Management of Fishery Resources and Sea Lamprey in Lake Champlain, 2003

Annual Report from the Lake Champlain Fisheries Technical Committee

Prepared by the Fisheries Technical Committee of the
Lake Champlain Fish and Wildlife Management Cooperative

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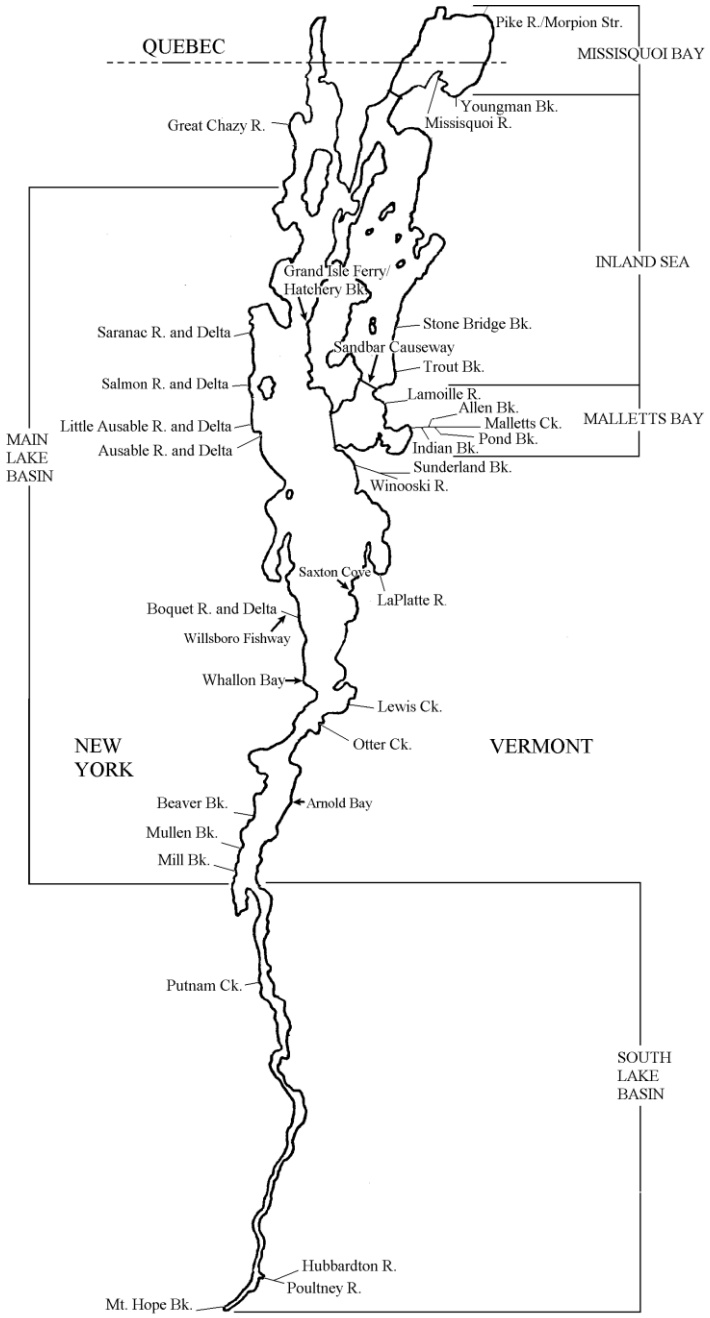
Executive Summary

The Lake Champlain Fisheries Technical Committee manages and conducts research on the fish resources of Lake Champlain. The Committee promotes a unified approach for the conservation of those resources. This report summarizes activities of the Committee in 2003.

A primary focus of the Fisheries Technical Committee has been to reestablish populations of the native landlocked Atlantic salmon and lake trout. Management of sea lamprey in Lake Champlain has become a major activity necessary to achieve those objectives. Two rivers and one delta were treated with lampricides in 2003. All of the treatments were successful at killing larval sea lamprey while having minimal nontarget impacts. One planned stream treatment in NY was canceled because of high flows. A planned stream treatment in VT was canceled because of delays in obtaining the necessary state permits. During their spawning run, sea lamprey were trapped on 17 streams. Quantitative sampling was conducted to estimate abundances of larval and transformer stage sea lamprey of two tributaries, and qualitative sampling to define areas requiring treatment were conducted on two deltas. Ongoing research will assess sea lamprey movements within the lake, and the relative contributions of several rivers to the population of adult lamprey in the lake. A sea lamprey life history model is in the process of being developed. The model will help identify future research needs and the relative effectiveness of various approaches to control. A control alternatives working group is investigating alternatives to lampricides as possible lamprey control procedures.

Salmonid management included stocking about 312,000 landlocked Atlantic salmon, 69,000 lake trout, 55,000 steelhead and 46,000 brown trout. Salmonid abundances were monitored through spring and fall near shore electrofishing, collections at the Willsboro Fishway and Winooski River Fish Lift, and an angler diary cooperator program. Natural reproduction by lake trout is the subject of a research project being conducted by the University of Vermont. Providing fish passage for salmon runs is an ongoing activity. A study to compare returns from three strains of salmon was begun with the stocking of differentially fin-clipped study fish in spring, 2003. Attack rates on lake trout and salmon in 2003 were generally higher than attack rates prior to the eight-year experimental sea lamprey control program. Sampling of salmon and lake trout by the Committee indicated that abundances of those species were relatively low, likely an indication of sea lamprey induced mortality. Completion of the Final Supplemental Environmental Impact Statement on long-term sea lamprey control in 2001 allowed a long-term control program to begin in 2002. Expectations are that the renewed control effort will yield improvements in the salmonid populations, as well as walleye, lake sturgeon and other fish populations over the next few years.

Figure 1. Map of Lake Champlain showing relevant tributaries and other fishery survey locations.



Introduction

This report summarizes activities conducted by the Lake Champlain Fisheries Technical Committee during 2003. A major focus of the Technical Committee has been to reestablish the native landlocked Atlantic salmon and lake trout populations in Lake Champlain. In addition, effort has been directed towards management of walleye, lake sturgeon, smelt and other species. Related activities include fish stocking, control of sea lamprey, research into sea lamprey biology in Lake Champlain, and studies of potential nontarget impacts from lamprey control.

The Lake Champlain Fisheries Technical Committee is part of the Lake Champlain Fish and Wildlife Management Cooperative (Cooperative). The Cooperative and the Fisheries Technical Committee were established in 1973 to promote "a unified approach for the protection and management of the fish and wildlife resources of interstate significance in Lake Champlain" (Lake Champlain Fish and Wildlife Policy Committee, 1977). The Fisheries Technical Committee includes representatives of the US Fish and Wildlife Service (USFWS), the Vermont Department of Fish and Wildlife (VTDFW), the New York State Department of Environmental Conservation (NYSDEC), the University of Vermont, and the Vermont Cooperative Fish and Wildlife Research Unit. In addition, representatives from the Province of Quebec, Sea Grant, and other universities are frequently involved in Technical Committee activities.

The organizations making up the Technical Committee obviously have a broad spectrum of management, regulatory, and research responsibilities. This document primarily discusses activities conducted cooperatively between the organization's members and/or activities that involve resources held in common across the lake's political boundaries.

Refer to the map of Lake Champlain (Figure 1) for locations of tributaries and other areas referred to in this report.

Fish Community Objectives

Objectives for the Technical Committee were initially developed in the 1977 document: "A Strategic Plan for Development of Salmonid Fisheries in Lake Champlain." That plan established a goal of developing and maintaining a diverse salmonid fishery to supplement existing fisheries. Program objectives included:

- *Re-establish a lake trout fishery by 1985 that will annually provide at least 45,000 additional man-days of fishing with an approximate yield of 18,000 lake trout averaging 5 pounds each.*

- *Re-establish a landlocked Atlantic salmon fishery by 1985 that will annually provide at least 41,000 additional man-days of fishing with an approximate yield of 12,200 Atlantic salmon averaging 4 pounds each.*

- *Establish a "steelhead" rainbow trout fishery by 1985 that will annually provide at least 31,000 additional man-days of fishing with an approximate yield of 6,100 steelhead averaging 4 pounds each*.

- *Maintain the rainbow smelt fishery at a level that will annually average at least 25,000 man-days of fishing with an approximate annual yield of 100,000 pounds*.

Subsequent work by the Cooperative concluded that the abundance of sea lamprey was a primary factor preventing achievement of the salmonid management objectives. Those findings were reviewed in the Final Environmental Impact Statement: "Use of Lampricides in a Temporary Program of Sea Lamprey Control in Lake Champlain with an Assessment of Effects on Certain Fish Populations and Sportfisheries." That document established the following objectives:

- *Achieve an abrupt and substantial reduction in the abundance of parasitic stage sea lampreys for 8 years with 2 complete treatments of important ammocoete-producing areas*.

- *Monitor and assess the effects of the sea lamprey reduction on the characteristics of certain fish populations, the sportfishery, and the area's economy*.

- *Upon completion of this program, formulate long-range policy and management strategies for minimizing the effects of sea lamprey in Lake Champlain*.

The eight-year experimental sea lamprey control program that was conducted in the 1990's, determined that sea lamprey control yielded substantial biological, economic, and recreational benefits. During this period the Cooperative conducted 24 stream treatments with the lampricide TFM, and 9 delta treatments with the lampricide Bayluscide. A favorable benefit:cost ratio of nearly 3.5:1 was estimated for the experimental program (Fisheries Technical Committee 1999).

The eight-year program lead to the Cooperative completing in 2001 the Final Supplemental Environmental Impact Statement (FSEIS): "A long-term Program of Sea Lamprey Control in Lake Champlain." The FSEIS includes objectives and strategies for the lamprey control portion of the Cooperative's activities. While the eight-year control program focused on the use of lampricides, the long-term sea lamprey control program incorporates a variety of techniques including barriers to spawning migrations, trapping migrating adults, and lampricides to control larval lamprey infestations.

