats in Vermont (Elizabeth Puchala and Donna Parrish, VT Coop F&W Res Unit)
Our research on stonecat populations in the two known Vermont locations, the LaPlatte and Missisquoi rivers, has focused on attempting to estimate population sizes and survivorship. From July to September 2015, the fourth year of our study, we used backpack electrofishing and minnow traps to

capture 504 stonecats in the LaPlatte River, of which 127 were recaptures. Total stonecats collected during four years of sampling is 2,062 in the LaPlatte River and 144 in the Missisquoi River. Summer 2016 is the last year of this study, which will conclude with conducting an electrofishing efficiency experiment.

River-run Restoration of Landlocked Salmon (Ardren USFWS)
The U.S. Fish and Wildlife Service is leading a large adaptive management experiment focused on restoring and enhancing river-runs of landlocked salmon to Lake Champlain.

Landlocked Atlantic salmon were extirpated from Lake Champlain in the early 1800s. Management actions, including sea lamprey control and stocking yearling smolts, provide for a popular salmon fishery in the lake. However, spawning runs of salmon to rivers (i.e., river-runs) have remained low. In 2010, we initiated a long-term adaptive management experiment focused on increasing river-runs of salmon to enhance in-river fisheries and restore natural populations. Examples of ongoing experiments include: (1) identifying indicators of smolting to optimize timing of stocking to periods when fish are likely to imprint on rivers and (2) evaluating alternative hatchery rearing methods. We identified gill Na+/K+ ATPase activity during the spring as a potential indicator of smolting for landlocked salmon but activity levels were much lower than observed in anadromous populations. We also observed a large impact of alternative hatchery rearing on adult returns to the Winooski River in 2013-2015. There was a sevenfold increase in adult return rate of smolts reared in river water with an ambient temperature profile compared to smolts reared on well water with an increased temperature profile. Our results demonstrate potential for rapid increases in river-runs using hatchery smolts combined with targeted research and adaptive management.

Evaluating Stocking Techniques for Atlantic salmon Fry (Ardren USFWS, Brunsdon, Fraser and Grant, Concordia University)-

Dispersal from nesting sites and habitat selection are essential for the fitness of young individuals and shape the distribution, growth and persistence of populations. These processes are important to consider when releasing young hatchery origin fishes into the wild to restore extirpated or depleted populations. By manipulating the density of released young-of-the-year (YOY) Atlantic salmon, we evaluated the effects of point- (releasing all the fish at one location) and spread-stocking (releasing the fish evenly over a complete reach) techniques on juvenile habitat use, dispersal, growth and survival in the Boquet River. Point-stocked YOY density decreased and growth increased with distance downstream, whereas spread-stocked YOY densities and growth were relatively constant over the reach. Overall, density, growth and survival did not differ between these two stocking techniques, likely due to the greater-than-expected mobility of fish in point-stocking reaches; YOY dispersed up to 1600m, with 41% moving over 200m downstream. As predicted from previous work, growth rate of individual fish was density-dependent, following a negative power curve. Our results provide insights into how the growth and survival of released individuals are altered via stocking techniques, ultimately shaping their distribution and growth rate. In the absence of detailed knowledge of reproductive and juvenile habitats, we suggest that an ideal method for stocking juvenile salmonids would be a combination of both point- and spread-stocking techniques. Point-stocking 2000-3000 fish at locations 400m apart throughout a river will allow for a relatively even distribution of densities throughout the reach by dispersal filling in the area in between each point-stock, while also using the entire habitat available. Furthermore, point-stocking 2000-3000 YOY together mimics the dispersal and competition that occurs in nature. This research was conducted as part of Eric Brunsdon's graduate thesis project at Concordia University.

Appendix 1. Members and Advisors of the Lake Champlain Fish and Wildlife Management Cooperative, Fisheries Technical Committee

U.S. Fish and Wildlife Service:

B. Young, B.J. Allaire, M. Lyttle, W. Ardren (FTC Chair),
Lincoln St., Essex Junction, VT
N. Staats – Liaison to VTDFW – West St., Essex Junction, VT
S. Smith – Liaison to NYSDEC – Lincoln St., Essex Junction, VT
H. Bouchard – North Chittenden, VT

Vermont Department of Fish and Wildlife:

B. Chipman, B. Pientka - Essex Junction, VT
C. MacKenzie, S. Good – Rutland, VT
K. Kelsey – Grande Isle, VT

New York State Department of Environmental Conservation:

L. Durfey, Tom Shanahan – Ray Brook, NY
R. Fiorentino, J. Pinheiro – Warrensburg, NY

University of Vermont:

