

LAKE CHAMPLAIN FISH AND WILDLIFE MANAGEMENT COOPERATIVE



FISHERIES TECHNICAL COMMITTEE

2022 ANNUAL REPORT

Approved at Lake Champlain Fish and Wildlife Management Meeting
August 29th, 2023



Bryan Ross (USFWS) with a large male salmon captured in the Saranac River using electrofishing.

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Executive Summary

Restoration efforts for native salmonids continued to be the primary focus of the Lake Champlain Fisheries Technical Committee (FTC) in 2021. Landlocked Atlantic Salmon were the focal species, accounting for approximately 60% of the fish stocked into the lake and its tributaries. Highlights from native salmonid management include:

- Eleven of 16 (69%) established fisheries indicators met target goals.
- Sea Lamprey wounding rate for all monitored species was below the target management level in 2022, a first.
 - Atlantic Salmon in the main lake was below the target level in 2022 (for 2 consecutive years now) and is one of the lowest observed rates in our monitoring history.
 - The wounding rate for Lake Trout is below the target level for the first time!
 - The wounding rate for Walleye also continues to be below the target level.
 - USFWS is developing a new assessment metric for adult Sea Lamprey to measure abundance. This will inform monitoring and treatment efforts.
- Atlantic Salmon
 - Fry stocking surveys in the Boquet and Ausable Rivers showed high survival and growth. Ongoing telemetry research in the Winooski River showed high rates of avian predation on stocked smolts near the Salmon Hole. This information was used to develop a stocking location change for 2023.
- Lake Trout
 - The proportion of unclipped Lake Trout was the highest observed since the stocking program began, with 26.2% of fish unclipped and considered reproduced from the lake. Stocking will be reduced again starting in 2024, to 50% of the stocking policy (stocking 41,000 Lake Trout in 2024).
- Condition factor for Atlantic Salmon and Lake Trout were both within the desired range in 2022.

Round Goby are an Aquatic Invasive Species of fish that is continuing to expand toward Lake Champlain from both the north and south ends of the lake. The Lake Champlain AIS Task Force is still developing a Rapid Response Implementation Plan to prevent the spread of Round Goby via the NYS Champlain Canal system. Through eDNA sampling using Metabarcoding, the USFWS did not detect any Round Goby at the 70 sites sampled throughout the lake and canals.

Monitoring efforts continued for Muskellunge, bass, Walleye, Yellow Perch, and Lake Sturgeon.

The Lake Champlain angler surveys continued for the second year.

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Introduction

Management of the fishery resources of Lake Champlain is coordinated by the Lake Champlain Fisheries Technical Committee (FTC), which is a workgroup of the Lake Champlain Fish and Wildlife Management Cooperative. Members and advisors of the FTC include staff from Vermont Fish and Wildlife Department (VTFWD), New York State Department of Environmental Conservation (NYSDEC), U.S. Fish and Wildlife Service (USFWS), University of Vermont (UVM), Vermont Cooperative Fish and Wildlife Research Unit (VTCFWRU), Quebec Ministry of Forestry, Wildlife and Parks (MFFP), Lake Champlain Sea Grant, and other universities.

This report briefly summarizes fisheries management and research activities carried out on Lake Champlain and its tributaries during 2022. The names of project leaders are listed after section headings and their affiliation can be found on the FTC Membership list at the end of this document (Appendix 1). Data presented in this report have not been peer reviewed and should be considered as provisional and subject to revision.

Salmonids

Salmonid Assessment Program for Lake Champlain (Salmonid Assessment Work Group)

A work group of the Lake Champlain FTC was established in 2014 with the goal of maintaining balanced and robust fish populations that provide a fishery for salmonids. The working group has five objectives: (1) evaluate status of salmonid populations; (2) evaluate the salmonid fishery; (3) evaluate salmonid hatchery production; (4) evaluate fish health status and impact of aquatic nuisance species; and (5) identify potential management actions. The working group reviewed relevant fisheries indicators that are part of annual monitoring efforts (Fisheries Technical Committee 2019).

In 2022, five of the 16 indicators fell out-of-bounds of the established thresholds (Table 1 and 2). Median total length of lake age-0 Atlantic Salmon *Salmo salar* was 376 mm and below the lower threshold of 390 mm for the second year in a row. Median weight of the top 10 Atlantic Salmon in the LCI derby was 2.48 kg, below the desired range of 2.86 to 3.68 kg. However, it should be noted that the LCI derby in 2022 was held during unfavorable conditions and the target of the top 10 Atlantic Salmon was not reached, indicating very few salmon were caught, which may skew the results. Similarly, the median weight and condition factor of Lake Trout *Salvelinus namaycush* from the LCI derby also were below the threshold. Although there were many more Lake Trout caught and entered compared to Atlantic Salmon, sample size was still below prior years. On a positive note, Sea Lamprey *Petromyzon marinus* wounding for Lake Trout was below the target threshold of <25 wounds/100 fish for the first time and wounding rate for Atlantic Salmon was below the threshold of <15 wounds/100 fish for the second year in a row. Proportion of Lake Trout unclipped was the highest observed since the stocking program began with 26.2% of fish unclipped and considered reproduced from the lake. This has led to discussion of another stocking reduction for Lake Trout in line with the recommendations of the indicators. Starting in 2024, the number of Lake Trout stocked will be reduced by 50% to 41,000 per year.

Table 1. Indicators and their thresholds for annually evaluating the state of landlocked Atlantic salmon, Lake Trout, walleye, and fish health in Lake Champlain. The median is the middle value of all values calculated. Condition factor describes the relative “plumpness” or “fatness” based on fish length and weight.

Species and Indicators	Thresholds or desired ranges	2022 Value	N
<i>Landlocked Atlantic Salmon</i>			
Pre-stock smolt size percentage > 150 mm	≥90 %	96%	2,803
Median Condition Factor – Lake Age 0	1.00 – 1.19	1.01	37
Median Condition Factor – Lake Age 1	0.86 – 1.01	0.94	319
Median Total Length – Lake Age 0	390 – 427 mm	376 mm	37
Median Total Length – Lake Age 1	494 – 562 mm	522 mm	498
Sea Lamprey Wounding Rate (lake-wide)	<15 wounds per 100	7.8	363
Median Weight of top 10 Atlantic Salmon from Lake Champlain International Fishing Derby	2.86 – 3.68 kg	2.48 kg	9
Median Condition Factor from Lake Champlain International Fishing Derby	1.01 – 1.22	1.09	9
<i>Lake Trout</i>			
Median Condition factor - Males	0.84 – 0.94	0.86	586
Sea Lamprey Wounding Rate (main lake)	<25 wounds per 100	23.1	221
Wild Lake Trout - Proportion Unclipped	≥15 %	26.2 %	149
Median weight top 10 Lake Trout from Lake Champlain International Fishing Derby	5.65 – 6.42 kg	5.07 kg	10
Median Condition Factor from Lake Champlain International Fishing Derby	0.93 – 1.09	0.91	90
<i>Salmonid Stocking</i>			
Number of salmonids stocked annually	512,000	497,432	
Landlocked Atlantic Salmon	304,000	312,211	
Lake Trout (new target 2022 – 54,120)	82,000	57,326	
Steelhead	58,000	59,247	
Brown Trout	68,000	68,648	
<i>Walleye</i>			
Median Condition Factor Walleye Males 350.5 – 475 mm	0.90 – 0.98	0.92	78
Health Testing Results	Detection of new disease	No Detection	490

Table 2. Indicators for annually evaluating the status of landlocked Atlantic Salmon, Lake Trout, and Walleye, and fish health in Lake Champlain. Condition factor describes the relative “plumpness” or “fatness” based on fish length and weight. **Status symbols:** Open Circle: Within desired ranges or threshold targets; Circle with X: Outside targets

Species and Indicators	2020 Status	2021 Status	2022 Status	2022 Value
<i>Landlocked Atlantic salmon</i>				
Pre-stock smolt size percentage	⊗	⊗	○	96%
Median Condition Factor – Lake Age 0	⊗	○	○	1.01
Median Condition Factor – Lake Age 1	○	○	○	0.94
Median Total Length – Lake Age 0	○	⊗	⊗	376 mm
Median Total Length – Lake Age 1	⊗	○	○	522 mm
Sea Lamprey Wounding (lake-wide)	⊗	○	○	7.8
Median Weight of top 10 Atlantic Salmon in Lake Champlain International Fishing Derby	○	○	⊗	2.48 kg
Median Condition Factor from Lake Champlain Inter. Derby	○	○	○	1.09
<i>Lake Trout</i>				
Median Condition Factor - Males	○	○	○	0.86
Sea Lamprey Wounding (Main-lake)	⊗	⊗	○	23.1
Wild Lake Trout - Proportion Unclipped	○	○	⊗	26.2 %
Median Weight of top 10 Lake Trout in Lake Champlain Inter. Derby	○	○	⊗	5.07 kg
Median Condition Factor from Lake Champlain International Fishing Derby	○	○	⊗	0.91
<i>Salmonid Stocking</i>				
Number of salmonids stocked annually	○	○	○	497,432
<i>Walleye</i>				
Walleye Median Condition Factor (Males 350 –475 mm)	NS	⊗	○	0.92
<i>Other</i>				
Fish Health Testing Results	○	○	○	ND

Stocking Summary (Balk)

Most salmonid stocking targets were met or exceeded in 2022 (Table 3). Shortages occurred for Brown Trout in the Main Lake and for Atlantic Salmon in Malletts Bay/Inland Sea but are within the +/- 10% that is allotted for stocking.

Table 3. Numbers* of salmonids stocked in Lake Champlain during 2022, and stocking targets for the lake.

Species	Main Lake		Malletts Bay/Inland Sea		Total number stocked in 2022
	Target	2022	Target	2022	
Atlantic Salmon	227,000	237,168	77,000	75,043	312,211
Lake Trout	57,000	57,326	0	0	57,326
Steelhead	53,000	54,247	5,000	5,000	59,247
Brown Trout	38,000	36,098	30,000	32,550	68,648
Total	375,000	384,839	112,000	112,593	497,432

*Atlantic Salmon in smolt equivalents (some fry stocked in tributaries); all others are fingerlings

Lake Trout *Salvelinus namaycush* (Pientka, Smith)

Annual fall nearshore salmonid sampling occurred from mid to late November 2022 to assess population structure, response to Sea Lamprey control, and provide broodstock for hatchery production. Biological data are collected from each fish including total length, weight, sex, as well as Sea Lamprey wounding data.

Traditional sites in Willsboro and Whallon bays were sampled with boat electroshocking, with an overall catch of 305 Lake Trout. Eighteen percent of the fish were unclipped (wild). A trap net was deployed in Hatchery Cove for three overnight sets in early November to sample the Lake Trout spawning aggregation, yielding 502 Lake Trout, of which 1% were unclipped. This is within the clipping error indicating Hatchery Cove adult spawners are mostly of hatchery origin and may reflect homing behavior as there is not great spawning habitat at this location (better habitat outside of the breakwall to the cove). The percentage of wild (unclipped) fish at other locations may better represent the actual percentages within the lake wide spawning population. The wide range of lengths of male and female Lake Trout collected by trap net in Hatchery Cove and by electrofishing in Whallon Bay show a strong population with lake trout total lengths exceeding 800 mm (Figure 1). These sites sample spawning populations which is evident by the lack of smaller fish.

Beginning in summer 2020 Lake Trout gillnetting was implemented. This sampling repeated the sampling that occurred during the 8 year experimental program (1989-1997). The primary objective was assessment of unclipped Lake Trout in the main lake area of Lake Champlain. In 2022, a total of 359 Lake Trout were captured of which 21% were unclipped. This was an increase from the 2021 value of 14%.