Over time the Cooperative members have devoted considerable effort towards protecting and improving Lake Champlain's walleye population. Stocking, monitoring the spawning runs, and monitoring lamprey impacts on walleye are primary areas of focus. Lamprey attack rates on

walleye suggest that, similar to salmonids, sea lamprey control may be an important strategy for improving the walleye resource. Walleye and salmonids also share the smelt forage base. Therefore, the smelt studies conducted by members of the Committee relate to the smelt's role as the primary forage for walleye and salmonids, in addition to sustaining a fishery directed specifically for smelt.

The Cooperative has pursued the above goals and objectives in a manner that is consistent with principles of ecosystem management:

- Management restores functions within the ecosystem that have been lost. Deep water, pelagic habitat accounts for roughly half of the lake's surface area. Lake trout and salmon were apparently the top piscivores in that portion of the lake. With their demise, neither native nor nonnative fishes filled that pelagic piscivore function. Another ecosystem function that is being restored is that of salmon runs in the lake's tributaries. Early records indicate that salmon were exceptionally abundant during the spawning runs. Due to the early loss of salmon, the broad implications of those runs to the basin's ecosystem are not known. However, salmon runs elsewhere provide important forage for fish eating mammals and birds.

- Management also reestablishes native components (native species) of the ecosystem that have been lost. Independent of their ecological function, reestablishing salmon and lake trout represents a restoration of native components of the ecosystem. Salmon and lake trout were historically found in the pelagic habitat of the lake and, in the case of salmon, in many of the tributaries. Adult salmon are present in tributaries during the fall spawning runs, and immature salmon are there throughout the year. An example that illustrates the distinction between function and components is the use of Pacific salmon in the Great Lakes: Pacific salmon are not a native component of the Great Lakes ecosystems, but they have been very effective at restoring the function of pelagic predator.

- The Cooperative stocks two nonnative species: steelhead (rainbow trout) and brown trout. Based on experience in the basin and elsewhere, neither species is likely to reach nuisance levels or be disruptive to the lake's ecosystem. Both species provide valuable diversification to angling opportunities in the lake and tributaries. In a lake and watershed with many significant ecological changes brought by humans, the non-disruptive nature of those stockings, combined with their recreational and economic value, makes their continued stocking appropriate.

- Key components of the ecosystem are monitored for potential impacts from management actions. The primary forage, smelt, is monitored for potential changes in abundance resulting from increased predation. Walleye, the primary competitor with salmon and lake trout, is also being monitored.

- Lastly, impacts of the sea lamprey control treatments on nontarget species are considered via toxicity tests, on-site observations during the treatments, and other studies. Results are used to develop effective treatment methodologies while minimizing potential nontarget impacts to the greatest extent possible.

By reestablishing native components, and by restoring functions of the historic Lake Champlain ecosystem, salmonid management by the Technical Committee is an excellent example of ecosystem management.

Sea Lamprey Management and Assessment

The Cooperative's current objectives for sea lamprey control in Lake Champlain, as established in the FSEIS for the long-term control program, include:

- *Achieve and maintain lamprey wounding rates at or below:*
  25 wounds per 100 lake trout (ideally 10 wounds per 100 lake trout);
  15 wounds per 100 landlocked salmon (ideally 5 wounds per 100 salmon);
  2 wounds per 100 walleye (ideally less than 1 wound per 100 walleye).

- *Attain target wounding rates within five years of full implementation of the long-term control program.*

Presently, sea lamprey control in the Lake Champlain Basin is achieved through the use of lampricides, barriers, and trapping. Ongoing efforts monitor the status of various life stages of sea lamprey to better direct those control efforts. Lastly, research efforts are being pursued to assess potential new control methodologies.

Lampricide Control

- TFM lampricide treatments were successfully completed on two streams in New York (Boquet River and Beaver Brook) and one delta (Ausable River delta) during 2003 (Table 1). High river flows required several treatment postponements on the Boquet River.

- Toxicity tests were conducted on each of the streams prior to beginning TFM applications.

- Observations following the 2003 TFM and Bayluscide applications indicate they were largely effective at killing ammocoetes (larval stage sea lamprey), yet caused minimal nontarget mortalities.

- The Beaver Brook treatment was only partially effective because of low flows and

variable water chemistries.

- The TFM treatment of Mt. Hope Brook was cancelled due to high flows. Several attempts to reschedule the treatment were unsuccessful. A toxicity test was performed on Mt. Hope Brook prior to the first scheduled treatment. The treatment will be rescheduled for 2004.

- A planned 2003 TFM treatment of the Winooski River in Vermont was cancelled due to delays in obtaining necessary state permits. Key issues included a delay in federal re-registration and re-labeling of the TFM formulation; a request from the Vermont Department of Health for additional information to assess human health risk associated with the treatment; and potential treatment impacts to the state-listed threatened American brook lamprey population in the Winooski River. The Winooski River treatment will be deferred to 2004, pending issuance of permits.

- A list of past and projected future stream treatments is provided in Appendix 1.

Table 1: Summary of lampricide applications in tributaries and deltas of Lake Champlain during 2003.

Stream or delta	Date treated	Flow (CFS)	TFM (lbs active ingredient)	Miles treated	Bayluscide (lbs active ingredient)	Acres treated
Ausable River delta	Sept 3-4	-	-	-	233.6	47.4
Beaver Brook	Sept 26-27	0.13	14.7	2	-	-
Boquet River	Oct 21	166-218	1,062	2.6		
		Totals:	1,076.7	4.6	233.6	47.4

Toxicity Studies

- Lampricide toxicity testing, necessary for obtaining essential treatment permits, was completed for young-of-the-year mudpuppies and the Vermont-listed, threatened American brook lamprey in 2003. NYSDEC tested both species at the Rome Laboratory and found them to be relatively sensitive to TFM, with significant mortality observed at or above the MLC (sea lamprey minimum lethal concentration).

- Attempts to collect pocketbook and fluted shell mussels were unsuccessful due to high river flows in potential donor rivers in Western NY. The mussels were to be collected to conduct a TFM/Niclosamide toxicity study. These species were tested previously with TFM-alone and found to be very tolerant of TFM.

- Plans to collect quillback for a TFM/Niclosamide toxicity study were cancelled because of scheduling difficulties.

Brook Lamprey Surveys

- The American brook lamprey (*Lampetra appendix*) and the northern brook lamprey (*Ichthyomyzon fossor*) are state-listed in Vermont as threatened and endangered, respectively. Information on their population levels and distribution throughout the basin allows the Cooperative to make informed decisions on sea lamprey control activities that may impact native lampreys, including the potential impacts to the overall native lamprey population and opportunities for mitigation.

- Twenty-three stream reaches were sampled for brook lamprey in the Lake Champlain Basin. American brook lamprey were found in two stream reaches where they were not previously documented: the Missisquoi River above the dam in the town of Swanton and in Hungerford Brook which flows into the Missisquoi River in this same reach.

Trapping and Barriers

- During winter 2002-2003, portable assessment traps were redesigned and manufactured to reduce the effort required to tend them. The new design allowed for an expanded trapping program during spring 2003. Traps were used to collect sea lamprey during their spawning migration on 17 tributaries to Lake Champlain during spring 2003 (Table 2).

- On nine of those tributaries, portable traps were installed as the primary method of sea lamprey control. Trapping has been implemented as a control technique on small streams where capture efficiencies are thought to be high, and where suitable trapping sites exist downstream of the spawning habitat.

- In the Great Chazy River, trapping is part of an integrated approach to controlling sea lamprey that includes lampricides in the lower river and trapping at the upstream barrier to limit their redistribution.

- Five streams were trapped solely to provide possible tag returns for a University of Vermont project investigating survival and movements of parasitic sea lamprey.

- Trapping was implemented on Morpion Stream to assess the potential for trapping spawning sea lamprey as a control measure. A local citizen was contracted by the USFWS to monitor traps in both Morpion Stream and the Pike River.

Table 2. Number of migratory-phase sea lamprey captured during 2003 in Lake Champlain tributaries where traps were deployed. Streams are grouped by watershed where applicable.

Stream	Number of migratory-phase sea lamprey captured
Great Chazy River [a]	373
Trout Brook [a]	165
Malletts Creek [a]	146
- Pond Brook [a]	10
- Indian Brook [a,b]	0
- Allen Brook [a]	0
Pike River	1
- Morpion Stream	89
Salmon River	59
Lewis Creek	38
Stone Bridge Brook [a]	31
Mt. Hope Brook	31
Mill Brook	15
Little Ausable River	12
Winooski River	NA
- Sunderland Brook [a]	7
Youngman Brook [a]	1
Mullen Brook [a]	1

[a] Streams where trapping was implemented as a potential control measure.
[b] Data suggest that trapping has eliminated sea lamprey production from Indian Brook.

Sea Lamprey Control in the Pike River System

The Pike River system in Quebec, including its major tributary, Morpion Stream, is one of the most important uncontrolled sea lamprey producers in the Lake Champlain Basin. In 1999, based on the results of work funded by the Lake Champlain Basin Program, approximately 136,000 sea lamprey inhabited this system. Most of the sea lamprey production in the Pike River system is believed to occur in Morpion Stream. Therefore, construction of a low-head weir near its mouth could eliminate most of the Pike River system's sea lamprey production, substantially reducing the need for lampricide treatments. This would also leave the main stem of the Pike River unrestricted by any new impediments to fish passage.

- In 2002 the Cooperative contacted the Québec Ministère de l'Environnement to initiate permitting for a lamprey weir near the mouth of Morpion Stream and/or to apply lampricides in the Pike River and Morpion Stream. In response, Québec officials suggested: "the control of sea lampreys should start with non chemical control."

- The Cooperative began technical evaluation of a low-head weir on Morpion Stream near its mouth during 2003.

- Funding was obtained from the Lake Champlain Basin Program for a lamprey weir hydrology and siting analysis.

