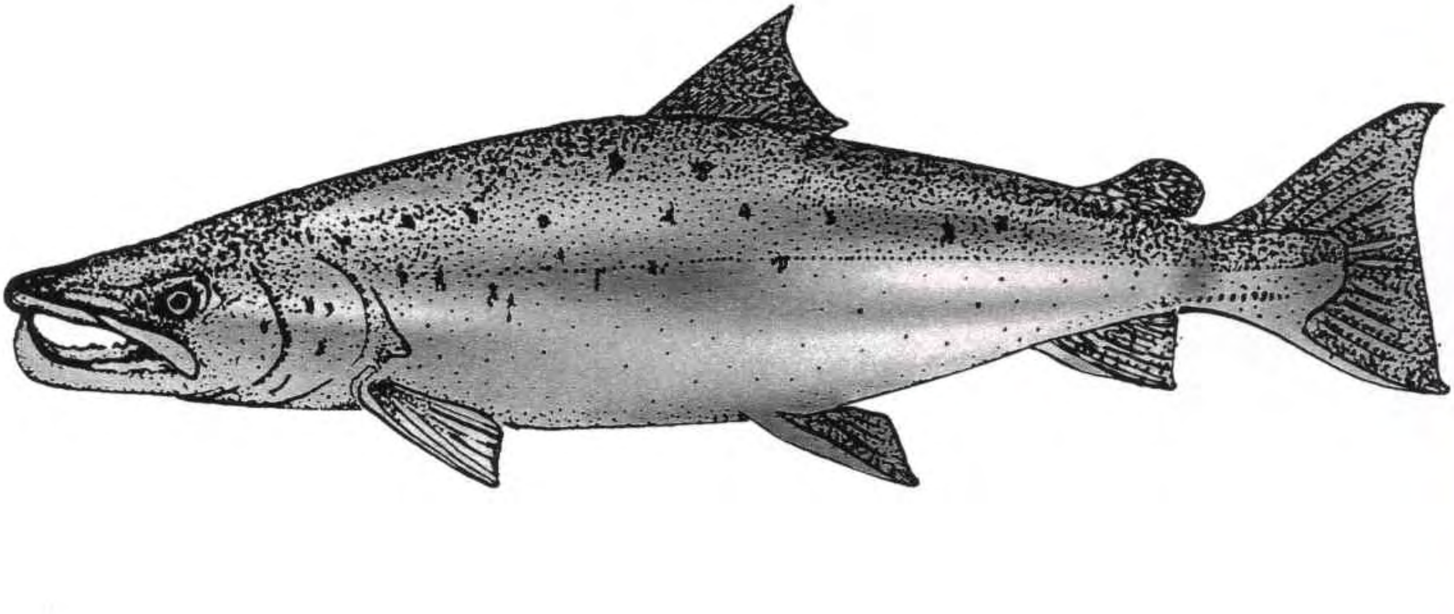
A Comprehensive Evaluation of an Eight Year Program of Sea Lamprey Control in Lake Champlain

Fisheries Technical Committee
Lake Champlain Fish and Wildlife
Management Cooperative



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

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Dedication

This report is dedicated to Gary Steinbach, who was a fishery biologist with the U.S. Fish and Wildlife Service's Sea Lamprey Control Program, stationed at the Marquette, Michigan Biological Station.

Gary died September 23, 1994 at age 51 as a result of a traffic accident near Lake Champlain's Crown Point Bridge in New York. He was in New York assisting with the experimental sea lamprey control program at the time. For 15 years before his death, Gary led field treatment crews to control sea lamprey in the Great Lakes. His many contributions to the refinement of sea lamprey treatment techniques resulted in significant reductions in the amount of lampricide used, monetary savings, and a reduction in mortality of nontarget species.

Loss of Gary's knowledge and experience left a tremendous void in the expertise of the U.S. Fish and Wildlife Service and its Sea Lamprey Control Program. Gary ranked with the finest of professionals. His dedication and loyalty, his ability to think clearly in difficult situations and his leadership by example won the admiration and respect of others. He was well-liked and inspired a strong sense of confidence. Gary's professional contributions to the Lake Champlain fisheries management program have been immense. The Lake Champlain Fish and Wildlife Management Cooperative has been most appreciative of Gary's efforts and will always feel a tremendous sense of loss in his passing.

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Executive Summary

The Lake Champlain Fish and Wildlife Management Cooperative, comprised of the United States Fish and Wildlife Service (USFWS), the Vermont Department of Fish and Wildlife (VTDFW) and the New York State Department of Environmental Conservation (NYSDEC), initiated an eight-year experimental sea lamprey control program on Lake Champlain in 1990.

This document compares results of the program to evaluation standards set forth in *A Comprehensive Plan for Evaluation of an Eight Year Experimental Program of Sea Lamprey Control in Lake Champlain* (Engstrom-Heg et al. 1990, Appendix A). It assesses the efficacy of lamprey reduction and its effects on the characteristics of certain fish populations, the sportfishery and the area's economy. Beyond the scope of Engstrom-Heg et al. (1990), it responds to concerns of regulatory agencies by addressing the effects of the program on nontarget organisms. The purpose of the evaluation is to provide the basis for the formulation of long-term policy and strategies for the mitigation of the adverse effects of sea lampreys in Lake Champlain.

The experimental program substantially reduced larval sea lamprey numbers in treated streams and deltas. Sixteen of twenty-four stream treatments met or exceeded the evaluation standard regarding reduction in residual larval sea lamprey populations. Six did not meet the criteria, and two were unable to be assessed because high flows prevented pre-treatment surveys. Eight of nine delta treatments achieved success in attaining satisfactory mortality levels among exposed, caged lamprey and exceeded the evaluation standard. The remaining delta treatment killed substantial numbers of lamprey and was considered partly successful. Catches of spawning-phase sea lamprey in portable assessment traps on three streams declined dramatically to levels within the success range of the associated evaluation standard. Nest counts did not diminish to the low levels considered an indication of success on nine of ten streams monitored.

TFM-induced adverse impacts on nontarget organisms were minimal, as documented by both routine surveys and special studies. The adverse impacts of Bayer 73 were more substantial, yet affected organisms recovered to near or greater than pre-treatment levels within four years of treatment. Impacts to nontarget species were consistent with those predicted in the Final Environmental Impact Statement (FEIS) (NYSDEC, USFWS, VTDFW 1990).

Post-control lake trout populations exhibited decreased lamprey wounding and scarring rates and increased survival, meeting five of six evaluation standards that demonstrated biological effectiveness of the sea lamprey control program. Open-water creel surveys and angler diary cooperator data showed substantial increases in both numbers and sizes of lake trout caught. This exceeded two of three pre-established evaluation standards when meeting only one of these was required for determining success at the fishery level.

Main Lake landlocked salmon also exhibited significant wounding reductions, and dramatic, 6- to 15-fold increases in the numbers of 1-, 2- and 3-lake-year salmon returning to the Boquet and Saranac Rivers. These wounding reductions and increases in older salmon occurred with no reduction in either mean, age-specific length or condition factor, and met or exceeded all three evaluation standards for biological success. At the fishery level, Saranac River and Main

Lake catches per equivalent smolt stocked increased more than three times. An increase in larger, older salmon, was recorded based on Saranac River and Main Lake creel surveys and angler diaries. At the level of fishery value, the Main Lake landlocked salmon exceeded criteria in a set of three pre-defined evaluation standards. Salmon from the Malletts Bay and Inland Sea basins did not achieve biological or fishery-level evaluation standards.

Success in achieving two steelhead evaluation standards either could not be determined or was not attained. However, Main Lake creel census data indicated a dramatic increase in numbers caught per stocked fish since lamprey control was implemented.

Three evaluation standards were established for brown trout. Insufficient data prevented analysis of one, a wounding standard. Length frequency analyses indicated improved survival, but actual survival estimates from Saranac River spring creel surveys and nearshore electrofishing failed to meet the survival standard. Increases occurred in angler catch per stocked brown trout in most data sets, demonstrating partial success relative to the catch rate evaluation standard.

University of Vermont researchers monitored rainbow smelt stocks during the eight-year experimental program. Findings were compared to standards developed in 1990 to determine if rainbow smelt populations were adversely impacted by the expected increase in number of predators. Overall, the smelt monitoring project met four of six associated evaluation standards, signifying no statistically significant negative impacts due to excessive predation. Prey species-size data associated with one of the two remaining standards was inconclusive. The last standard could not be assessed because smelt sex could not be determined during the summer sampling period to track any shift in sex ratio. Continued, careful monitoring of smelt biomass is warranted, however due to the significant decreases in catch per unit effort (CPUE) monitored at one main lake site during the period. Another clear trend that emerged from the study was an unexplained general decrease in smelt mean length-at-age.

Anglers and participants in water-based recreation placed a very high value on the Lake Champlain eight-year experimental sea lamprey control program and indicated they would substantially increase their activities if the program is continued. Discounted to 1990 values, benefits of the eight-year program were estimated at $29,379,211 and costs at $8,781,969, producing a benefit:cost ratio of 3.48:1. Continuation of sea lamprey control on lake Champlain would be expected to generate an additional 1,217,609 days of fishing and $4,150,768 in fishing-related expenditures each year. The finding that benefits greatly exceed costs demonstrates that sea lamprey control on Lake Champlain is justifiable on economic grounds.

Overall, the Lake Champlain experimental sea lamprey control program met or exceeded the majority of pre-established evaluation standards (see following summary chart). Termination of sea lamprey control on Lake Champlain would result in a resurgence of the sea lamprey population to pre-treatment levels within approximately four years and rapidly lead to diminished quality in the lake's salmonid fishery. Conversely, long-term continuation of an integrated sea lamprey control program would be expected to further enhance benefits which have accrued to important fish populations, the sport fishery and the economy. The information summarized in this report provides impetus for continued sea lamprey control.

Summary Chart Comparing Program Results to Comprehensive Evaluation Standards:

Topic	Evaluation Standard	Standard Achieved	Standard Not Achieved	Standard Not Evaluated
Lamprey Reduction	Post-treatment population densities at index stations, do not exceed 10% of pre-treatment values	X[a]		
	Caged ammocoete mortality on Bayer 73 treated deltas exceeds 50% in at least 85% of the targeted area, and mean mortality within the 50+% zone exceeds 85%	X[b]		
	Substantial reductions [~10-20% of pre-control levels] occur in numbers of spawning adults	X		
	Reduction in the numbers of tallied sea lamprey nests to 20% of pre-control values		X	
Fishery Response - Lake Trout	A ≥25% reduction in estimated total instantaneous mortality rate from age 3 to age 4, as compared to mean for baseline period	X		
	A significant [$P \leq 0.05$] decrease in the log-linear slope of catch curve for ages 3-5 or 3-6 in pooled gill net data after correction for selectivity		X[c]	
	A decrease in estimated, instantaneous natural mortality rates for older, fully recruited lake trout or minimally no significant increase	X		
	Significantly increased gill net catch per unit effort in areas outside of Zones 3A and 3B	X		
	A reduction [$P \leq 0.05$] in the number of lamprey wounds per 100 lake trout	X[d]		
	A corresponding decrease occurs in accumulated lamprey scars (Stage IV) for given age classes	X[d]		
	There were separable increases of 25% or greater in number of lake trout with no reduction in average weight harvested; <u>OR</u>	X		

[a] Sixteen TFM stream treatments achieved or exceeded the standard; six streams did not meet the standard, but four of these exhibited substantial reductions ranging from 66.3% - 81%; and 2 streams could not be evaluated due to pre-treatment high flows.

[b] Eight of nine deltas treated exhibited greater than 87% caged ammocoete mortality in target area; the Boquet was considered partly successful with 73% mortality in the target area.

[c] Catch curves were analyzed by an alternative to the log-linear slope method. This standard was achieved in estimates of survival made by comparison of netting year, and nearly achieved in survival estimates made by comparison of year classes.

[d] These wounding and scarring standards were achieved for all size classes when no attempt was made to adjust for the number of lamprey-vulnerable lake trout in the population; they were achieved for the three smallest of five size classes when an approximate adjustment was made.

Summary Chart Comparing Program Results to Comprehensive Evaluation Standards (Continued):

Topic	Evaluation Standard	Standard Achieved	Standard Not Achieved	Standard Not Evaluated
Lake Trout (Continued)	There were separable increases of 25% or greater in average weight of lake trout harvested; OR		X	
	There were separable increases of 25% or greater in number of angler-caught lake trout over 25 inches	X		
Fishery Response - Landlocked Salmon	A reduction [$P \leq 0.05$] in the number of adult lamprey wounds per 100 fish	X[e]		
	A doubling of 1-lake-year salmon returning to the Boquet, Saranac and Lamoille Rivers, followed by at least a doubling of 2- and 3-lake-year fish	X[f]		
	No reduction of over 10% in either mean age-specific length or condition factor	X[g]		
	At least a doubling of total Main Lake tributary catch per equivalent smolt stocked	X[h]		
	A progressive increase in the proportion of older fish in the tributary catch after the initial increase in age 3+ (2-lake year) fish	X		
	No serious negative impact on rainbow smelt due to increased landlocked salmon predation that could not be compensated for by decreased stocking	X		
Fishery Response - Steelhead	A reduction ($P \leq 0.05$) in adult lamprey wounds per 100 fish			X[i]
	At least a doubling of the catch of age 3+ fish in the Saranac River		X	

[e] Landlocked salmon wounding was significantly reduced for the Main Lake basin only, not the Inland Sea / Malletts Bay basins.

[f] The doubling was clearly achieved in the Boquet and Saranac Rivers. Results for the Lamoille River were ambiguous. Sandbar Bridge area sampling indicated partial achievement of the standard.

[g] An inconsistent exception to achievement of this standard were reductions in Main Lake condition factors by approximately 20-33% for two size classes of landlocked salmon less than 532 mm as assessed by creel survey and the Lake Champlain International Fishing Derby.

[h] This rating was based on Saranac River fall returns and Main Lake creel census results. Spring Saranac River returns did not achieve criteria, but spring tributary fisheries may not be reliable indicators of this parameter. Pooled angler diary data from Main Lake tributaries exhibited a near doubling (from .085 to .166) in mean catch per angler hour supporting the rating.

[i] The number of wounds per 100 fish decreased 83%, but could not be tested for significance due to small sample size.

Summary Chart Comparing Program Results to Comprehensive Evaluation Standards (Continued):

Topic	Evaluation Standard	Standard Achieved	Standard Not Achieved	Standard Not Evaluated
Fishery Response - Brown Trout	A decrease [$P \leq 0.05$] in lamprey wounds per 100 fish on age 2+ and 3+ brown trout			X[j]
	An increase in estimated survival between age 2+ and 3+ brown trout		X[k]	
	An increase in catch per fish stocked, as indicated by creel census results	X[l]		
Impacts on Forage Fish - Rainbow Smelt	Catch-per-unit-of-effort is not lower [$P \leq 0.05$] at all sampling stations than in the same months as in previous years for the four consecutive years at all stations sampled	X		
	Salmonids and walleye show no consistent and significant changes in selection of either prey species or sizes; Index of Relative Importance of smelt does not fall below 80% during summer sampling periods.			X[m]
	Length-at-age of smelt from midwater trawls in August indicates no significant change [$P \leq 0.05$], and that mean length-at-age for all age classes has not changed	X[n]		
	No 25% or greater decrease in survival rate compared to 1984-1985 and 1987 accompanied by an increase in total mortality over the last four years of sampling	X		
	Angler/cooperators demonstrate no significant change [$P \leq 0.05$] in catch per unit of effort and/or in size distribution of smelt caught	X[n]		
	The male:female ratio shows no consistent decreases over the period of sampling.			X

[j] Insufficient data existed to determine whether a decrease in brown trout wounding occurred.

[k] Length frequency distributions of all brown trout reported caught in the Saranac River creel surveys (spring and fall) showed increases in larger, older fish. However the standard was not achieved based on nearshore electrofishing samples and fish handled by agents during the Saranac River spring creel survey.

[l] This standard was partially achieved. Increases were documented in the Main Lake, Malletts Bay and the Inland Sea, but decreases were recorded in the Saranac River.

[m] The Index of Relative Importance could not be calculated as prey in stomachs were not weighed. Results regarding size selection were ambiguous.

[n] These standards anticipated predatory impacts would cause increased mean lengths. Significant differences in sizes occurred, but they were decreases. Therefore, it has been determined that the standards were achieved.

A Comprehensive Evaluation of an Eight-Year Program of Sea Lamprey Control in Lake Champlain

I. Introduction

A. Concept / Purpose

Overall, this report is a comprehensive assessment of the efficacy of sea lamprey reduction, the impacts of TFM and Bayer 73 treatments on nontarget species, the effects of sea lamprey reduction on the characteristics of certain fish populations, the sport fishery response to sea lamprey control and the impacts of improved salmonid survival on forage fish. It furnishes a benefit:cost analysis for the program. Its purpose is to provide the basis for the formulation of long-term policy and strategies for the mitigation of the adverse effects of sea lampreys in Lake Champlain.

B. Background

Lake Champlain's indigenous populations of landlocked Atlantic salmon and lake trout were rapidly depleted as development in the area progressed during the 1800's. Early attempts to re-establish populations of these species through stockings failed, and efforts were abandoned until the late 1950's and early 1960's. Then New York and Vermont began stocking lake trout and salmon that produced a limited fishery. Realizing the importance of integrated management of Lake Champlain fishery resources, New York State Department of Environmental Conservation (NYSDEC), the Vermont Department of Fish and Wildlife (VTDFW), and the U.S. Fish and Wildlife Service (USFWS) formed the Lake Champlain Fish and Wildlife Management Cooperative (the Cooperative) in 1973. The Cooperative soon adopted and implemented *A Strategic Plan for Development of Salmonid Fisheries in Lake Champlain* (Fisheries Technical Committee 1977). The objectives of this program were to re-establish a lake trout and salmon fishery, establish a rainbow (steelhead) trout fishery, and maintain the existing harvest of rainbow smelt. These objectives set forth numbers and sizes or pounds of fish to be harvested and numbers of angler trips to be generated for lake trout, landlocked salmon, steelhead and rainbow smelt. The Strategic Plan also identified sea lamprey control as a potential future need.

The Cooperative determined sea lamprey were hampering development of the salmonid fishery in Lake Champlain based on study results described in the *Lake Champlain Salmonid Assessment Report* (Plosila and Anderson 1985) and the *Lake Champlain Sea Lamprey Assessment Report* (Gersmehl and Baren 1985). A follow-up report, *Salmonid-Sea Lamprey Management Alternatives for Lake Champlain* (Fisheries Technical Committee 1985), developed and analyzed program alternatives for future management of the lake's salmonids and sea lamprey. The Cooperative's Salmonid/Sea Lamprey Subcommittee recommended initiation of an eight-year experimental sea lamprey control program. Objectives included the reduction of sea lamprey through two rounds of lampricide treatments and an evaluation of responses by the sea lamprey population and salmonid sportfishery. The recommendation was reviewed and adopted by the Cooperative's Policy Committee.

Pursuant to guidelines in the National Environmental Policy Act (NEPA), and the New York State Environmental Quality Review Act (SEQRA) for preparation of a Draft Environmental Impact Statement (DEIS), four public scoping meetings were held in New York and Vermont during October, 1985. The purpose of those meetings was to review the proposed sea lamprey control program, and to allow public input concerning issues that should be addressed in the environmental impact statement. The DEIS, *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* (NYSDEC et al. 1987) was released for public review in 1987.

Three more studies, *Evaluation of the Potential Impact of Lampricides (TFM and Bayer 73) on Lake Champlain Wetlands* (Gruendling and Bogucki 1986), *Analysis of Rhodamine WT Dye Plume Studies on Lake Champlain, New York*, (Myers 1987), and *Evaluating Lampricide Transport in Lake Champlain*, (Laible and Walker 1987), provided plume dilution and dispersion data required to develop mitigation plans to avoid human and/or wetlands exposure to TFM. A Final Environmental Impact Statement (FEIS) with the same title as the draft was released on July 19, 1990 (NYSDEC et al. 1990). Five permits necessary for application of the lampricides were negotiated and obtained. Three of these (a freshwater wetlands permit, a TFM pesticides permit and a Bayer 73 pesticides permit) were issued by the New York State Department of Environmental Conservation; one (a freshwater wetlands permit) was issued by the New York State Adirondack Park Agency; and one (an Aquatic Nuisance Control Permit) was issued by the Vermont Department of Environmental Conservation. Subsequent modifications of the NYSDEC wetlands and TFM pesticides permits were issued on 3/19/92, 4/22/96 and 10/25/96. The Vermont Aquatic Nuisance Control Permit was amended on 4/4/91; a new Vermont permit with modifications was issued on 3/17/92 and subsequently withdrawn by the applicant on 11/1/95; and another new Vermont permit was issued on 10/10/96. Most modifications were requested to allow greater effectiveness in treatment of the Poultney / Hubbardton system and for treatment date changes. Not all permit changes sought by the Cooperative were approved by permit-issuing agencies. The 1996 modifications required the filing of an Environmental Assessment in accord with NEPA and resulted in the issuance of a Finding of No Significant Impact. Substantial bioassay work on a variety of mussel species, the eastern sand darter and the channel darter was conducted to support requested modifications (Neuderfer 1997).