No juvenile sampling occurred in 2022.

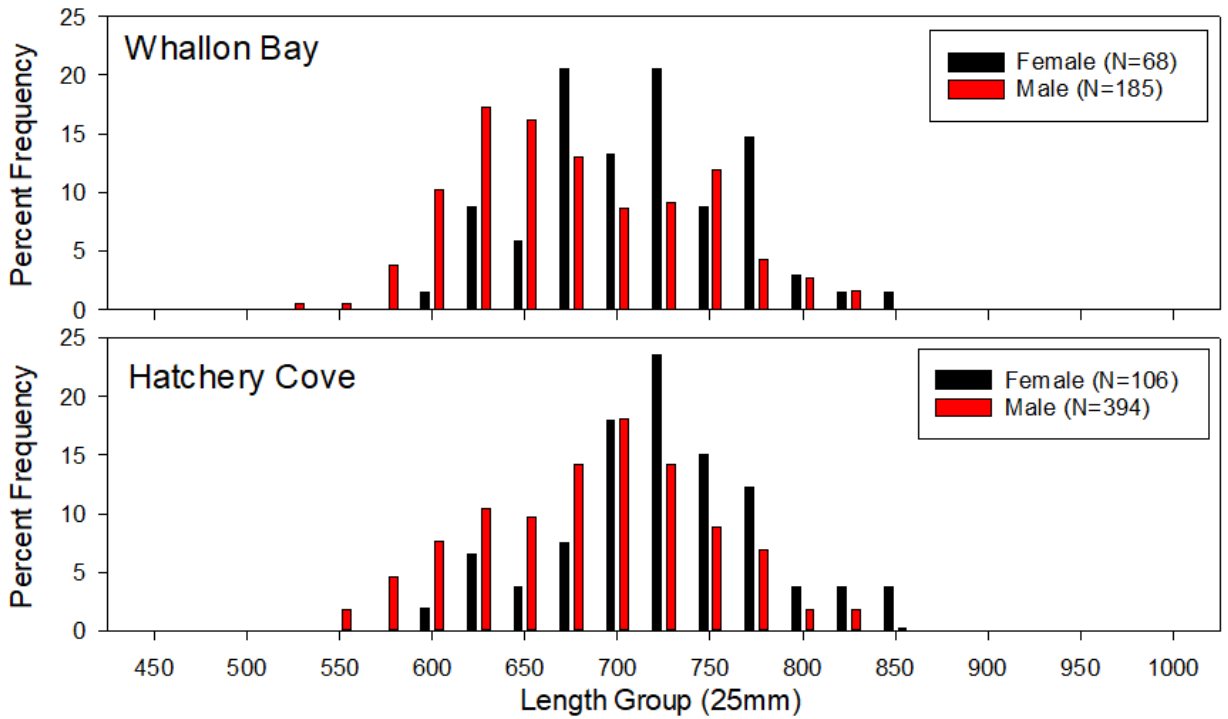


Figure 1. Length frequency distributions of male and female Lake Trout collected by trap net in Hatchery Cove and by electrofishing in Whallon Bay, November 2022.

Atlantic Salmon *Salmo salar*

Based on the 2020 Strategic Plan, the objective for this species is to maintain a lake and tributary fishery, while restoring natural reproduction. The key components to successful management of this species are annually monitoring the success at the hatcheries contributing to the Lake Champlain Atlantic Salmon program and monitoring and assessment of population trends in the lake fishery as well as those related to the Lake Champlain Landlocked Atlantic Salmon River-run Plan (Lake Champlain Fisheries Technical Committee 2022). Additional research associated with these efforts is highlighted in the “Research” section of this report.

Hatchery Propagation and Stocking Updates (Hanlon, Kelsey, Pientka, Earley, Heim)

Stocking - As indicated in Table 3, 312,211 Atlantic Salmon smolts or smolt-equivalent fry were stocked into Lake Champlain in 2022. Overall, 96% of the fish stocked exceeded the 150 mm total length criteria set for smolt transformation.

Table 4. Pre-stocking assessment of yearling Atlantic Salmon stocked in Lake Champlain. Total number of yearling Atlantic Salmon stocked and the number that reached the viable smolt size (greater than or equal to 150 mm total length) are reported for stocking years from 2012-2022 (Note: 198,000 fry were stocked by Adirondack in 2022 which represents 9,900 smolt equivalents).

Hatchery (agency)	Year	Mean Size (mm)	Numbered Sampled	% Viable Smolts	Total Stocked	Viable Smolts Stocked
Adirondack (NYSDEC)	2017	167	400	85.8	45,000	38,610
	2018	172	400	90.3	45,000	40,635
	2019	183	100	94.0	12,730	11,966
	2020	167	200	85.5	45,000	38,475
	2021-22	NA	NA	NA	NA	NA
Ed Weed FCS (VTFWD)	2017	190	1,100	99.7	160,028	159,548
	2018	191	900	99.7	139,128	138,711
	2019	181	900	99.7	139,411	138,993
	2020	182	900	99.7	158,663	158,187
	2021	188	900	100	149,595	149,595
	2022	185	1,000	99.3	144,543	144,531
Eisenhower (USFWS)	2017	161	1,800	80.7	113,947	91,955
	2018	153	1,431	67.1	85,510	57,377
	2019	165	1,100	91.7	69,651	63,870
	2020	158	1,500	68.7	90,835	62,404
	2021	157	1,600	71.8	157,196	112,867
	2022	169	1,803	94.3	157,768	148,775
Overall	2017	171	3,300	91.0	318,975	290,113
	2018	168	2,731	87.8	269,638	236,723
	2019	173	2,100	96.9	221,792	214,829
	2020	167	2,600	88.0	294,498	259,066
	2021	175	2,500	85.6	306,791	262,462
	2022	175	2,803	96.0	302,311	292,306

Broodstock evaluation - The USFWS continues to maintain two Atlantic Salmon broodstocks, thiamine deficiency tolerant (TDT) and maximum diversity (max-diversity), at White River National Fish Hatchery. Within-year-class crosses of the 2018 and 2019 year-class fish were used to establish the 2022 broodyear fish. The number of unique families used to establish the 2022 broodyear was around 260 families for each of the TDC-tolerant broodstock and the max-diversity broodstock. Among these broodstocks, a total of 1,012,006 green TDC eggs and 985,910 max-diversity eggs were taken for the 2022-year class with 55% eye up for both groups. Average fecundity was approximately 4,330 and 3,548 per female for the 2018 and 2019 broodstock, respectively. A total of 317,155 eyed eggs were transferred from White River NFH to Dwight D. Eisenhower NFH where they will be reared to the smolt stage and stocked into Lake Champlain tributaries in 2024, specifically, the Winooski, Boquet, and Saranac rivers. Additionally, 291,731 eyed eggs were transferred from White River NFH to the NYSDEC Adirondack hatchery where they were reared and stocked as fry in two New York tributaries in spring 2023, the Boquet and Ausable rivers. About 297,000 Atlantic Salmon are housed at the White River NFH tank room until June, when they are transferred to the Dwight D. Eisenhower NFH for further grow-out; these fish will be used for Lake Ontario restoration efforts. An additional 18,000 eggs were dedicated to salmon in the classroom efforts in Vermont and New York.

Feral Atlantic Salmon Broodstock - Utilizing feral broodstock for smolt production at Ed Weed FCS began in 1998. The enhanced performance of Atlantic salmon smolts derived from eggs obtained from feral broodstock has been documented by previous evaluations conducted on Lake Champlain. Adult broodstock are primarily sourced at a fish trap on the outfall of Ed Weed FCS, with some adults also being sourced during fall sampling assessments on the Lamoille River. The broodstock are individually sampled for length and weight. Each fish receives a floy tag and then is transported to an isolation holding area at the facility exclusively designed for biosecure spawning.

Spawning is conducted using single paired random mating. Year class crossing (identified by size) is applied to the greatest extent possible. Strict biosecurity protocols are applied throughout the spawning events, currently using day spawn isolation techniques. Fertilized eggs are water-hardened, disinfected in a 50ppm iodophor solution for thirty minutes, followed by a 10,000ppm bath of thiamine mononitrate for one hour. This egg bath technique was developed in collaboration with the USGS Tunison Laboratory in 2013 as a more effective and efficient way to treat for thiamine deficiency complex (TDC) when compared to bath treatments of newly hatched sac fry. All eggs collected are held in isolation until fish health diagnostic clearance is received before transferring to the early rearing production incubation room.

A total of 473,571 eggs were collected from seven egg takes between November 4-23. 156 pairs were spawned with an average fecundity of 3,093 per female. The average eye-up percentage for the seven takes combined was 67%. These eyed eggs will be used to produce smolts at Ed Weed FCS for direct lake entry and tributary stockings in the Lake Champlain basin.

River-run Restoration and Fall Nearshore and Tributary Returns (Earley, Heim, Pientka, Simard, Balk)

Thiamine - Thiamine deficiency complex is believed to be a major obstacle to successful natural reproduction of Atlantic Salmon in Lake Champlain (Harder et al. 2018, 2020; Ladago et al. 2020). In 2022, mean total egg thiamine concentration was 3.65 nmol/g (sd = 1.76, max = 9.75, min = 1.66), the lowest it has been since 2017 (Figure 2). Out of 30 individuals sampled, 20 were below 4 nmol/g (66%), 14 were below 3 nmol/g (46%), and 4 were below 2 nmol/g (13%). The time-series displays a notable cyclical trend with peaks around 2008, 2015, 2019. The cause for variation in total thiamine concentration across years remains unknown. Potential explanations include either a variation in the proportion of Alewife in Atlantic salmon diets, or variation in the enzymatic activity of thiaminase present in Alewife. The results from 2022 highlight a continued concern for impacts of low thiamine on the viability of Atlantic Salmon eggs produced in the wild. This is an active topic of research and focus of several studies being conducted by the Lake Champlain Fish and Wildlife Management Cooperative.

Adult Returns - Sampling in the tributaries has been completed by different agencies for different purposes using a variety of gear and effort. In New York tributaries, USFWS has been attempting to capture returning adults in the Saranac, Ausable, and Boquet rivers to collect tissue samples for genetic analysis to inform the Parental-based Tagging effort (see Research). Sampling in the Fall of 2022 went well with 149 unique Atlantic salmon captured (27 recaptures). Anglers were recruited to collect genetic samples, providing an additional 11 samples, for a total of 160 samples in 2022. High water levels made hoop netting impossible during a large portion of the survey period on the Saranac and Ausable rivers in 2022. Opportunistic electrofishing was added in 2022 at the Saranac River with high success, collecting 51 out of 92 samples using this method; the rest were caught using overnight trap net sets.