- Field data collection necessary for siting and design was completed during the summer. Modeling of stream flows and various weir crest heights, design work, and cost estimates will be completed during 2004. A final report is due in June 2004.

- Trapping was implemented on Morpion Stream as part of the sea lamprey tagging study and to assess the potential for trapping spawning sea lamprey as a control measure. A local citizen was contracted by the USFWS to monitor traps in both Morpion Stream and the Pike River.

Sea Lamprey Tagging Project

The sea lamprey tagging study is intended to estimate the production of transformer lamprey in selected tributaries of Lake Champlain and to estimate those tributaries' relative contribution to Lake Champlain's parasitic (adult) population of sea lamprey. The study will also provide information on movements of sea lamprey within and among basins in Lake Champlain. The project is funded by the US Geological Survey (USGS) and the Great Lakes Fishery Commission, and is being conducted by staff from the University of Vermont, Lake Champlain Sea Grant, Cornell University, and the USFWS.

- Transformer sea lampreys (i.e. sea lamprey at the stage when they change from the larval, non-parasitic form to the juvenile, parasitic form) were collected, individually marked with coded-wire tags, and returned to the streams. In the fall/winter of 2002-03, the second year of the project, a total of 1,564 transformer-phase lampreys were tagged in 5 streams (Table 3). Recaptures of tagged lamprey by anglers and during spring spawning assessments provide the information on movements and abundance.

Table 3. Number of sea lamprey transformers tagged in tributaries to Lake Champlain in the fall/winter of 2001-2002 and fall/winter of 2002-2003. Rivers are listed from north to south.

River	Fall/Winter 2001-2002	Fall/Winter 2002 - 2003
Pike River	569	148
Morpion Stream	501	155
Saranac River	23	0
Malletts Creek	199	382
Winooski River	13	0
Lewis Creek	1,215	787
Mill Brook	9	0
Putnam Creek	50	92
Poultney River	74	0
Total	2,653	1,564

- By the end of 2003, 130 people had returned a total of 889 parasitic phase lamprey, of which five contained tags (Table 4). An additional 1,376 migratory and adult lamprey were captured in portable assessment traps, on nests, and migrating up the Lewis Creek falls; 16 of these lamprey contained tags. The majority of the recaptured lampreys were tagged in Lewis Creek (14; 66%); three (14%) were tagged in the Pike/Morpion system, three (14%) in Mallets Creek, and one (5%) in the Saranac River. The greatest distance traveled between tagging and recapture was 90 km; five (24%) of the lamprey returned to the tributary in which they were spawned.

Table 4. Summary of recaptures of tagged parasitic phase sea lamprey to date in Lake Champlain.

Stream Tagged	Date tagged	Location recaptured	Date recaptured	Distance traveled (km)
Parasitic phase recaptures				
Morpion Cr.	30-Nov-01	Inland Sea (Eagle Mtn)	18-May-02	64
Lewis Cr.	26-Sep-01	Burlington Bay	9-Jul-02	30
Lewis Cr.	06-Nov-01	Stave Island	25-Jul-02	42
Lewis Cr.	27-Sep-01	Burlington Bay	11-Oct-02	30
Lewis Cr.	06-Nov-01	Grand Isle Ferry	28-Sep-02	56
Spawning phase recaptures				
Pike R.	03-Oct-01	Morpion Stream	7-May-03	8
Pike R.	20-Sep-01	Great Chazy	21-May-03	50
Malletts Cr.	12-Sep-01	Malletts	8-May-03	0
Malletts Cr.	17-Sep-01	Malletts	12-May-03	0
Malletts Cr.	17-Nov-01	Great Chazy	9-Jun-03	46
Lewis Cr.	30-Oct-01	Malletts	12-May-03	50
Lewis Cr.	26-Sep-01	Lewis Creek falls	19-May-03	0
Lewis Cr.	26-Sep-01	Lewis Creek falls	19-May-03	0
Lewis Cr.	29-Oct-01	Lewis Creek falls	19-May-03	0
Lewis Cr.	26-Sep-01	Trout Brook	20-May-03	51
Lewis Cr.	26-Sep-01	Mill Brook (Port Henry)	20-May-03	27
Lewis Cr.	22-Oct-01	Great Chazy	21-May-03	90
Lewis Cr.	26-Sep-01	Great Chazy	28-May-03	90
Lewis Cr.	25-Oct-01	Great Chazy	28-May-03	90
Lewis Cr.	22-Oct-01	Great Chazy	28-May-03	90
Saranac R.	15-Nov-01	Morpion Stream	29-May-03	56

- Collections of parasitic phase lamprey will continue through the spring of 2004. Tagged sea lamprey will also be collected during spawning migrations and on nests in 2004.

Alternative Control: Alternatives Workgroup

The Final Supplemental Environmental Impact Statement for long-term sea lamprey control recommends "deferment of lampricide treatment of the Poultney River for five years

after [program] initiation to fully assess potential alternatives to lampricides and the effects of the proposed sea lamprey control program on wounding rates." This provides an opportunity to investigate potential alternative control techniques, while currently feasible control activities are implemented elsewhere in the Champlain Basin. An "Alternatives Workgroup" was formed to evaluate sea lamprey control methodologies that do not involve the use of lampricides. The workgroup consists of 30 members from 16 governmental and non-governmental organizations, including representatives from: the U.S. Fish and Wildlife Service; the Vermont Department of Fish and Wildlife; the New York State Department of Environmental Conservation; the Lake Champlain Walleye Association; the Vermont BASS Federation; charter captains; the Lake Champlain Committee; and The Nature Conservancy. The USFWS, as chair of the Alternatives Workgroup for the Cooperative, is chartering the Workgroup as a Federal advisory committee under the Federal Advisory Committee Act (FACA). Chartering the Workgroup under FACA provides an opportunity for stakeholders to give policy and technical advice to the Cooperative about sea lamprey control techniques that may provide useful alternatives to lampricides. Following our June 2003 meeting, meetings were postponed until the Workgroup was formally chartered under FACA. The USFWS expects to charter the workgroup through the Department of Interior in early 2004.

- Members of the workgroup helped leverage funding for a variety of alternatives-related projects. Grants for alternative control research includes: a total of $62,000 from the Lake Champlain Basin Program, $46,000 from The Nature Conservancy, $50,000 from Lake Champlain Sea Grant, and $10,000 from the Lake Champlain Ecosystem Team. In 2003, progress was made on four tasks: 1) population modeling, 2) microelemental analysis of sea lamprey statoliths to determine stream/delta of origin, 3) in- and out-of-nest egg survival, 4) lamprey telemetry project to identify potential trapping sites on the Poultney River.

- A sea lamprey life-history model incorporating all sea lamprey life stages is being developed by the University of Vermont's Dr. Ellen Marsden and graduate student, Eric Howe. Impacts of various management options (i.e., lampricide, angler impact, nest dismantling, and adult trapping) can be incorporated into the model to estimate the relative effect each respective management tool may have on the overall growth rate of the population.

- Validation of micro-elemental analysis of statoliths as a tool for tracking stream origins of sea lamprey builds on ongoing research being conducted by Dr. Ellen Marsden and colleagues in which sea lamprey are being tagged as transformers and recaptured as parasites in Lake Champlain. Once the microchemistry of sea lamprey statoliths (lamprey ear bones) is worked out, it is hoped that the method can be used to identify stream of origin of parasites. This method has great potential to reduce the use of lampricides by identifying the streams or deltas that are the major contributors to the parasitic population. In this way, managers will be able to focus control efforts on those streams that have the greatest impact on fish populations, while reducing or even

eliminating control activities on others.

- A radio-telemetry project was funded by The Nature Conservancy and is being conducted by Dr. Donna Parrish from the Vermont Cooperative Fish and Wildlife Research Unit and graduate student, David Hitchcock. This project will assess whether an engineered sea lamprey trap may be feasible in the Poultney River as part of a control strategy for this river. Effective sea lamprey trapping on the Poultney River would require that sea lamprey migrate to Carvers Falls before falling back to their primary spawning area just downstream from the falls.

- As identified above, the sea lamprey life history model is currently under development by researchers at UVM that will allow managers to estimate the impacts of control options targeted at different life stages of sea lamprey. Survival rates estimated for various life stages can significantly impact the model output. An important gap in our knowledge of sea lamprey life history is the survival rates of eggs incubated within the nests constructed by lamprey and the survival rates of eggs that are swept from the nest during spawning. The Nature Conservancy provided funding to Dr. Ellen Marsden and research assistant Steve Smith to begin assessing egg survival during spring 2004. The Lake Champlain Basin Program will announce a $35,000 request for proposals in the fall of 2004 to further this work.

Sea Lamprey Assessment

Sea lamprey assessment activities include monitoring several stages of the sea lamprey life cycle. Abundances of the larval (ammocoete) and transformer stages are estimated using quantitative assessment sampling (QAS) techniques in wadeable stream sections, and deepwater electrofishing surveys in delta areas. The data from those two techniques help the Committee prioritize lamprey treatments on streams and deltas. Lastly, monitoring sea lamprey attack rates on salmonids and walleye yields an indication of impacts of the parasitic stage (attack rates are discussed elsewhere in this document).

Sea Lamprey Assessment - ammocoetes and transformers in tributaries

- QAS surveys were done on two Lake Champlain tributaries during the summer of 2003 (Table 5). Because low numbers of sea lamprey larvae were captured during surveys conducted on the Missisquoi River in 2002, an additional survey was conducted during 2003. The stream was stratified into two reaches based on larval distribution identified during the 2002 surveys and sampling effort was intensified in the reach of stream where sea lamprey occur. In the Great Chazy River, surveys were conducted both above and below the barrier dam. Sea lamprey larvae were confirmed above the dam at population levels that likely warrant lampricide application in 2004.

Table 5. Summary of larval sea lamprey surveys conducted on Lake Champlain tributaries during 2003.