The Lake Champlain Fish and Wildlife Management Cooperative initiated the eight-year experimental sea lamprey control program on Lake Champlain in 1990.

Specific objectives of the program, as described in its associated FEIS, were:

a. Achieve an abrupt and substantial reduction in the abundance of parasitic stage sea lampreys for eight years with two complete treatments of important ammocoete-producing areas using chemical lampricides TFM and Bayer 73 (5% granular).

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

c. Upon completion of this program, formulate long-range policy and management strategies for minimizing the effects of sea lamprey in Lake Champlain. Strategies would include a combination of best available techniques which would provide the optimum results in terms of fish resource and fishery benefits as well as environmental compatibility, cost-effectiveness and economic benefits.

Two rounds of treatments were planned for each significantly infested stream and delta. From 1990 through 1996 twenty-four TFM treatments were conducted on fourteen Lake Champlain tributaries, and nine Bayer 73 (5% granular) treatments were conducted on five deltas.

Stream treatments involved the precise metering of liquid formulation TFM into infested streams at concentrations ranging from about 1.0 to 9.0 parts per million for a duration of 12 to 14 hours. Application techniques were described in the FEIS and permit-associated operating procedures. During the eight-year, experimental period, a cumulative total of approximately 141 stream miles were treated in this manner.

TFM treatments of the targeted streams occurred in the years designated with check marks, as shown in the chart, below:

	1990	1991	1992	1994	1995	1996
Boquet R.	✔			✔		
Little Ausable R.	✔			✔		
Ausable R.	✔			✔		
Salmon R.	✔			✔		
Beaver Br.	✔			not treated		
Putnam Cr.	✔			✔		
Lewis Cr.	✔			✔		
Stone Bridge Br.		✔			not treated	
Mount Hope Br.		✔			✔	
Trout Br.		not treated			✔	
Saranac			✔			not treated
Poultney R.			✔			✔
Hubbardton R.			✔			✔
Great Chazy R.			✔			✔

A TFM treatment in Trout Brook could not be undertaken in 1991 because permit conditions regarding the relocation of a specific number of American brook lamprey (Vermont threatened species) upstream of the primary application point could not be satisfied. Additionally, second-round treatments in Beaver Brook (1994), Stone Bridge Brook (1995) and the Saranac River (1996) were deemed unnecessary and canceled due to lack of substantial ammocoete / transformer presence.

Bayer 73 treatments were conducted by a field team comprised of members of the Cooperative and private sector contractors on the major sea lamprey infested river deltas in the New York waters of Lake Champlain. Cropduster aircraft, calibrated to deliver 100 pounds of formulation per acre, were used for the application of 63,700 pounds of Bayer 73 (5% granular) formulation to a total lake area of 637 acres in 1991. In 1995, a total of 58,300 pounds of Bayer 73 (5% Granular) was applied to 583 acres.

Bayer treatments were coordinated through centralized radio communications involving the pilot(s), a command boat and other boat crews who marked completed flight swaths. This technique also was fully described in permit-associated operating procedures. Bayer treatments took place on river deltas as follows:

	1990	1991	1992	1994	1995	1996
Boquet Delta		✔			✔	
Little Ausable D.		✔			not treated	
Ausable Delta		✔			✔	
Salmon Delta		✔			✔	
Saranac Delta		✔			✔	

A second-round treatment of the Little Ausable Delta was unnecessary due to lack of ammocoete / transformer presence.

To complete this schedule, many challenges were overcome. During the first year of treatments, a radical environmental group moved for injunction of the program in Federal Court (*<u>Elliot v. U.S. Fish & Wildlife Service</u> Civil No. 90-263*). The U.S. Fish & Wildlife Service's motion for summary judgment and dismissal of the complaint was granted, and the program continued. Later the Poultney River Committee sought a State of Vermont, Rutland Superior Court Order to stop treatment of the Poultney and Hubbardton Rivers in 1992 (*<u>In re: Appeal of Poultney River Committee</u> Rutland Superior Court, Docket No. S0693-92 RcCa, February 3, 1994*). The Court refused to issue the order, and the treatments were conducted.

Water supply issues created other challenges. A demanding and complex prior notification, posting and water supply plan was developed and approved through the permit process. It required treatment-year surveys of riparian water users to determine the source of their supply, and whether they would need an alternate source during and immediately following treatments when water use advisories were in effect. Notifications were mailed to all riparians in the advisory zone, and door-to-door notification of those who used stream or lake water were conducted within a few days preceding each treatment.

Thousands of gallons of commercially bottled water were delivered to affected riparians for potable use. Bulk tank trailers were deployed in central locations to provide household water for purposes other than cooking and drinking. Where expedient, arrangements were made for affected riparians to use nearby state or other public facilities for obtaining water, showering, etc. during advisory periods. Activated charcoal filtration systems were installed in some instances at program expense where delivery of commercially bottled water would have been infeasible or undesirable. Agricultural users were supplied with water for livestock from bulk water tankers and other means. Notably, a herd of approximately six hundred cattle was watered for nearly two weeks during each treatment of the Great Chazy River by transporting lake water from an unaffected area and pumping it into the farmer's water supply pump-house (isolated from adjacent lake water inflow via a custom-designed pipe cap) with a large-capacity, special-purposes tanker truck. To limit exposure to treated water, electric fencing was installed in some cases and/or cattle were moved by sea lamprey control personnel.

The first Great Chazy River treatment had to be deferred until after 1990 when the Village of Champlain switched their municipal water supply from the river to a well field. An agreement with the Georgia-Pacific Company, which uses about 3.5 million gallons of water per day drawn from an intake near the mouth of the Saranac River, also had to be reached before treatments of the Saranac River or delta could take place. The agreement involved connecting the Georgia-Pacific Company to the City of Plattsburgh municipal water supply at the expense of NYSDEC.

More challenges were met through the arrangement and implementation of numerous special studies to determine the degree of any adverse impacts associated with the program.

The Cooperative anticipated a need to objectively measure the success of the experimental sea lamprey control program. To facilitate this evaluation, *A comprehensive plan for evaluation of an eight year program of sea lamprey control in Lake Champlain* (Engstrom-Heg et al. 1990, Appendix A) was developed before treatments were initiated. The evaluation plan outlined measures for assessing the control program's effects on sea lamprey abundance, salmonid populations, the sportfishery response, the rainbow smelt forage base and the economy of the Lake Champlain Basin. This report responds directly to all evaluation standards laid out in the comprehensive evaluation plan. By doing so, it fully addresses FEIS 'Objective b', and it facilitates accomplishment of 'Objective c', as stated above. In addition to the topics outlined in the evaluation plan, this document also reports program-related adverse impacts to nontarget organisms as specified in permits issued for the project by regulatory agencies.

The substance of this report is contained in five major sections labeled, (II) Efficacy of Lamprey Reduction, (III) Nontarget Species Impacts, (IV) Salmonid Population and Sport Fishery Response, (V) Impacts on Forage Fish and (VI) Benefit Cost Analysis. These sections are followed by documentary sections titled, (VII) List of Preparers, (VIII) Literature Cited and (IX) Appendices. Each of the first five sections begins with an abstract summarizing the effects of sea lamprey control on its subject matter. Section III presents considerable information, supplemental to the comprehensive evaluation plan, describing the effects of sea lamprey control on nontarget organisms. Sections II, IV, V and VI, address each of the numerous comprehensive evaluation standards. These standards appear in boldface italics for easy recognition. The standards follow descriptive headings that provide summary information on what parameters were considered and/or techniques applied. Occasionally other important results, for which no evaluation standard was developed, are presented. In these instances, the lack of an associated standard is indicated.

II. Efficacy of Sea Lamprey Reduction

Abstract

Sea Lamprey Larval Assessment

Larval sea lamprey assessment included monitoring population abundance before, during and after control treatments on streams and deltas inhabited by sea lamprey. Evaluation of treatment success included measures of abundance of residual sea lamprey after a chemical treatment had been conducted and bioassays of caged ammocoetes. Other sea lamprey assessments included immediate, post-treatment mortality counts; documentation of re-establishment of sea lamprey larvae in streams after treatment, monitoring growth rates of sea lamprey in various streams, estimating relative abundance and distribution within streams, and monitoring streams that have no known sea lamprey populations, but do have suitable habitat for spawning sea lamprey adults and larval development.

TFM Treatments - Post-treatment electrofishing surveys at index stations on TFM treated rivers were conducted to determine the number of lamprey that survived previous TFM treatments ("residual sea lamprey"). The evaluation standard called for a reduction in catch rate of sea lamprey larvae at index stations to less than 10% of pre-treatment catch rates. After the 1990 treatments, four of seven rivers treated met the evaluation criteria. One did not, and two were unable to be evaluated, based on the absence of pre-treatment data because high flows prevented population density surveys prior to the scheduled treatment. During the 1991 treatments, Stone Bridge Brook received a successful treatment, and reestablishment of sea lamprey larvae has not been recorded to date. The treatment of Mount Hope Brook, however, did not meet the evaluation criteria for a successful treatment. During the 1992 and 1994 TFM treatments, two of the four rivers treated and four out of six rivers treated, respectively, received treatments which met the criteria for success. The treatments of five rivers during 1995 and 1996 were all successful.

Bayer 73 Treatments - Bioassay cages were used as an indicator of treatment success during Bayer 73 treatments on deltas in Lake Champlain. Larval sea lamprey were placed in cages in various parts of the treatment area and outside the treatment zone. Treatment-zone, live-cage mortality on four of the five deltas treated with Bayer 73 (5% granular) during 1991 was 100%, surpassing the evaluation standard for success of achieving caged ammocoete mortalities exceeding 50% in at least 85% of the treated area and a mean mortality within the 50%+ zone of more than 85%. A mean mortality of 73% was recorded in the Boquet River, which did not meet the criteria for a successful treatment. However, significant numbers of animals were killed, and the treatment was considered partly successful. During the 1995 Bayer treatments, four deltas were treated and bioassay cages on all exhibited mortality meeting the standard for successful treatments.

Spawning Phase Assessment

Spawning phase sea lamprey were monitored throughout the eight-year control program through the use of portable assessment traps and by conducting nest counts in index sections of 10 tributaries. Data were collected on the relative abundance of nests, the numbers of sea lamprey captured in portable assessment traps and changes in the sex ratio and the size of animals in the population. The criteria for evaluation of the spawning phase sea lamprey included a reduction to 10 - 20% of pre-control levels in the numbers of spawning phase adults captured in portable assessment traps, and a reduction in the number of sea lamprey nests to 20% of pre-control numbers.

Portable assessment traps were monitored annually during the sea lamprey spawning run from 1989 to the present in three Vermont tributaries; Stone Bridge Brook in the Inland Sea, Indian Brook in Malletts Bay, and Lewis Creek, in the Main Lake basin. Lewis Creek has been monitored annually since 1981, and the others were monitored annually since 1989 and intermittently prior to 1989. There were substantial reductions in the number of animals captured in all three streams meeting the evaluation criteria of reductions of 80 to 90% from pre-control levels. There was no significant shift in the sex ratio of sea lamprey in any of the three tributaries. A significant ($P \leq 0.05$) increase in the mean weight of sea lamprey was seen in Lewis Creek, but no significant mean weight difference occurred in Indian or Stone Bridge Brooks.

Nest count data were collected on a yearly basis beginning in 1983. A reduction in the number of sea lamprey nests to less than 20% of pre-control levels was not achieved in any of the rivers monitored.

A. Larval Sea Lamprey Investigations

1. Post-treatment Mortality Estimates in TFM-Treated Streams

No Standard: ***Engstrom-Heg et al. (1990) established no mortality count evaluation standard. However, post-treatment mortality estimates in treated streams provide useful indicators of treatment effectiveness, and are considered here based on their own merits.***

Dead, resident sea lamprey were often the first and most obvious indicator of an effective stream treatment. Although not associated with an evaluation standard, mortality counts after stream TFM treatments helped quantify relative treatment effectiveness on target lamprey. Additionally, they provided peripheral information such as which portions of sea lamprey habitat were most densely populated. A randomized sampling scheme intended to provide quantitative estimation of sea lamprey mortality on deltas resulting from Bayer 73 (5% granular) treatments was attempted in 1991. However, the technique was determined to be inadequate for obtaining reliable estimates of sea lamprey mortality, and the widely variable results (Nashett 1992) are not further discussed here.

To facilitate the evaluation of stream treatment effectiveness in various parts of each river system, the streams were divided longitudinally into numerous sections based mainly upon changes in physical characteristics of the stream, the most important of these being gradient changes. In some cases roads or rail crossings marked the section endpoints. Stream station boundaries were marked on specially prepared topographic maps and personnel involved in the target/non-target mortality surveys were briefed on the recognition of section boundaries and methodology to be used in recording the data, as well as the collection and handling/preservation of specimens. Stream treatment maps listing the survey sections, numbered in increasing order from the application point to the mouth, are presented in Appendix B.

Permit conditions mandated that non-target mortality surveys be conducted throughout the treatment zones of each stream. The day after the TFM treatment block had passed from the stream, crews were sent out to record and/or collect non-target mortalities of fish or amphibians. These personnel were also instructed to record the extent of the "target" sea lamprey mortality either by direct tally (of dead lamprey) or, in cases of extremely high numbers, by estimation. Accuracy of counts and estimates was affected by depth, water clarity, discharge and scavengers that consumed dead sea lamprey before they could be tallied. In order to evaluate species composition as well as age, growth and percent transformation, an unbiased sample of 200 dead lamprey were also collected if possible.

Mortality count surveys are discussed below. Generally, surveys showed highest lamprey numbers downstream from primary spawning sites. This result can be attributed to larval migration during the first few years after spawning. Summary tabular data are presented in Table 1.

Boquet River

The first treatment of the Boquet River was conducted on September 11, 1990, with the application of TFM to approximately 2.6 miles of stream habitat. To assess the lamprey kill, the river was divided into eight river segments and one delta segment. Adult spawning habitat was limited to section 1. Post-treatment target mortality surveys indicated that the larval population was concentrated in sections 6, 7, and 8 in the lower portion of the river, where over 83% of the mortality estimate of over 6,300 sea lamprey was made. This same section of river was treated again with TFM on September 13, 1994, and resulted in a tally of over 6,500 sea lamprey.

Little Ausable River

Application of TFM was started on September 13, 1990, when approximately 6.0 miles of the river were treated. The sea lamprey population in the Little Ausable River reflects the physical habitat conditions, which are ideal for larvae in the lower half of the treated zone. The river was divided into eleven assessment sections. Adult sea lamprey spawning habitat was located primarily in the upper portion of section 3 and throughout all of sections 4, 6, and 7. Post-treatment surveys indicated that the bulk of the larval population (92% of approximately 122,000 sea lamprey killed) occurred downstream in sections 9 and 10. The same segment of the Little Ausable River was treated again with TFM on September 15, 1994. A mortality count of over 38,000 sea lamprey was recorded during a post-treatment mortality survey of the treatment zone on September 16, 1994.

Ausable River

Application of TFM was conducted on September 15, 1990, and most of the approximately 6.0 miles of the river below Rainbow Falls at Ausable Chasm and an additional 0.5 mile of the tributary Dry Mill Brook were treated. Because of the unanticipated variable flow patterns in the multi-channel lower portion of the Ausable River, a lethal TFM block did not move completely through the south fork of the river channel and an effective treatment through this portion of the Ausable River was not achieved. Survey results showed significant numbers of sea lamprey survived treatment in the south fork of the Ausable River. Adult spawning habitat was concentrated in sections 2-6. Post-treatment surveys indicated a major concentration of the lamprey larval population (82%) occurs in sections 9-11B. A count estimate of about 24,500 sea lamprey was made after this treatment. The same portions of the Ausable River and Dry Mill Brook were again treated with TFM on September 17, 1994. Approximately 69,000 sea lamprey were tallied after this treatment.

Salmon River

Application of TFM took place on September 17, 1990, and approximately 4.0 miles were treated. Very little reduction in the TFM concentration was observed and treatment personnel felt that minimum lethal concentration was carried to the mouth. For assessment purposes the river was divided into eight sections. Adult spawning habitat is concentrated primarily in section 3 with some nesting occurring in sections 2, 4, and 7. Post-treatment surveys recorded approximately 65,000 dead lamprey and indicated that a major concentration of the larval population (89%) occurred in sections 3-5. This section of the Salmon River received a second TFM treatment on September 19, 1994 resulting in an estimated 64,000 dead lamprey.

Beaver Brook

Application of TFM to this stream was conducted on September 19, 1990. Plans called for treating the lowermost 2.5 miles of Beaver Brook. Due to extremely low flow conditions during the scheduled treatment period, the decision was made to move the application point downstream, and approximately one mile of the brook above lake level was treated. Some adult spawning habitat, but very little ammocoete habitat, occurred above the relocated application point. The stream was divided into six sections to facilitate surveying and collection of post-treatment results. Post-treatment surveys indicated the highest mortality (88%) occurred in sections 3 and 4 and recorded an estimated treatment zone total of about 1,000 dead lamprey. No treatment of this stream occurred in 1994 because electrofishing surveys indicated very few transformers were present.

Putnam Creek

Putnam Creek was treated with TFM on September 20, 1990, and about two-thirds of the approximately 4.8 miles of river below the primary application point was exposed to TFM at greater than or equal to the Minimum Lethal Concentration (MLC) for sea lamprey. Although adult spawning habitat occurs from section 1-10, the major spawning concentration occurs in sections 6-10. Larval habitat is sparse above section 9, but large amounts of prime habitat occur from section 10 downstream to the mouth. Post-treatment surveys tallied an estimate of over 30,000 dead sea lamprey in 1990, and indicated that the bulk of the larval mortality occurred in sections 11 and 12. The same segment of Putnam Creek was again treated with TFM on September 22, 1994. MLC was achieved in most of the treated segment, and just under 21,000 sea lamprey were estimated killed.

Lewis Creek

Application of TFM to this stream was started on September 23, 1990, and completed on the 24th. Approximately 9.4 miles of the stream were treated. Lewis Creek was divided into 14 sections from the application point down to Lake Champlain for post-treatment surveys. Over 92% of the sea lamprey larval mortality (estimated at approximately 26,000 individuals, total) occurred below section 5. Lewis Creek was treated again with TFM on October 5, 1994. The primary application point was moved downstream and the treatment covered approximately 7.0 miles of stream. An estimated kill of over 41,000 sea lamprey resulted.

Stone Bridge Brook

Approximately 2.9 miles of Stone Bridge Brook were treated with TFM once during the experimental program on September 17, 1991. The estimated kill of approximately 500 sea lamprey was lower than anticipated. A high percentage of transformers in the sample collections and fewer younger animals than expected indicate that low survival rates may be a limiting factor affecting the size of the larval population in this stream. No 1995 treatment was conducted as surveys indicated no recolonization of sea lamprey.

Mount Hope Brook

This stream was treated with TFM on September 20, 1991 and again on September 8, 1995. Approximately 1.3 miles were treated each year. The brook was divided into five sections to assess the target/nontarget mortality. Sea lamprey spawning habitat was present in the uppermost treated portion of the brook below an impassable waterfalls, with the majority of larval habitat occurring in the lower 1.0 mile of the treated segment of the brook. Mortality assessment crews estimated approximately 27,000 and 11,000 sea lamprey were killed in 1991 and 1995, respectively.

Saranac River

TFM treatment of 3.3 miles of the Saranac River began on September 14, 1992. The river was divided into five sections to assess the target/nontarget mortality. Sea lamprey spawning habitat was present throughout most of the river below the barrier created by a dam at Imperial Mills with the majority of the larval habitat occurring in the lower one-half mile of the river. Most of the lamprey kill was observed in this portion of the river. During the evening hours of the day of treatment, hundreds of ammocoetes were observed in the lower section of the river swimming and drifting with the current toward Lake Champlain. Crews also observed a resident flock of approximately 100 mallards and several hundred gulls feeding on the ammocoetes. During the following day's assessment survey, after this heavy predation, fewer than 400 lamprey were counted. Extreme flooding destroyed larval lamprey habitat to the degree that a second treatment planned for 1996 was deemed unnecessary and canceled.