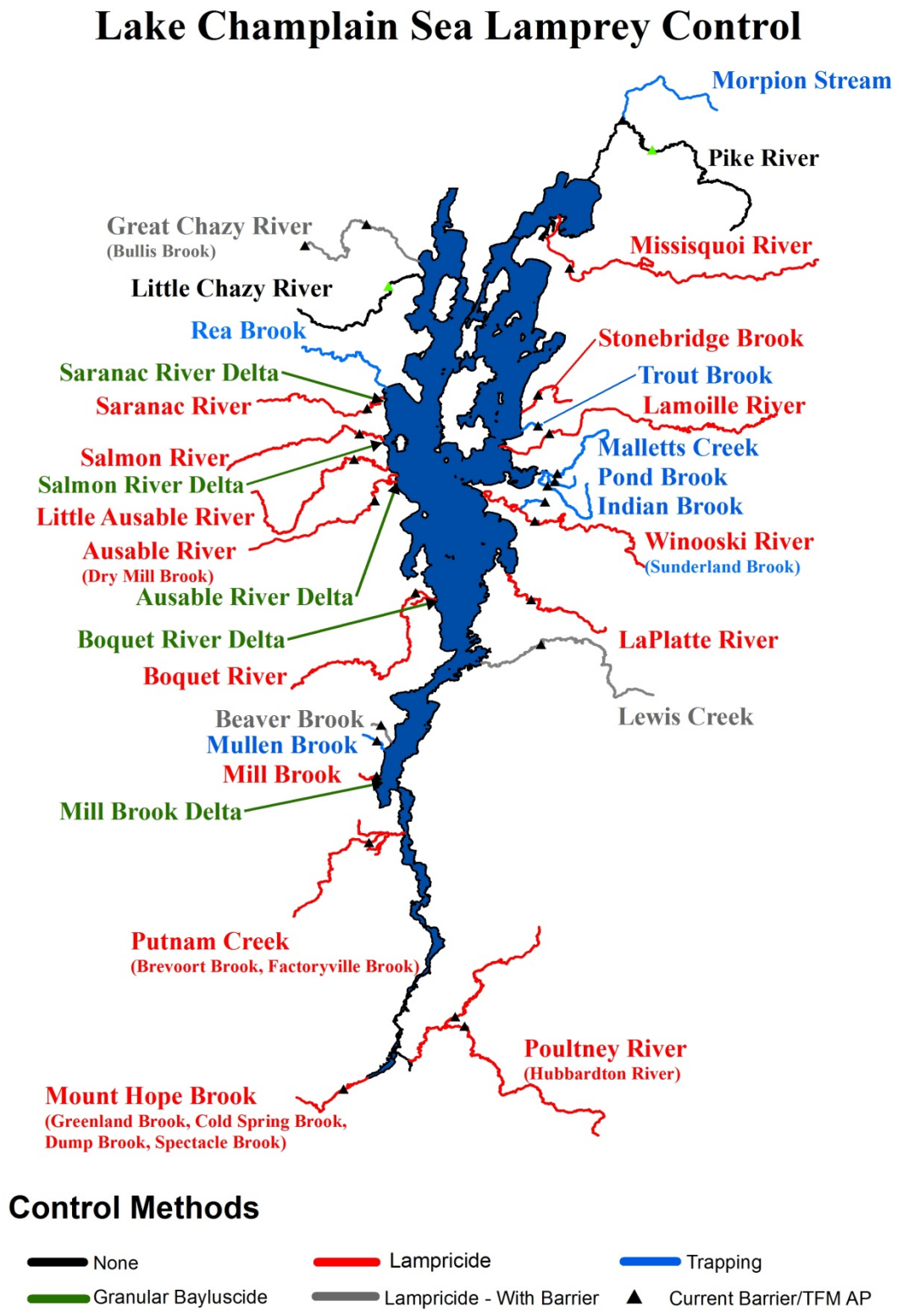
E. Marsden – Burlington, VT
A. Lochet – Burlington, VT

Vermont Cooperative Fish and Wildlife Research Unit (USGS):

D. Parrish – Burlington, VT

Lake Champlain Sea Grant:

M. Malchoff – Plattsburgh, NY



Appendix 2: Map of Lake Champlain tributaries included in the sea lamprey control program and control methods planned for use on those tributaries.

Appendix 3: Schedule of completed Lake Champlain lampicide treatments 1990-2016 and projected treatments through 2020. The "T" denotes completed TFM only treatments, "B" denotes completed Granular Bayluscide, "C" denotes completed TFM + 1% Niclosamide and "P" denotes proposed treatments. Note that in 2017, the geographic reorganization plan was completed by way of several off-schedule treatments. The result is the temporal and geographical alignment of treatments in the Lake Champlain Basin and new cycle of treatments in 3 out of every 4 years.

			90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
New York	WEST	Great Chazy River			T				T				T				T				T				T		T				P		
		Little Chazy River																													P		
		Rea Brook																													P		
		Saranac River			T																					C					P		
		Saranac Delta		B				B									B				B				B		T				P		
		Salmon River	T				T				T				T				T				T				T				P		
		Salmon Delta		B				B																			B				P		
		Little Ausable River	T				T				T				T				T				T				T				P		
		Ausables Delta Complex		B				B								B				B				B			B				P		
		Ausable River	T				T					T			T				T	T			T				T	T			P		
		Boquet River	T				T					T				T				T				C			C				P		
		Boquet Delta		B				B																			B				P		
	SOUTH	Beaver Brook	T								T					T				T									T			P	
		Mill Brook																			T				T							P	
		Mill Delta																			B				B							P	
		Putnam Creek	T				T				T				T				T				T			T			T			P	
		Mt. Hope Brook		T				T				T					T				T				T			T				P	
----		Poultney/Hubbardton rivers			T				T											T				T				T				P	
		Lewis Creek	T				T								T				T				T				T	T				P	
Vermont	EAST	LaPlatte River																											P				P
		Winooski River															T				T				T			T					P
		Trout Brook						T																									
		Stonebridge Brook		T																						T			P				P
		Lamoille River																				T				T							P
		Missisquoi River																			T				T				P				P