Tributary and reach	Year last treated	Year last assessed	Estimated 2003 larval population	Estimated Transformer Production 2003	Estimated Transformer Production 2004	On 2004 treatment schedule
Missisquoi R.	Never	2002	8,020	1,337	NA	No
Great Chazy R (below [a])	2002	1999 [b]	45,615	0	1,708	Yes
Great Chazy R. (above [a])	1996	1996 [b]	209,300	0	5,163	Yes

[a] "Above" and "below" refer to the dam on the Great Chazy River just upstream of the Village of Champlain. The dam is located about 11km upstream of the river mouth. There are about 21km of potential sea lamprey ammocoete habitat above the dam.

[b] Surveys prior to 2000 were relative abundance surveys based on catch-per-unit-effort.

Sea Lamprey Assessment - ammocoetes and transformers on deltas

Two deepwater electrofishing crews, one staffed by NYSDEC, the other with a USFWS contract crew, conducted deepwater sea lamprey surveys on two river deltas in 2003. The construction of an additional electrofishing unit allowed sampling effort to be expanded.

- Deepwater electrofishing surveys for sea lamprey larvae were completed on the Boquet and Saranac River Deltas. Surveys indicated that larval sea lamprey densities are largely limited to the lake/river interface on the Boquet. However, almost the entire Saranac River Delta is infested, even beyond the potential boundaries specified in pesticides permit applications. As a result, Saranac Delta boundary limits were revised and a permit modification request was submitted to the Bureau of Pesticides. Saranac Delta sea lamprey concentrations may number as high as 500,000 larvae. Verification sampling is planned prior to scheduled treatments in 2004.

Sea Lamprey Assessment - spawning phase

- Annual nest count surveys were abandoned during spring of 2003 due to the effort required for the expanded trapping program, shortages in staffing, and the limited reliability of nest counts as an index of abundance. No additional nest counting activities

are planned in the future.

Forage Fish Assessment

Rainbow smelt are the primary food for walleye and salmonids, and also comprise an important winter sport fishery in Lake Champlain. Predation on rainbow smelt is likely to increase as sea lamprey control yields increased survival of salmonids. Therefore, a program was initiated in 1990 to monitor rainbow smelt stocks annually in several areas of the lake.

- A total of 36 midwater trawls were collected between July 28 and August 12, 2003. Five stations were sampled in the main lake portion of Lake Champlain; two in the Northeast Arm (Inland Sea); and one in outer Malletts Bay.

- Calculated mean catches-per-unit-effort (CPUE) in 2003 were substantially higher than the 2002 CPUE at three, nearly the same at a fourth, and lower at the fifth main lake station. In the Northeast Arm, catch was lower in 2003 than in 2002 and CPUE more than doubled at the Malletts Bay station. Figures 2-4 compare CPUE over time at three stations representing each of the lake areas sampled.

Figure 2. Mean CPUE for the main lake station, Barber Point, 1987, 1993-1997 and 1999-2003.

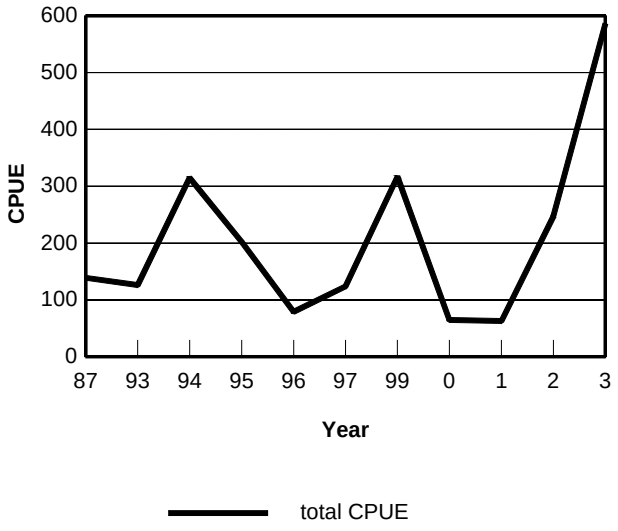


Figure 3. Mean CPUE for Northeast Arm, 1987 and 1990-2003.

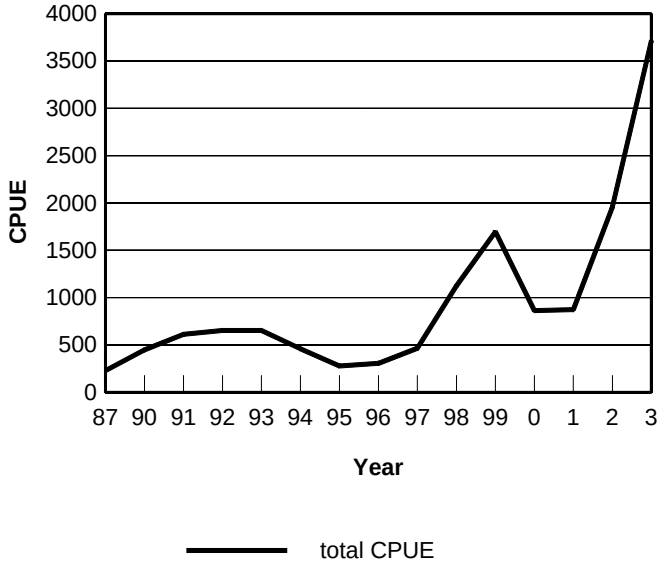
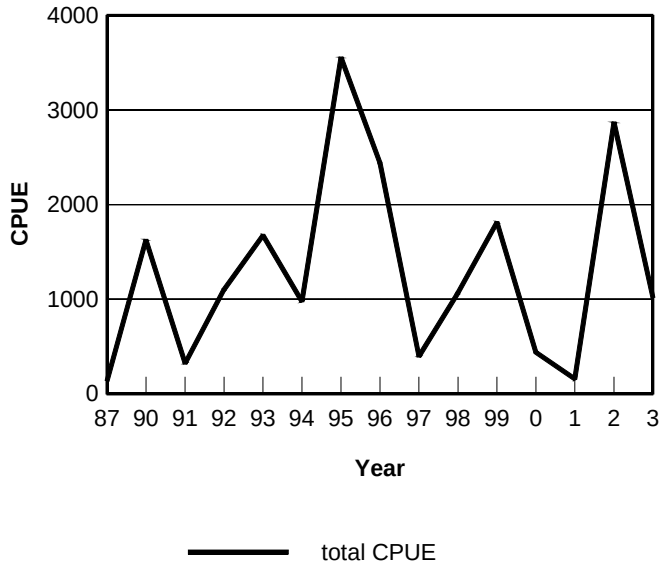


Figure 4. Mean CPUE for Malletts Bay, 1987 and 1990-2003.



- During 2003, the rainbow smelt research project funded by Lake Champlain Sea Grant focused on completing smelt diets, zooplankton abundance and composition, modeling cannibalism, and estimating smelt distribution and abundance related to several abiotic variables. Data analyses are continuing and a final report is due at the end of February 2004.

Salmonid Management

Salmonid management activities include stocking of landlocked salmon, lake trout, steelhead, and brown trout. On certain rivers, fish passage is being developed at dams to facilitate spawning of migratory species. A variety of sampling procedures are conducted to monitor the status of the salmonid populations, including evaluations of potential natural reproduction.

Salmonid Stocking Summary

- Salmonid stockings in Lake Champlain during 2003 included about: 312,000 landlocked Atlantic salmon (smolt equivalents); 55,000 steelhead (smolt equivalents); 69,000 lake trout; and 46,000 brown trout (Table 7). The list includes landlocked Atlantic salmon and steelhead that were stocked in the tributaries to the lake. Also listed in Table 7 are the stocking targets for each species. The stocking numbers are presented as "stocking equivalents." Salmonids are stocked at widely 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 equivalents to better represent the effective numbers stocked.

Table 7. Numbers (in stocking equivalents [a]) of salmonids stocked in Lake Champlain during 2003, and stocking targets for the lake.

Species	Main Lake		Malletts Bay/Inland Sea		Total number stocked in 2003
	Target	2003 stocking	Target	2003 stocking	
Landlocked salmon	207,000	238,688	60,000	73,780	312,468
Lake trout	82,000	69,400	0	0	69,400
Steelhead	73,000	52,766	12,000	1,812	54,578
Brown trout	38,000	25,880	40,000	20,133	46,013
Total	400,000	386,734	112,000	95,725	482,459

[a] Salmonids are stocked in a range of sizes which exhibit very different survival rates. The numbers stocked are converted to stocking equivalents based on expected survival rates.

Salmon Fry Stocking Evaluations

- Landlocked salmon fry were stocked in several tributaries to Lake Champlain during 2003. Subsequent electrofishing surveys assessed survival rates in the Lamoille and Winooski Watersheds.

- Approximately 130,020 and 149,100 salmon fry were stocked in the Lamoille and Winooski River watersheds, respectively. Length of fry at stocking ranged from 23 to 44 mm in length. The larger fry were stocked in the main stem of the Winooski and Lamoille Rivers in an effort to increase survival.

- Survival estimates of fry through their first summer ranged from 10 to 46 percent at seven stations sampled in 2003. Several areas of the main stem of the Winooski and Lamoille Rivers were also checked for the presence of parr resulting from the larger fry stocked. Twelve parr were collected from one location on the Winooski River where planted fry were 39 mm average length. The sampled parr mean length was 105 mm. No parr were collected from the Lamoille River main stem.

Sea Lamprey Attack Rates on Salmonids

- Wounding rates on lake trout and salmon were high during 2003. Table 8 shows that for the size classes selected for monitoring, 2003 wounding rates were much higher than the wounding objectives, and were even substantially higher than average wounding rates for several years prior to the experimental control program.

Table 8. Wounding rates on Lake Champlain lake trout and salmon sampled in the main lake during 2003.