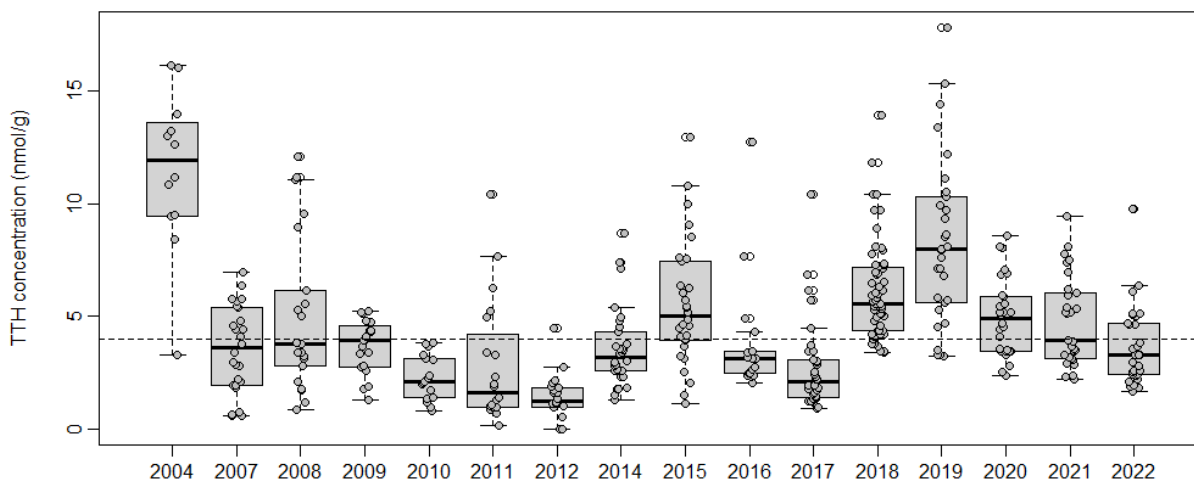


Figure 2. Total thiamine concentration in eggs collected from feral Atlantic salmon at Ed Weed Fish Culture Station from 2004 (prior to Alewife introduction) to present. The dotted line represents the threshold of 4 nmol/g that has been established for lake trout; a threshold that has not been established for Atlantic salmon.

Fall Nearshore and Tributary Sampling - Fall nearshore sampling occurred from mid to late November 2022 at traditional sites in Willsboro and Whallon bays. One hundred forty Atlantic Salmon were captured, slightly more than in 2021. While some older, larger fish were collected the catch was dominated by smaller Atlantic Salmon that were stocked in spring of 2022 (Figure 3).

Fall electrofishing in the Lamoille River captured 136 Atlantic Salmon in twenty trips. No electrofishing trips occurred on Otter Creek. Eighteen electrofishing trips occurred on the Missisquoi River with 25 Atlantic Salmon captured. Although the fall run started later than typical, the number of salmon collected in the fall 2022 tributary runs were generally strong. For example, Lamoille River salmon returns were the highest observed since 2015. Winooski River salmon returns were the highest observed since 2014.

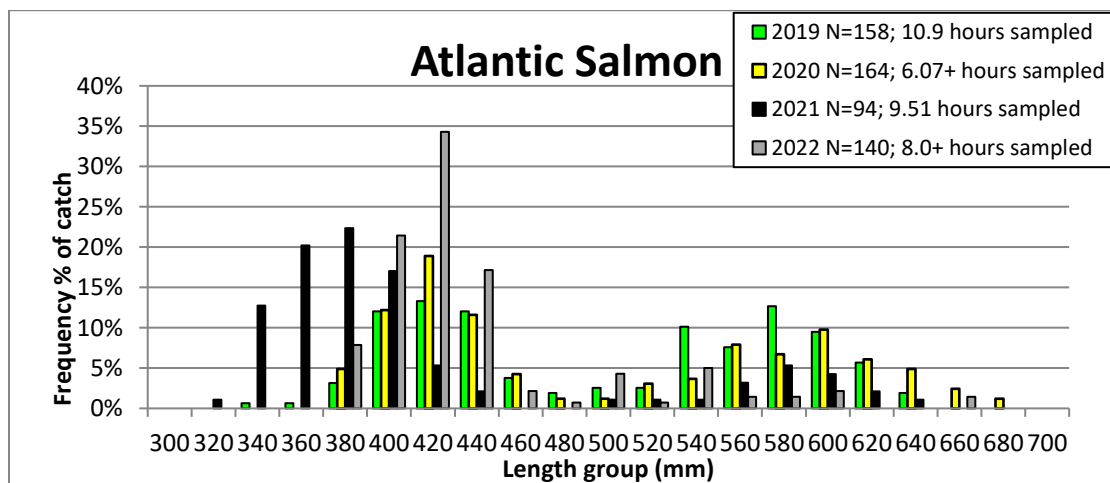


Figure 3. Length frequency distributions of Atlantic Salmon collected from Willsboro and Whallon bays by electrofishing, 2019-2022.

The Hatchery Brook trap was operated from September 15 to November 23, 2022 to assess fall populations and collect salmon for feral broodstock. Typically, the trap is only operated until November 15th, but due to late run the operation continued. During fall, 416 Atlantic Salmon were captured and processed along with 7 Brown Trout and 7 steelhead. A total of 156 adult Atlantic salmon pairs were spawned at Ed Weed FCS in fall 2022. Thirty-one individuals were lethally sampled for disease testing; all others that survived were released.

Unlike Willsboro and Whallon bays, length frequency distributions of Atlantic Salmon captured in Hatchery Brook and Lamoille River appeared to have more larger fish compared to previous years with both rivers peaking at 525 mm total length (Figure 4). Age distributions of salmon from these two sites are generally similar to past years. Lake age-1 made up a high percentage of the catch in 2022. Lake age-2 were approximately 20 percent of the catch (Figure 5). This is a higher percentage than many of the past years and may indicate that survival beyond age-1 is increasing.

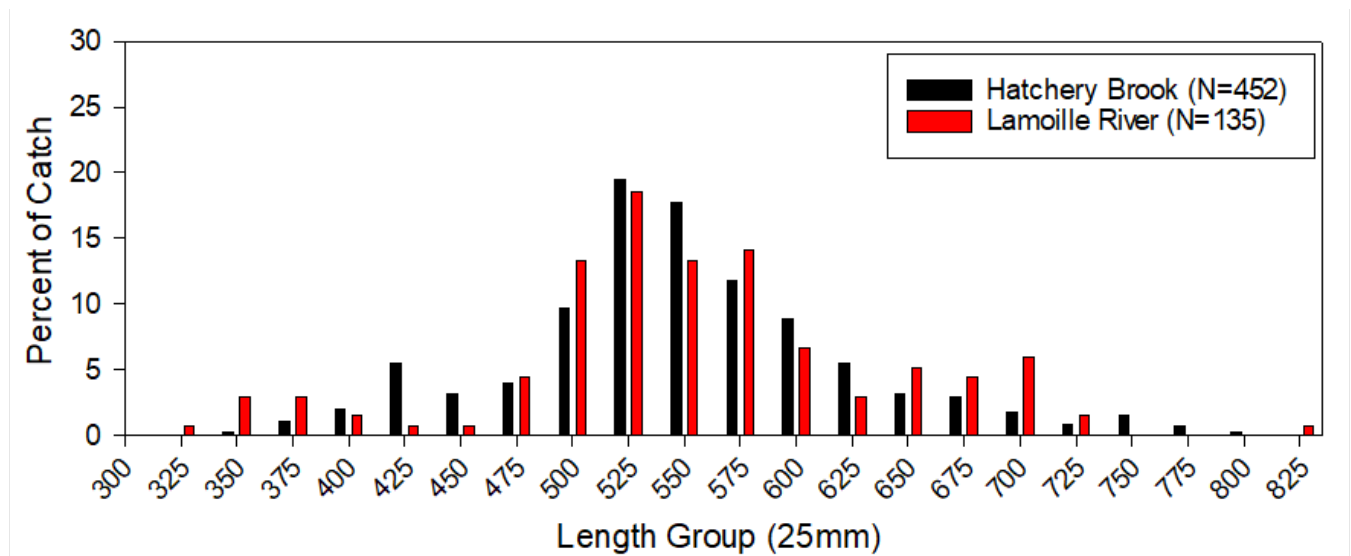


Figure 4. Length frequency distributions of Atlantic Salmon collected from fall spawning runs in Hatchery Brook and Lamoille River in 2022.

Habitat Assessment- Understanding and improving stream habitat is fundamental to strategic restoration of river-run populations of landlocked Atlantic Salmon in Lake Champlain. Few assessments have been conducted to evaluate habitat suitability for Atlantic Salmon in Lake Champlain tributaries. The USFWS has been collecting habitat data that will be used to estimate habitat availability for each life stage of Atlantic Salmon within each of the targeted rivers. These data can be incorporate into life cycle models, used to set appropriate restoration targets, and used to develop appropriate stocking levels. Through initial efforts in 2021 on the Saranac River and in 2022 on the Boquet River, USFWS has identified that modifications need to be made to the protocol, but will continue to complete surveys in 2023. A summary report for 2021 and 2022 also will be finalized in 2023.

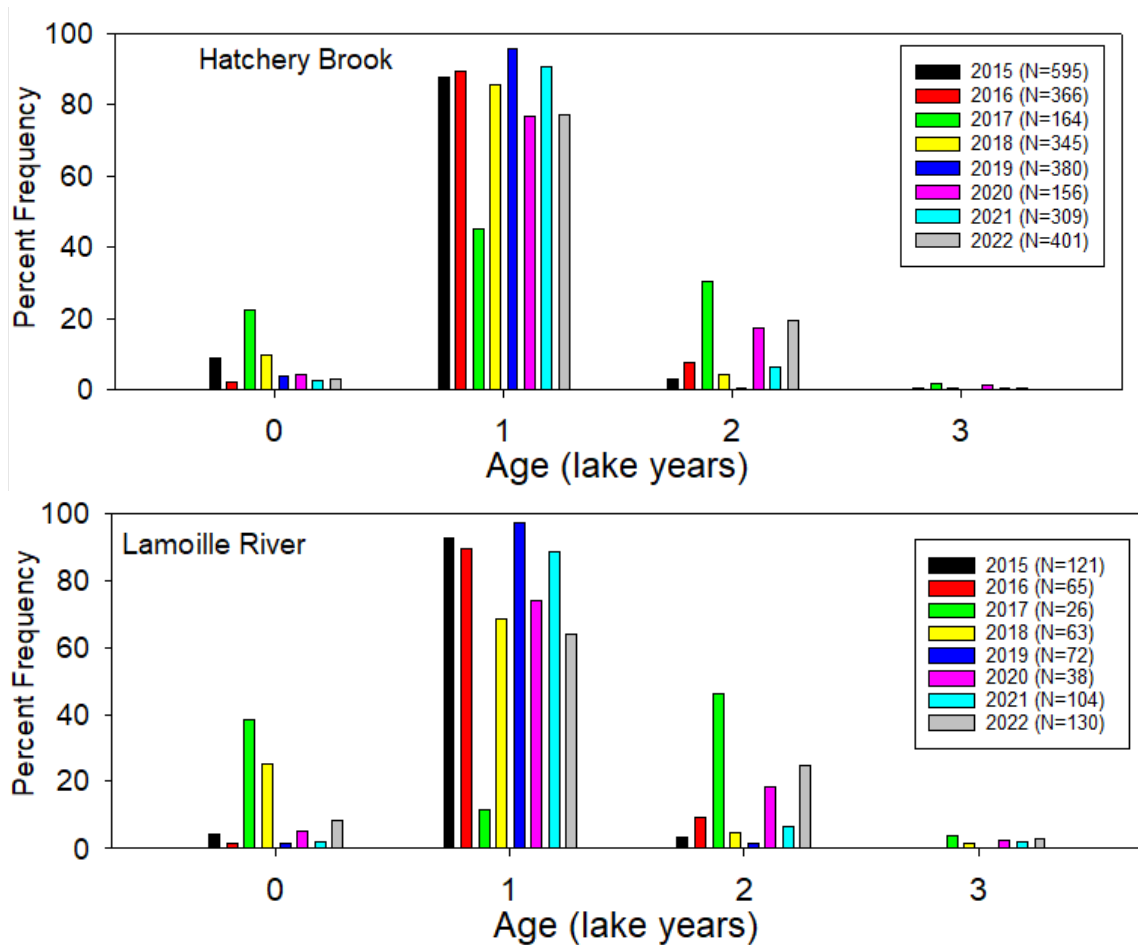


Figure 5. Age distributions (lake years) of Atlantic Salmon from Lamoille River and Hatchery Brook, 2015-2022.