Poultney River

Approximately 10.5 miles of the Poultney River was treated with TFM on September 23, 1992. The lampricide was applied at a very low concentration of 0.8 times minimum lethal concentration of TFM as mandated by pesticide use permits. Although sea lamprey spawning habitat is mainly restricted to the 0.5 mile segment of stream below the dam at Carver's Falls, larval habitat extends downstream for a distance exceeding eight miles. The river was divided into eight sections for mortality assessment purposes. Sea lamprey spawning habitat is present in the upper 1.0 mile portion of the river below the barrier, with the majority of ammocoete habitat occurring in the middle portion of the river. Pre-treatment surveys have shown the highest densities of larval sea lamprey occur in the vicinity of the Coggman Bridge, located 3.5 miles below the sea lamprey barrier. The chemical block of TFM was well below MLC when it passed through the middle portion of the stream. As a result, a low mortality count (just under 200 individuals) was recorded during a survey of the entire treatment zone.

The second, more effective treatment of the same reach of the Poultney River began on October 30, 1996 under modified permit conditions. This treatment resulted in an estimated kill of approximately 7,000 sea lamprey.

Hubbardton River

The Hubbardton River, a tributary of the Poultney, was treated with TFM on September 25, 1992. Approximately 2.0 miles were exposed to TFM treatment. The 1.0 mile stretch of river below the TFM application point is prime sea lamprey spawning habitat. Extensive sea lamprey larval habitat occurs in the lowermost 0.5 mile. Prior to the treatment the river was divided into four sections for assessment purposes. Survey personnel recorded lower sea lamprey mortality than expected (less than 200 animals). Extremely turbid conditions reduced visibility and lowered counting and collection efficiency.

A second treatment of the Hubbardton River took place on October 30, 1996. This time the primary application point was moved downstream and only 0.5 mile was treated. Rainfall during the treatment resulted in excessive turbidity during the post-treatment mortality count survey on October 31, 1996. The poor visibility again resulted in a low mortality count of sea lamprey (only 20 individuals).

Great Chazy River

The first treatment of the Great Chazy River began on September 29, 1992, and most of the treated 20.6 miles were exposed to concentrations of TFM greater than or equal to MLC. The river was divided into 13 sections for assessment purposes. This lampricide treatment resulted in the largest kill of sea lamprey (estimated at approximately 133,000) of any stream treated during the experimental period, many of which were undergoing transformation. The majority of the lamprey kill occurred in a four mile, slow moving stretch of the river located 12 miles above the river mouth.

The Waterworks Dam, located approximately 7.0 miles upstream from the mouth, was reconstructed prior to the 1995 spawning run to serve as a sea lamprey barrier. However, after September, 1992 two spawning migrations of sea lamprey had the opportunity to challenge temporary obstructions placed at the site to impede upstream passage before the same 20.6 mile reach of the Great Chazy River was treated with TFM a second time on September 12, 1996. MLC was carried throughout virtually the entire treatment zone. This TFM treatment resulted in a kill of approximately 23,000 sea lamprey, very few of which were undergoing transformation.

Trout Brook

In 1991, a scheduled treatment of Trout Brook was canceled in compliance with permit conditions regarding the relocation of a specific number of American brook lamprey, classified as threatened in Vermont, from the proposed treatment zone to a location upstream of the application point. During the second round of TFM treatments, the special permit conditions were met, and TFM treatment of Trout Brook occurred on September 11, 1995. Approximately 0.5 mile received an application of TFM. A mortality count of less than 200 sea lamprey was recorded.

2. Sea Lamprey Residual Abundance, Larval Re-establishment and New Colonization

a. Standard 1: *A dramatic reduction in larval sea lamprey populations in treated streams. A stream TFM treatment will be considered "successful" if post-treatment population densities at index stations, as indicated by relative abundance or removal type population estimates, do not exceed 10 percent of pre-treatment values.*

Materials and Methods

Residual sea lamprey larvae, representing escapement from previous treatments, were sampled from tributaries following treatments. Electrofishing surveys were conducted at index stations (Appendix C) using a 250 volt direct current (DC) generator mounted in a canoe. Electrofishing surveys also documented re-establishment of larval sea lamprey one year after most treatments. However, re-established lamprey were separable in the samples from residual lamprey as determined by aging through length-frequency analyses. These analyses also allowed determination of growth rates among year classes of re-established lamprey. Electrofishing surveys were also conducted in streams in 1991-1993 and 1996-1997 where larval habitat is present, but where populations of sea lamprey were not known to occur ("sea-lamprey-negative streams").

Results

Thirteen Lake Champlain tributaries were treated during the first round of TFM treatments conducted from 1990 through 1992. Greater than 90% reduction in catch of residual sea lamprey larvae was indicated by relative abundance indices in seven of eleven streams. Due to high flows, pre-treatment surveys could not be conducted on the Boquet River and Beaver Brook, before the 1990 treatments. Sea lamprey population densities at index stations, as indicated by relative abundance were not reduced by greater than or equal to 90 percent of pre-treatment levels in the Ausable (41.9% reduction), Mount Hope Brook (66.3% reduction), the Saranac River (76.4% reduction) or in the Poultney River (15.3% *increase*) during the first round of treatments (Table 2).

In the second round of TFM treatments, from 1994 through 1996, eleven streams were treated. Treatments were not conducted on Beaver Brook, Stone Bridge Brook or the Saranac River based on very low levels of larval lamprey present in surveys preceding the second round. However, Trout Brook was treated for the first time during this round as special permit conditions regarding the pre-treatment transfer of American brook lamprey to an upstream location could be satisfied. Over 95% reduction in residual lamprey larvae catch was recorded in post-treatment surveys of eight streams treated in this round and reductions in a ninth stream, the Hubbardton River, approached 95% (94.4%). Only two second-round stream treatments did not achieve the criteria for success, although substantial reductions in larval lamprey densities were documented. These were the Boquet River and Putnam Creek where the post-treatment reduction in catch rates were 81% and 69.1% respectively (Table 2).

Extensive sampling on a number of streams allowed comparisons of densities within streams. These data are presented in Appendix D. Data are expressed as CPUE. Collections were standardized to ½ hour sampling periods. Following the 1990 treatments sampling protocols were revised, resulting in more extensive sampling on some tributaries. The letters “ns” indicate a plot that was not sampled in a particular year, due to accessability, poor shocking conditions, and time/personnel constraints.

Adult lamprey have successfully spawned and re-established larval lamprey in all but two TFM-treated tributaries one year after treatment. The exceptions were Stone Bridge Brook (where there is no evidence of ammocoete production since 1991) and Trout Brook (where no newly produced ammocoetes have been found since 1995). Often no re-establishment is documented the year following treatment, probably because young-of-year sea lamprey are difficult to locate and sample. Instead, re-establishment in the year following treatment is determined by aging through length-frequency analyses in later collections. This may explain why, as of 1997, none were found in the Poultney/Hubbardton or Great Chazy Rivers following the 1996 treatments (Table 3).

Growth rates of re-established ammocoetes (Table 4) were used to predict the age at which ammocoetes would begin metamorphosis for each stream. This is important in the scheduling interval of any future TFM treatments. The minimum size of ammocoetes from earlier collections that had undergone metamorphosis (transformers) was as follows:

Salmon River - 120 mm, Ausable River - 127 mm, Little Ausable River - 127 mm, Lewis Creek - 126 mm, Putnam Creek - 130 mm, Boquet River - 133 mm, Poultney River - 120 mm, and Great Chazy River - 135 mm. Growth rates of re-established larvae after four years of stream growth indicated that ammocoetes would require one or more additional years of growth in order to begin metamorphosis. The predicted age for metamorphosis was 4+ to 5+ for ammocoetes in most streams. In the Poultney River apparent growth rates indicated that metamorphosis may possibly begin after 3 to 4 years of stream growth.

Nineteen presence / absence electrofishing surveys (some surveys in 1992 also involved use of Bayer 73) were conducted in streams determined to be sea-lamprey-negative before initiation of the experimental program. Crews sampled the Mettawee River, Mullen Brook and two small tributaries of the Great Chazy River in 1991; the Mill River, and Otter Creek in 1992; Sax Brook (a tributary of the Rock River in Vermont) and Wallbridge Stream (a small tributary of the Pike River in Quebec) in 1993; Coggman Creek, Horton Brook, and three small, unnamed tributaries in the vicinity of Benson, VT in 1996; Corbeau Creek (a small tributary of the Great Chazy River), the Little Chazy River and Coggman Brook (a tributary of the Poultney River) in 1997. During this period the LaPlatte River was surveyed three times, in 1992, 1993, and 1997.

New colonization by sea lamprey was documented for the first time in Mullen Brook near Port Henry, New York. Until this discovery in early December 1991, the American brook lamprey had been the only lamprey species recorded for this stream. In November 1993, sea lamprey larvae were also found for the first time in the La Platte River in Shelburne, Vermont. Electrofishing surveys in 1997 on the La Platte River confirmed the presence of sea lamprey larvae as well as the presence of silver lamprey for the first time.

Discussion

The majority of post-treatment survivors were older ammocoetes. When post-treatment surveys were conducted again the following year, the majority of residuals from the prior year's treatment had transformed. Transformers were not found during surveys conducted prior to mid-July, when transformation begins. During treatments, on-site observations of habitat changes, potential groundwater infusion points, etc., combined with the standard, careful monitoring and recording of TFM concentrations, provided a basis for explaining lack of treatment success in some cases. Reasons why first round treatments of the Ausable, Saranac and Poultney Rivers and the second round treatment of Putnam Creek did not meet the "success" criteria for lamprey population density reduction follow.

Because of the variable flow patterns of the Ausable River, a lethal TFM block did not move completely through the south fork of the river channel. An effective treatment through this portion of the river was not achieved in 1990. Survey results showed substantial numbers of sea lamprey survived treatment in the south fork of the Ausable River.

Electrofishing surveys, conducted on the Saranac River on October 14, 1992 following a TFM treatment on September 14, 1992, revealed reductions in catch rates of 100 percent at six index stations. However, treatment effectiveness at two stations was poor with reductions of only 8-22 percent. Stations one and two, where reductions were less, are located in a backwater area approximately 300 yards upstream from the mouth. It is likely that the TFM did not reach those areas as the movement of water in and out is extremely sluggish.

Sea lamprey larval populations were surveyed on the Poultney River before and after September 23, 1992 TFM treatment. Post-treatment surveys were conducted during June of 1993. A total of 19 stations were sampled by electrofishing. Before treatment, the overall catch rate was 13.05 per hour. After treatment the catch rate increased to 15.05 per hour, but the difference was not statistically significant (t-test, $P \leq 0.05$; Gersmehl 1993). The 1992 treatment of the Poultney River was largely ineffective in reducing the sea lamprey population due to compliance with especially restrictive permit conditions that prevailed in 1992. Treatment staff sought and received a modified permit before the 1996 treatment.

During the 1990 treatment of Putnam Creek, attenuation of the chemical bank was noted in the lower river which resulted in significant numbers of mostly large ammocoetes surviving the treatment, although this treatment met population-density-reduction success criteria. Several wetlands occur in the vicinity of Putnam Creek and substantial ground-water infusion is the probable cause for the survival of the ammocoetes recorded after treatment in 1990 and for not achieving a “successful” treatment in 1994. However, electrofishing surveys conducted following the second round TFM treatment showed substantial reductions at some index stations. During pre-treatment surveys on two stations, conducted on August 3, 1994, 184 and 132 sea lamprey were collected. When the two plots were resurveyed following treatment no lamprey were observed or collected in either station, indicating that the percent reduction in these two plots approached 100%.

In sixteen of twenty-four treatments conducted during the experimental program, post-treatment larval lamprey population densities at index stations, as indicated by relative abundance population estimates, did not exceed 10 percent of pre-treatment values, and therefore, met this “success” criteria. Six stream treatments did not achieve this level of success. However, substantial reductions ranging from 66.3 % to 81% occurred after four of these six treatments. First round treatments of the Ausable and Poultney Rivers did not produce desirable reductions in lamprey population densities, and two other treatments could not be assessed against this criterion because of a lack of pre-treatment surveys. TFM treatments caused a dramatic reduction in larval sea lamprey populations in the majority of treated streams, leading to the overall conclusion that this standard was achieved by the program.

3. Live Cage Bioassays During Bayer and TFM Treatments.

a. Standard 2: ***Significant reductions in larval sea lamprey populations on delta areas treated with Bayer 73. A delta Bayer 73 treatment will be considered "successful" if caged ammocoete mortalities exceed 50 percent in at least 85 percent of the targeted area, and if mean mortality within the 50+ percent zone exceeds 85 percent. Treatments that kill significant numbers of ammocoetes but that fall short of this standard will be considered to be "partly successful".***

Bayer Treatment Live Cages

Bayer 73 (5% granular) treatments were conducted on the Boquet, Little Ausable, Saranac, Salmon and Ausable River deltas in 1991. Two to four live-cages (Figure 1) were placed in the treatment zone of each of these deltas before treatment as "test" cages, and one control cage was placed outside the designated treatment zone on each delta, except for the Boquet delta. Two control cages were used on the Boquet in 1991. Twenty larval lamprey were placed in each cage. Staff recovered all twenty lamprey from only one control cage on the Little Ausable delta and two test cages of the Salmon delta. Most, but not all lamprey were recovered from all other cages.

Similar live cage testing was done during the second round of Bayer treatments in 1995, except that the Little Ausable Delta was not treated due to a lack of sea lamprey recolonization after the first round of treatments, and no control cages were deployed on any of the deltas.

One hundred percent of recovered, test-cage lamprey were killed on the Little Ausable, Saranac, Salmon and Ausable River deltas in 1991, and no control cage mortality occurred (Table 5). These treatments fully met the live-cage evaluation standard for success. Only 73% of the lamprey recovered from test cages exposed to the 1991 Boquet delta treatment were killed, and 2.6% of the lamprey recovered from the Boquet's two control cages were killed. This latter treatment was judged "partly successful" in accordance with the evaluation standard.

In 1995 full recovery of caged lamprey occurred only on the Boquet delta. Two live cages were lost off the north fork of the Ausable River and only about two-thirds of the individual lamprey placed in cages on the Salmon River delta were recovered. However 96% and 87% of the lamprey recovered from the Ausable and Salmon River deltas were killed and 100% of those recovered from cages on the Boquet and Saranac deltas were killed. Therefore, all 1995 Bayer treatments were deemed successful (Table 5).

TFM Treatment Live Cages

Though not associated with an evaluation standard, live cages (Figure 1) containing sea lamprey ammocoetes and/or transformers were placed in three TFM treated rivers in 1990, 1994 and 1996. They served as an immediate check on treatment effectiveness and supported data collected later in post-treatment electrofishing surveys.

In 1990 transformers were mixed in with ammocoetes in each live cage deployed on the

Boquet and Ausable Rivers. Fifteen transformers were placed with 20 ammocoetes in each of two live cages deployed on the Boquet River, and 10 transformers were placed with 10 ammocoetes in each of seven live cages on the Ausable river. The 1990 Little Ausable River treatment was evaluated with live cages containing only sea lamprey ammocoetes (20 in each of two cages). Mortality in the Boquet was 100 % in one cage and 87 % in the other. In the Ausable 75 % of the ammocoetes in cages placed in the north fork died while 70% of those placed in the south fork died. Mortality of ammocoetes on the Little Ausable was 100 % in both cages (Table 5).

The three stream treatments evaluated via this methodology in 1994 were the Little Ausable, Ausable and Salmon. Three live cages, each containing 20 ammocoetes were deployed in each before treatment. Following treatment, 100% mortality was documented in each cage (Table 5).

In 1996, three live-cages were placed in the Great Chazy, and five live-cages were placed in both the Poultney and Hubbardton Rivers before TFM treatment. Twenty ammocoetes were put into each cage, and in each river, one cage was placed outside of the treatment zone as a control. One hundred percent mortality occurred in all test cages, and no mortality occurred in any of the control cages (Table 5).

B. Spawning Phase Assessment

1. Trapping Results

a. Standard 3: ***Substantial reductions in the numbers of adults spawning in Lake Champlain tributaries. [No percentage criteria were established by Engstrom-Heg et al.; however it was noted "After chemical lamprey control was implemented in the late 1950's in Lake Superior, lakewide catches of spawning run sea lampreys at electrical barriers dropped to and remained at between 10 and 20 percent of pre-control levels."]***

Data on relative abundance of spawning phase sea lamprey adults have been collected on various streams before and throughout the eight-year experimental program. Portable assessment traps, fyke nets, and in the case of the Great Chazy River in New York, permanent traps, have been used to collect data on the numbers of sea lamprey spawning in various Lake Champlain tributaries.

Three Vermont streams, Stone Bridge Brook, Indian Brook, and Lewis Creek have been monitored each year since 1989 (Table 6; Figure 2).

There has been a marked decline in the numbers of sea lamprey trapped during the spring spawning runs in these three streams over the eight-year experimental program. Comparing the 1989 and 1997 data, the number of spawning-run, adult sea lamprey trapped in Stone Bridge Brook, Indian Brook and Lewis Creek decreased to 1.9%, 13.1% and 9.7% of pre-control levels, respectively.

Pre-control versus post-control comparisons were not made on the Great Chazy River.

Trapping began there in 1993 using portable assessment traps to determine the abundance of spawning phase sea lamprey, and to assess the movement of lamprey around the Old Waterworks Dam in Champlain, New York. A permanent trap was developed in 1995 when the dam was reconstructed to serve as a sea lamprey barrier. Since 1993 numbers of adult, spawning-run sea lamprey trapped have ranged from a low of 223 animals in 1997 to a high of 1,236 animals in 1996 (Table 7).

The evaluation standard (Engstrom-Heg et al. 1990) called for substantial reductions in the numbers of adults spawning in Lake Champlain tributaries and noted that a reduction to between 10 and 20 percent of pre-control levels occurred in Lake Superior catches at electrical weirs. These criteria have been met for Lewis Creek, Indian Brook, and Stone Bridge Brook.

2. Population Index Via Size / Sex Ratio Information

In addition to the relative abundance information collected on spawning phase sea lamprey, data were also collected on sex ratio and size. Long term data are available for Stone Bridge Brook in the Inland Sea, Indian Brook in Malletts Bay, and Lewis Creek in the Main Lake Basin.

Sex ratio information was collected from trapping data and is presented in Figures 3-5. Studies on the Great Lakes have shown a positive correlation between the abundance of sea lamprey and the percentage of males in the population (Heinrich et al. 1980). Statistical tests were run to determine whether there was a significant change in the proportion of males in the spawning population before and after control. A t-test was done using data ranging back to 1979, to compare sex ratios in the populations of spawning adult sea lamprey before and after treatments began. No significant change in the sex ratios at Stone Bridge Brook, Indian Brook, or Lewis Creek was detectable at $P = 0.05$. Small sample size may have influenced this statistical analysis.

Weight data were also collected on sea lamprey trapped from the three rivers (Figures 6-8). Statistical analyses were performed to determine if there was a significant change in the weight of animals collected before and after treatments. There was no significant difference in the mean weight of animals in the spawning population of Indian Brook and Stone Bridge Brook. However, Lewis Creek showed significant increases ($P < 0.001$) in the average weight of spawning-phase sea lamprey collected following the initiation of sea lamprey control.

3. Populations of Spawning Sea Lamprey from Nest Count Index Surveys Conducted on Ten Lake Champlain Tributaries

a. Standard 4: *A reduction in the numbers of sea lamprey nests tallied at index sites on Lake Champlain tributaries to 20 percent of pre-control values.*

The number of sea lamprey nests observed in sections of ten Lake Champlain tributaries was used as an index of sea lamprey abundance. The total length of the index stations in the ten tributaries was 13.3 miles. Nest count surveys began in 1983 and continued through the experimental control program which concluded in 1997.

Comparing the total number of nests counted in all 10 index tributaries, from 1983 through 1991 to those counted from 1992 through 1997, there was a reduction to 42.6% of the pre-control average number of nests (Figure 9, and Tables 8 & 9). The 1991 spawning run was largely unaffected by the 1990 treatments. Therefore, the 1991 nest count data were included as pre-treatment data. The reductions in the number of spawning phase sea lamprey, resulting from the treatment of rivers in 1990 is not evident until the 1992 spawning run, because parasitic phase lamprey spawning in 1991 were in the lake during 1990 TFM treatments.

Major declines in the number of nests on the Great Chazy River are a result of the construction of the barrier dam in Champlain, New York. Nest count surveys were conducted above the barrier dam before and after construction. The small number of nests found above the dam after its completion in 1994 represent escapement above the dam through a side channel, which has since been blocked.

Overall, the nest count evaluation standard was not attained by the experimental lamprey control program.