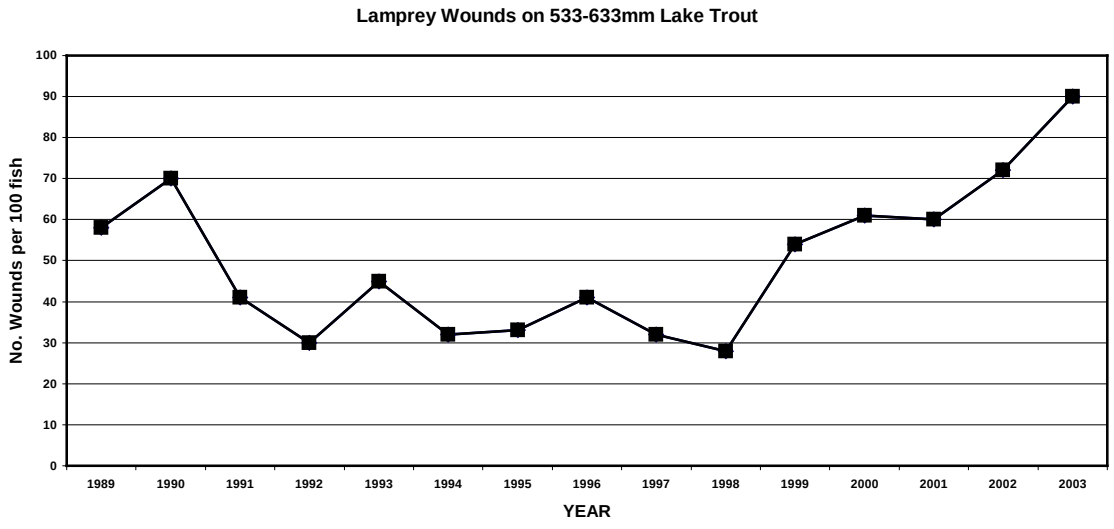
Species	Number of lamprey wounds per 100 fish			
	Objective	Pre-control	Eight-year control	Year 2003
Lake trout[a]	25	55	38	90
Landlocked salmon[b]	15	51	22	85

[a] Lake trout in the 533-633 mm length interval.
For lake trout, pre-control included 1982 - 92, while eight-year control includes 1993 - 97.

[b] Salmon in the 432-533 mm length interval.
For salmon, pre-control included 1985 - 92, while eight-year control includes 1993 - 98.

- Annual wounding rates for lake trout from 1989 through 2003 show a substantial reduction in wounding during the experimental control program, and a rebound in recent years (Figure 5).

Figure 5. Sea lamprey wounds (fresh and healing) per 100 lake trout, 533-633 millimeters total length, sampled in the main lake by electrofishing, 1989-2003.



- A similar pattern of high wounding rates occurred for three size classes of salmon returning to the Willsboro Fishway, Lamoille River, Sandbar Causeway, Winooski River Fish Lift and Hatchery Brook (Table 9). Wounding rates for the post-experimental control period are roughly as high, or higher than, wounding rates for the period before control began.

The major lamprey producing tributaries (excluding delta areas) in New York were treated during the interim control period, yet wounding rates increased to pre-control levels. Density compensatory mechanisms, and/or increased lamprey production from deltas or other locations are likely explanations for that trend. Regardless of the cause, the trend demonstrates that control must be expanded substantially beyond treating just the New York tributaries to achieve the desired benefits to the salmonid resources.

Table 9. Sea lamprey wounding rates by size group for adult landlocked Atlantic salmon captured at various locations during various phases of sea lamprey control. There is a time lag of 1-2 years before treatments conducted for the long-term control program could have influenced wounding rates.

	PRE-CONTROL (1985 –1992)		EXPERIMENTAL CONTROL (1993 – 1998)		INTERIM CONTROL (1999 – 2002)		2003	
LOCATION/ SIZE GROUP (mm)	N	Wounds per 100 salmon	N	Wounds per 100 salmon	N	Wounds per 100 salmon	N	Wounds per 100 salmon
Willsboro Fishway								
432-533	43	51	101	22	34	65	0	-
534-634	80	73	157	44	46	80	0	-
635-736	32	156	30	40	12	12	0	-
Lamoille River								
432-533	200	32	335	43	81	56	11	82
534-634	116	83	237	58	26	69	10	80
635-736	31	77	44	82	6	33	0	
Sandbar Causeway								
432-533	191	42	241	37	50	60	57	110
534-634	114	59	156	69	18	89	26	135
635-736	47	104	29	84	3	67	5	200
Winooski River Fish Lift								
432-533	n/a	-	160	21	31	64	3	167
534-634	n/a	-	165	28	46	63	10	140
635-736	n/a	-	18	61	9	278	4	300
Hatchery Brook								
432-533	n/a	-	196	33	416	35	57	70
534-634	n/a	-	100	45	254	68	21	71
635-736	n/a	-	20	85	34	65	1	-

Fish Passage

Winooski River Fish Lift

The Winooski One hydroelectric station in Winooski, Vermont, is the first upstream barrier on the Winooski River. More than 33 kilometers of suitable salmonid habitat exist upstream of the dam. The Winooski One fish "trap and truck" project has allowed fisheries managers the opportunity to restore wild migratory salmonid populations and fisheries in the lower Winooski River that have been restricted by barriers built on the river. The goals of the project are: To create quality stream fisheries for lake-run steelhead rainbow trout and landlocked Atlantic salmon in the Winooski River; and to encourage natural reproduction of Lake Champlain landlocked Atlantic salmon and steelhead rainbow trout in the Winooski River watershed.

- The fish lift operated from March 25 through May 17 and from September 15 through November 15, 2003.

- Four steelhead and 2 salmon were lifted in the spring of 2003.

- Fourteen salmon and three steelhead were recorded in the fall (Table 10). Of the salmon processed in the fall, 8 were male and 6 female. All but three salmon aged had spent one year in the lake. The remaining three salmon (females) were two lake-year salmon. Mean lengths of one lake-year salmon were 574 mm and 563 mm for male and female salmon, respectively. The two lake-year female salmon mean length was 672 mm.

- Three salmon (2 males and 1 female) lifted in the fall were sent to the Ed Weed Fish Culture Facility for egg-take. All others were released above the trap.

Table 10. Summary of landlocked Atlantic salmon and rainbow steelhead trout lifted at the Winooski One fish passage facility, 1993-2003.

Year	SPRING		FALL	
	Salmon	Steelhead	Salmon	Steelhead
1993	NA	0	36	7
1994	179	0	32	15
1995	38	0	12	9
1996	45	0	45	3
1997	8	0	115	24
1998	23	0	85	80
1999	54	0	53	13
2000	22	0	29	3
2001	7	0	6	0
2002	5	1	21	3
2003	4	2	14	3

Willsboro Fishway

The Willsboro Fishway is located on the Boquet River in the Town of Willsboro, Essex County, New York. The fishway provides fish passage upstream, over the most downstream dam on the Boquet River.

- No adult salmon were collected in the Willsboro Fishway during 2003 despite suitable river flows. The lack of adult salmon in the fishway is consistent with reports for 2003 from other tributaries to Lake Champlain. High attack rates by sea lamprey are the probable cause for the low abundance of adult salmon.

Imperial Mill Dam fish passage

The Imperial Mill dam is located on the Saranac River in the City of Plattsburgh, Clinton County, New York. The dam is located approximately 5.3 km from the river mouth, and is the first upstream barrier to fish passage on the Saranac River.

- Efforts continued to develop fish passage at the Imperial Mill Dam.

- Dam safety deficiencies were identified and must be corrected prior to, or concurrent

with, installation of fish passage. Lowering the elevation of the dam crest would be the least expensive option for correcting the deficiencies.

- Conceptual agreement was reached with the former owner of the dam to lower the crest. However, the mill and dam were sold in 2003 and the mill was converted into an industrial park with multiple tenants. The new owner has expressed an interest in maintaining the present crest elevation to generate hydropower to supply the industrial park tenants with electricity. Discussions were initiated, and will continue, with the new owner to reach a mutually agreeable solution to the dam's deficiencies and potential fish passage.

Spring and Fall Salmonid Assessments

Spring and fall boat electrofishing surveys for salmonids are conducted annually in addition to the sampling discussed above on the Boquet and Winooski fish passage facilities. This sampling allows for the collection of biological data including length, sex and age information as well as lamprey wounding data. The data are utilized in hatchery product/strain evaluations and to monitor sea lamprey control progress through time.

- Salmonids were sampled on four New York tributaries to Lake Champlain (the Saranac, Little Ausable, Ausable and Boquet Rivers) during spring. Spring sampling occurred during a one-week period in April instead of the usual two weeks of sampling. Electrofishing produced 146 landlocked Atlantic salmon that were captured for information and released. No brown trout or rainbow trout were encountered during sampling.

- The Spring 2003 catch rate was high compared to similar sampling conducted in previous years. Despite high sea lamprey wounding rates, three apparent year classes were represented in the sample, indicating some adult survival in spite of high sea lamprey attack rates.

- During New York's fall 2003 electrofishing, salmon were very difficult to collect in spite of efforts to sample historically productive areas. Only 137 landlocked salmon were captured in spite of aggressive collection efforts. Wounding was high and adults were poorly represented in the sample, suggesting that a large parasitic sea lamprey population fed heavily on salmon between the spring and fall of 2003.

- Vermont conducted fall electrofishing surveys on Whallon Bay, Grand Isle Ferry breakwater and adjacent Ed Weed Fish Culture Station discharge stream, Lamoille River and Sandbar Causeway from late September through mid-November, 2003. Fish were also sampled in Hatchery Brook one day in July. Selected data from salmonids sampled in these surveys are summarized in Table 11.

Table 11. Number and average total length (TL) of salmonids collected by Vermont in 2003 fall electrofishing surveys.