Fish Passage (Simard)

Winooski One Dam Fish Lift – In 2022, 128 Atlantic Salmon were trapped at the Winooski One fish passage facility in the fall (Figure 6). For the Atlantic Salmon, 66 were female, 61 were male, and one was immature. Fin clips and scales were used to age 121 Atlantic Salmon of which 106 (87.6%) were lake age-1, 10 (8.3%) were lake age-2, and two (1.7%) were lake age-3. Three Atlantic Salmon (7.8%), including the one immature fish, were lake age-0. Of the lake age-1 fish, 44 (41.5%) were from those stocked below the Essex 19 Dam while 51 (48.1%) were from those stocked below Winooski One dam in 2021. Genetic testing to determine from which brood stock (Max Gen vs. Low TT) the returning fish originated has not been completed. Following processing, Atlantic Salmon were transported above the next two dams and released into the Winooski River in Richmond.

Atlantic Salmon returns reached their fourth highest total since the fish lift began operating in 1993. Atlantic Salmon smolt stocking locations were adjusted in 2021 with the 44,000 stocked smolts being split between release locations below Essex 19 and Winooski One to assess whether stocking further upstream would increase return rates. The relatively strong return year in 2022 might be attributable to this stocking location adjustment but could also be due to the low Sea Lamprey wounding rates

observed in Lake Champlain; the favorable weather conditions during the fall lift season, specifically, periods of high flow corresponding with cooler water temperatures; or other unknown causes. The stocking location experiment will continue through 2024 with assessments continuing until 2025. Results of the assessment will be critical to informing future Atlantic Salmon management strategies on the Winooski River.

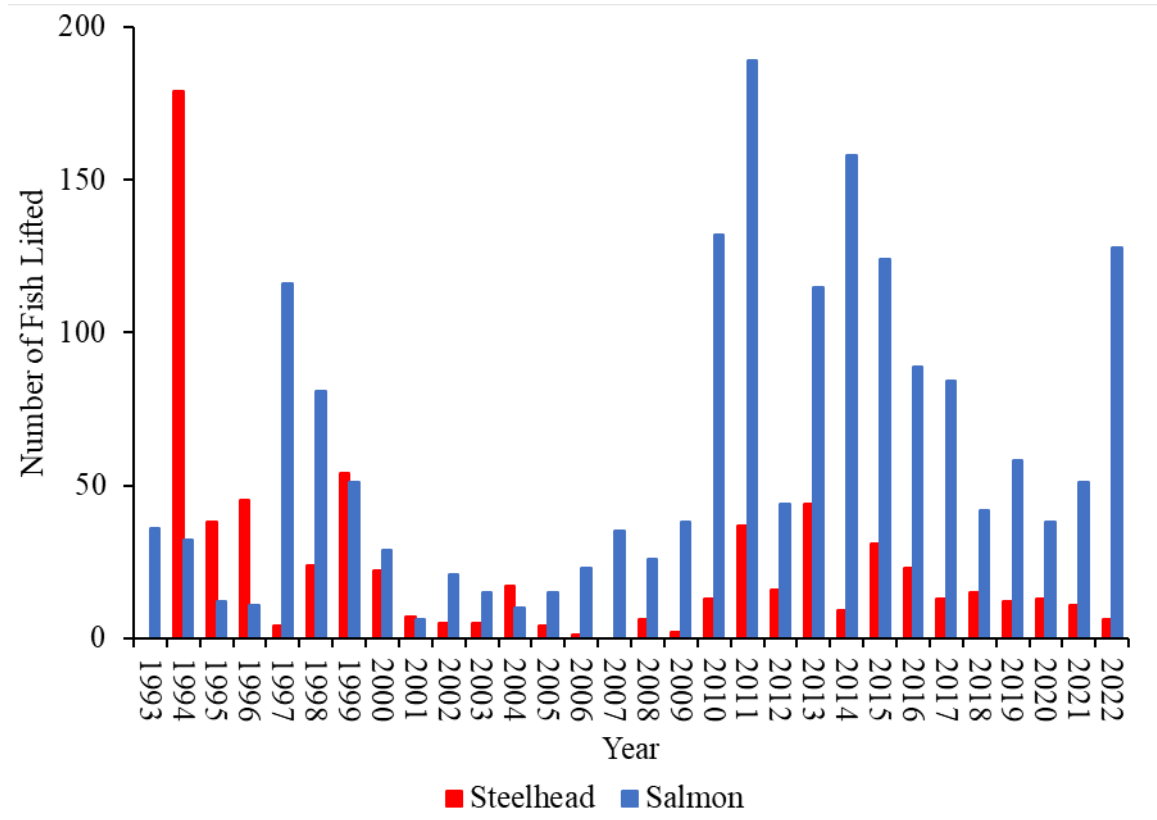


Figure 6: Number of steelhead trout (spring season) and Atlantic Salmon (fall season) lifted at the Winooski One fish passage facility, 1993-2022.

Steelhead *Onchorhynchus mykiss*

In 2022, six steelhead were trapped at the Winooski One fish passage facility in the spring. One additional steelhead was lifted during the fall season. All steelhead were released directly above the Winooski One dam. Overall, spring steelhead return rates remained very low. Approximately 20,000 steelhead are stocked into the Winooski River each year. However, other than three slightly higher returns in 2011, 2013, and 2015, no more than 23 steelhead have returned to the lift in a given year since 2000, with most years not exceeding 15 fish.

Petromyzontids

Sea Lamprey *Petromyzon marinus*

Pre-treatment Larval Assessment Surveys (Allaire)

Streams are typically surveyed the year prior to a scheduled lampricide treatment to confirm that a treatment is needed. In 2022, Lake Champlain tributaries including Lewis Creek, Poultney River,

Hubbardton River, Mount Hope Brook, Putnam Creek, Mill Brook, Beaver Brook, and Hoisington Brook were all surveyed to determine if a fall 2023 lampricide treatment would be needed. From these surveys, it was determined that lampricide treatments are needed in Lewis Creek, Poultney River, Mount Hope Brook, and Putnam Creek. No Sea Lamprey larvae were found in reach 2 of Lewis Creek (upstream of Ferrisburgh Fall), in the Hubbardton River, or in Hoisington Brook. Very few Sea Lamprey larvae were found in Mill Brook and Beaver Brook. Targeted surveys will be done in those tributaries in 2023 before making a final determination if a lampricide treatment will be needed or not.

Post-treatment Larval Assessment Surveys (Allaire)

Post-treatment larval surveys are conducted the year following a lampricide treatment. No lampricide treatments were conducted in the Lake Champlain Basin in 2021, so no post-treatment surveys were needed in 2022.

Other Larval Assessment Surveys (Allaire)

Due to the closure of the US – Canada border, Sea Lamprey larval surveys were not conducted in the Pike River or Morpion Stream in Quebec in 2020 or 2021. These tributaries had been surveyed annually between 2014 and 2019 to monitor changes in larval densities and determine the effectiveness of the Morpion Barrier. In 2022, larval surveys were completed in Morpion Stream and the Pike River. During the 2022 larval surveys it was expected that large numbers of 1+ and 2+ year old larvae would be found and that these would reflect the uncontrolled spawning activities that occurred in the spring of 2020 and 2021. This was not the case and few sea lamprey larvae were collected during the survey. The low catch numbers in both the Pike River and in Morpion Stream in 2022 were surprising. Note that Sea Lamprey larval surveys in the Pike River and Morpion Stream are typically done in August, but in 2022 surveys were not completed until late October and early November due to a very busy larval assessment and lampricide treatment season in other areas of the Lake Champlain Basin. Water temperatures were cold (<10°C). Larvae caught were often very slow to react, which is common when sampling in cold water. The Morpion Barrier was not installed in 2021, but traps and barriers were installed in a number of other tributaries throughout the basin. In 2021, a record low catch total was observed for many of the adult traps. It is likely that the number of adult Sea Lamprey migrating in the Pike River and Morpion Stream was also down in 2021. Larval surveys will continue, hopefully under better stream conditions, and it can be determined if this year's catch totals were artificially low or if they were an accurate representation of the larval population.

Delta Larval Assessment Sampling (Allaire)

Delta surveys are typically conducted in the same year as a scheduled delta treatment to limit the time for larvae to relocate between surveys and treatments. In preparation for possible delta treatments in the fall of 2022, delta surveys were conducted on the Saranac, Salmon, Ausable, and Boquet deltas. Based on results of these surveys, Bayluscide treatments were conducted on select areas of the Saranac, Salmon, and Ausable Deltas. Very few Sea Lamprey larvae (2) were found on the Boquet Delta, and no delta treatment was needed.

Detection Sampling (Allaire)

In 2022, staff conducted surveys in a number of streams in the northwest quadrant of Lake Champlain including a few tributaries in Quebec. No new Sea Lamprey larval populations were found.

Trapping (Allaire)

After Covid-19 shut down all trapping operations in the Lake Champlain Basin in 2020 and in Quebec in 2020 and 2021, normal trapping operations resumed in 2022. This included operating a trap in the Great Chazy River for the first time since 2015. In 2022, a mark-recapture program began, where adult Sea Lamprey are given a fin clip and released downstream. The number of marked vs. unmarked adults will be used to calculate adult spawning abundance.

Adult Sea Lamprey were trapped in 8 tributaries to Lake Champlain (4 in Vermont, 3 in New York, and 1 in Quebec) during the spring of 2022 (Table 5). A few Sea Lamprey pot traps were also placed in the Pike River to see if we could catch a number of adults with minimal effort.

Barriers (Allaire, Young)

LaPlatte River – In 2022, a low-head barrier was completed on the LaPlatte River at Shelburne Falls (Figure 7). The barrier will prevent Sea Lamprey from accessing over 10 miles of upstream spawning and larval habitat. This will eliminate the need to conduct lampricide treatments in this upstream area, where a large population of Stonecats *Noturus flavus* are present (Vermont state listed species – Endangered).



Figure 7. New low-head barrier on the LaPlatte River at Shelburne Falls in Vermont.

Great Chazy River – Adult lamprey have been using cracks in the bedrock under the Frog Farm Dam (also known as the Whiteside Dam) to access over 13 miles of upstream spawning and larval habitat. Phase I was completed in 2021 and included the dewatering of a large area above the dam, using ground penetrating radar, drilling 96 holes and injecting over 16 cubic yards of grout. In 2022, Phase 2 of work to block adult Sea Lamprey from passing under the dam was completed. Phase 2 included work in Mill Race, a side channel just above the dam. Mill Race was dewatered and over 36 cubic yards of cement was added to fill in fissures (Figure 8). If successful, this work will reduce future lampricide treatment time by over 70%.



Figure 8. Fissures in Mill Race side channel before (left) and after filling with cement (right) at Frog Farm Dam in NY.

Table 5. Results of spawning phase Sea Lamprey trapping in 2022.

Date Set	State / Province	Stream	Date Removed	% Days Operational	Lamprey Captured	5 Year Avg	% Change From 5 Year Avg
4/11/22	NY	Beaver Brook	6/21/22	91.5%	0	16	-100%
4/12/22	VT	Trout Brook	6/23/22	NA	2	21	-90.4%
4/18/22	VT	Malletts Creek	6/21/22	82.8%	53	131	-59.5%
4/4/22	VT	Pond Brook	6/16/22	97.4%	7	67	-89.6%
4/4/22	VT	Sunderland Brook	6/16/22	100%	21	21	-
4/11/22	NY	Mullen Brook	6/23/22	78.1%	62	36	+72.2%
4/26/22	NY	Great Chazy River	6/21/22	100%	845	NA	NA
5/3/22	QC	Morpion Stream	6/21/22	89.8%	83	127	-34.6%
5/6/22	QC	Pike River	6/21/22	NA	1	NA	NA
TOTAL					1074		

Lampricide Control (Smith)

Lampricide treatments were completed on six tributaries and three delta areas in 2022 (Table 6). Control status of Lake Champlain tributaries is presented in Figure 9. A treatment history and schedule of future treatments is presented in Appendix 2.