III. Nontarget Species Impacts

Abstract

Pesticide use and wetland permits associated with the eight-year experimental sea lamprey control program contained special conditions requiring the Cooperative to conduct routine and special-study nontarget species adverse impact evaluations. The extensive efforts made to assess nontarget impacts, along with findings that adverse impacts were minimal, are described here.

Routine Surveys

Routine post-treatment surveys conducted by crews wading or canoeing treated stream sections and delta shorelines showed three species of native, nontarget lamprey were affected by both TFM and Bayer 73 treatments. Of these, American brook lamprey experienced the heaviest mortalities. Survey crews found affected species of nontarget lampreys following the second round of TFM and Bayer 73 (5% Granular) treatments in all streams and deltas where they found them after the first round. Apparently some individuals survived and/or immigrated from outside the treatment area.

Excluding native lamprey, TFM treatments affected 47 identifiable species of nontarget fin fish. Losses were minimal among most species. Stonecats, log perch, bluntnose minnow and blacknose dace experienced the greatest losses. Routine survey crews also observed mortality among twelve groups of nontarget invertebrates and amphibians after TFM treatments. Groups most affected were frog tadpoles, salamanders not identified to the species level, red spotted newts, and mudpuppies. Once again, presence of the same species among affected nontargets in both rounds of treatments on most streams suggests some survived the first treatments and/or immigration to treated sections took place. In either case it is apparent that no long-term adverse impacts due to TFM treatments have occurred to amphibians and invertebrates. Bayer 73 treatments affected 26 identifiable species of nontarget fish. Mortality among most species was very limited. However, routine survey crews observed substantial mortality among banded killifish, mimic shiner, spottail shiner and fish unidentified to species (generally small fish in sections where visual estimates were made) that were most likely cyprinids or killifish. Although the affected numbers of these four groups were high, their cumulative biomass was low. Few dead or stressed amphibians and invertebrates were observed by routine survey crews following Bayer 73 treatments.

Special Studies

The Fisheries Technical Committee of the Lake Champlain Fish and Wildlife Cooperative (the Cooperative) conducted two special studies documenting a lack of adverse impacts on caged eastern sand darters in Lewis Creek due to the 1990 and 1994 TFM treatments, affirming eastern sand darters were moderately tolerant of this lampricide.

Vermont Department of Environmental Conservation (VTDEC) researchers conducted

short-term (1990) and long-term (1988-1993) studies of the effects of TFM on nontarget fish and macroinvertebrate populations in Lewis Creek. Both studies concluded that no undue adverse effect occurred on the macroinvertebrate or fish communities due to the 1990 TFM treatment.

Efforts were made to monitor mussel beds to detect effects from the 1992 TFM treatment of the Poultney River. Mussels in a bed observed during treatment showed no signs of stress, and those in two beds monitored before and after treatment exhibited no adverse effects.

VTDEC staff evaluated the effects of the 1995 TFM treatment on nontarget fish and macroinvertebrates in Trout Brook. They documented no short term adverse impacts on the brook's macroinvertebrate population and no significant mortality of non-lamprey, nontarget fish due to the TFM treatment. Notably, they concluded that intense electrofishing the day before treatment to collect American brook lamprey (for the purpose of holding them safe during the treatment, then releasing them back into the stream later) was the probable cause of a decrease in fish numbers observed after treatment.

SUNY Plattsburgh researchers carried out a special study on the Little Ausable and Ausable deltas to evaluate impacts of TFM plumes from the associated river treatments on macroinvertebrate communities. They concluded there were no significant differences in pre- and post-treatment densities among the dominant invertebrates on either delta, and that no statistically significant mortality occurred among unionid mussels held in test cages on the deltas.

USFWS staff conducted mussel glochidia retention studies during the 1996 TFM treatment of the Poultney River. No glochidia were found in any of the drift net samples below the TFM application point. Also, gravid mussels held in plastic trays within the treatment area and those in a natural mussel bed below Coggman Bridge did not release glochidia during and for at least five days after the 1996 treatment.

New York State Department of Environmental Conservation (NYSDEC) Endangered Species Unit staff studied the effects of both TFM and Bayer 73 on the amphibians of the Little Ausable and Ausable Rivers and delta areas. Most special effort surveys focused on the Ausable River where they detected 24 affected mudpuppies after the 1990 TFM treatment and 40 after the 1994 TFM treatment. Survival and/or recolonization was indicated. However, the researchers stated it was unclear what effects repeated treatments in a long-term program may have on the mudpuppy population. They recorded little effect on amphibians due to Bayer 73 treatments.

The greatest adverse effects attributed to the eight-year program were documented by SUNY Plattsburgh scientists who assessed 1991 Bayer 73 treatment impacts on macroinvertebrates of the Ausable and Little Ausable deltas. Macroinvertebrate groups tested in cages exhibited varying sensitivity to the Bayer 73 treatments. Community sampling documented significant declines in density for four of eight Little Ausable macroinvertebrate groups following Bayer 73 treatments. One year later, three of these (Hirudinea, Gastropoda and Pelecypoda) remained significantly lower than in pre-treatment samples. Five of eight groups monitored declined significantly in density on the Ausable delta after Bayer 73 treatment. A year later, Diptera, Gastropoda and Pelecypoda remained significantly lower in density compared to

1990 pre-treatment levels. Substantial mortality of caged mussels occurred on both deltas during Bayer 73 treatments, while none occurred at the Port Kent control site. Mussel population sampling showed significant declines in density estimates of both *Lampsilis radiata radiata* and *Elliptio complanata* on both deltas. These populations had not recovered one year after treatment.

In 1995, USFWS staff studied the Little Ausable and Ausable deltas to determine if mussel and gastropod population densities recovered four years after the 1991 Bayer 73 treatment. Two native species not observed in the earlier study, the Eastern floater and giant floater, were present with the previously documented Eastern elliptio and Eastern lampmussel. The nonnative zebra mussel was also present by 1995. Excluding zebra mussels, overall mussel density had recovered to near pre-treatment levels on the Little Ausable and exceeded pre-treatment levels on the Ausable delta. Recruitment of mussels was determined to be fairly stable and consistent and had occurred since 1991. Gastropod density recovered and was higher in 1995 than in any other year monitored. Secondary impacts of temporarily reduced gastropod or mussel densities in these relatively small treatment areas to Lake Champlain's migrating and breeding waterfowl were also determined to be minimal.

A. Routine Surveys

1. TFM treatments

Materials & Methods

Nontarget mortality was assessed by crews wading or canoeing nearly all treated stream sections, approximately 24 hours behind the leading edge of the TFM chemical bank, and tallying actual counts of affected organisms with two exceptions. One exception was the relatively short, inaccessible stretch of the Ausable River that flows through Ausable Chasm. The other exception was a 1700' segment of "Section 9" of the Great Chazy River, where counts of nontargets in two 50' wide transects were expanded in 1992 to provide total mortality estimates for the segment due to time constraints and difficulties of conducting a total enumeration in this relatively deep, wide stream section. The expanded estimates for this section resulted in the inclusion of 48 log perch and 16 stonecats in the fin fish totals, and 32 salamanders in the amphibian total. Crews identified and counted as many fish and amphibians as possible in the field and preserved samples of unidentified species for later laboratory identification. Large macro-invertebrates such as crayfish and mussels were also observed and counted. No attempt was made to count dead aquatic insects and other small aquatic invertebrates. The actual count technique produces a minimal estimate of nontarget kill. Water clarity, light conditions, water depth, vegetation, substrate characteristics, etc. undoubtedly prevent detection of all affected organisms.

Results

Lamprey

Surveys for non-target and target lamprey mortality were conducted concurrently. Treated streams were divided into habitat sections, ranging in number from four to fourteen. Counts, or in some cases expanded estimates, of the number of all dead lamprey found in each section were made. When available, samples of 200 dead lamprey were collected in most stream sections. Laboratory examination of the lamprey samples was conducted to determine species, length, life stage, etc. and allow estimation of the mortality of target and nontarget lamprey.

The mean annual proportion of nontarget lamprey mortality among all lamprey mortality ranged from 0.22% to 11.85%. Some nontarget lamprey mortality occurred in all TFM treatments conducted from 1990 through 1996, except the Saranac River in 1992 and the Hubbardton River in 1992 and 1996 (Table 10). Over the course of the experimental period, a total of about 40,852 American brook lamprey were killed in the Ausable, Little Ausable and Salmon Rivers. Approximately 8,619 silver lamprey were killed in the Boquet and Poultney Rivers, Putnam and Lewis Creeks and Beaver, Stone Bridge and Mount Hope Brooks. An estimated 209 northern brook lamprey were killed in the Great Chazy River. The heaviest mortality of nontarget lamprey occurred in the 1990 and 1994 treatments of the Ausable river in which 12,193 and 28,246 American brook lamprey were killed. Combined, this represents 81% of all nontarget lamprey mortality or 99% of all American brook lamprey mortality assessed over the eight-year experimental period. Appendix E, Tables 1-7, 13-26, and 31-33 provide a detailed accounting of nontarget lamprey mortality observed on a stream section basis.

Fish

Forty-seven identifiable species of nontarget fin fish (excluding native lamprey) were affected by TFM treatments. In addition, the treatments affected three other fin fish groups (not identified to the species level) categorized as an unidentified *Notropis* species (two individuals from Lewis Creek), an unidentified cyprinid species (two individuals from the Poultney/Hubbardton system) and other unidentified fish species (one individual from the Boquet, one from the Ausable, and one from Mount Hope Brook). The dead unidentified fish from the Boquet and Ausable were likely not a result of treatment, as field notes indicated these specimens were so badly decomposed they could not be identified. No field notes accompanied the report of the unidentified Mount Hope Brook specimen.

Very few individuals (less than 50) of most nontarget fin fish species or groups mentioned above were observed to be killed. Over fifty affected individuals were observed in each of ten species. In four of these more than five hundred affected individuals were tallied. The greatest mortalities were recorded among stonecats (6,730 counted), log perch (1,057 counted), bluntnose minnow (755 counted) and blacknose dace (517 counted). Table 11 summarizes these results for all TFM stream treatments. Appendix E, Tables 1-7, 13-26, and 31-33 provide a more detailed accounting on a stream section basis.

Amphibians & Invertebrates

Assessment crews observed mortality among twelve groups (some identified to the species level) of nontarget invertebrates and amphibians after TFM treatments. More than 50 individuals were recorded in each of four groups. Two of these groups were frog tadpoles (5,461 individuals) and “unidentified” salamanders (1,832 individuals). Red-spotted newts (362 individuals) and mudpuppies (91 individuals) comprised the other two most affected groups.

Table 12 presents a comprehensive summary of the numbers of amphibians and invertebrates killed by TFM stream treatments. Again, Appendix E, Tables 1-7, 13-26, and 31-33 provide a more detailed accounting on a stream section basis.

Discussion / Conclusion

Lamprey

American brook lamprey experienced substantial mortality in the Ausable River in both 1990 and 1994. It is noteworthy that more than twice as many American brook lamprey were affected in the Ausable River during the second treatment in 1994. Similarly, more nontarget lamprey were affected during second round treatments in every stream where they were killed during the first round, except for silver lamprey in Mt Hope Brook and northern brook lamprey in the Great Chazy River. Except for the Poultney River where a substantial increase in efficacy for target species was realized due to permit condition changes, no major modifications occurred in the treatment methodologies. This indicates some survival of TFM treatments or immigration from untreated upstream locales or tributaries.

Fish

The adverse impacts of TFM treatments on most exposed fishes were minimal. Those observed for stonecat, log perch and blacknose dace were consistent with information presented in the project FEIS (NYSDEC, USFWS, VTDFW 1990). The fact that stonecat were killed during second round treatments in every stream where they were killed during the first round, affirms that the species was able to survive treatment or immigrate back into treated sections. Second round observations of dead log perch were similar with one exception. In Mount Hope Brook, where only 10 log perch were observed dead after the first-round treatment, none were recorded dead after the second-round treatment. Blacknose dace were also observed dead after all second-round treatments of streams where they were affected in the first round, except for Lewis Creek (where only 66 dead blacknose dace were observed after the first treatment) and the Ausable and Salmon Rivers (where only one individual in each was recorded after the first-round treatment).

Most (96%) of the bluntnose minnow mortality observed over the entire eight-year period occurred in a short section of Stone Bridge Brook during the 1991 treatment. A potential explanation for this isolated, adverse impact on the bluntnose minnow is that this section experienced a longer than usual exposure to TFM due to the nature of the application and the slow TFM travel time through numerous ponded segments.

Although some localized, temporary effects within individual streams was apparent, no overall, significant adverse impacts to nontarget fish were associated with TFM treatments.

Amphibians and Invertebrates

Over 90% of the “unidentified” salamanders and frog tadpoles were observed in the 20.6-mile, treated section of the Great Chazy River. This seemingly large overall mortality must be viewed in perspective. The observed mortality rate per mile of “unidentified” salamanders on the Great Chazy River was approximately 60 per mile in 1992 and 21 per mile in 1996. Great Chazy River frog tadpole mortality rates per mile were approximately 71 and 175, respectively, in 1992 and 1996.

All red-spotted newts observed dead following treatments were found in Mount Hope Brook. After the 1991 treatment, 295 individuals were observed; after the 1995 treatment 67 individuals were recorded.

Eighty-three of the 91 affected mudpuppies observed during routine post treatment surveys over the experimental period were recorded in the Ausable River and Lewis Creek. Following 1990 treatments, 35 were observed dead in the Ausable and 17 were tallied in Lewis Creek. Second-round treatments on these waters resulted in 22 and 9 dead mudpuppies, respectively. The fact that mortality again occurred in these waters during the second round indicates that individuals survived the first treatments and/or immigration to treated sections took place. In either case it is apparent that no long-term adverse impacts have been experienced by mudpuppies.

Observations of affected amphibians and invertebrates were consistent with expectations presented in the project FEIS (NYSDEC, USFWS, VTDFW 1990).

2. Bayer 73 (5% Granular) Treatments

Materials & Methods

1991 Delta Treatments - Nontarget mortality observations were made by two methods in 1991. To facilitate a quantitative assessment of target mortality, the deltas of rivers treated with Bayer 73 were broken into open-water “Gull Plots”. Gull plots were chosen at random and lamprey mortality was assessed by counting gull feeding events during timed periods following treatments. Crews counting gull feeding events also recorded any affected nontarget organisms they observed. Also, following completion of each treatment, crews walked and waded along the shoreline within each treatment zone and tallied dead target and nontarget organisms observed along a shoreline band of unspecified width. A sample was collected from each section for analysis and species identification. Nashett (1992) provided detailed information on the methods used and results obtained.

1995 Delta Treatments - Due to an apparent lack of gull count reliability noted in 1991, none were conducted during 1995. Therefore, no off-shore information on affected nontargets is available from second-round Bayer treatments. However, observations were made along a band of shoreline approximately 20' wide from water’s edge toward the lake and extending along the entire shoreward boundary of the treatment zone on most deltas. Entire shoreline surveys did not occur on the Saranac Delta due to mistaken identification of the southern boundary of the treatment zone, and on the Boquet Delta which was systematically subsampled due to impending darkness.

At times assessment crews estimated shoreline counts of various species for particular sections or collected representative samples from an estimated overall number of nontargets within a section.

Results

Results presented here must be viewed as qualitative, not quantitative, due to the Bayer treatment assessment methodology and the estimation and sampling techniques employed.

Lamprey

Nontarget lamprey mortality was recorded only on the Ausable River delta in 1991 and on the Salmon and Ausable River deltas in 1995. American brook lamprey were the only nontarget lamprey affected. Nearly 59% of the total lamprey collected after the 1991 Bayer 73 treatment of the Ausable delta were American brook lamprey. After the 1995 Ausable treatment, about 38% of all affected lamprey were American brook lamprey. Twenty-five percent of lamprey mortality on the 1995 Salmon River delta was attributed to American brook lamprey. Tables 13 and 14 show the river deltas that received applications of Bayer 73 and the target/nontarget lamprey mortality counts for 1991 and 1995, respectively. In 1995, lamprey mortality counts were restricted to shoreline sections; no gull feeding-activity counts were conducted.

Appendix E, Tables 8-12 and 27-30 provide a more detailed accounting on a gull-plot/shoreline-section basis. Footnotes of the appendix tables explain the sampling, data expansion, visual estimate and actual count methods employed to assess nontarget mortality resulting from delta treatments.

Fish

Twenty-six identifiable species of nontarget fin fish (excluding native lamprey) were affected by Bayer 73 treatments. In addition, four other fin fish groups (not identified to the species level) were observed and categorized as an unidentified *Notropis* species, an unidentified cyprinid species, a *Lepomis* species and other unidentified fish species.

For fish which were identified as belonging to a species or family/genus group, fewer than twenty-five individuals were killed in 18 of the 26 species groups and one of the three potentially broader groups (unidentified *Notropis* species, unidentified Cyprinid species and *Lepomis* species) in both rounds of treatments combined. Cumulative mortality observations ranged from 81 to 215 individuals among five species groups (emerald shiners, longnose dace, white suckers, tessellated darters and yellow perch). Substantial mortality was observed among unidentified fish (approximately 147,170 individuals), banded killifish (approximately 20,296 individuals) mimic shiner (approximately 9,385 individuals), and spottail shiner (approximately 2,168 individuals). Fish categorized as unidentified were generally small fish in sections where visual estimates were made, and were most likely cyprinids (minnows), *Notropis* species or Cyprinodontidae (killifish).

Table 15 summarizes nontarget fin fish observations for all Bayer 73 delta treatments. Appendix E, Tables 8-12 and 27-30 provide a more detailed accounting on a gull-plot/shoreline-section basis. Footnotes of the appendix tables explain the sampling, data expansion, visual estimate and actual count methods employed to assess nontarget mortality resulting from delta treatments.

Amphibians and Invertebrates

Assessment crews observed little nontarget mortality among four groups of nontarget invertebrates and amphibians after Bayer 73 (5% Granular) treatments. Total observed mortality by routine survey crews following two rounds of Bayer treatments consisted of 32 mussels, 2 crayfish, 2 snails and 1 frog tadpole. Table 16 summarizes amphibian and invertebrate observations for all Bayer 73 delta treatments. Appendix E, Tables 8-12 and 27-30 provide a more detailed accounting on a gull-plot/shoreline-section basis.

Discussion / Conclusion

Lamprey

The FEIS for the project states that nontarget, native lamprey species are sensitive to Bayer 73, but little impact due to Bayer delta treatments was expected because they had not been collected in the delta areas. Finding dead American brook lamprey among the dead sea lamprey in the samples was not anticipated. Life history descriptions in the scientific literature indicate they spend their whole life in streams, never migrating to lakes. Their presence among affected lamprey on the second treatment of the Ausable delta (and also among dead sea lamprey after the second treatment of the Salmon River delta) confirms that their use of such habitat, at least in Lake Champlain, is not unusual. The finding also provides evidence that, either they were not eliminated by the first treatment in these habitats, or that substantial recruitment occurred after the first treatment on the Ausable delta, perhaps due to the effects of flooding and scouring events on surviving American brook lamprey in the river.

Fish

The number of dead unidentified fish, banded killifish, mimic shiners and spottail shiners observed after treatment was substantial. A qualitative estimate of their total number (Table 15) for nine Bayer 73 treatments conducted on five deltas approximates 179,000 individuals. Most of these individuals were very small. For instance, the mean length of 109 banded killifish collected after the 1991 Ausable Delta treatment was 38 mm (~1.5 inches). Lengths of mimic shiners and spottail shiners were similar (Nashett 1992). Most of the unidentified fish were probably members of these three species. A crude, overall estimate of biomass affected among these groups can be made by applying conversion factors developed for fish hatchery operations which equate individual fish length to the number of fish per pound. Adirondack Hatchery's landlocked salmon conversion table indicates there would be 854 salmon per pound if their individual lengths were each 1.5 inches. Applying this conversion factor to these species, a combined estimate of affected biomass for these most affected groups is (179,000) / (854/pound), or approximately 210 pounds. Considering the relatively small area treated with Bayer 73 compared to the lake's surface area, and the biological potential of Lake Champlain (the annual, angler harvest objectives for lake trout, salmon, brown trout and rainbow trout, alone, total 163,200 pounds), the cumulative loss of approximately 210 pounds of fish due to two rounds of Bayer 73 treatments is not biologically significant.

Amphibians and Invertebrates

As noted above, very few adversely affected amphibians and invertebrates were observed by routine survey crews. More definitive information on the effects of Bayer 73 treatments on these groups is presented later in the description of the Gruendling and Bogucki (1993) and Lyttle (1995) studies.

B. Special Studies

1. TFM Treatments

a. "Impacts of TFM Treatment on Caged Eastern Sand Darters in Lewis Creek" (MacKenzie 1991).