	Lake Trout		Salmon		Steelhead		Brown Trout	
Area	N	TL (mm)	N	TL (mm)	N	TL (mm)	N	TL (mm)
Whallon Bay	198	677						
Grand Isle[a]	278	643	84	520	43	344	3	411
Lamoille River			22	543				
Sandbar Causeway			93	525				

[a] Includes Grand Isle ferry breakwater, Hatchery Brook and surrounding shoreline

- A total of 203 lake trout collected by Vermont and New York electrofishing were within the slot size (432-533 mm) selected for evaluation of lamprey wounding rates.

Research on Lake Trout Reproduction in Lake Champlain

Research conducted by the University of Vermont is focused on documenting the status of lake trout reproduction in Lake Champlain, and evaluating the role of egg and fry predators, such as crayfish and sculpins, as potential impediments to restoration. The project began in 2001, and is conducted in collaboration with research teams working in northern Lake Michigan and Parry Sound, Lake Huron. The Great Lakes Fishery Trust and Great Lakes Fishery Commission fund this work. The objectives of the project are to:

1. Survey Lake Champlain for lake trout spawning sites.
2. Assess egg deposition and interstitial predator abundance at sites in Lake Champlain, Lake Michigan, and Parry Sound.
3. Measure fry emergence and relate to levels of egg deposition and survival.

- One additional site with fry emergence was identified in 2003; over 1,000 fry were collected on the intake crib in Arnold Bay, with a density of fry almost 5 times higher than seen at any other site in Lake Champlain (Table 10).

Table 10. Lake trout fry collections in Lake Champlain, 2003. Fry/m^2 was calculated as total number of fry divided by the total area under all the traps at a given site. CPUE = number of fry collected per trap-day. Number of fry per 100 eggs was calculated from quantitative estimates of eggs (from fall egg bags) divided into quantitative estimates of fry (from diver traps) x 100.

Site	Trap type	Deployed	# Traps	# Fry	Fry/m^2	CPUE	Eggs/ m^2	Fry/ 100 eggs
Whallon Bay	diver	4/22-6/19	13	152	297.9	0.29	1,299	11.7
Grand Is.	diver	4/22-6/12	12	463	907.5	1.10	3,183	14.5
Grand Is.	surface	4/23-6/12	7	176	704.0	0.74	---	---
Saxton Cove	soft	4/30-6/4	10	4	16.4	0.02	---	---
Arnold Bay	soft	4/29-6/10	10	1,008	4,032.0	3.60	---	---

- Final results from this project are detailed in the following paper:

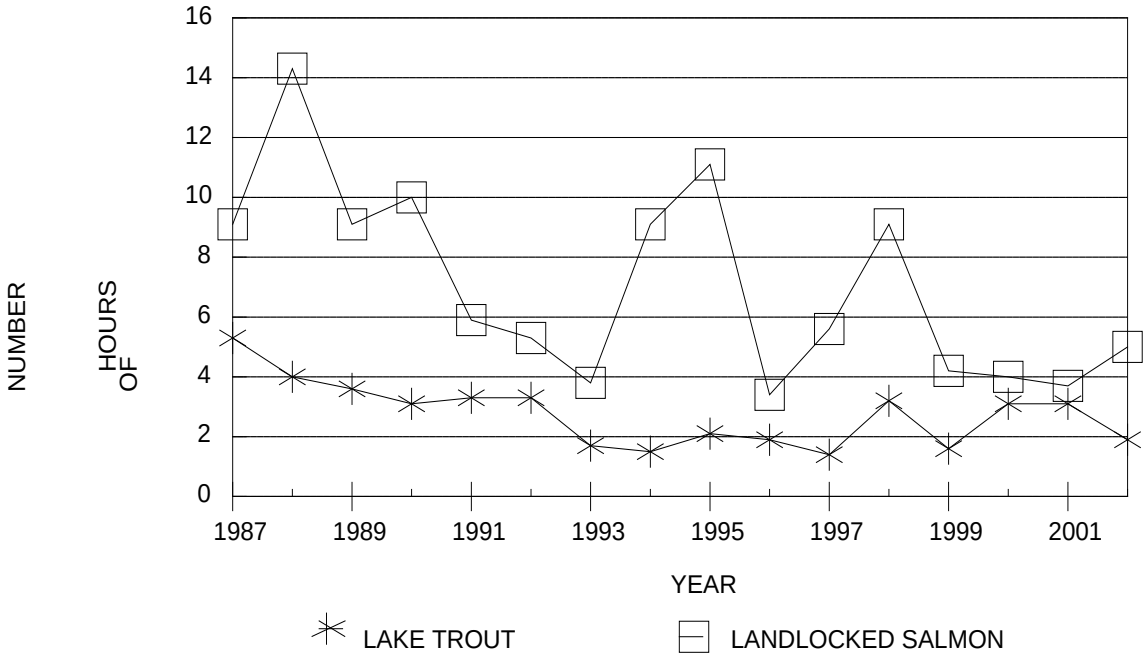
  Ellrott, B. E. and J. E. Marsden. 2004. Lake trout reproduction in Lake Champlain. Trans. Am. Fish. Soc. 133:252-264.

Lake Champlain Salmonid Angler Diary Program

- During the 2002 open-water fishing season, 34 cooperators recorded information from 414 fishing trips.

- For lake fishermen, the catch rate for lake trout anglers was 0.52 legal-sized lake trout per hour, and 0.20 legal-sized landlocked salmon per hour for landlocked salmon anglers (Figure 6).

Figure 6. Main lake catch rates (hours of fishing per fish) for legal-sized lake trout and landlocked salmon, 1987 - 2002.



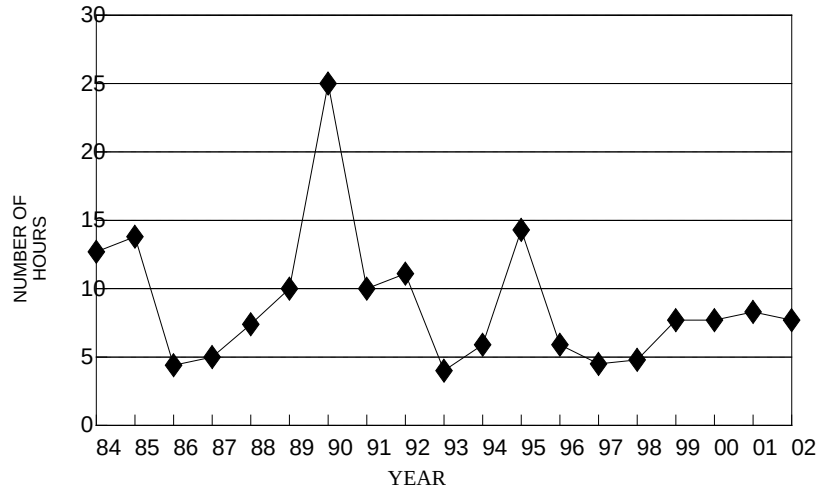
These figures include only trips where a single species was targeted.

- Catch rates for legal-sized landlocked salmon (≥ 381 mm) worsened slightly in 2002, however, catch rates of larger salmon size classes increased.

- Cooperators reported few lake-caught brown trout and steelhead, and no lake trips exclusively targeting these two species were made during 2002.

- Tributary fishing has worsened since the good salmon fishing of the 1990's, which followed effective sea lamprey control (Figure 7). For example, in 1993 it took just 4 hours of tributary fishing to catch a legal-sized salmon. In 2002 this had increased to over 8 hours. Cooperators reported catching 165 landlocked salmon, the vast majority of which were legal-sized (≥381 mm).

Figure 7. Tributary catch rates (hours of fishing per fish) for legal-sized landlocked salmon for the years 1984 through 2002.



These figures include trips where salmon alone or in combination with another salmonid were listed as the target.

- Cooperators also reported catching 23 brown trout and 30 steelhead during fishing trips on tributaries. However, for both of these species, the majority of the catch was comprised of sub-legal fish (< 305 mm).

Lake Champlain Landlocked Atlantic Salmon Strain Evaluation

The Cooperative initiated a landlocked Atlantic salmon strain evaluation in 2002. The study will assess the relative performance of Sebago, Memphremagog, and Little Clear (Adirondack) strain salmon. The Memphremagog, and Little Clear strains are both primarily West Grand Lake progeny and have a long stocking history in Lake Champlain. Sebago strain salmon have been stocked in Lake Champlain in recent years, and monitoring at the Ed Weed Fish Culture Station discharge stream indicates favorable returns from those stockings. In their native lakes, West Grand Lake salmon tend to utilize the outlet for spawning, while Sebago Lake salmon orientate to the inlet. Limited evidence indicates some salmon have out-migrated from Lake Champlain to the St Lawrence River. Such behavioral differences, or other differences between strains, could result in one strain yielding better returns in Lake Champlain than the others. Expectations are to raise 15,000 yearlings of each strain for each year of the study. Prior to stocking, each strain will receive a different mark for future identification. Initial stockings

occurred in spring 2003 with evaluations beginning that fall using river mouth and stream electrofishing techniques. Relative returns to the sample, sea lamprey wounding, and biological data will be collected for strain comparisons. The strain stockings will occur for at least three brood years and their performance will be evaluated through 2007.

- Eggs have been obtained from Lake Champlain Sebago strain salmon and are being grown with Memphremagog and Little Clear strains (15,000 smolt equivalents each) at the Pittsford National Fish Hatchery. In 2002, Little Clear fish were reared at the Adirondack Hatchery because space was not available at Pittsford. With all three strains receiving equal treatment at the same hatchery, rearing anomalies are minimized. In spring, all three strains are stocked simultaneously and in equal smolt equivalent numbers in the Boquet River, New York. Initial stockings occurred in spring 2003 with early samples of juveniles sampled in fall 2003 in conjunction with fall electrofishing efforts.

Walleye, Sturgeon, Alewives, Cormorants, and Mudpuppies

Walleye Spawning Run Assessments

- Walleye spawning runs were monitored in three tributaries of Lake Champlain during the spring of 2003 (Table 11). Adult populations are sampled to determine lamprey wounding rates, collect eggs for the fish culture program and to provide population indices (e.g. length distribution, age structure, etc.). Wounding rates are summarized in Table 11.