Table 6. Summary of 2022 lampricide applications in tributaries to Lake Champlain.

Stream or delta	Date treated	Discharge (CFS)	TFM (lbs. active ingredient)	Bayluscide (lbs. active ingredient)	Length treated miles (acres)
Great Chazy River	10/18-21/22	140	2,134		20.6
Saranac River	10/12/22	700	1,360	19	2.5
Saranac River delta	10/14/22	NA		293	(59)
Salmon River	09/13/22	16-60	285		4.0
Salmon River delta	09/14/22	NA		55	(11)
Little Ausable River	09/29/22	20	375		5.3
Ausable River	10/3/22	415	1,882		7.0
Ausable River delta	10/5/22-10/6/22	NA		689	(140)
Boquet River	09/22/22	300	766	12	2.6
TOTAL			6,802	1,068	42, (210)

Lake Champlain Sea Lamprey Population Distribution and Control Methods

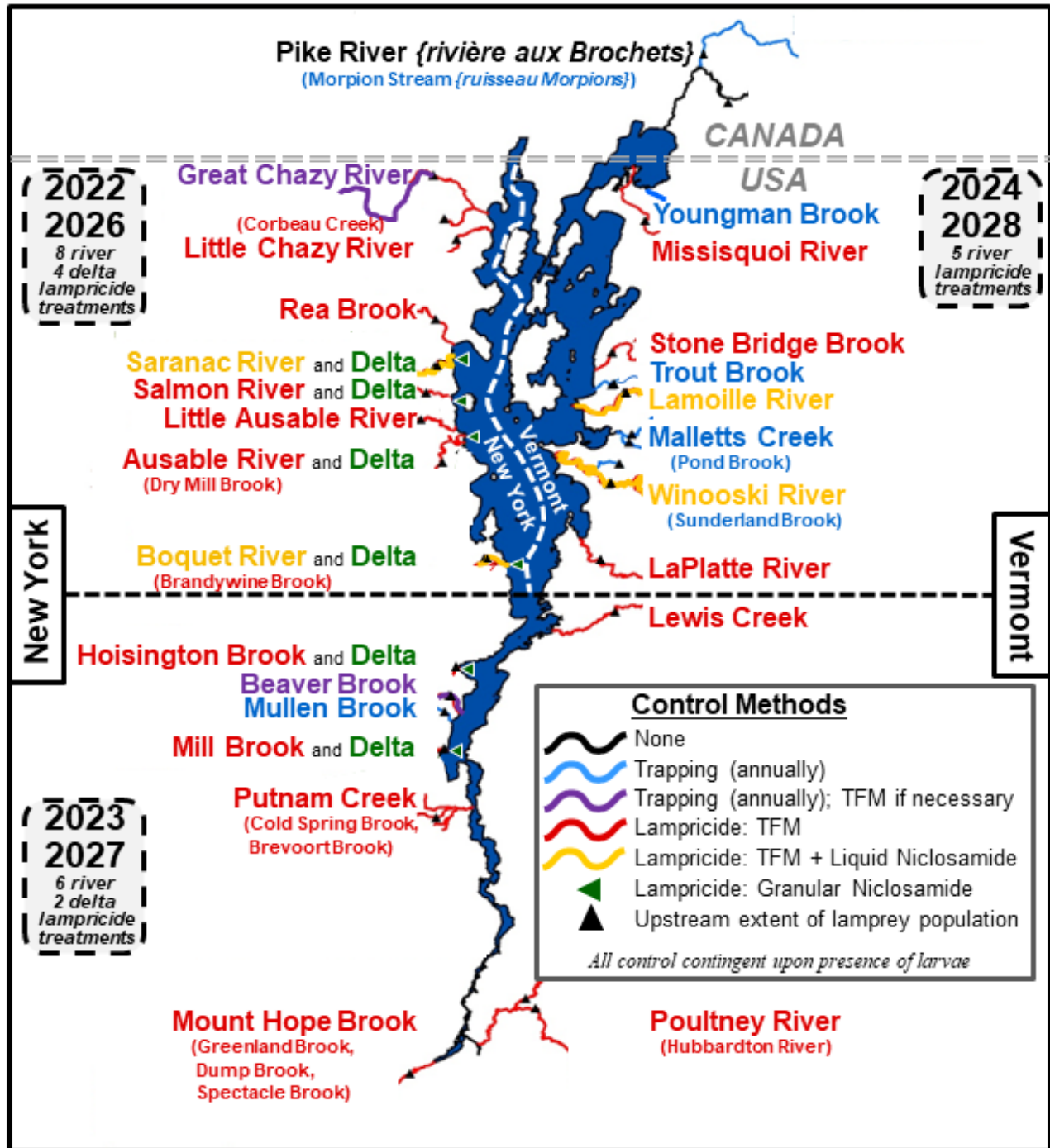


Figure 9. Map of waters for scheduled Sea Lamprey control treatments and monitoring.

Wounding Rates (Pientka, Smith)

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 Atlantic salmon, and 2 wounds per 100 Walleye.

Sea Lamprey wounding rates calculated for 533-633 mm TL Lake Trout collected in fall 2022 decreased to 23.1 wounds per 100 fish (n=221), which is below the program objective of 25 (Figure 10). This is the first time Lake Trout wounding rate has dropped below the management target. The 2022 wounding rate estimate for Atlantic Salmon in the 432-533 TL interval increased slightly to 7.8 wounds per 100 fish (n=363) but remains below the program objective of 15 (Figure 16).

The wounding rate index as a metric to gauge Sea Lamprey abundance has received increased scrutiny in recent years in the Great Lakes and Lake Champlain. The number of different variables that affect the index are difficult to individually quantify and can lead to misleading interpretations. This issue has led to investigations into new approaches in the Great Lakes that more accurately measure Sea Lamprey abundance. We are coordinating with our partners in the Great Lakes and are in the process of developing a new adult assessment metric that will provide better information on the response of the Sea Lamprey population to control efforts.

The Sea Lamprey wounding rate assessment for Walleye (534 - 634 mm TL) was planned for the Missisquoi River in 2022. Sea Lamprey wounding rate for Walleye from Missisquoi River (1.2 wounds per 100, n=343) was below the management target of 2 wounds per 100.

Lake Champlain Sea Lamprey Wounds per 100 fish

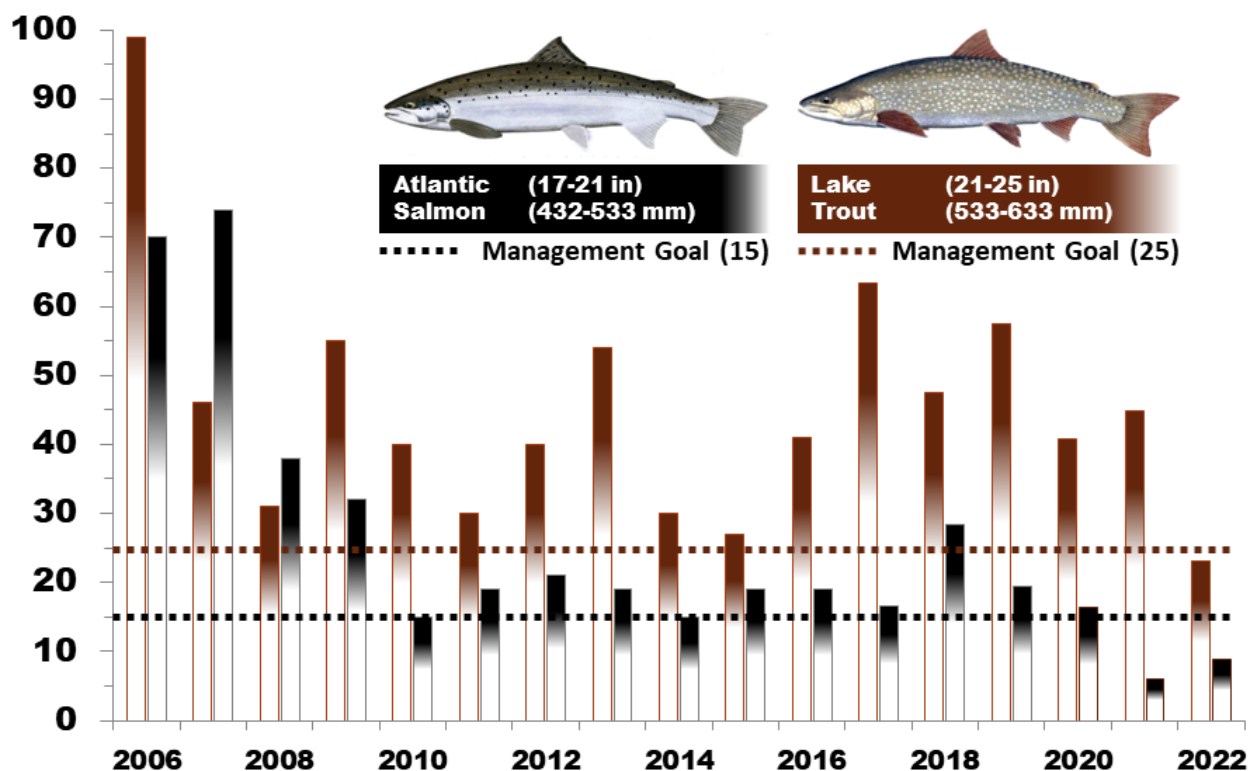


Figure 10. Fall Sampling (2022): Type A1-A3 Sea lamprey wounds (fresh and healing) per 100 Atlantic Salmon and per 100 Lake Trout.

Percids

Yellow Perch *Perca flavescens* (Pientka)

Yellow Perch are the most preferred species for resident anglers during the ice fishing season, accounting for 48% of the targets of anglers interviewed in the 2022 ice fishing angler survey (Balk 2023), and monitoring will help to better understand potential changes at locations around the lake. Experimental gillnets are set overnight at multiple locations in Vermont annually to monitor the Lake Champlain fish community. While these nets are not specifically targeting Yellow Perch, they do provide insight into relative abundance of Yellow Perch. In 2022, sampling occurred between July 7th and July 28th.

Yellow Perch catch per overnight set (CPUE) in 2022 was compared to the multiyear average CPUE for 2009 to 2021 (Figure 11). Yellow Perch CPUE in Malletts Bay was higher than the multiyear average. Missisquoi, Shelburne, and St. Albans Bays were slightly below the multiyear average. Overall, the Yellow Perch population is relatively steady based on catch rate and total length. Sampling will continue in 2023.