Materials and Methods

The Cooperative conducted an *in situ* cage study in Lewis Creek, Addison County, Vermont, to determine the impacts of TFM on the eastern sand darter, *Ammocrypta pellucida* under field conditions. Eastern sand darters are classified as "endangered" by New York and "threatened" by Vermont. The objective was to evaluate the adequacy of permit conditions to be imposed to protect the eastern sand darter during TFM treatment of the Poultney River, where there is a resident population.

Ninety-one eastern sand darters were seined from the Lamoille River and transported to Lewis Creek. Twenty were placed in exposure chambers at each of four sites for over two days of acclimation. Three of these sites were test sites and the fourth was a control site. The eleven extra darters were placed in spare exposure chambers near the control site. Staff checked the darters once daily before treatment. During and after the TFM treatment on September 23, 1990, the darters were checked every two hours. Two-hour checks began at 0700 hours on September 23rd and continued through 0900 on September 24th. The darters were checked again at 1500 hours on September 24th and 0900 and 1500 hours on September 25th.

Results

One sand darter died prior to TFM application. No other mortality occurred before, during, or after treatment. TFM Minimum Lethal Concentration (MLC) was 3.5 ppm at two test sites and 3.6 ppm at the third. TFM concentrations during treatment peaked at 1.6 MLC, 1.4 MLC and 1.4 MLC at the three sites.

Discussion / Conclusion

Caged eastern sand darters suffered no observable impacts due to the 1990 TFM treatment of Lewis Creek at higher MLCs than would be permitted for use during treatment of the Poultney River. Eastern sand darters exhibited at least moderate resistance to TFM.

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b. "Impacts of a TFM Application on Caged Eastern Sand Darters in Lewis Creek, Ferrisburg, VT, 1994" (MacKenzie 1995)

Materials and Methods

A second, caged eastern sand darter study was conducted during the October 5-6, 1994 TFM treatment of Lewis Creek to collect additional information to support a proposed Poultney River permit modification.

Again, the darters were seined from the Lamoille River and transported to Lewis Creek. However, only 27 eastern sand darters were captured this time. They were placed in exposure chambers at two sites - a control site upstream of the application point, and an experimental site about 1.2 miles downstream of the application point. Four chambers with three darters each were placed in a cage at each site, and the remaining darters (two at the experimental site and one at the control site) were placed in one chamber in a second cage. One of the darters at the experimental site had red discoloration beneath its gills. A pre-treatment and treatment check schedule similar to that used in 1990 was implemented.

Results

All sand darters were alive immediately before TFM application began. At the TFM exposed site two dead sand darters were discovered when the fish were removed from the exposure chambers 48 hours after treatment, and one fish was missing from this site. One of the dead darters was in the chamber where the darter with the red discoloration near its gills had been, but staff were unable to determine which darter died. All fish in the control chambers were alive at the end of the study. A maximum TFM concentration of 4.9 ppm (1.1 MLC based on a 12 hour bioassay) was recorded at the experimental site.

Discussion / Conclusion

The Mantel Haenszel statistic that would stop a TFM treatment on the Poultney River if 14 darters were placed at both control and experimental sites (28 total) and no deaths occurred at the control site requires 5 deaths (rather than the two observed in this study) at the experimental site. A lack of adverse impacts on eastern sand darters due to TFM treatments was once again documented.

Though not reported by MacKenzie (1995), it is noteworthy that no caged eastern sand darters, monitored in similar *in-situ* studies and including stop-work conditions, died during the

1992 and 1996 TFM treatments of the Poultney River.

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c. "The effects of the lampricide TFM on non-target fish and macroinvertebrate populations in Lewis Creek, Vermont" (Langdon and Fiske 1991).

Materials and Methods

Macroinvertebrates

Langdon and Fiske assessed the effects of the September 23, 1990 TFM treatment on the macroinvertebrate community of Lewis Creek at established sites via before-and-after statistical comparison, utilizing the Mann Whitney-U non-parametric statistic. Six sites representing four stream habitat types were monitored. One of these six sites was a control site. Researchers used a semi-quantitative, timed D-Frame net technique at the three upper riffle sites and a 6-inch tall Ekman Dredge that collected a quantitative 0.02 m^2 sample at the three lower sites.

Fish

Langdon and Fiske also assessed the effects of the 1990 TFM treatment on the nontarget fish community and individual species of nontarget fish in Lewis Creek. They conducted quantitative sampling with electrofishing gear in three discrete stream sections and mortality observations during treatment in two of these sections. Plans called for one control section above the primary application point (AP) and three test sections downstream of the AP. The three test sections were sampled before treatment in September of 1989 and 1990, and after treatment in October of 1990. Although the control section was to be sampled both pre-and post-treatment, no sampling could be conducted after treatment in October, 1990 due to sustained high stream flows.

Results

Macroinvertebrates

Macroinvertebrate density decreased at two of the three riffle sites after treatment by 29 and 26 percent ($P \leq 0.05$). However, these decreases were not considered biologically significant (Langdon and Fiske 1991). In fact, one site was the control, implying the TFM application had little or nothing to do with the decrease at this site. High flows prior to the post-control sampling period were cited as the major cause of the observed decrease (Langdon and Fiske 1991).

Community richness (mean number of species) and EPT richness (mean number of species from the pollution sensitive insect orders Ephemeroptera [mayflies], Plecoptera [stoneflies] and Trichoptera [caddis flies]) were very similar at all three riffle sites and no biologically or statistically significant decreases were found between pre- and post-treatment levels. Community diversity as measured by the Shannon-Weaver Index (Weber 1973) exhibited little change and remained in a range considered very good compared to other streams. A measure of community trophic structure and function, the Bio Index value, ranged from about 2.0 to 2.5 and placed Lewis Creek in the "good" range before and after treatment. A measure called the EPT/chiro index, the ratio of pollution sensitive EPT individuals to tolerant Chironomidae individuals, remained "good" at all riffle sites during all sampling periods. The dominant genus (*Symphitopsyche* spp.) percentage changed very little after TFM treatment at each riffle site. The Pinkham-Pearson Coefficient of Similarity measures likeness between two communities, and was employed to compare numerical and percent composition similarity of major taxa of the riffle communities before and after TFM treatment. No adverse effects on macroinvertebrate communities were indicated by this coefficient.

The researchers also monitored TFM-sensitive species abundance per unit effort of sampling time at the three riffle sites for five species. Only *Chimarra* spp. showed a significant ($P \leq 0.05$) decrease in abundance of 63% and 97% at the two riffle sites downstream of the AP.

Density of the stream bank habitat site community increased slightly after treatment. Richness and diversity were virtually unchanged. Dominant species composition changed from 21 to 18 percent. The number of major taxa changed slightly from 8 to 6, and the Pinkham-Pearson Coefficient of Similarity indicated very similar communities before and after treatment. *Phylocentropus* sp. and *Oligochaeta* showed no significant change in density, the fingernail clam, *Pisidium* spp., increased significantly ($P \leq 0.05$) in density and the mayfly *Hexagenia limbata* decreased significantly ($P \leq 0.05$) in density.

No adverse changes occurred due to TFM treatments in the macroinvertebrate community at the mid-channel site. All parameters remained essentially unchanged. *Oligochaeta*, *Phylocentropus* sp. and *Pisidium* spp., reportedly sensitive to TFM, showed no significant changes in density after treatment.

A similar lack of change was noted for all parameters in the macroinvertebrate community at the delta site.

Fish

Post-treatment electrofishing catches at the upper and middle test sites were 30% and 42% lower, respectively, than 1990 pre-treatment catches. However, the catch at the middle site was higher than that recorded in the 1989 pre-treatment sample. The post-treatment catch size was 4% higher than for the pre-treatment sample at the third, lower-most test station where the mean TFM concentration and exposure time were greater.

Two to three fewer species were present in post-treatment samples at all three test locations. However, except for bluntnose minnow at the lower site, the absent species were present only in very low numbers in the pre-treatment samples, and their absence may be due to sampling error.

Vermont's modified Index of Biotic Integrity (VTIBI) values were high in all sections for all sampling dates.

Nontarget fish losses during treatment were monitored in the upper and middle sections. The researchers observed two common shiners and one member of the *Notropis* species, which may have been another common shiner, affected by the treatment in the uppermost section. They observed six tessellated darters, one smallmouth bass, one common shiner, one bluntnose minnow and one *Notropis* specimen killed in the middle test section.

Discussion / Conclusion

Macroinvertebrates

Overall, community level analysis showed no adverse effects on macroinvertebrates after the TFM treatment at any of the habitat areas sampled. The decreases in macroinvertebrate density observed at two riffle sites (the control site above the AP and the upstream-most test site) after treatment were probably caused by high stream flows on October 1st and 5th before the post-treatment assessment was undertaken. *Chimarra* spp., a TFM-sensitive species in the riffle sites, exhibited significant decreases at the two sites downstream of the AP, but was not totally eliminated. Its short, one-year life cycle and high fecundity should allow it to recover to previous levels within one year. The researchers anticipated *Hexagenia limbata*, a mayfly which decreased significantly in density at the stream bank habitat site, would require a recovery period of up to two years because of its longer life cycle and because second-year nymphs made up a higher percentage of affected animals.

Fish

Lower post-treatment electrofishing catches at the upper and middle test sections were probably due to sampling error exacerbated by abnormally high flows, not TFM mortality. Decreases in water temperature approximating 10 °C between pre-and post-treatment sample efforts also may have stimulated suckers and salmonids to move to overwinter areas. The reductions were evenly distributed among TFM-sensitive and resistant species, also indicating that TFM treatment was not the cause of the decline.

The nontarget fish mortality observed during treatment was minimal. Pre-treatment population estimates for common shiners in the upper test section and tessellated darters in the middle test section indicate that the observed mortality due to treatment represented about 0.4 - 0.5% and 0.5 - 0.7%, for these species in these sections, respectively. The authors concluded that “TFM treatment had no measurable impact on the resident fish communities of the wadeable portion of Lewis Creek, which made up approximately two-thirds of the treated stream reach.”

d. “The long term effects of the lampricide TFM on non-target fish and macroinvertebrate populations in Lewis Creek, Vermont” (Fiske and Langdon 1994)

Materials and Methods

Macroinvertebrates

The primary purpose of this study was to determine the long-term impacts to nontarget macroinvertebrates following the first treatment of Lewis Creek. Fiske and Langdon conducted long term monitoring at the lowermost riffle site and at the stream bank habitat site of the previous short term Lewis Creek study. These sites, referred to in this study as station 3.5 and station 0.5, respectively, were selected because they were locations where declines in abundance indices of the caddisfly *Chimarra* spp. and the mayfly *Hexagenia limbata* were most pronounced after the 1990 treatment. The aim of the long term monitoring was to document recovery time for these two species and monitor the long-term community integrity.

The researchers measured community metrics used in the short term study (density, species richness, EPT richness, bio index, diversity, EPT/chiro index, % dominant taxa and density of the sensitive *Chimarra* sp.) at station 3.5 for a six-year period spanning from 1988 - 1993. They also monitored overall similarity in proportion of the dominant taxa at station 3.5 over time via the Index of Biotic Similarity. Similar community metrics (density, richness, diversity, % dominant taxa and density of *Hexagenia*, *Phylocentropus* and *Pisidium* spp.) were measured at station 0.5 for the same six-year period.

Fish

Researchers selected the fish community at the middle test station of the short-term study (station 3.7 in this study) to monitor for long-term effects. Based on the results of the short term study no adverse effects were anticipated. Therefore, this was the only long-term fish community station established. Fiske and Langdon sampled fish via electrofishing using methods described in their earlier short-term study. Species diversity, Vermont’s modified Index of Biotic Integrity (VTIBI), the Index of Biotic Integrity (B) and community concordance (W) were assessed.

Results

Macroinvertebrates

No change in community metrics occurred at site 3.5 over the six year period sampled. One year after treatment *Chimarra* spp. densities had recovered to those found during the three pre-treatment years. They remained consistent over the last three years of this monitoring (Table 17). The mean Index of Biotic Similarity (B) was determined for each of three contrast associations at site 3.5. All combinations of years within a contrast association were compared. The three contrast associations were: 1) only dates on which samples were collected before treatment, 2) dates sampled before to those sampled after treatment, and 3) only dates on which samples were collected after treatment. Mean B was only 0.45 comparing the three pre-treatment years. The index indicated the community to be slightly more similar (mean B = 0.52) between the years before versus the years after treatment. B similarity has been consistent after treatment averaging 0.51 between all four post-treatment years (Table 18).

Community metrics measured at site 0.5 indicated no community level changes for the year after treatment. However in the second and third years post-treatment, taxa richness increased significantly ($P < 0.05$) at the site. Density also increased significantly ($P < 0.05$) in 1993 from an average of about 5,428 / m^2 over the previous five years to 12,130 / m^2 (Table 19). *Hexagenia* sp. (mayfly) density, reduced approximately 60% due to TFM treatment, rose to the highest figure recorded (273 / m^2) one year later in six years of monitoring (Table 19). This value was significantly higher ($P < 0.05$) than those reported in 1989, 1990A, and 1993 and is the only year significantly different from any other year. That is, the post-treatment population decrease fell within the long-term expected population density levels. *Phylocentropus* sp. (caddisfly) showed no effects from TFM treatment in the short term study. The long term monitoring indicated the 1991 population was significantly lower ($P < 0.05$) than in 1989 and in 1990, both before and after treatment. However, it was not significantly different from 1988, 1992, or 1993.

Fish

The two pre-treatment collections and the first post-treatment collection yielded 17-18 species each. The 1991 and 1992 samples each contained 14 species (Table 20). Six dominant species (tessellated darter, smallmouth bass, common shiner, longnose dace, logperch and white sucker) accounted for 95-98% of the catch in all five collections. Researchers collected large-mouth bass, brown bullhead, northern pike, rainbow trout, silvery minnow and burbot only in the pre-treatment samples, however they attributed this to natural distributional qualities and sampling error. Sand shiner, rosyface shiner, and fallfish were observed only in post-treatment samples.

VTIBI values were high for fish. They were 39 out of a possible 45 for the first four collection dates, and 41 for the 1992 collection. Population densities based on two electrofishing runs per collection were very consistent over the years except for the 1990 pre-treatment sample, which was almost twice the post-treatment sample (Table 20).

Fiske and Langdon calculated means of the Index of Biotic Similarity (B) contrasting all possible combinations of pairs for a particular association. Lower values indicate less similarity; higher values more similarity. The pre-treatment Lewis Creek value for 1989 versus 1990 was 0.36. Another measure of non-impacted background similarity, the mean of five other sites on different rivers, was 0.43. The mean of 1989 versus 1990 A (after treatment) and 1990 B (before treatment) versus 1990 A values was 0.48. A mean of 0.56 resulted from the following long-term contrasts: 1989 versus 1991, 1989 versus 1992, 1990 B versus 1991 and 1990 B versus 1992.

The Coefficient of Concordance (W) measures community change over time by analyzing species ranks and has a range of potential values from 0 to 1.0. Zero values indicate a total change in species between samples, while a value of 1.0 indicates the same species and dominance exist. In Lewis Creek the value of W (0.92) was higher during the sampling period than for other Vermont Rivers.

Discussion / Conclusion

Macroinvertebrates

Long term study data from a riffle type habitat and a lower river clay bank habitat showed that TFM treatment of Lewis Creek had "no undue adverse effect" on the integrity of its macroinvertebrate communities. Although treatment decreased the densities of two sensitive species in the short term, both species had recovered one year later.

Fish

Fiske and Langdon also concluded that "no undue adverse effect" on the fish community resulted from the 1990 TFM treatment of Lewis Creek.

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e. "Unionid mussels of the Lower Poultney River" (Fichtel 1992)

Materials and Methods

Fichtel monitored four mussel beds documented in 1990 and 1991 during 1992 partly to detect any effects on mussels from a lampricide treatment conducted in September, 1992. Two beds were between Carvers Falls and Coggman Bridge, and two were downstream of the bridge. All mussels observed within 30 m^2 strip transects, placed parallel to the riverbank within the known beds, were identified and counted. The number of transects surveyed varied with the bed. Fichtel and an assistant censussed each of the four beds once between July 25 and September 14, 1992. One of the beds expected to be subjected to the maximum concentration of TFM, was observed during the September 24, 1992 TFM treatment. Two of the beds (including the one observed during treatment) were resurveyed on October 2, 1992 approximately one week after the TFM treatment.

Results

Mussels in the bed observed during TFM treatment showed no signs of stress. All appeared to maintain proper orientation and normal filtration. In the two beds monitored both pre-and post-treatment, there was no evidence of dying or gaping mussels and there were no other apparent adverse effects due to treatment. Species identified and counts made in the mussel beds are presented in Table 21.

Discussion

Number discrepancies between sampling periods at the two pre- and post-treatment monitored beds are unexplained. However, one potential reason for the decreased numbers observed in the bed not observed during treatment is that a greater proportion of the mussels were buried in the substrate and less active during the October census, an observation consistent with the researcher's experience.

f. "The effects of a lampricide treatment on non-target fish and macroinvertebrates in Trout Brook, Milton, Vermont - September, 1995" (VTDEC 1996)

Materials and Methods

Macroinvertebrates

Staff used the VTDEC kick net sampling method to collect three replicate samples before TFM treatment on September 5, 1995 and again after treatment on September 15, 1995. Treatment occurred on September 11, 1995. Primary sampling habitat consisted of debris dams in a reach approximately 1700 feet below the TFM application point (AP). Preserved samples were subsampled in the laboratory by picking 25% of a sample and a minimum of 300 animals if not present in the 25% sub sample. Community biometrics were compared with the Mann-Whitney-U Rank Sum Test.

Fish

Fish in a blocked 89 meter section, also about 1700 feet below the AP, were collected in two upstream passes with a backpack electrofishing unit. Pre- and post-treatment samples were collected on September 5th and 15th, respectively, in 1995. Those stressed or killed by the sampling were noted. Others were identified and released evenly throughout the section.

Results

Macroinvertebrates

Density, richness and EPT Index were slightly greater after treatment, although no differences were statistically significant *(P* > 0.05). Three other measures of community biometrics remained virtually unchanged. An Ephemeropteran mayfly, *Stenonema* sp., was the dominant taxon in both pre- and post-treatment samples (Table 22**)**. Major groups of macroinvertebrates showed no shifts in percent composition before and after treatment (Table 23). All functional groups were represented in the macroinvertebrate community, and little change was measured before and after treatment (Table 24). The level of similarity between pre- and post-treatment species composition, as measured by the Pinkham-Pearson Coefficient of Similarity, was 0.49. This indicated a minor shift in densities of dominant taxa (Table 25).

Fish

Total fish density was 173 / 100 m^2 and 97 / 100 m^2 in pre- and post-treatment samples, respectively. The sum of each species' population estimate dropped from a pre-treatment value of 292.7 / 100 m^2 to 132.2 / 100 m^2 after treatment. Post-treatment density estimates of individual species were also lower in the post-treatment sample except for white sucker. Brown bullhead and banded killifish, collected in very low numbers before treatment, were absent in the post-treatment sample. However, fathead minnows and blacknose dace were present only in the sample following treatment. Fifteen species were present in each sample. Dominant species changed places among each other. VTIBI scores were identical at 31 before and after treatment. An estimate of the number of non-lamprey fish in the treated segment, extrapolated from the sum of individual population estimates, ranged from 5,975 to 8,941. Only 59 fish , or 0.6 to 1.0 percent, of non-lamprey nontarget fish were killed by TFM treatment.

Discussion / Conclusion

Macroinvertebrates

VTDEC staff documented no short term adverse impacts of TFM treatment to the Trout Brook macroinvertebrate population.

Fish

Intense electrofishing the day before the TFM treatment, rather than any toxic effects of TFM, is the probable cause of the decrease in fish numbers observed after treatment. The electrofishing effort was made to collect American brook lamprey to be held in untreated water during treatment and released back into the stream following treatment in accord with permit conditions. Substantial numbers of several fish species were killed as a result of the electrofishing effort. The authors concluded that mortality of non-lamprey, nontarget fish due to the TFM treatment of Trout Brook was not significant.

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g. “Assessment of the Impacts of TFM on Non-target Macroinvertebrates in Lake Champlain Delta Areas” (Gruendling and Bogucki 1993)

Materials and Methods

Gruendling and Bogucki evaluated impacts of TFM on nontarget macroinvertebrate communities of the Little Ausable and Ausable delta areas, and established a reference site, on the untreated Port Kent ‘delta’.