Table 11. Numbers of walleye sampled, and sea lamprey wounding rates for walleye collected in three tributaries to Lake Champlain, 2003.

River	Total Walleye Sampled [a]	Total in 534-634 mm Length class	Fresh Wounds	Healing Wounds	Wounds per 100 walleye
Poultney	292	85	0	2	2
Missisquoi	344	140	0	1	0.71
Winooski	471	174	1	12	7.47

[a] Not including same-year recaptures.

Walleye Stocking

Recent stocking efforts began in 1986 in cooperation with the Lake Champlain Walleye Association. Eggs were collected from the spawning run in South Bay, NY, reared at the Essex County Hatchery in Crown Point, NY and stocked in the South Lake. In 1988, the Salisbury Fish Culture facility in Salisbury, VT began rearing eggs collected from the Poultney River. In 1991, walleye fish culture efforts were moved to the Bald Hill Fish Culture Station in Newark, VT. Annual stocking ranged from 1 to 4 million fry and 12.5 to 70 thousand fingerlings prior to the completion of the Lake Champlain Walleye Restoration Plan adopted by the Vermont Department of Fish & Wildlife in 1999. The restoration plan objective is to collect 12 million eggs and produce 8 million fry for Lake Champlain fry stocking and fingerling production annually. Since 1999, 9 to 12.5 million eggs have been collected annually resulting in 6.1 to 8.3 million fry and 45 to 95 thousand fingerlings being stocked into Lake Champlain each year.

- In 2003, 12 million eggs were collected resulting in 6.7million fry and 144.5 thousand fingerlings being stocked into the lake.

Walleye Stocking Evaluation

A priority need identified in the Walleye Restoration Plan was to evaluate the contribution of stocked fry and fingerlings to the Lake Champlain walleye population. Experimentation with oxytetracycline (OTC) marking techniques began in 1998. The OTC technique involves exposing fry or fingerlings to OTC prior to stocking. The exposure leaves a permanent mark in bony tissue that fluoresces under ultraviolet light and allows identification of stocked walleye years after stocking. OTC techniques were developed by 2000 that allowed the mass marking of all fry and fingerlings stocked into Lake Champlain.

- In 2003, a sample of 30 young walleye (ages 2 - 4) was collected from the Missisquoi River to examine for OTC marks. Forty percent of these fish were marked. Fish stocked as fry (13%) and fingerlings (27%) were found.

Sturgeon

Lake Champlain once supported a small commercial fishery for lake sturgeon that harvested from 50 to 200 fish annually in the late 1800's and early 1900's. Annual harvest declined rapidly in the late 1940's, and the fishery was closed in 1967. Lake sturgeon are currently listed as endangered by the state of Vermont. In 1998, sampling began in tributaries near historic spawning locations to determine if adult sturgeon were still present and their

relative abundance. The Missisquoi, Lamoille, and Winooski Rivers, and Otter Creek are the four tributaries where sturgeon spawning activity had been noted in the past.

Gillnets were used to sample for adult sturgeon during the spawning runs in the Lamoille and Winooski rivers from 1998 thru 2002. Three to eleven individual sturgeon were captured each year. Several sturgeon were captured in more than one year and more than once in a year. The total number of individual sturgeon captured and tagged during the 5 years of gillnetting was 15 in the Winooski and 9 in the Lamoille. Sampling with gillnets near spawning sites on the Missisquoi River in 2001 and 2003 was unsuccessful.

Sturgeon ranged in size from 965 to 1,854 mm, weighing from 5 to 33 kilograms. All captured sturgeon were identified as males with the exception of two small sturgeon that could not be sexed. Lake sturgeon were weighed, tagged with PIT tags (small tags placed under the skin, just behind the skull) and measured for fork and total length. A small section of the first pectoral spine was removed from the left pectoral fin for aging and tissue samples were collected and archived for future genetic analysis.

In addition to the sturgeon collected by gillnetting, two adult sturgeon were captured in the Winooski River while electrofishing for walleye in 2003 and a large dead sturgeon was found in Otter Creek in 2000. One young sturgeon (170 mm) was caught by seining in the Winooski River during August 2001.

Sampling for sturgeon eggs began in the Winooski and Lamoille rivers in 2003. Egg traps were placed in a grid on the river bottom in suspected spawning areas. Egg traps were built using mats of latex-coated hog hair filter fabric wrapped around concrete blocks. Eggs are ensnared in the filter fabric as they drift downstream after being released by spawning adults.

Fourteen egg blocks were placed in the Lamoille River on May 5, 2003. Twenty-one blocks were set in the Winooski River on the next day. The number of blocks in each river ranged from 14 to 41 depending on stream flow. Blocks were checked for eggs 2 to 3 times per week per river depending on flow conditions and staff availability. The blocks were removed from the Lamoille River on May 26th and from the Winooski on the 27$^{th.}$

A total of 22 sturgeon eggs and 1 sturgeon prolarvae were collected in the Winooski River. Seven sturgeon eggs were collected from the Lamoille River.

Alewives

Alewives are not native to the Lake Champlain Basin. Their potential establishment in Lake Champlain could have serious ecological impacts. Alewives were discovered in Lake St. Catherine, Vermont (a tributary to Lake Champlain) in July 1997. It is thought that the Lake St. Catherine population was established through a purposeful, illegal stocking. The existence of alewives in Lake St. Catherine is of great concern because of their potential to spread to, and

impact, Lake Champlain and other area lakes. Alewives may spread unassisted to Lake Champlain via Lake St. Catherine's outlet that flows to the Mettawee River, and eventually into the southern end of Lake Champlain. To date, larval alewives have been collected immediately below the Lake St. Catherine dam in Mill Brook, but not further downstream. No juvenile or adult alewives have been found downstream of Lake St. Catherine.

As a result of the threat from alewives, various alternatives to manage alewives in Lake St. Catherine were investigated: 1) Public Education & Outreach, 2) Population Reduction, 3) Containment, and 4) Eradication/Reclamation. While drawbacks are present in all alternatives, some are more problematic than others and reduce the viability of those alternatives.

Unfortunately, there is no straightforward answer to the current alewife problem. It is rare when an invasive exotic species can be eradicated. More often than not, managers must find ways to cope with the invasive species. Alewives could be re-introduced illegally to Lake St. Catherine or any other lake in Vermont in the future. In addition, it is quite possible that alewives may eventually migrate to Lake Champlain via the Hudson River and Champlain Barge Canal, as have blueback herring, gizzard shad, and a host of other recent Lake Champlain fish invaders.

Through the selection of Alternative #1, Public Education and Outreach, the Vermont Department of Fish & Wildlife will continue their efforts to prevent the further movement of alewives through increased public education, and the adoption of pertinent regulations. The Vermont Department of Fish & Wildlife will also continue to search for new alternatives to control or eradicate alewives.

- In late 2003, the Fisheries Technical Committee discussed the alewife environmental assessment report and its selection of the preferred ***Public Education and Outreach*** alternative. Leo DeMong (NY), a member of the AFS Taskforce on Fishery Chemicals, offered his thoughts on the feasibility of a Lake St. Catherine reclamation. The pros and cons of a treatment were discussed. The committee felt that the potential impacts of alewives to the Lake Champlain ecosystem were great enough to warrant revisiting the chemical treatment alternative and it was recommended that a tour of Lake St. Catherine by reclamation experts be arranged.

Cormorant Research

- During 2003, 30 double-crested cormorants from the Four Brothers nesting colony were radio-tagged and followed to160 foraging locations.

- Cormorants from the Four Brothers tend to forage further from the colony than do cormorants from Young Island, which is likely related to the deepwater habitat surrounding the islands.

- A total of 10 cormorants were collected for diet analysis. Stomach contents verify that cormorants consumed age 2 smelt from a large smelt cohort that hatched in 2001.

- Eggs were oiled on 50% of the nests on Young Island.

- Cormorants from oiled portions of Young Island in 2002 returned to Young Island in 2003 at a lower rate than cormorants from un-oiled portions of the colony.

- Cormorants from oiled portions of Young Island in 2002 moved to Four Brothers Island in 2003 at a higher rate than cormorants from un-oiled portions of Young Island.

Mudpuppy Surveys

Potential impacts of lampricide treatments on mudpuppies have been raised as a concern, particularly in the Vermont tributaries to Lake Champlain. Therefore, substantial efforts have been directed to better understand the distribution and status of mudpuppies in the tributaries of the lake. The mudpuppy is a type of salamander that breathes via gills throughout its life cycle. Mudpuppies are relatively sensitive to TFM, but otherwise are very difficult to sample. Therefore, much of what is known about mudpuppy distributions has resulted from the TFM treatments themselves. Where we have treated with TFM we have a good idea of whether mudpuppies are present. Where we have not treated, we know very little about their abundances.

- Trapping was conducted for mudpuppies primarily in the Great Chazy River and Lewis Creek resulting in four mudpuppy captured. All four mudpuppies were captured in the Great Chazy River in spring. Two types of minnow traps were used in sampling: a non-modified (holes not enlarged) collapsible (fabric net material on a wire frame) trap and a standard minnow trap. The standard minnow trap is made of the standard metal mesh material that had been modified by enlarging the diameter of the entrance holes. Bait used included live fish (spottail shiners and golden shiners), frozen rainbow smelt, hatchery mortalities (1 to 2 inch trout) and bread. A total effort of 13,604 trap hours was expended. The highest effort (35%) was in the Great Chazy River and most of this effort was during the open-water period.

- In addition to sampling, a mudpuppy informational poster was designed and distributed to bait dealers and posted at fishing access areas. The intent of the poster was to educate the angling public on basic mudpuppy life history and solicit anglers to report mudpuppy catches. Reports received from anglers will be used to assist in determining the distribution of the mudpuppy. The poster resulted in 3 reports.