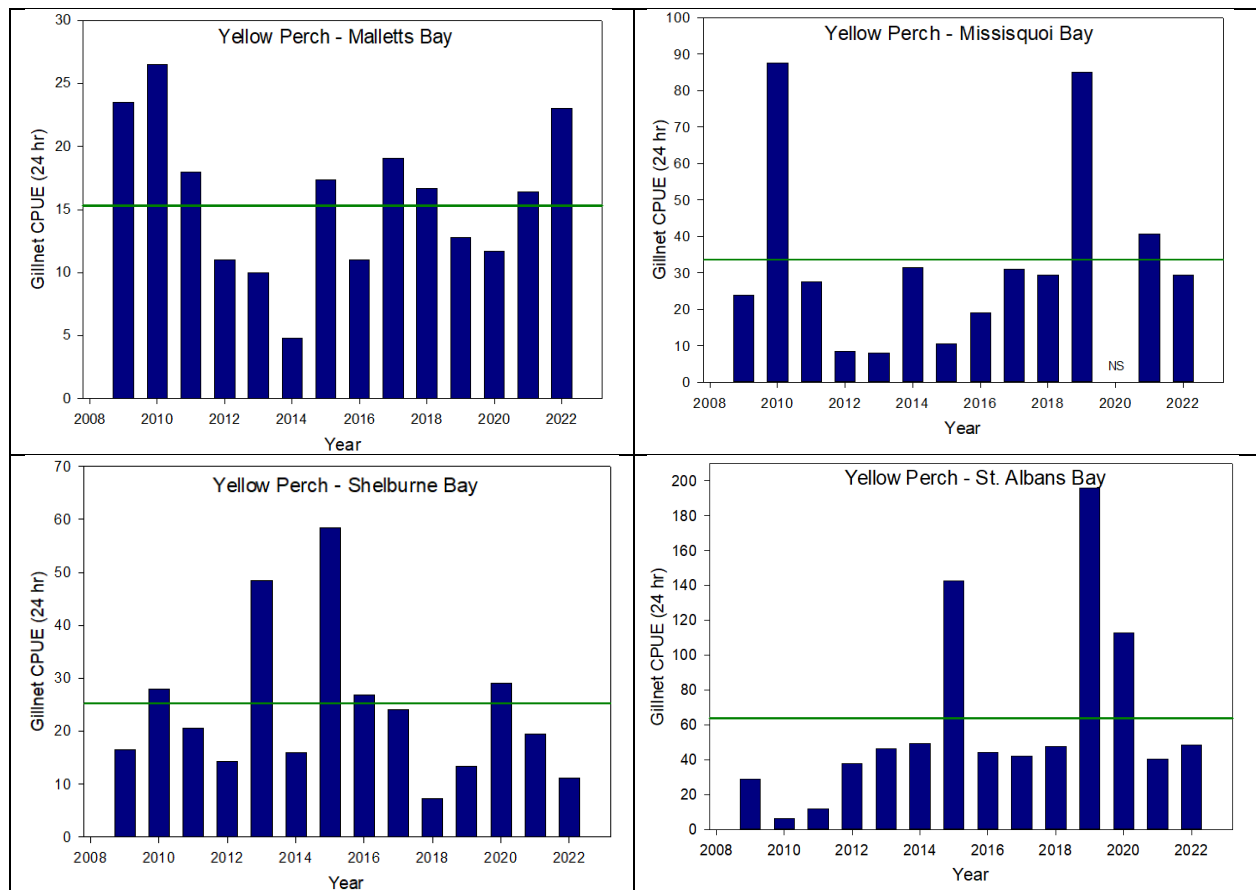


Figure 11. Yellow Perch CPUE for 2009-2022 at four Lake Champlain locations (note different y-axis scale). NS=not sampled. The green line represents the multiyear average CPUE for 2009 to 2021.

Walleye *Sander vitreus* (Pientka, Good)

Lake Champlain Walleye anglers reported their perception that Walleye fisheries declined during the latter part of the 20th century in Lake Champlain. As late as the 1970's, there was a large angler interest in fishing for Walleye, and it was the primary game fish in the Inland Sea. Sound management techniques are needed to continue restoration and management efforts for this popular fishery, within the bounds of the lake's ability to supply the proper habitat and forage. Walleye management activities in 2022 on Lake Champlain included monitoring adult Walleye returning to spawn in the Missisquoi River (VT). The Missisquoi River spawning stock was used for collection of brood stock for the fish culture and stocking program, and for evaluation of the contribution of stocked walleye to spawning populations.

Five hundred and forty-three Walleye (421 males, 122 females) were collected from the Missisquoi River. Thirty-two females and fifty-nine males from Missisquoi River walleye were spawned, resulting in 4.03 million eggs which were hatched at the Ed Weed FCS in Vermont. Fingerlings were reared in the hatchery's intensive culture system and in one pond managed by the Lake Champlain Walleye Association. All fry and fingerlings were marked with oxytetracycline (OTC) prior to stocking. Twenty-nine age-3 males were collected for evaluation of the contribution of stocked fish to the spawning run in the Winooski River. All 3-year-old males examined were found to be of hatchery origin (OTC mark present on the otoliths).

The 2022 angler survey found that only 1% of the open water anglers were targeting Walleye while they were fishing in the main lake. Similarly, in the 2022 ice angler survey only 1% of the ice anglers were targeting Walleye.

Sauger *Sander canadensis* (Fiorentino)

Currently the Sauger population within Lake Champlain is unknown as only one fish has been documented in the last 20 years. The goal for the species in the Strategic Plan is to restore a self-sustaining population in the South Lake and South Bay to eventually sustain a fishery. Identification of an appropriate brood or transfer source has not yet been determined. To date no action has been taken towards restoration of sauger in Lake Champlain as NYSDEC is focusing on other major projects within the watershed. When staff availability and a propagation facility is identified the restoration effort will be returned to.

Centrarchids

Largemouth Bass *Micropterus salmoides* and Smallmouth Bass *Micropterus dolomieu* (Good, Pientka, Balk)

Angling for Largemouth Bass and Smallmouth Bass in Lake Champlain continues to be highly popular. During the 2022 open water angler survey, 53% of the anglers were targeting black bass. Catch rates varied by zone, with 0.79 fish/hour for the northern zone, 1.33 fish/hour for the central zone, and 1.73 fish/hour for the southern zone. The lake is considered to be one of the top bass fishing destinations in the country, and it attracts and supports a high level of recreational and tournament-oriented fishing pressure. In 2022, Vermont issued 111 permits for bass tournaments on Lake Champlain. A total of 2,920 anglers participated in those tournaments, weighing in 41,327 pounds of bass. Tournament report forms indicate an average live release rate of 98%, with a range of 92% to 100%. The estimated average bass catch rate (fish caught per hour) for tournament anglers, derived from completed tournament reports, was 0.38 bass per hour. Both major U.S. professional bass fishing tournament series, Bassmaster (B.A.S.S) and Forrest L. Wood (FLW)

Outdoors, hold regular events on the lake. Event results from these organizations indicate that tournament catches have remained very consistent since the first professional tournament was held on Lake Champlain in 1997.

Spring electrofishing surveys were conducted at standardized sites in the Vermont portion of northern and southern Lake Champlain in 2022. For northern Lake Champlain, 8 transects were sampled at 2 different sites. A total of 2.98 hours of electrofishing resulted in the collection of 94 bass. Largemouth Bass ranged in size from 343 to 557 mm total length and Smallmouth Bass ranged in size from 148 to 508 mm TL. On southern Champlain, 20 standardized sites were surveyed in May. Over 8.22 hours of electrofishing, 277 Largemouth Bass and 299 Smallmouth Bass were collected. Smallmouth Bass ranged from 90 mm to 528 mm total length and Largemouth Bass ranged from 129 mm to 515 mm total length. Summer electrofishing was conducted in July at the same 20 sites on southern Lake Champlain. A total of 8.52 hours of electrofishing captured 519 Largemouth Bass (64 mm – 525 mm total length) and 165 Smallmouth Bass (58 mm-474 mm total length).

Esocids

Muskellunge *Esox masquinongy* (Good)

Muskellunge is highly regarded as a prized game fish across its entire native range of eastern North America, including Lake Champlain. The population once supported a popular recreational fishery; however, beginning in the late 1970's it slowly declined to where catching one became a rare occurrence in the lake. Muskellunge objectives include restoring a naturally reproducing and self-sustaining population to Lake Champlain and its tributaries, focusing on its native range, and providing recreational muskellunge angling opportunities.

NYSDEC continued fall Muskellunge stocking in the Great Chazy River. A total of 1,150 Muskellunge averaging 254 mm (10 inches) in total length were stocked in mid-October. These fish are reared to summer fingerling size in tanks at the Chautauqua Hatchery, then transferred to outdoor ponds and reared on live minnows before being harvested for stocking in mid-October.

After 4 consecutive years (2018-2021) of not receiving surplus Muskellunge fingerlings from NYSDEC's Chautauqua Hatchery, VTFWD received 5,050 summer fingerlings in August of 2022. With an average total length of 126 mm (4.9 inches), half of the fish were stocked in the lower Missisquoi River and Missisquoi Bay, and the other half were stocked above the Swanton Dam.

Electrofishing surveys were conducted by VTFWD above and below the Swanton Dam in late October to capture fall young-of-year Muskellunge. A total of 27 fall young-of-year Muskellunge were collected in 3.25 hours of electrofishing effort above the dam. Fish total length ranged from 162 mm to 234 mm (median length: 208 mm) and were presumed to be from the August stocking, showing an average increase in length of 82 mm (3.2 inches) over a 2-month period. Only 3 fall young-of-year Muskellunge were collected in 1.9 hours of electrofishing effort below the dam. These fish measured 171, 173, and 176 mm total length. One larger Muskellunge was collected above the Swanton dam that measured 332 mm (13.1-inches), indicating it was likely a 1.5-year old fish. Because no fish were stocked in 2021, this fish is presumed to be wild, from natural reproduction in 2021.

Northern Pike *Esox lucius* (Good)

Northern Pike are one of the most popular sportfish sought by resident and non-resident anglers in Vermont, particularly during the ice fishing season. In the open water season, pike are the 9th most preferred species by resident Vermont anglers and the 7th most preferred species by non-resident anglers; during the ice fishing season, pike are the 2nd most preferred by resident anglers and the 1st most preferred species by non-resident anglers in Vermont (Responsive Management 2020). In NY, they were the 6th most preferred species during the 2022 open-water season and the 3rd most popular target in the 2022 ice fishing season. Efforts to monitor the status of Northern Pike in popular waters such as Lake Champlain, and collect data on population size structure, are important to inform management actions to maintain or improve pike populations and to provide quality angling opportunities.

Anguillids

American eel *Anguilla rostrata* (Earley)

American Eel remain a species of interest to the FTC, as concerns continue about the species status throughout their range. The 2020 Strategic Plan indicated that the USFWS would continue to assist with efforts to monitor and restore this catadromous species. Hydro-Quebec initiated a 10-year stocking effort in 2005 and the last evaluation of the success of that program conducted by USFWS was in 2016. No additional monitoring was completed by any entity in 2022.

Acipenserids

Lake Sturgeon *Acipenser fulvescens* (Murphy, Simard)

Many factors including overharvest, habitat alteration and fragmentation, flow regulation, pollution, and species invasions led to the decline of Lake Sturgeon in Lake Champlain. A number of strategies have been identified to determine if the Lake Sturgeon populations in Lake Champlain are declining, stable, or increasing. Specific focus was given to the four major tributaries to the lake (Missisquoi, Lamoille, Winooski rivers, Otter Creek) where Lake Sturgeon were historically known to spawn.

During spring 2022, sampling for adult Lake Sturgeon occurred in the lower reaches of the Missisquoi River and the Dead Creek of Missisquoi River channel on five occasions using multifilament gillnets between late April and mid-May 2022. Seven or eight nets were set at a time and were either retrieved later that day or left overnight and checked the following morning. Daytime gillnet set duration averaged 2.8 hours while overnight set duration averaged 19.6 hours. No Lake Sturgeon were observed.

Sampling also was conducted in the Inland Sea using gillnets and trotlines in June, October, and November 2022. Gillnet sets consisted of six nets set overnight with an average duration of 19.4 hours with 2 events in spring and six set events in fall. In addition, during the fall sampling events two trot line sets were also used with an average duration of 21.0 hours. Two Lake Sturgeon were captured in overnight gillnet sets, one on June 10, 2022 measuring 1,452 mm total length, 1,302 fork length, and 20.95 kg and one on November 2, 2022 measuring 1,209 mm total length, 1,068 mm fork length, and 16.80 kg. Both fish were marked with a PIT tag, surgically implanted with a V16 acoustic tag, and a genetic sample was taken for future analysis; no ageing structures were removed. Manual tracking during the remainder of the year of the fish captured in June noted detections as far as 15 km away from the release location, while manual tracking of the fish captured in November noted detections as far as 7 km from the release site.