Community Samples

They collected 50 community samples from each of the two treatment sites before TFM arrived on the deltas and another 50 samples from each, two to four days after TFM dropped below detectable levels. A 22.9 cm x 22.9 cm Ponar Grab Dredge was used to collect samples, which were then bagged, cooled and transported to the laboratory for immediate analysis. Specimens were gleaned from other sample contents by sieving, hand picking and extraction with concentrated sugar solution, and then placed in 80% ethanol. The first Little Ausable River treatment began on September 13, 1990. TFM leading edge entered the delta on September 15, 1990. Researchers collected Little Ausable pre-treatment samples on September 10, 1990 and post-treatment samples on September 18, 1990. TFM was first applied to the Ausable River on September 15, 1990 and entered the lake mostly via the north mouth the same day. Ausable delta pre-and post-treatment community samples were collected on September 11 and 19, 1990.

Water Samples

Gruendling and Bogucki took water samples with a Syringe Water Sampler at a depth of 0.1 meters above the substrate at 11 sites on the Little Ausable and 10 sites on the Ausable deltas. TFM concentrations were analyzed with High Performance Liquid Chromatography (HPLC).

Mussel Population Samples

Mussel population densities were estimated at most of the Little Ausable and Ausable delta water chemistry sites to evaluate TFM dose / response. Quadrats of 0.25 m^2 were employed on the Little Ausable delta, while larger, 10 m^2 quadrats were used on the Ausable delta. The difference in quadrat size was based on mussel density variance and the amount of aquatic vegetation within the two habitats. Four 0.25 m^2 quadrats were established at each sampling location on the Little Ausable and two 10 m^2 quadrats were sampled at each location on the Ausable. A SCUBA diver hand picked all mussel specimens within the established quadrats from each location. Specimens were classified as alive, stressed, or dead. Counts and biomass were determined in the laboratory on refrigerated specimens.

Caged Animal Experiments (Bioassays)

Unionid mussels from the Port Kent reference site were also placed in cages at most water chemistry sites on the Little Ausable and Ausable deltas. Researchers put ten mussels in each cage and allowed them to acclimate for 5 days before treatment. Ninety-six hours after TFM dropped to non-detectable levels, the cages were removed, and the animals were placed into untreated Lake Champlain water. They were observed and classified as alive, stressed or dead.

Results

Community Samples

Gastropoda (snails), Oligochaeta (worms), Amphipoda (scuds), Hirudinea (leeches) and Pelecypoda (mussels) dominated the Little Ausable delta sediment invertebrate community. Diptera (midges), Oligochaeta, Gastropoda, Pelecypoda and Ephemeroptera (mayflies) dominated the Ausable delta invertebrate community. No significant differences occurred in pre- and post-TFM treatment densities on either delta.

Water Samples

The highest TFM concentration monitored on the Little Ausable delta was 1670 ppb and that for the Ausable 1125 ppb. Target concentrations in each river were 5400 and 1600 ppb, respectively. Analyses detected some TFM in the emergent wetland fringe area along the Little Ausable River delta. An emergent wetland site east (down wind) of the Little Ausable mouth had the highest TFM concentration and longest exposure time. No TFM was detected in stations near the south mouth of the Ausable, indicating most of the plume exited the north mouth.

Mussel Population Samples

Considerable variability was observed between samples within location on each delta. Little Ausable delta density and biomass estimates per 0.25 m^2 quadrat ranged from 0-17 animals and 0-580 grams, respectively. Mean density and mean biomass there were 17.0/m^2 and 494 gm/m^2 fresh weight. On the Ausable delta density ranged from 0 - 65 animals/10 m^2 quadrat, while the mean was 1.1/m^2. Biomass estimates ranged from 0 - 2306 gm/m^2; mean biomass was 53.5 gm/m^2.

Caged Animal Experiments (Bioassays)

No statistically significant mortality occurred with only four deaths among the 180 unionid mussels in test cages on the Little Ausable and Ausable deltas. However, the highest level of apparent impact occurred in the cage at the location exposed to the highest TFM concentration on the Ausable River delta. Researchers recorded one dead and 2 stressed mussels there.

Discussion / Conclusion

Community Samples

TFM treatment of the Little Ausable and Ausable Rivers caused no significant impacts on associated delta invertebrate communities.

Water Samples

TFM concentrations did not reach river levels at any site monitored on either delta. Further, TFM did not cover each delta completely. Wind speed and direction apparently determined TFM's dispersal and resident time after it reached the deltas.

Mussel Population Samples

Gruendling and Bogucki noted that unionid mussels comprise a major proportion of the biomass on each delta. SCUBA sampling was conducted only after treatments on September 21, 1990. Therefore, they drew no definitive conclusions regarding TFM impact on unionids from this sampling. However, it could be inferred from the caged mussel studies that none occurred. The information however, was useful in developing evaluation strategies for 1991 and 1995 Bayer 73 (5% Granular) treatments.

Caged Animal Experiments (Bioassays)

No significant TFM-induced mortality was recorded at either delta.

h. “Investigation of Native Mussel Glochidia Retention in the Poultney River During TFM Treatment” (Lyttle and Pitts 1997)

Materials and Methods

Five drift nets deployed in three locations were sampled hourly from dawn till dusk before, during and after TFM treatment by removing and preserving all materials collected. Two trays holding gravid mussels were placed immediately upstream of the two drift nets in the treatment zone at Carvers Falls. A mussel bed was situated immediately upstream of the two drift nets below Coggman Bridge, also in the treatment zone. A control tray with gravid mussels was placed upstream of a single drift net set above the TFM application point.

Results

No glochidia were observed in four pre-treatment samples examined, or in any of the treatment or post-treatment samples collected below the TFM application point. The authors decided on this basis not to examine control samples. Gravid mussels held in the plastic trays and those residing in the Coggman Bridge mussel bed released no glochidia for at least five days post-treatment.

Discussion / Conclusion

The 1996 sea lamprey control treatment of the Poultney River caused no adverse impact on the retention of glochidia by native mussels exposed to TFM at treatment concentrations.

i. “Effects of Lampricides on Amphibians: Little Ausable and Ausable Rivers and Deltas, Lake Champlain, NY (1990-1995)” also known as “Breisch Amphibian Study” (Breisch 1996)

Materials & Methods

A special condition of the New York Adirondack Park Agency Freshwater Wetlands permit required the Project Sponsor Group to make “an increased effort to collect and detect affected amphibians...in several locations on both the Little Ausable and north branch of the Ausable Rivers.” Investigators were to carefully probe and search approximately 300 feet of the emergent / submergent wetland bordering the mouth of the Little Ausable and several upstream areas adjacent to riparian wetlands. Two other similar lengths of shoreline near wetlands were also to be investigated on both the Little Ausable and Ausable Rivers following TFM treatments. Additionally, the applicant was to make routine, post-treatment collections of all affected amphibians in all treatment areas.

Results

1990 - Special effort surveys, under the direction of Al Breisch of the NYSDEC Endangered Species Unit (ESU), resulted in the collection and/or observation of 6 dead two-lined salamanders and 25 dead tadpoles from the Little Ausable River, and 24 dead mudpuppies (Table 26) and 32 dead tadpoles from the Ausable River after 1990 TFM treatments. Other amphibian mortalities due to these treatments were detected during routine nontarget assessment surveys conducted along the entire length of treated stream and have been reported in a preceding section.

1991 - ESU staff also conducted similar work after the 1991 Bayer 73 (5% Granular) treatment of the Little Ausable delta. The only amphibians they detected were 76 tadpoles. A delayed treatment and ensuing scheduling conflicts precluded ESU staff from conducting a special effort survey after the 1991 Ausable delta Bayer 73 (5% Granular) treatment.

1994 - No effort was expended on the Little Ausable after the minor impacts noted in 1990. Instead, an extensive effort was focused on the Ausable River. In September, 1994, before the Ausable treatment, ESU staff searched for mudpuppies via probing beneath submerged rocks and into other potential refuges. They also set baited minnow traps for a total of 22 trap-nights. Efforts were concentrated on two stream sections where most mudpuppy mortality occurred in 1990. They found no mudpuppies before treatment. However, special-effort amphibian surveys, following the 1994 treatment of the Ausable River, resulted in the observation of 40 dead mudpuppies and two stressed, adult mudpuppies. Several size classes indicating the presence of various age classes were represented (Table 26).

1995 - ESU staff could not conduct special-effort post-treatment studies following Bayer 73 (5% Granular) application on the Ausable delta due to scheduling conflicts. No Bayer 73 (5% Granular) treatment was required on the Little Ausable delta in 1995 due to lack of sea lamprey colonization. Instead, Vance Gilligan of the Region 5 Wildlife Unit was designated to collect amphibians and transmit them to the Endangered Species Unit. Only one frog tadpole (*Rana* spp.) was observed and collected.

Discussion / Conclusion

Breisch considered the detection of forty dead mudpuppies in 1994 following the second TFM treatment of the Ausable River as an indication substantial recolonization occurred after the first treatment in 1990. Three of four size classes observed in 1990 were represented again in 1994. A fifth size class, not represented in 1990 was observed in 1994. Frequencies of individuals within size classes was similar between years. However, Breisch stated it was unclear what the effects of continuous, long-term treatments may be on the sensitive mudpuppy population there.

2. Bayer 73 (5% Granular) Treatments

a. "Assessment of Bayer 73 (5% Granular) Impacts on Non-target Macroinvertebrates in Lake Champlain Delta Areas" (Gruendling and Bogucki 1993b)

Materials & Methods

The purpose of this study was to evaluate the impact of Bayer 73 (5% Granular) application on the nontarget macroinvertebrate communities of Lake Champlain's Little Ausable and Ausable River deltas. Treatment of the Little Ausable delta occurred on September 10, 1991 and the Ausable delta on September 12, 1991. Gruendling and Bogucki conducted pre-treatment assessments in 1990 and 1991, and post-treatment assessments immediately following treatment in 1991 and again in 1992, after a one-year recovery period. This study is the first known to have reported simultaneous, *in situ* monitoring of Bayer 73 concentrations and an evaluation of invertebrate impacts and population recovery rates.

Objectives of the study were to determine pre-treatment (baseline) macroinvertebrate community assemblages, the impacts of Bayer 73 (5% Granular) on macroinvertebrates and their recovery rates after treatment, the concentrations of Bayer 73 (5% Granular) at caged invertebrate sites following treatment, as well as the responses of selected macroinvertebrate species to various concentrations.

As in their TFM impact study Gruendling and Bogucki utilized the Port Kent 'delta' as a reference site. Initially the Port Kent site was to serve as a control for population comparison data. However, the researchers determined through subsequent field testing that its macroinvertebrate communities were not similar enough to serve this purpose. Instead it was used only as a control for caged animal experiments.

Water Sampling and Bayer 73 Analysis

Gruendling and Bogucki established ten water sampling sites on the Little Ausable delta, eleven on the Ausable delta and one at the Port Kent reference site. Water samples were collected at 3, 6, 12, and 24 hours after Bayer 73 application and every 24 hours thereafter until the lampricide was below 10 ppb at a depth of 0.1 m above the substrate. Samples at six time sequences were also collected at the reference site. Samples were analyzed with a Hewlett-Packard Model 1090M HPLC.

Community Sampling

Fifty community sediment samples were collected from the Little Ausable delta and fifty were collected on the Ausable delta with a Ponar Grab Dredge (22.9 x 22.9 cm) during each of four sampling periods. These were the 1990 baseline, the 1991 pre-Bayer 73 treatment, the 1991 post-Bayer 73 treatment, and the 1992 recovery periods. A total of four hundred samples resulted. The samples were processed as described in the narrative regarding the Gruendling -

Bogucki TFM impacts study, above.

Unionid Mussel Population Sampling

Research conducted during the 1990 Gruendling - Bogucki TFM impacts study documented the high incidence of two species of unionid mussels (*Elliptio complanata* and *Lampsilis radiata radiata*) among the macroinvertebrate fauna of the Little Ausable and Ausable deltas. Due to their dispersed distribution and relatively large size, a SCUBA sampling technique, rather than the Ponar Grab Dredge technique was developed. To estimate density and biomass of these mussels, five transects were established across each delta from its outer edge shoreward to a depth of approximately 0.5 m. Loran C instrumentation was used in subsequent sampling periods to provide nearly adjacent transects. A SCUBA diver placed a metal frame on the sediment, at approximately 10 meter intervals along the transect, and within the quadrat, collected visible mussels and sifted through the sediment with a bare hand to detect buried specimens. Based on preliminary population information, divers used a quadrat of 0.25 m^2 on the Little Ausable delta and a quadrat of 2.5 m^2 on the Ausable delta (accomplishing the latter by flipping over the 0.25 m^2 frame ten times at each sampling plot). Water level changes, random underwater movement of the SCUBA diver and rough water conditions near shore resulted in unequal sample sizes among the sample periods. Researchers collected the samples from each plot for later identification, counting and length and weight measurement in the laboratory. Biomass estimate specimens were opened, drained and placed on paper towels for five minutes before determining shell and fresh tissue weights.

Caged Animal Experiments (*In Situ* Toxicity Tests)

Unionid Mussel Toxicity Tests - Researchers placed ten *Elliptio complanata* and ten *Lampsilis r. radiata* specimens in each of twenty-two cages located at the established water sampling sites on the treatment deltas and reference site. The animals acclimated 3 - 4 days before Bayer 73 treatments, and were checked *in situ* at 24 and 48 hours after exposure to Bayer 73 began. Mussels were removed from the cages and placed into untreated water after 72 hours. Normally filtering animals were categorized as "alive"; slightly open animals that responded to probing stimuli were categorized as "stressed"; open, nonresponsive mussels were classified as "dead". In addition to the caged samples, post-treatment SCUBA sampling of four quadrats using a point-quarter procedure at twenty-two reference stakes set adjacent to each cage/water sampling site on both the Little Ausable and Ausable deltas took place. Quadrat size on the Little Ausable was 0.25 m^2; that on the Ausable delta was 1.25 m^2. Sampling four of these at each reference stake resulted in sample plots of 1 m^2 on the Little Ausable, and 5 m^2 on the Ausable delta. The same "alive", "stressed", or "dead" classifications were assigned after treatment and the mussels were returned to the sediment.

Other Macroinvertebrate Toxicity Tests - On the Little Ausable delta, researchers also placed representative species of six macroinvertebrate groups (Amphipoda, Isopoda, Decapoda, Gastropoda, Odonata and Pelecypoda) in exposure chambers at the established water sampling sites. These animals were collected from a nearby non-treatment area and acclimated on the test site for 24 hours before treatment. They were removed 24 hours after treatment and transferred to untreated water to be observed for survival / mortality behavior.

Laboratory, Cage, and *In Situ* LC$_{50}$ Experiments

Gruendling and Bogucki used replicated renewal acute toxicology tests (Rand and Petrocelli 1985) to determine Bayer 73 LC$_{50}$ values for *L. r. radiata* and *E. complanata* in the laboratory, in cages and *in situ*. Target Bayer 73 concentrations in parts per billion were 0, 250, 500, 1000, 2000 and 4000. Actual exposure levels were lower. Researchers put 40 liters of lake water and an 8 cm layer of sand from the Ausable delta into each of six 120-liter glass treatment tanks and six 40-liter recovery tanks. The tanks were aerated and maintained at 20 °C.

Fourteen *L. r. radiata* specimens and fourteen *E. complanata* specimens from the Port Kent reference site were placed into each treatment tank and acclimated for two days for each test. Appropriate amounts of Bayer 73 (5% Granular) believed necessary to achieve target concentrations were sprinkled evenly into each tank. After 24 hours of exposure, the mussels were transferred to recovery tanks. Mussel condition was examined 3 hours post-treatment, 24 hours post-treatment and 24 hours post-recovery, and mussels were classified as “unaffected”, “stressed” or “dead”. Researchers took water samples during the 3 hour post-treatment period to determine actual Bayer 73 (5% Granular) concentrations.

LC$_{50}$ values were also calculated for these species in cage experiments and post-treatment sample plots.

Statistical Analysis

A consulting statistician compared count distributions using the Wilcoxon Rank Sum Test. Researchers estimated the LC$_{50}$ value of Bayer 73 (5% Granular) in both the laboratory and the field via probit graph analysis.

Results

Water Sampling and Bayer 73 Analysis

Concentrations of Bayer 73 (5% Granular) were monitored over 4 day post-treatment periods at ten stations on the Little Ausable delta and eleven stations on the Ausable delta. One station at the Port Kent reference site was monitored during the same time as the Ausable delta stations. A striking variability in concentrations, as much as 10 - 30 fold differences, occurred among sample sites within the treatment areas. Maximum concentrations at a depth of 0.1 m above the sediment occurred at all Little Ausable sites within 24 hours (although timing of peak values among sites varied), and at all Ausable sites within 13 hours (most sites peaking within 6 hours of application). Detectable levels of Bayer 73 (>10 ppb) were found at all stations 98 hours after initial application on the Little Ausable delta and at only two stations on the Ausable delta approximately 95 hours after initial application. About 24 hours after initial application on the Ausable delta, small concentrations of Bayer 73 (15 - 18 ppb) were detected at the Port Kent reference site, apparently driven there by a strong northerly wind.

Concentrations on the Ausable were substantially lower and shorter in duration than those on the Little Ausable delta.

Community Sampling

The Little Ausable delta exhibited a higher species diversity than the Ausable delta. Gastropoda (snails), Oligochaeta (aquatic worms) and Amphipoda (scuds) dominated the Little Ausable pre-treatment community. Two species of Pelecypoda (mussels), *L. r. radiata* and *E. complanata*, very important to the delta's macroinvertebrate biomass, are summarily treated here, and more extensively treated separately in this study. Comparing pre-treatment 1991 (9/3/91) to post-treatment 1991 (9/15/91) samples, statistically significant ($P < 0.001$) declines in densities occurred in Gastropoda, Pelecypoda, Diptera (midges) and Hirudinea (leeches) (Table 27). Amphipoda densities increased substantially. Isopoda (aquatic sow bugs), Oligochaeta and Trichoptera (caddis flies) exhibited essentially no impacts due to Bayer 73 treatment. One year later, Diptera densities had rebounded and exceeded pre-treatment levels. Gastropoda, Hirudinea and Pelecypoda remained significantly ($P < 0.05$) lower than either pre-treatment sample. Amphipoda and Isopoda significantly increased ($P < 0.001$) over pre-treatment levels (Figure 10).

Except for Diptera and Ephemeroptera (mayflies), macroinvertebrate densities were lower both before and after treatment on the Ausable River delta than on the Little Ausable delta. Diptera, Gastropoda and Oligochaeta dominated pre-treatment macroinvertebrate communities there. After Bayer 73 treatment, significant decreases ($P < 0.005$) in mean sample counts occurred in Gastropoda, Pelecypoda, Oligochaeta, Hirudinea and Diptera (Table 28). Amphipoda, Isopoda and Ephemeroptera showed no significant changes. A year after treatment on the Ausable delta, Gastropoda, Pelecypoda, Oligochaeta, Hirudinea and Diptera all remained significantly lower ($P < 0.001$) in density than in 1991 pre-treatment samples. However, the pre-treatment 1991 densities of Gastropoda, Pelecypoda, Oligochaeta, Hirudinea, Diptera, Amphipoda and Isopoda were greater than those in pre-treatment 1990 samples. Comparing levels one year after treatment to 1990 pre-treatment densities showed that significant decreases remained only in Diptera, Pelecypoda and Gastropoda. Hirudinea and Oligochaeta had rebounded to near 1990 levels and Amphipoda densities were significantly greater ($P < 0.05$) in 1992 than in 1990 (Figure 11).

Unionid Mussel Population Sampling

Elliptio complanata was the dominant unionid mussel on the Little Ausable River delta. *Lampsilis r. radiata* dominated the Ausable River delta. Pre-treatment density estimates of both species combined ranged from 16.7 - 19.3 / m^2 on the Little Ausable delta and from 2.2 - 2.4 / m^2 on the Ausable delta. Individual species densities were 12.1 - 13.6 / m^2 for *E. complanata* and 4.6 - 5.7 / m^2 for *L. r. radiata* on the Little Ausable delta. On the Ausable delta, *L. r. radiata* density estimates ranged from 1.6 to 1.7 / m^2, while those for *E. complanata* ranged from 0.6 - 0.7 / m^2.

Significant declines ($P < 0.001$) in the density estimates of both species were observed on both deltas immediately after treatment (Table 29). *L. r. radiata* declined 77% and *E. complanata* declined 42% on the Little Ausable delta. Declines of these species on the Ausable delta were 43% and 49%, respectively. Additional mortality may have occurred as the population density estimates conducted one year post-treatment suggest overall mortality for *L. r. radiata* was 86% and that for *E. complanata* was 69% on the Little Ausable delta. Overall mortality estimates for these species on the Ausable delta were 71% and 77%, respectively (Table 30).