- In 2003, a study was conducted to determine if mudpuppies could be sampled using trotlines. The study had three objectives:

Objective 1. Design an adequate facility to safely house mudpuppies for the duration of the experiment.

Objective 2. Determine if hooks can safely capture mudpuppies.

Objective 3. Determine if individual mudpuppies can be identified by skin pigmentation patterns.

- Two closed recirculating systems were designed and constructed. Each system contained a reservoir with cooling capabilities, a filter system, and a submerged pump. This housing was sufficient to hold mudpuppies and provided adequate water circulation and ample oxygen. However, as ambient temperatures increased in June, additional cooling units had to be incorporated.

- One hundred adult mudpuppies were purchased from William Limburger Biological Supplies in Oshkosh, Wisconsin. The mudpuppies, originating from Otter Tail County, Minnesota, arrived in crowded conditions on April 9, 2003 by overnight mail. The mudpuppies were immediately divided into twenty-five tanks, each containing eight gallons of flowing water.

- The aquarium facility adequately held all mudpuppies used in the hooking studies. Although there was some initial mortality, the cause appeared to be stress induced by the shipping and not from the holding facilities.

- Hooking as a sampling technique was investigated because of the low cost of the equipment, its ease of use in a variety of field situations, and because a number of mudpuppies were captured as by-catch on hooks set for sturgeon during 2002. A variety of hook styles, sizes and different presentations were studied. Mudpuppies were able to free themselves from hooks unless they were swallowed beyond the mouth and into the stomach. Removal of swallowed hooks proved fatal in most cases. Consequently, this sampling methodology was rejected as inappropriate.

- Several mudpuppy photographs taken in this study suggest individuals can be identified by skin pigmentation patterns. Clear photographs of the dorsal surface of mudpuppies handled in the field may help to identify individuals and determine the percent of recaptures. The addition of a measuring device in the picture is helpful.

Champlain Canal Barrier

Researchers from the University of Vermont, Plattsburgh State University, Lake Champlain Sea Grant, Vermont Department of Environmental Conservation and the Lake Champlain Basin Program initiated a cost-benefit analysis and feasibility study of potential Champlain Canal barrier options. The purpose of a barrier would be to prevent the introduction

of nuisance aquatic species into Lake Champlain via the Champlain-Hudson canal. In 2002, Lake Champlain Sea Grant convened a workshop to identify stakeholders' concerns relative to this issue. Project staff are now attempting to integrate such concerns with ecological and economic impact findings, in hopes of listing several management alternatives. A summary document and associated public workshops are being planned for 2004.

- A draft manuscript describing the impact of aquatic nuisance species introductions via the Champlain Canal to date, along with a threats assessment of future introductions likely to occur absent any physical/procedural changes in the canal structures and/or operations, has been completed. A final version is expected during 2004.

- Cost-benefit analyses of possible canal barrier solutions remain incomplete because of the Fulbright Scholar leave of one of the Principal Investigators. When completed, the cost-benefit information can be merged with an already completed draft framework manuscript describing options for an exotic species barrier at the Champlain Canal.

Prospects for 2004

The management and research activities discussed above will generally continue in 2004. Expectations are that the impacts of sea lamprey will begin to decline with the renewal of treatments in Vermont and treatments of lamprey producing delta areas in New York. Over the long-term, research activities will assist in improving and refining the management of the lake's aquatic resources. A brief synopsis of expectations for 2004 include:

- Staffing has improved for the USFWS and for VTDFW. The USFWS was able to fill a vacancy that had been open for several years with a biologist who will concentrate on sea lamprey issues. Also, VTDFW replaced a fisheries biologist who recently retired. In contrast, NYSDEC has experienced substantial staff reductions due to retirements, and replacements are unlikely to occur until that state's fiscal situation improves.

- Given current fiscal concerns, the availability of funding in 2004 is unclear. Previous congressional appropriations secured by Vermont Senator Leahy and other area congressional representatives have been exhausted. The fate of additional congressional appropriations is unclear. However, as an interim measure NY has committed funds necessary for lampricide purchases necessary for the 2004 treatments.

- Conduct lampricide treatments on the Saranac and Boquet River Deltas, Mount Hope Brook, the Great Chazy and Winooski Rivers.

- Continue the University of Vermont sea lamprey tagging study. Collections of adult sea lamprey during 2004 will help to track parasitic- and spawning-phase lamprey movements in the Lake.

- Sea lamprey trapping will continue during 2004.

- No streams are currently scheduled for treatment during 2005. Quantitative Assessment Sampling (QAS) of larval abundances may be conducted on several streams to determine the need for future treatments and monitor populations being controlled through trapping.

- Conduct surveys on the Saranac and Boquet River deltas to gain information on the distribution and status of their respective larval sea lamprey populations, relative to their planned treatments in 2004.

- Additional surveys will be conducted to gain information on the distribution and status of brook lamprey populations in the Lake Champlain Basin and throughout Vermont.

- NYSDEC and the USGS Upper Midwest Environmental Sciences Center at LaCrosse, Wisconsin will conduct several toxicity tests to evaluate impacts of TFM/Niclosamide combination treatments to nontarget organisms. Combination treatments offer the potential to reduce the cost of treatments and possibly reduce nontarget impacts. However, toxicity tests must be conducted on several species before permits will be issued for combination treatments. Species to be tested include: quillback (a species of sucker); yearling mudpuppies; pocketbook and fluted shell mussels; American brook lamprey; eastern sand darter; and channel darter. Collecting test animals, conducting the tests, and analyzing the results make these activities a substantial commitment of staff and time.

- Design a barrier for Morpion Stream in Quebec. When a design is available, the permitting process can begin.

- Pursue New York and Vermont permits and permit modifications as needed for lamprey control activities. In New York, lampricide treatments require Wetlands permits from the NYSDEC and the Adirondack Park Agency. In addition, pesticides permits are required from the DEC. Current NY permits are good thru 2009. In Vermont, Aquatic Nuisance Control and Endangered and Threatened Species permits are required prior to conducting lamprey treatments. For both states the permitting process has required a substantial commitment of staff time.

- The Cooperative and the Alternatives Workgroup will continue to evaluate potential alternatives to lampricides. Data from the 2002 nest raking study will be analyzed and reported. The Alternatives Workgroup will continue to assess other alternatives. Staff stay in close communication with the Great Lakes Fishery Commission on related research conducted by that organization.

- Continue activities related to sea lamprey assessment, salmonid assessment and sea lamprey/salmonid interactions. Procedures will be similar to those described above for 2003.

- Initiate an update of the 1977 document "A Strategic Plan for the Development of Salmonid Fisheries in Lake Champlain" to better reflect the multi-species work pursued by the Cooperative.

- Continue research into cormorant diets and population dynamics.

- Conduct walleye and sauger spawning run assessments, walleye egg collection, walleye stocking (including marked fingerlings and marked and unmarked fry), and walleye stocking evaluations.

- Complete summary documents and associated public workshops regarding feasibility and effects of Champlain Canal barrier options.

References:

Fisheries Technical Committee. 1999. Comprehensive Evaluation of an Eight Year Program of Sea Lamprey Control in Lake Champlain. Lake Champlain Fish and Wildlife Management Cooperative. 209 pp.

Fisheries Technical Committee. 2001. A Long-term Program of Sea Lamprey Control in Lake Champlain, Final Supplemental Environmental Impact Statement. Lake Champlain Fish and Wildlife Management Cooperative. 358 pp.

Lake Champlain Fish and Wildlife Policy Committee. 1977. A Strategic Plan for Development of Salmonid Fisheries in Lake Champlain. NYS Department of Environmental Conservation 20pp.

Appendix 1: Schedule of Lake Champlain lamprey treatments through 2003, and projected treatments for 2004 and beyond.

1990: Salmon River
Little Ausable River
Ausable River (and Dry Mill Brook)
Boquet River
Beaver Brook
Putnam Creek
Lewis Creek

1991: Mount Hope Brook (and Greenland Brook)
Stone Bridge Brook
Ausable Delta
Saranac Delta
Little Ausable Delta
Salmon Delta
Boquet Delta

1992: Great Chazy River
Saranac River
Poultney River
Hubbardton River

1993: no treatments

1994: Salmon River
Little Ausable River
Ausable River (and Dry Mill)
Boquet River
Putnam Creek
Lewis Creek

1995: Mount Hope Brook (and Greenland)
Trout Brook
Ausable Delta
Salmon Delta
Boquet Delta
Saranac Delta

1996: Great Chazy River
Poultney River
Hubbardton River

1997: no treatments

1998: Little Ausable River
Salmon River
Putnam Creek
Beaver Brook

1999: Mount Hope Brook (and Greenland)
Boquet River
Ausable River (and Dry Mill)

2000: Great Chazy

2001: no treatments

2002: Little Ausable River
Ausable River (and Dry Mill)
Salmon River
Putnam Creek
Beaver Brook
Lewis Creek

2003: Mount Hope Brook – postponed
Beaver Brook
Boquet River
Ausable Delta
Little Ausable Delta – no treatment required
Salmon Delta – no treatment required
Winooski River - postponed

2004: Great Chazy River
Saranac Delta
Boquet Delta
Mount Hope Brook (and Greenland)
Winooski River

2005: no treatments

2006: Little Ausable River
Ausable River (and Dry Mill)
Salmon River
Putnam Creek
Lewis Creek

2007: Mount Hope Brook (and Greenland)
Beaver Brook
Boquet River
Ausable Delta
Little Ausable Delta
Salmon Delta
Poultney River[1]
Hubbardton River[1]

2008: Great Chazy River
Saranac Delta
Boquet Delta
Winooski River

2009: no treatments

2010 and beyond: Repeat the cycle listed above for 2006 through 2009 while possibly adding the Pike River and others as appropriate.

[1] If wounding rate objectives are not met and no feasible control alternatives exist.

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