Recreational Fishery Monitoring

Angler Surveys (Balk, Pientka)

Lake Champlain was the fifth highest ranked water for estimated angler effort in the New York Angler Effort and Expenditures Survey in 2017 (Duda et al. 2019). Angler surveys are important to understand angler use characteristics of the fishery, whether anglers are satisfied with their fishing experiences as well as inquiring as to their thoughts and concerns about the fishery. Value can be found in documenting changes in fisheries, adapting management to anglers' desires as well as changes to species composition and environmental disturbances in the lake.

No angler surveys were conducted by VTFWD in 2022.

NYSDEC conducted a second year of angler surveys on Lake Champlain during the ice and open water fishing seasons. Information gathered includes preferred target species, catch and harvest rates, and angler opinions about the fishery. Overall, anglers are very receptive to the survey. The ice fishing angler survey was conducted from January to March, (Balk 2020a), followed by an open-water angler survey that started in April and continued until the end of October (Balk 2020b). Reports will be published annually to the [DEC website](#).

Ice fishing angler survey

In 2022, 188 completed trip interviews were conducted from January 1 through March 18. Mean trip length was seven hours. Anglers fished for an estimated 2,568 angler days, with more effort in the afternoons than mornings. Interviewed anglers caught 1,495 fish and harvested 70% of them. Mean catch rate for all species was 1.15 fish per angler hour. Mean harvest rate for all species was 0.80 fish per angler hour, almost double the harvest rate from the 2021 season. More than half of the anglers interviewed practiced catch and release. Yellow Perch was anticipated to be the primary target species for the Lake Champlain ice fishery, and it was, targeted by 48% of the anglers interviewed (Table 7).

Table 7. Species or species group targeted, listed by rank with percentage of anglers targeting them during the 2021 Lake Champlain ice fishing season.

Target Species	Sum of no. anglers in party	Percentage of anglers targeting
Yellow Perch	143	48
Anything	59	20
Northern Pike	41	14
Black Crappie	25	8
Lake Trout	11	4
White Crappie	6	2
Walleye	4	1
Largemouth Bass	3	1

Open-water angler survey

In 2022, 331 completed trip interviews were conducted from April 4 through October 25. The average trip length was approximately six hours. Anglers interviewed fished for an estimated 2,276

hours (down from 7,362 hours in 2021). Due to habitat differences within the lake, locations were separated into three zones: northern, central, and southern.

Black bass were the primary target species for the open-water survey, targeted by 53% of the anglers interviewed. The top open-water targets in all lake zones were black bass and anything (Table 8). Other species targeted varied by lake zone.

Table 8. Top target species for each lake zone with the percentage of the anglers interviewed that were targeting them.

Northern zone		Central zone		Southern zone	
Target species	Percentage of anglers targeting	Target species	Percentage of anglers targeting	Target species	Percentage of anglers targeting
Black bass	60	Black bass	45	Black bass	58
Anything	11	Anything	16	Anything	26
Yellow Perch	9	Lake Trout	15	Channel Catfish	5
Lake Trout	8	Atlantic Salmon	12	Black Crappie	2
Northern Pike	5	Yellow Perch	7	Panfish	2

Interviewed anglers caught 6,721 fish and harvested 36% of them. Mean catch rate for all species was 1.72 fish per angler hour. Mean harvest rate for all species was 0.62 fish per angler hour.

In the northern zone, black bass targeted catch rate was 0.79 fish/hour while the harvest rate was 0.05 fish/hour. Both Largemouth Bass and Smallmouth Bass were specified as targets in the northern zone.

In the central zone, black bass were targeted more than any other species at a rate of 45%, with a catch rate of 1.33 fish/hour and a harvest rate of 0.02 fish/hour. Lake Trout were the third most common target, caught at a rate of 0.42 fish/hour and a harvested at a rate of 0.14 fish/hour. Anglers specifically targeted both Largemouth Bass and Smallmouth Bass. Atlantic Salmon were only targeted in the central zone.

In the southern zone, black bass were targeted more often than other species at a targeted rate of 58%. The catch rate for black bass was 1.73 fish/hour and the harvest rate was 0.05 fish/hour. Anglers in the southern zone specified Largemouth Bass as a target, but no Smallmouth Bass.

This survey also collected data on angler satisfaction. For example, anglers were asked to rate their fishing experience on the day of the interview, with 1 being the worst and 5 being the best. Approximately 40% of the anglers rated it a 4 or a 5 indicating they were satisfied with their fishing experience; 30% rated it a 1 or a 2 and were dissatisfied. Anglers were also asked to rate their satisfaction with fishing for their target species for the year. Almost 50% of them rated it a 4 or a 5 and were satisfied, while 20% rated it a 1 or a 2 saying they were dissatisfied.

The creel clerks measured 129 fish; 35% of those were Lake Trout measuring between 406-889 mm total length (16 to 35 inches) and averaged 619 mm (24 inches; st. dev. 86 mm). Only seven Atlantic Salmon were measured and ranged between 254-610 mm (10 to 24 inches) and averaged 435 mm (17 inches; st. dev. 123 mm).

Fish Health (Jones, Balk, Garceau)

Walleye Fish Health Inspection

Walleye adults were collected from the Missisquoi River and transferred to a bio-secure isolation station at the Ed Weed FCS where they were spawned. Eggs were water hardened in iodine at 50-ppm concentration for 30 minutes. Fertilized eggs were held in a bio-secured isolation area until associated fish health inspection laboratory work was completed. On April 18, through April 19, 2022, lethal samples were collected from 2 adult walleye (1 male & 1 female) and 30 males being held for OTC analysis. Non-lethal ovarian fluid samples were collected from 32 adult females. Tests were conducted for viral and bacterial fish pathogens of concern to include IPN, IHN, VHS, OMV, AS and YR, (Appendix 3). All fish tested negative (Table 9).

The gastrointestinal tract was examined and revealed most Walleye harbored tapeworms presumptively identified as *Proteocephalus sp.* Several of the adult Walleye sampled had an irregular scale pattern on their flanks (circular and just posterior to pectoral fin). District Fisheries Biologist reported seeing this condition on multiple Walleye adults (Figure 12). It was suspected that the irregular scale pattern was the result of a previous wound or infection, but exact cause wasn't confirmed. Muscle tissue was visually examined for the *Heterosporis sp.* parasite which wasn't detected. In addition, the viral disease Lymphocystis was presumptively identified in several fish examined.



Figure 12. Irregular scale pattern observed on adult walleye from Missisquoi River.

Wild Landlocked Atlantic Salmon Inspection

Sebago strain Atlantic Salmon, originating from Lake Champlain, were captured from the Ed Weed Fish Culture Station discharge stream and from the Lamoille River. Fish were transferred to the Ed Weed isolation station where they were spawned. Eggs were water hardened in iodine at 50-ppm concentration for 30 minutes. Fertilized eggs were held in a bio-secured isolation area until associated fish health inspection laboratory work was completed. From November 4, thru November 23, 2022, a total of 31 Atlantic Salmon (28 male and 3 female) were lethally sampled for viral and bacterial pathogens of concern (IPN, IHN, VHS, OMV, BKD, ER, AS and AQ), (Appendix 3). Non-lethal, ovarian fluid samples were collected from 152 females and tested for IPN, IHN, VHS, OMV, BKD and AQ (Appendix 3). All fish sampled tested negative (Table 9). The gastrointestinal tract was examined and found empty of tapeworms.

Wild Lake Trout Inspection

To ascertain the potential presence of Epizootic Epitheliotropic Disease Virus and/or Namaycush Herpesvirus in feral Lake Champlain, wild Lake Trout adults were collected from 2 locations. On November 16, 2022, Lake Trout were obtained from a Vermont Fish & Wildlife Department trap netting project at the Hatchery Cove (HC) and on November 22, 2023, USFWS personnel collected Lake Trout from Whallon Bay (WB) using nearshore electrofishing. Fin tissue (lower caudal) was collected from 15 male and 15 female fish from both locations. Ovarian fluid was collected from 15 females from Hatchery Cove. All samples were tested using Quantitative PCR technique. Lake Trout from both locations tested positive for both EEDV and NamHV (Table 9).

Table 11. Summary of Disease Testing in Lake Champlain walleye, landlocked Atlantic Salmon & Lake Trout

Date	Sp.	# Test	IPN	IHN	VHS	LMB	BKD	SVCV	AS	YR	OMV	AQ	EEDV	NamHV
4/18/22 to 4/19/22	WAL	32 lethal	NEG	NEG	NEG	N/A	N/A	N/A	NEG	NEG	NEG	NEG	N/A	N/A
4/18/22 to 4/19/22	WAL	32 O/F	NEG	NEG	NEG	N/A	N/A	N/A	N/A	N/A	NEG	NEG	N/A	N/A
11/4/22 to 11/23/22	LAS	31 lethal	NEG	NEG	NEG	N/A	NEG	N/A	NEG	NEG	NEG	NEG	N/A	N/A
11/4/22 to 11/23/22	LAS	152 O/F	NEG	NEG	NEG	N/A	NEG	N/A	N/A	N/A	NEG	NEG	N/A	N/A
11/16/22	LAT (HC)	15 Male Fin	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	POS 1/15	POS 6/15
11/16/22	LAT (HC)	15 Female Fin	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	POS 3/15	POS 6/15
11/16/22	LAT (HC)	15 Female O/F	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	POS 5/15	POS 2/15
11/22/22	LAT (WB)	15 Male Fin	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	POS 11/15	POS 11/15
11/22/22	LAT (WB)	15 Female Fin	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	POS 6/15	POS 4/15

Species Key: WAL - walleye, LAS - landlocked Atlantic salmon, LAT – Lake Trout

Results: POS - Positive Neg - Negative N/A - Not Tested For O/F - Nonlethal ovarian fluid

Disease Testing for USFWS’s Natural Fish Population Survey

Two locations were sampled in 2022 and samples were forwarded to the USFWS Lamar Fish Health Center to be included in the USFWS’s Natural Fish Population Survey. On April 18, 2022 samples were collected from Lake Champlain (Sandy Point) located in Swanton, VT. Testing encompassed four fish species for a total of 100 fish sampled. Pathogens tested for included: VHS, IHN, IPN, LMBV, SVCV, AS, and YR (Appendix 3). No pathogens were detected in this sample (Table 10). Common parasites detected include yellow grub, blackspot, and redworm.

On May 11, 2022, samples were collected from Lake Champlain (Larabee’s Point and East Creek) located in Shoreham, VT. Testing encompassed six fish species for a total of 98 fish sampled. No pathogens were detected in this sample (Table 10). Common parasites detected include yellow grub, blackspot, white grub, and redworm. A single Brown Bullhead *Ameirus nebulosus* was documented with melanism on the skin surface.