Caged Animal Experiments (*In Situ* Toxicity Tests)

Unionid Mussel Toxicity Tests - Mean mortalities of caged *Elliptio complanata* and *Lampsilis r. radiata* specimens, 70.0% and 94.0% respectively, were highest on the Little Ausable Delta (Table 31). These species exhibited mean mortality rates of 32.7% and 73.6%, respectively, on the Ausable delta (Table 32). *L. r. radiata* was most sensitive to Bayer 73 at all sites. Caged *E. complanata* showed no mortalities at half of the Ausable delta sites. No mortality occurred at the Port Kent reference site.

In situ field plots located adjacent to caged unionid mussel stations also resulted in higher mortalities for both *E. complanata* and *L. r. radiata* on the Little Ausable delta than on the Ausable delta. Mean mortality rates observed for *E. complanata* and *L. r. radiata* on the Little Ausable were 29.2% and 76.8%, respectively (Table 31). On the Ausable River delta, they were 9.1% and 52.5%, respectively (Table 32).

Other Macroinvertebrate Toxicity Tests - On the Little Ausable delta, caged Gastropoda and Pelecypoda exhibited extreme sensitivity to Bayer 73 and experienced mean mortality rates of 87% and 89%, respectively. Mean mortality rates were 34% for Odonata, 29% for Amphipoda, 24% for Isopoda and 0% for Decapoda in exposure chambers there. None of the caged animals at the Port Kent reference site died.

Laboratory, Cage, and *In Situ* LC_{50} Experiments

The replicated, renewal acute toxicity tests showed a direct relationship between *E. complanata* and *L. r. radiata* mortality and Bayer 73 concentrations. Regression analysis of plots of mortality rates after probit transformation versus log-transformed Bayer 73 concentration data resulted in laboratory-estimated LC_{50} values of 998 ppb for *E. complanata* and 178 ppb for *L. r. radiata.* The laboratory LC_{50} value for *E. complanata* was higher than the maximum concentrations recorded on either delta. *In situ* LC_{50} values calculated for this species fell within the range of Bayer 73 concentrations on both deltas. The lab LC_{50} value and the *in situ* LC_{50} values for *L. r. radiata* were within the range of concentrations monitored on the two deltas.

Discussion / Conclusion

Water Sampling and Bayer 73 Analysis

Reasons for the differences in Bayer 73 (5% Granular) concentration and duration between treated deltas are unclear. Gruendling and Bogucki hypothesize that they may have resulted from a higher application rate on the Little Ausable delta and/or a lower dilution rate.

> [Note: The applicators took precautions to assure that the proper dosage, 100 pounds of formulation / acre, was evenly applied over the measured treatment area. The exact amount of formulation required to treat the measured acreage was loaded onto the crop duster aircraft; and the aircraft, using carefully calibrated dispensing equipment, ran out of material at expected points, indicating that the deltas indeed were treated at 100 pounds / acre.]

The Little Ausable delta is shallower, heavily vegetated and sheltered from prevailing winds. The Ausable delta on the other hand is deeper (i.e. it has a greater water volume) lacks significant vegetation and is substantially exposed to winds and currents. Concentrations on both deltas indicated lampricide movement in the treatment zone and dilution along the outer edge of the plume.

Community Sampling

Dense vegetation probably accounted for the higher species diversity on the Little Ausable delta, as compared to the high energy, non-vegetated Ausable delta. Gruendling and Bogucki reported that impacts to macroinvertebrates on the Little Ausable and Ausable deltas were similar to those observed in other populations exposed to Bayer 73. Differences between this Lake Champlain study and others were that, here, no significant effect was detectable on caddis flies or mayflies, but snails (previously reported as experiencing little impact) sustained heavy mortality on the Little Ausable and Ausable deltas. Not surprising, considering that Bayer 73 has been used as a molluscicide, were data showing that Pelecypoda and Gastropoda showed no recovery a year after treatment on either delta.

Unionid Mussel Population Sampling

Higher densities of unionid mussels found on the Little Ausable delta were probably related to the more stable substrate and more dense aquatic vegetation there compared to the exposed, less vegetated, scoured sands of the Ausable delta. Pre-treatment mussel density values for the Little Ausable River delta were at the high end, while those for the Ausable delta were at the low end, of the range for northeastern lakes. The lack of recovery of mussel densities one year following Bayer 73 treatment indicate no apparent recolonization by adults. Potential recruitment could come from immigration, *in situ* reproduction and infusion of larvae from other sites. Gruendling and Bogucki felt that immigration would not play an important role as a recruitment source. During post-treatment sampling in 1992, few Unionidae less than four years of age were collected. Only two of 192 animals collected on the Little Ausable delta could have been recruited during 1991 - 1992. None of the 130 animals collected on the Ausable delta could have been 1991 - 1992 recruits. However, small mussels less than 25 mm in length may be missed when samples are collected by hand, as with SCUBA sampling. In the Lake Champlain study few juveniles were collected with either SCUBA or the Ponar Grab Dredge. These two techniques may have inadequately sampled young mussels and underestimated post-treatment recruitment. Gruendling and Bogucki, however, concluded that the Little Ausable and Ausable delta unionid populations would recover slowly.

Caged Animal Experiments (*In Situ* Toxicity Tests)

Unionid Mussel Toxicity Tests - The higher mortality rates observed on the Little Ausable River delta as compared to the Ausable delta were probably due to the higher concentrations and greater retention time of Bayer 73 there. *L. r. radiata* is apparently more sensitive to Bayer 73 than *E. complanata*. These mortality results are similar to those obtained from laboratory studies.

Other Macroinvertebrate Toxicity Tests - Mortality among caged groups was similar to that observed from community sampling. However, field mortality rates tended to be lower, probably due to the ability of some invertebrate groups to minimize exposure to Bayer 73 in field conditions. Stress among caged animals may also have been a factor.

Laboratory, Cage, and *In Situ* LC_{50} Experiments

The differences in tolerance of Bayer 73 between the two species of unionid mussels, *E. complanata* and *L. r. radiata,* are due to physiological tolerances, and the greater ability of *E. complanata* to avoid the lampricide by burrowing and tightly closing valves when exposed. LC_{50} values calculated in the laboratory, among caged specimens and in field plots were more variable for *E. complanata* than for *L. r. radiata*. Exposure to higher Bayer 73 concentrations or the fact that *E. complanata* could not burrow in the cages may account for this. In the lab the mussels quickly burrowed under the sand upon exposure to Bayer 73.

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b. “Assessment of Mussel Populations on Select Delta Areas of Lake Champlain Following the Application of Lampricide (Bayer 73)” (Lyttle 1996)

Materials & Methods

Gruendling and Bogucki (1993b) determined that mollusc population densities (mussels and gastropods) had not recovered to pre-treatment levels one year after Bayer 73 treatment of the Little Ausable and Ausable River deltas. Lyttle conducted further assessment in 1995, four years following treatment, employing Gruendling and Bogucki procedures.

Lyttle’s primary objectives were to “investigate the distribution and relative abundance of Lake Champlain mussels, with emphasis on the Ausable and Little Ausable Deltas”, to determine mussel age structure and how it relates to recruitment stability and variability, to assess Ausable and Little Ausable delta gastropod status and to project the potential impact of repeated Bayer 73 treatments on several New York deltas on lake-wide mollusc populations.

Besides intensive surveys of the Ausable and Little Ausable deltas, fifty littoral sites covering all sections of Lake Champlain, ranging in depth from 0.5 to 2.0 m. and in substrate composition from sand/silt on the deltas to a mixture of sand/cobble/shale, were evaluated for native mussel and gastropod populations.

Mussel Surveys on the Ausable and Little Ausable Deltas

Researchers expanded the Gruendling and Bogucki (1993b) procedures to estimate population density and recruitment of unionid mussels on the Ausable and Little Ausable deltas. Transects, 100 m in length, were established starting at depths of about 3 m and proceeding toward shore, except for the transect near the south mouth of the Ausable. This latter transect was placed parallel to shore due to a rapid depth change.

Between June 19 and 23, 1995, a SCUBA diver placed a 0.25 m^2 metal frame (quadrat) at points along each transect and hand picked all mussels inside on the substrate surface and for a depth of 15 - 20 cm below the substrate surface. The material below the surface was excavated and sifted through a 5 mm mesh screen to collect any juvenile mussels present. To estimate the mussel population within 25% of the true value with 95% confidence, the diver sampled 658 quadrats on the Ausable delta and 158 quadrats on the Little Ausable delta. Mussels were aged and measured (long axis) in the field, and a linear regression analysis was conducted by species to determine if lengths could accurately predict ages for future studies.

Gastropod Survey on the Ausable and Little Ausable Deltas

Researchers collected 50 samples on each delta (Ausable and Little Ausable) with a Ponar Grab Dredge (22.9 cm x 22.9 cm) to evaluate gastropod numbers. The snail samples were filtered, picked, bagged and refrigerated until analyzed. To compare results, Lyttle calculated the number / plot, the mean number / plot and the number / m^2 of gastropods reported by Gruendling and Bogucki (1993b).

Lake-wide Mussel and Gastropod Survey

Lake Champlain littoral area sampling locations were established using a stratified random sampling design. VTDEC sampling techniques (Fiske and Levey 1995) were employed. First a 15-minute visual inspection of each area was completed with snorkeling gear; then three 3.0 m transects were sampled to provide quantitative data. Mussels were identified to species, measured and aged. Researchers collected snails with a sweep net for later laboratory identification.

Impacts to Available Food Resources for Waterfowl

A determination of the importance of mussels and gastropods as Lake Champlain waterfowl foods was attempted through the review of waterfowl life histories and other data. Waterfowl concentrations were mapped using Geographic Information System (GIS) technology.

Results

Mussel Surveys on the Ausable and Little Ausable Deltas

Divers collected native Eastern elliptio, Eastern lampmussel, Eastern floater and giant floater on both the Ausable and Little Ausable deltas (Table 33). Gruendling and Bogucki (1993) did not collect either the Eastern floater or the giant floater. Lyttle's group also noted the non-native zebra mussel, that first had been documented in Lake Champlain in 1994. Zebra mussels were excluded from this analysis. Unfortunately, the mussel population sampling raw data from Gruendling and Bogucki (1993) were unavailable, and no statistical comparisons could be made. However, a simple comparison of combined Eastern elliptio and Eastern lampmussel densities/m^2 was possible (Figure 12). Also, a comparison of overall mussel densities/m^2 was possible. Little Ausable pre-treatment densities based on Gruendling and Bogucki (1993) were 16.7 and 19.3 mussels/m^2 in 1990 and 1991, respectively. In 1995 they had recovered to 13.5 mussels/m^2. Those on the Ausable delta in 1990 and 1991 were 2.2 and 2.4 mussels/m^2, respectively, while in 1995 they were 3.7 mussels/m^2.

Lyttle's age-frequency distribution plots of mussels from both deltas showed recruitment is fairly stable and consistent rather than sporadic. The plots also contained mussels younger than four years, demonstrating that recruitment has occurred since the 1991 Bayer 73 treatments. Combined delta age-frequency distribution plots were similar between 1992, a year from which mussel shells were available, and 1995. Unfortunately, no pre-treatment (1990 or 1991) age data or mussel shells were available for a pre-treatment versus 1995 comparison, and the 1992 mussel shells from the two deltas had been combined without a means of assigning them to their original source.

Linear regression analyses showed that the total variability in the relationship of length to age was too great to use length as an accurate age indicator. Combined delta values of r^2 for Eastern elliptio and Eastern lampmussel were 0.485 and 0.659, respectively.

Gastropod Survey on the Ausable and Little Ausable Deltas

Lyttle compared Gruendling and Bogucki gastropod data, available as numbers of gastropods from each dredge sample and a species list, collected on the Ausable and Little Ausable deltas with her 1995 data (Figure 13). The earlier researchers documented statistically significant gastropod decreases ($P < 0.05$) between (1990 and 1991A) pre-treatment samples and samples collected immediately post-treatment (1991B). They also found statistically significant declines between (1990 and 1991A) pre-treatment samples and samples collected one year after treatment (1992). Lyttle, however found no significant differences between pre-treatment samples and the samples collected in 1995. In fact, gastropod samples collected in 1995 indicated a higher density of animals than in any of the other years (Table 34).

From 1990 through 1992 Gruendling and Bogucki collected five gastropod species on the Ausable delta and six gastropod species on the Little Ausable delta. In 1995 Lyttle collected 14 species on the Ausable and 21 on the Little Ausable. Three of the species collected on the

Ausable, and five collected on the Little Ausable, by Gruendling and Bogucki were not collected by Lyttle on the corresponding deltas.

Lake-wide Mussel and Gastropod Survey

All mussel species found by Lyttle on the Ausable and Little Ausable deltas are widely distributed in Lake Champlain (Table 35), and gastropods were documented at most of the mussel survey sites (Table 36). Lyttle collected no gastropods listed as unique or rare by state or federal agencies.

Impacts to Available Food Resources for Waterfowl

A list of Lake Champlain waterfowl species that rely on molluscs for hatch and recruitment success and as a winter food source was developed. The list included seven dabbling duck species (mallard, American black duck, wood duck, northern pintail, green-winged teal, blue-winged teal and American wigeon), four diving duck species (ring-necked duck, common goldeneye, common merganser and hooded merganser) and the Canada goose.

Discussion / Conclusion

Mussel Surveys on the Ausable and Little Ausable Deltas

No long-term loss of mussel species was detected on the Ausable or Little Ausable deltas four years following Bayer 73 treatments. Besides the Eastern elliptio and Eastern lampmussel, this study documented presence of the Eastern floater and giant floater (two additional native mussels), on both deltas. Changes in habitat, notably the predominant presence of Eurasian water milfoil, which was not reported by Gruendling and Bogucki, may account for the presence of the “new” native species. Pumpkinseed and carp, which are host species for the juvenile stages of the Eastern floater and giant floater, often associate with this vegetation. The non-native zebra mussel was also observed.

The overall density of mussels (number/m^2) was somewhat higher on the Ausable delta and slightly lower on the Little Ausable delta than recorded during pre-treatment surveys. Neither difference was significant.

Age frequency plots showed survival of 1991 young-of-year mussels among all four native species. Shapes of the catch curves, however, suggested that the sampling technique under- represented the smaller, younger age groups.

Gastropod Survey on the Ausable and Little Ausable Deltas

Densities of gastropods had recovered since the 1991 Bayer 73 treatment and substantially exceeded pre-treatment estimates on both deltas. Lyttle states that “[c]olonization of gastropods from outside the borders of a disturbance area is not uncommon.” The findings of this study appear to support the premise that greater diversity occurs in areas with an intermediate level of disturbance. Disturbance levels may be considered intermediate or moderate because delta areas treated with Bayer 73 are a relatively small proportion of available Lake Champlain gastropod habitat; emigration of species from adjacent, untreated habitats could be easily accomplished; chemical breakdown of Bayer 73 occurs rapidly without bioaccumulation; and the application frequency allows interim recovery to pre-treatment levels.

Impacts to Available Food Resources for Waterfowl

The authors concluded, due to the relatively small areas treated and the short term nature of the effects of treatments on populations of mussels and gastropods, that the impacts on food resources available to Lake Champlain migrating and breeding waterfowl were minimal. This was especially true in light of the wide-spread distribution within Lake Champlain of these mussel and gastropod species.

IV. Salmonid Population and Sport Fishery Response

A. Lake Trout

Abstract

Gill netting data, revealing improved lake trout survival, met three of four evaluation standards, and were ambiguous with respect to the other. Survival of Age 3-4 lake trout improved 25% over pre-control levels and met the evaluation standard. Age 3-6 survival improvements fell just shy of the evaluation standard when survivals were calculated on a year-class basis, but exceeded the evaluation standard when analyzed on a netting-year basis. There was an increase in survival of older, fully recruited lake trout, and significantly increased gill net catch per unit of effort for lake trout outside of Zones 3A & 3B, both of which met or exceeded pre-defined evaluation standards.

Sea lamprey wounding rate and accumulated scar reductions met pre-defined evaluation standards for all five size classes of lake trout. Prior to 1992, the number of sea lamprey wounds on lake trout was high and variable for different size classes of lake trout. In 1992, the number of wounds declined below pre-treatment levels for all size classes. An independent samples t-test found significant differences between pooled pre- and post-control groups for all size classes in both the number of wounds and number of scars per fish.

At the fishery level, whole-lake open water creel surveys and angler diary data reveal lake trout fishery evaluation standards were exceeded. Pre and post-treatment creel surveys revealed a 76% increase in estimated lake trout catch with an increase of 7% in average weight of harvested lake trout, both of which exceed one of the fishery evaluation standards. A second fishery evaluation standard was also exceeded; the proportion of lake trout larger than 25" in the post-control harvest increased 42% over pre-control levels and salmonid angler diary cooperators experienced a 126% increase in post-control catch rates (including harvested and released fish) for lake trout larger than 25" over pre-control rates.

1. Stocking

A coordinated lake trout stocking program was initiated in Lake Champlain in 1972. Lake trout stocked into Lake Champlain have generally come from fish produced by NY and VT state hatcheries, or the Pittsford National Fish Hatchery. Strains and ages of stocked lake trout have varied through time, however they were standardized in 1985 (Table 37) with respect to age, and 1988 with respect to strain. Variable post-stocking survival rates associated with fluctuating ages and sizes of trout required that a means be developed for standardizing numbers stocked. This standard is referred to as an “equivalent yearling”. In summary, a trout stocked as a spring yearling equals one “equivalent yearling” while five lake trout stocked as fall fingerlings equal one “equivalent yearling”. A detailed stocking history is appended (Appendix G). The stocking rate during most of this period was governed by “A Strategic Plan for the Development of Salmonid Fisheries in Lake Champlain” which was implemented by NY, VT, and the USFWS in 1977. An attempt was made to keep stocking levels of lake trout steady for the duration of the experimental sea lamprey control program. However, bioenergetics modeling data developed during the course of the eight-year experimental program indicated that current stocking rates were potentially too high to be sustained by the rainbow smelt forage base with the expected improvement in salmonid survival rates due to sea lamprey control. As a result, stocking rates for lake trout were approximately reduced by half beginning with the 1994 year class (Fisheries Technical Committee 1995). The year classes stocked at the reduced rate did not affect this evaluation as they were too young to be fully recruited to either the sport fishery or the sampling gear used. Despite the intent to keep stocking numbers consistent, variations in number of equivalent yearlings stocked did occur. Prior to the 1994 year class, these variations reflect the vagaries of hatchery production.

2. Estimating Survival from Gill Netting

The sea lamprey control program will be considered effective at the biological level for lake trout if a reduction occurs in natural mortality of younger age classes of lamprey-vulnerable lake trout, as indicated by:

a. Standard 1: ***A 25% or greater reduction in the estimated total instantaneous mortality rate from age 3 to age 4, as compared to the mean for the baseline period.***

b. Standard 2: ***A significant (5% level)*** **[$P \leq 0.05$]** ***decrease in the log-linear slope of the catch curve for ages 3-5 or 3-6 in pooled gill net data after correction for selectivity.***

c. Standard 3: ***A decrease in estimated instantaneous natural mortality rates for older, fully recruited lake trout. Minimally, these rates should not show a significant increase.***

Methodology

A Comprehensive Plan for Evaluation of an Eight Year Experimental Program of Sea Lamprey Control in Lake Champlain by Engstrom-Heg et al. (1990) (Appendix A) determined the methods used in the lake trout gill netting analysis. New York and Vermont conducted intensive gill netting from 1982 to 1997, in order to collect catch per effort data as an index of abundance. The sampling net used this entire period has been a standardized gill net 6' deep, 400' long, incorporating eight 50' long panels of multifilament nylon netting varying in (stretch) mesh size from 2 ½" to 6" and hung on a one-half basis. The panels were arranged sequentially by mesh size. Originally, the panels were hung on 3/8" diameter polyfoam core float line and number 30 leadcore bottom line. Both states used spreader bars at each end of the net. Vermont used spreader bars through the entire sampling program, while NY did not begin to use spreader bars until 1985 or 1986. Vermont used spreader bars made primarily of wood, while NY used spreader bars constructed of foam insulation-filled 1/2" diameter PVC pipe. In 1994 NY State personnel became concerned that the nets were not performing correctly at depth because of the pressures exerted on the polyfoam core float line. A commercial diver was hired to inspect and video-record the nets while they were fishing at depth. The video revealed the nets to be performing poorly, with underwater currents and any large fish able to collapse substantial portions of the net. Apparently water pressure at the depths fished was sufficient to compress the polyfoam core float line, rendering it substantially less buoyant. In addition, neither state's spreader bars were functioning properly - both lay on the bottom, pulling down sections of the largest and smallest mesh at each end of the net. Consequently, NY switched in 1995 to a net whose meshes were hung on 3/16" braided polypropylene rope with external hard foam floats (1 1/4 oz. buoyancy) with crushing depths rated at 2500' and a heavier, number-50, leadcore bottom line. In addition, NY discontinued the use of spreader bars. Vermont did not switch net styles or discontinue the use of spreader bars. Vermont replaces substantial numbers of their nets each year. Because most of their nets at any one time were newer than NY's, Vermont biologists felt the nets would be less affected by the compressing polyfoam core float line. This was somewhat supported by the videotapes of the nets fishing at depth. There was a general tendency for newer nets to fish better than older nets.