Table 10. Summary of Lake Champlain Disease Testing for USFWS’s Natural Fish Population Survey

Date	Location	Sp.	# Test	IPN	IHN	VHS	LMB	BKD	SVCV	AS	YR	OMV
4/18/2022	Sandy Pt.	YP	75	NEG	NEG	NEG	NEG	N/A	NEG	NEG	NEG	NEG
4/18/2022	Sandy Pt.	NP	10	NEG	NEG	NEG	NEG	N/A	NEG	NEG	NEG	NEG
4/18/2022	Sandy Pt.	LGM	10	NEG	NEG	NEG	NEG	N/A	NEG	NEG	NEG	NEG
4/18/2022	Sandy Pt.	PMS	5	NEG	NEG	NEG	NEG	N/A	NEG	NEG	NEG	NEG
5/11/2022	Larabee’s Pt.	FWD	5	NEG	NEG	NEG	NEG	N/A	NEG	NEG	NEG	NEG
5/11/2022	Larabee’s Pt.	LGM	8	NEG	NEG	NEG	NEG	N/A	NEG	NEG	NEG	NEG
5/11/2022	Larabee’s Pt.	SMB	5	NEG	NEG	NEG	NEG	N/A	NEG	NEG	NEG	NEG
5/11/2022	Larabee’s Pt.	YP	30	NEG	NEG	NEG	NEG	N/A	NEG	NEG	NEG	NEG
5/11/2022	Larabee’s Pt.	ALW	30	NEG	NEG	NEG	NEG	N/A	NEG	NEG	NEG	NEG
5/11/2022	Larabee’s Pt.	GLS	20	NEG	NEG	NEG	NEG	N/A	NEG	NEG	NEG	NEG

Species Key: LMB - Largemouth Bass, SMB - Smallmouth Bass, YP-Yellow perch, PMS – Pumpkinseed *Lepomis gibbosus*, GLS - Golden Shiner *Notemigonus crysoleucas*, FWD - Freshwater Drum *Aplodinotus grunniens*, ALW – Alewife *Alosa pseudoharengus*, NP - Northern Pike

Fish Kills

No fish kills were reported or investigated in calendar year 2022.

Aquatic Invasive Species (Modley, Young)

Lake Champlain is currently affected by 51 known Aquatic Invasive Species (AIS) which place stress on the basin’s ecological stability and integrity. While several species are positioned to invade Lake Champlain through natural waterways or accidental and intentional introductions, Round Goby *Neogobius melanostomus* and Grass Carp *Ctenopharyngodon idella* present the most immediate and pending threats. In 2022, the USFWS implemented a basin-wide AIS baseline data collection initiative to document the presence and geographic distribution of selected species for use in a long-term monitoring program. This involved collecting environmental DNA (eDNA) samples at 72 sites throughout the basin from Glens Falls, NY north to Saint Jean sur Richelieu, QC. These eDNA samples were analyzed using genetic metabarcoding, a method that allows for detection of multiple species from a single water sample. Preliminary results from the 2022 samples found no detections of Round Goby or Grass Carp at any of the sites, although the number of samples with Tench *Tinca tinca*

detections indicate that species is more widespread in the lake than previously known. Detection of other species of conservation interest were also documented and found evidence of widespread American eel distribution as well. The USFWS and Lake Champlain Basin Program have partnered and secured funding to continue annual eDNA sampling of this geographic array of sites in the basin from 2023 to 2027 and establish a systematic approach for the detection of both suspected and unknown AIS that pose threats to Lake Champlain. These data will help to develop new methods of AIS spread prevention such as the proposed Champlain Ship Canal barrier, enable rapid response AIS control measures when necessary, and lead to more informed management decisions for species of management concern.

Research

Lake Trout Population Dynamics (Benjamin Marcy-Quay, J. Ellen Marsden, UVM)

The objectives of this funded project are to assess the relative performance (growth and survival) of the two stocking strategies used by New York and Vermont and identify the parental population contributing to recruitment, using next-generation genetics to determine the origin of stocked fish and the size and structure of the parental population contributing to wild recruitment. A genetic marker panel was developed and validated for population and kinship assignment. Approximately 2,100 fish have been genotyped using the panel and analysis is ongoing.

Lake Trout Thiamine (Jacques Rinchard, Colin Clark – SUNY Brockport; Matt Futia, J Ellen Marsden - UVM)

The goal of this research, initiated in 2021, is to investigate whether lake trout eggs and free embryos can acquire sufficient thiamine from natural sources to mitigate early mortality from thiamine deficiency. The objectives are to (1) measure thiamine in water on spawning reefs in fall, (2) determine whether thiamine concentrations in Lake Trout eggs increase during incubation in natural waters, and (2) determine whether wild free embryos with access to natural food have different thiamine concentrations and occurrence of TDC than free-embryos reared under hatchery settings (hatchery water and diet). Field work and laboratory controls are being conducted in Lake Champlain/UVM and Lake Ontario/SUNY Brockport. An assay for thiamine in water has measured high thiamine levels in natural water sampled in fall; preliminary data indicate that thiamine levels in eggs and hatched fry in spring are higher than in unfertilized and newly fertilized eggs.

Landlocked Atlantic Salmon research projects (USFWS)

Ongoing research on Atlantic Salmon includes:

- Study 1 - Assessment of 18 experimental release groups of salmon representing different broodstocks (see Atlantic Salmon section), stocking locations, and ages;
- Study 2 - Testing of the TDT broodstock with a controlled feed study at White River National Fish Hatchery;
- Study 3 - Smolt telemetry to assess to-lake survival from different release locations;
- Study 4 - Assessment of releasing retired adult broodstock (to spawn in the wild) as an alternative stocking approach; and,
- Study 5 - Estimating stocked fry survival, growth, and competitive interactions with native Brook trout.

The genetic marker panel that will be used to evaluate tissue samples and the associate sub-studies related to Study 1 is still under development. Panel finalization and validation testing will be completed by summer 2023.

There are no updates on Study 2 at this time, but it will be continued in 2023.

Related to Study 3 listed above, the USFWS and VTFWD are conducting a four-year study to assess two different stocking locations (upstream, downstream) and two different genetic broodstocks (TDT, Max-diversity) in the Winooski River. The study design has four study groups (two broodstock and two release locations) with 11,000 smolts/group released annually from 2021 to 2024. All smolts are marked according to their release group using parentage-based tagging. Success will be assessed using the metric of the number of returning adults from each release group captured at the Winooski One Fish Lift. Two years of radio-telemetry studies (2021 and 2022) were conducted to determine differences in to-lake survival of smolts from these release groups. Based on the results from the two-year telemetry study, VTFWD and USFWS reviewed and discussed stocking fish at a different downstream location due to the high level of mortality observed in the Winooski Dam tailrace and the Salmon Hole. It was determined that moving the downstream release location within a reasonable distance would not greatly impact the longer four-year study. A new site was selected for the 2023 downstream location, which was the Gardener Supply parking lot, less than 1 km from Winooski Dam. The USFWS agreed to another year of the telemetry study to assess smolt emigration and to-lake survival.

Preliminary findings for Study 4 show that the majority of redds observed in North Branch Boquet River in 2020, 2021, and 2022 were found near the broodstock outplanting sites and suspected to be created by broodstock or combination of broodstock and river returning Atlantic Salmon. The number of redds found within the North Branch in all three years, as well as fry found in the spring of 2021 and 2022, were greater than the numbers reported in past years, suggesting that broodstock may be contributing to Atlantic salmon fry production. Tissue samples from captured fry and outplanted broodstock still need to be processed. Once results are available, genetic parentage analysis will be conducted to determine the outplanted broodstock contribution.

2022 Scientific Publications

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Appendices

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

Name	Role	Affiliation
Jackie Lendrum	Policy	New York DEC, Albany
Christopher Herrick	Policy	Vermont FWD Montpelier
Kyla Hastie	Policy	USFWS, Region 5, Hadley, MA
Steve Hurst	Management	New York DEC, Albany
Eric Palmer	Management	Vermont FWD, St. Johnsbury
Lowell Whitney	Management	USFWS, Region 5, Hadley, MA
Nicole Balk	Technical, Chair	New York DEC, Ray Brook
Rob Fiorentino	Technical	New York DEC, Warrensburg
Margaret H. Murphy	Technical	Vermont FWD, Rutland
Shawn Good	Technical	Vermont FWD, Rutland
Bernie Pientka	Technical	Vermont FWD, Essex Junction
Lee Simard	Technical	Vermont FWD, Essex Junction
Kevin Kelsey	Technical	Vermont FWD, Ed Weed Fish Culture Station
Tom Jones	Technical	Vermont FWD, Randolph
Laurie Earley	Technical	USFWS, Assessment, Lake Champlain FWCO
Bradley Young	Technical	USFWS, Sea Lamprey, Lake Champlain FWCO
Kurt Heim	Technical	USFWS, Assessment, Lake Champlain FWCO
B.J. Allaire	Technical	USFWS, Sea Lamprey, Lake Champlain FWCO
Steve Smith	Technical	USFWS, Sea Lamprey, Lake Champlain FWCO
Shane Hanlon	Technical	USFWS, Dwight D. Eisenhower & White River NFH's
Ellen Marsden	Technical Advisor	University of Vermont, Rubenstein Lab
Ben Marcy-Quay	Technical Advisor	University of Vermont, Rubenstein Lab
Mark Henderson	Technical Advisor	USGS, VT Fish and Wildlife Cooperative Unit
Meg Modley	Technical Advisor	Lake Champlain Basin Program
Aude Locht	Technical Advisor	Lake Champlain Sea Grant
Tom Berry	Technical Advisor	Great Lake Fisheries Commission
Steve Garceau	Technical Advisor	Quebec Ministry of the Environment, the Fight Against Climate Change, Wildlife and Parks

Appendix 2. Schedule of completed and projected Lake Champlain lampricide treatments.

The “T” denotes completed TFM-only treatments, “B” denotes completed Granular Bayluscide delta treatments, “C” denotes completed TFM + 1% Niclosamide treatments, and “P” denotes pending treatments. Treatment histories from the experimental control program (1990-2000) and the long-term program from 2001-2009 are available in earlier annual reports. The first full 4-year cycle of the geographic reorganization plan was completed in 2017 resulting in the temporal and geographical alignment of treatments in the Lake Champlain Basin and a regional cycle of treatments in 3 of every 4 years.

		10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27			
NEW YORK	Region 1	Great Chazy River			T	T				T				T					P			
		Little Chazy River									T											
		Rea Brook									T											
		Saranac River				C					C				C					P		
		Saranac Delta			B		T				B				B					P		
		Salmon River	T				T				T				T					P		
		Salmon Delta					B				B				B					P		
		Little Ausable River	T				T				T				T					P		
		Ausable Delta Complex		B			B				B				B						P	
		Ausable River	T				T	T			T				T						P	
		Boquet River		C			C				C				C						P	
Boquet Delta					B																	
NEW YORK	Region 2	Hoisington Brook									T											
		Beaver Brook							T													
		Mill Brook			T							T				P					P	
		Mill Delta			B																P	
		Putnam Creek	T			T			T			T				P					P	
		Mt. Hope Brook			T			T				T				P					P	
VERMONT	Region 3	Poultney / Hubbardton rivers		T			T				T				P					P		
		Lewis Creek	T				T	T			T				P					P		
		LaPlatte River							T				T				P				P	
		Winooski River			T			T					T				P				P	
		Stonebridge Brook				T			T													
VERMONT	Region 3	Lamoille River				T						T				P				P		
		Missisquoi River			T								T				P				P	

Appendix 3. Summary of pathogen abbreviations.

Pathogen	Abbreviation	Pathogen	Abbreviation
Infectious Pancreatic Necrosis	IPN	Spring Viremia Carp Virus	SVCV
Infectious Hematopoietic Necrosis	IHN	Furunculosis	AS
Viral Hemorrhagic Septicemia	VHS	Enteric Redmouth Disease	YR
Largemouth Bass Virus	LMB	Oncorhyncus Masou Virus	OMV
Renibacterium salmoninarum	BKD	Aquareovirus A	AQ
Epizootic Epitheliotropic Disease Virus	EEDV	Namaycush Herpesvirus	NamHV