NY generally gill netted during the last two weeks of June through mid-July. Beginning with 1986, NY sampled a specific number of net sets in each of zones 3A and 3B (Table 38 and Appendix F). Vermont typically gill netted between June and August, with the majority of net sites in zones 3A and 3B. Vermont also netted outside these main-lake zones to determine if the lake trout population was expanding into suitable habitat in zones 2B, 2C, 3C, 4A and 4B, and 5A, 5B and 5C (Table 38 and Appendix F). Each state's net sites were marked by depth and LORAN coordinates, and these same sites were sampled from year to year (within the capabilities of LORAN technology). In 1991 NY experienced an economic shortfall, and NY netting operations that summer were suspended. Vermont conducted all netting on both sides of the lake that year and sampled approximately half the number of sites that ordinarily would have been netted by the two states combined.

Standard codes and forms were used by both states. Data recorded for individual lake trout, brown trout, salmon and steelhead collected included total length (mm), weight (generally to the nearest 10 grams), fin clip, and number of sea lamprey scars and fresh and healing sea lamprey wounds. However, weights prior to 1986 were taken by a variety of methods. NY weighed their fish to the nearest ounce on a platform scale and weights were converted to grams. Vermont weighed fish less than a 1,000 grams to the nearest 2 grams on a platform scale. Fish larger than this were weighed to the nearest two-hundredths of a pound on a hanging scale. In reality, even the recent years' weights must be viewed with caution, as they were taken on-board with the platform scales mounted directly to the research boats in use. Rough seas increased the imprecision proportional to the degree of roughness.

Scale samples were also taken from each captured lake trout, and beginning in 1986, the method of capture of individual lake trout in the gill net meshes was recorded; i.e. whether they were gilled or not gilled. These method of capture data were required for subsequent selectivity curve determinations. Other fish species were routinely measured for total length and lamprey wounding and scarring.

Data collected were entered into a software package developed for data management and statistical analysis (SPSS/PC+ Version 3) . Lake trout ages were determined by a combined analysis of length frequency distributions and fin clip information. In areas of overlap, or where there was reasonable doubt, scales were mounted and read. Length frequency and clip data were generally felt to be reliable methods of aging until at least age 6. This was confirmed by the stocking of a double fin-clipped portion of the 1989 year class in 1990. Ordinarily, lake trout are clipped on a 5 year rotation with one of the paired fins (ventral and pectoral) or the adipose fin getting clipped in a particular year. In 1990, hatchery personnel accidently clipped the left ventral fin on a portion of the 1989 year class, which was supposed to have received an adipose clip. Fortunately, the error was detected before the trout were stocked and the adipose was clipped on the portion of the year class which had received the left ventral clip. A double clip had not been used on Lake Champlain lake trout fall fingerlings or yearlings since 1976. Thus these double clipped fish served as an easily identifiable year class and a check and verification of our aging techniques. Ages of lake trout aged via scale readings were entered into the database individually. Ages assigned by length frequency and fin clip data were assigned to individual fish via SPSS/PC+ Version 3 programs after ages from scale reading had been entered.

Before the lake trout data could be analyzed for survival, the numbers collected by size had to be corrected for gill net selectivity. Length by mesh data were combined for NY data from 1995 through 1997. NY data were chosen for selectivity curve development because of a large discrepancy between NY and Vermont data in the proportion of fish reported as gilled (Table 39), and because this data set came from the "new"-style gill nets that fished in a more consistent manner. Selectivity curves were developed for each pair of mesh sizes as per Holt (1963). This method assumes that probabilities of capture for a given mesh are normally distributed around an optimum fish length for that mesh. Generally, the data showed fairly good agreement with the model assumptions, although there was a tendency for increased variance with increasing mesh size. The Holt methodology results in two separate estimates of optimum fish length for each mesh except for the smallest and largest meshes. With the case of the mesh pair 38 mm and 44 mm, the model statistics did not correspond well with estimates derived from the other mesh pairs, nor did the resultant estimate of optimum fish length correspond well with the observed data. Therefore the values for the 38 mm and 44 mm mesh pair were discarded, and the values of optimum fish length for these two meshes were obtained from the 32 mm / 38 mm and 44 mm / 51 mm mesh pairings.

Because the data showed increasing variance with increasing mesh size, an attempt was made to develop a selectivity curve using the methodology of Helser et al. (1991). Their method uses nonlinear iterative least squares regression to simultaneously fit a curve as a function of both mesh size and fish size. This method can handle skew-normal distributions and can accommodate instances where mesh size and variance of fish lengths within that mesh are linearly related. SPSS for Windows was used to build and run the model, however the results indicated a poor fit, perhaps because the initial parameter estimates were not close enough to the final solution, or because an inappropriate initial model was chosen. Therefore, the selectivity curves developed via the Holt model described above were used.

The resultant selectivity curves were used to correct data from all years and both state's gill netting. This was deemed appropriate because there were no consistent trends in condition factors observed through time and no significant strain changes made in the stockings. An ANOVA of condition factors of 100 mm size groups revealed a significant difference in condition factors between years for three size groups, however multiple comparison procedures failed to reveal any consistent pattern in pre- versus post-control condition factors. There is, however, a general trend toward lower condition factors through time for fish larger than 500 mm. Fish were grouped into 25 mm groups as for development of the selectivity curve, and condition factors for individual fish in these size groups were split into two groups; one pre-control and one post-control. Pre-control was defined as 1986 through 1990, and the post-control as 1991 through 1997. The pre-control period's initial year of 1986 was chosen because uniform weight-taking methodologies were begun then. Of the 60 size groups tested with an independent samples t-test, significant differences between pre and post-control periods were found in 8 size groups, ranging from the 525 - 549 mm size group up to the 750 - 774 mm size group.

The selectivity curves may be less appropriate in correcting gill net catches from the early to mid-1980's, as these lake trout catches were not comprised entirely of Finger Lakes strain (Appendix G). However, the contribution of non Finger Lakes strain fish to the total catch was generally minor in all meshes and years, and thus negligible impact would be expected on the overall suitability of the developed curves. Also, we have no data to indicate these other strains differ substantially in their length/girth ratio from Finger Lakes strain, although such an assumption seems reasonable. No systematic effect on selectivity could be determined from the partially collapsed gill nets. The collapsing would at least be expected to contribute to increased variance in catches from year to year. The influence of the collapsing on the probability of capture-type is unclear; however no increase in the proportion of gilled lake trout was observed from 1995 through 1997 when the "new"-style gill net was used. Finally, the curves developed may be somewhat less appropriate for earlier years because of the general tendency for reduced condition factors in some size groups in the more recent data.

After the selectivity curves were developed, the probability of capture (via gilling) was calculated for each length class (25 mm groups) in each mesh, and the probabilities for each size class were added across mesh sizes. Probabilities of capture by means other than gilling were estimated by the ratio of non-gilled fish in a given mesh to gilled fish in the mesh with the highest probability of capture for fish of that length, times the gilling probability for that mesh and length class. These probabilities were then added to those for gilling (Engstrom-Heg and Kosowski 1990).

As per the recommendation of Engstrom-Heg et al. (1990), a "Rudstam Correction Factor" (Rudstam et al. 1985) was also used to adjust the developed selectivity curves. The basis of this factor is that larger fish have higher probabilities of encountering a gill net because of their faster swimming speed and greater foraging range. The correction factors used were adapted from Lotus spread sheets developed by Robert Engstrom-Heg, NYSDEC Research Scientist III, for evaluation of the Finger Lakes sea lamprey control program (Engstrom-Heg and Kosowski 1990).

Quattro-Pro (Version 8) spread sheets were developed for each year's netting that multiplied the appropriate selectivity correction for each size class by the number of fish in that size class sorted by length, age, and fin clip, and both Vermont and NY data were included.

Corrected fish numbers were then used in a separate spreadsheet that adjusted year classes for netting effort (a netting year was arbitrarily defined as 199 net lifts) and stocking levels of equivalent yearlings stocked in each year class. A separate spreadsheet was developed for each year of gill netting from 1982 to 1997.

Engstrom-Heg et al. (1990) also suggested inclusion of a separate pre-control data set into the evaluation analysis. This data set spanned years 1977 to 1980. The nets used during this period were of a different design and total lake trout catch was very limited. Selectivity curves for these nets could not be generated because of the limited amount of data. Therefore, the data set used in this evaluation spans the 1982 through 1997 period, for which spreadsheets were derived.

Catch per unit of effort (CPUE) in Zones 3A and 3B through time demonstrates a fairly steady upward trend (Figure 14). This upward trend began prior to sea lamprey control and probably represents a lake trout population building from the combined effects of stabilizing strain and size at stocking. Of course, this factor does not preclude determination of any impact from sea lamprey control. However, one problem with gill netting data and the use of CPUE as an index of abundance is the variation from year to year in the catchability of the lake trout population. For some unknown reason, perhaps related to weather and its effect on thermocline development and depth, lake trout were exceptionally vulnerable to our gill nets in certain years. This was especially noticeable in 1996 (Figure 14) and to a lesser extent in 1984. This increase in CPUE in 1984 was also noted by Plosila and Anderson (1985). Inclusion of these year's unadjusted CPUE data would bias the analysis by inflating survival estimates in the post-control period because of the disproportionally large CPUE in 1996 . Inclusion of the uncorrected data also leads to the nonsensical situation of cohorts increasing with time (at least temporarily). Engstrom-Heg et al. (1990) recognized the likelihood of variations in catchability of lake trout through time and recommended the data be adjusted for this effect. As a correction factor for these two year's CPUE data, two separate linear regressions were run for average annual CPUE versus year; one for the pre-control period from 1982 to 1990, and one for the post control period from 1991 to 1997. Both regressions were run without the aberrant '84 and '96 figures included. The regressions were then used to predict CPUE values for the '84 and '96 netting years, and the result was used to adjust the fish numbers downward for those two problematic years (Figure 15).

Results

When the CPUE values are weighed by total numbers of yearling equivalents stocked, regardless of strain, there is a potential bias introduced by a greater preponderance of non-Finger Lakes strain in earlier, pre-control years. Finger Lakes strain are known to be better performers in Lake Champlain (Engstrom-Heg et al. 1990, Plosila and Anderson 1985). This would potentially result in low survival estimates for year classes comprised of large numbers of non-Finger Lakes strains, and higher survival for year classes comprised mostly or entirely of Finger Lakes strain. Engstrom-Heg et al. (1990) recommended "refined" scale reading to determine what the contribution of non-Finger Lakes strains is to the total catch each year. However, this was not deemed possible. Simply determining ages from scales was considered difficult enough. In an attempt to correct this bias, the returns of non-Finger Lakes strains were eliminated where possible, and each cohort was weighed by only the number of Finger Lakes equivalents stocked. This was a conservative approach that minimized the impact of sea lamprey control because it was not always possible to identify non-Finger Lakes strain as they did not always receive a different fin clip than Finger Lakes strain within the same cohort. Thus, the catches in earlier years were biased somewhat higher because there certainly was *some* contribution of non-Finger Lakes strains to the catch. This was the case with portions of the 1982, 1981, and 1980 year classes.

The truncated Chapman-Robson method was used to estimate survival rates of individual year classes for age 3-6 and age 4-9, and the Heincke estimate for age 3-4. Engstrom-Heg et al. (1990) suggested using the third year after the initial treatment as the post-control period, when the full effects of lamprey control (if any) would begin to be realized. Originally, however, it was planned that the first round of treatments on all Lake Champlain tributaries and deltas would be completed within one or two years. However, a full round of treatments was not completed until the third year of treatments (1992). Thus, the full impact of the first complete round of sea lamprey control would not be realized until the summer 1994 gill netting (summer gill netting precedes fall control treatments in any given treatment year). However, by looking at individual year classes through time, the resulting post-control data set would be too limited if 1994 were used as the beginning of the post-control period. Therefore 1991 was used as the first post-treatment year. This was another conservative approach to sea lamprey control evaluation, and should have lessened any observed benefits. Lake trout were not fully vulnerable to the gill net until age 3 (Figure 16). Consequently, survival estimates required elimination of all lake trout younger than age 3.

Engstrom-Heg et al (1990) recommended that survival estimates be conducted on the adjusted lake trout data both on a year-class basis and a netting-year basis. The results could then be compared; large discrepancies between the estimates derived from the two approaches would indicate potential errors and distortions. Survivals were first estimated on a year-class basis.

For age 3 - 4 survival, the 1988 through 1993 year classes were used as the post-control data set, since all age 3 fish in these year classes had reached age 3 on or after 1991, when they could be expected to derive some benefit from a partially reduced lamprey population. The survival estimates indicate a positive impact from sea lamprey control (Table 40). Pre-control survival estimates averaged 0.35 (SD = 0.07), while the post-control average was 0.44 (SD = 0.06). This is a statistically significant ($P = 0.015$) improvement. It also represents a 25% increase over the pre-control period and matches the increase established as the target evaluation standard in Engstrom-Heg et al. (1990) for age 3 - 4 lake trout.

For age 3 - 6 lake trout, the pre-control data set was defined as year classes 1979 through 1987. For the post-control period, year classes 1988 through 1991 were used. The pre-control average survival rate was estimated at 0.47 (SD = 0.05) while the post-control average survival was 0.52 (SD = 0.03) (Table 40). This represents a 10% improvement over the pre-control period. This is a substantial improvement, but the significance level associated with the difference, ($P = 0.069$), fell somewhat shy of the criteria ($P \leq 0.05$) established by Engstrom-Heg et al. (1990) for age 3 - 6 lake trout.

Older, fully recruited lake trout were defined as age 5 - 9 fish. The pre-control data set was defined as year-classes 1979 through 1985. For the post-control period, year classes 1986 through 1988 were used. Results indicate a small but positive impact from sea lamprey control. The pre-control average survival rate was estimated at 0.57 (SD = 0.03), while the post-control average survival was 0.58 (SD = 0.01) (Table 40). This represents a small (2%) improvement in survival rates and meets the standard established above for older, fully recruited lake trout.

One of the limitations of survival estimates by year class is the limited number of year classes available for the post-control data set. The analysis by netting-year increases the number of data points in the post-control data set. However, it is apparent that there is highly variable survival from stocking to age 3, as the numbers caught at age 3 vary widely even after being adjusted for stocking levels and netting effort (Table 40). This highly variable early (post stocking to age 3) survival precludes the use of a single year's netting results to construct a catch-curve to estimate survival, as the assumption of equal survival rates between cohorts is violated. However, age 3 fish were weighed to a uniform number (Everhart and Youngs 1981) and, using the same adjustment factor for that same year class through time, expanded or decreased each year class for each year's netting results. These corrected data were then used to run survival estimates as a check on estimates derived from the year-class analyses. Results were similar (Table 41), with average age 3 - 4 survival rates estimated at 0.35 (SD = .07) for the pre-control period (1982 - 1990) and at 0.43 (SD = .06) for the post-control (1991-1997) period. Before rounding, these results led to calculation of a 24% increase in survival rate over the pre-control period, a value just below the evaluation standard's success threshold of 25% . Use of this technique served as a check on the year-class method that did meet the evaluation standard's minimum requirement for success. The similar values generated, as well as the statistical significance ($P = 0.021$) of the improvement in survival rate noted via the netting-year method, support the idea that a substantial and real increase occurred, thus allowing the standard to be deemed achieved.

Results by netting year revealed the average survival for age 3-6 lake trout (Table 41) in the pre-control period ('85-'90) was .47 versus .51 in the post-control period ('91-'97), a 9% improvement over the baseline period, similar to the 10% increase observed for the analysis by year-class. The greatest difference between the year-class and netting year survival estimates was in the age 5-9 lake trout. In the netting year estimate, the pre-control ('86-'90) average survival was estimated at .51, while the post control ('91-'97) estimate was .59, a 16% improvement over the baseline period, versus the 2% improvement observed in the year-class analysis. All post-control average survivals were significantly higher than pre-control averages in all age group comparisons (maximum $P = 0.037$) in the netting year analysis (Table 41).

3. Mortality/Survival Rates from Angling

No Standard: ***Engstrom-Heg et al. (1990) established no survival/mortality rate evaluation standards as derived from angling data. Their purpose was to provide a check on estimates derived from gill netting data.***

a. Survival Rates from Angler Diary Data

Angler diary data provided another source of potential survival information. A salmonid angler diary cooperator program was begun on Lake Champlain in 1971. The cooperators maintained records of their fishing trips for trout and salmon on the lake and its tributaries, and returned their diaries by mail at the end of the fishing year. While the program began in 1971, only records from 1987 to the present were available in computerized format, and so only those years were included in these analyses.

One of the problems with angler diary information is that anglers may miss or misidentify fin clips that professionals would not. Cooperators may miss one part of a double clip, recording, for example, an LV-AD mark as LV. They may overlook a clip entirely, especially the AD, and may record right for left or vice-versa on occasion. These scenarios are confirmed by a comparison of gill netting and angler diary data for each year. The percentage of "no clip" fish in the diary data is consistently much higher than in the gill netting data each year. Nonetheless, angler diary data were used to build catch curves by year as a check against survival estimates made from gill netting data. Diary data were sorted by length and mark. Length/fin-clip-at-age criteria established from gill netting data were used to assign ages to the diary data set. Length-at-clip data that did not correspond to gill netting data were eliminated from the set, as it was not always clear based on length alone, what a more likely clip would be. No attempt was made to assign ages to lake trout recorded as "no clip". Only lake trout that came from lake trout targeted trips were used, and only trips that had recorded fishing effort were used. Generally, these criteria resulted in elimination of about two thirds of the available lake trout numbers. After correcting the numbers for fishing effort and stocking levels of Finger Lakes strain, the Chapman-Robson estimator was used to estimate survival across year classes within a fishing year. Full recruitment to the fishery appeared to occur at age 5 in most years, and so only age 5 - 9 survival estimates were done. Results were fairly close in most post-control years to those estimates from gill netting data. There was, however, a general tendency for diary estimates to be lower than gill net estimates, especially for the pre-control period. There may be a tendency for lower survival estimates from angler diary data in general, as fin regeneration may become more complete with time. This may result in anglers reporting a progressively higher percentage of these older ages as "no clip", as regeneration of clipped fins increases. The numbers in the diary data set were much more variable than in the gill netting data, and so a greater degree of confidence seems warranted in the survival estimates derived from the gill netting data.

b. Survival Estimates from Creel Survey Data

Individual catch curves (Ricker 1975) were constructed from lake trout checked in creel surveys from 1986 through 1997 for comparison with gill net and diary data. Ages were assigned by fin clip and length frequency analysis. Frequency of each year class was corrected to adjust for marked yearling equivalent stocking numbers and the model assumes constant early age mortality. Gill netting data indicated this assumption was not true, however the model requiring this assumption is the only one that could be used with the available data set. Unmarked fish, (ranged from 0 to 11% of each sample), and unmarked lots of fish (stocked in 1984 and 1988) were excluded from the analysis. In addition, 1990 through 1997 samples were corrected for Finger Lakes strain (including Champlain and L. Ontario Wild) equivalents stocked; there were excessive overlaps of marks in the earlier year classes to adjust reliably for Finger Lakes stocking in the pre-1990 survey samples. In contrast to the angler diary data, lake trout were not fully recruited to the creel census-monitored sport fishery until age 6, so for this data set, mortality rates were estimated from the log-linear slope of the catch curve for ages 6-9. This difference in recruitment to the fishery likely results from the angler diary data being comprised of all lake trout caught, while the creel survey samples consisted of only harvested fish.

Only the 1990 open water, 1997 open water and 1997 winter creel surveys yielded significant estimates of total instantaneous mortality for age 6-9 lake trout (log-linear slope of the catch curve not equal to zero; $P < 0.05$). Other creel surveys did not yield sufficient sample sizes of lake trout to obtain meaningful results. When corrected for Finger Lakes strain stocking, estimated annual mortality declined from 0.79 in 1990 to between 0.30 and 0.39 in 1997 (Table 42).

The 1997 open water estimate was in fairly good agreement with the estimates derived from gill netting and angler diary data in 1997. However, the 1990 open water survival estimate was considerably lower than the estimates derived from gill netting and diary data. Small sample size and relative uncertainty in age determination caused by fin clip overlap in the age 8-10 cohorts may have been factors contributing to the difference observed in the 1990 estimates. Violation of the assumption of equal recruitment to the fishery or variations in catchability may also account for some of the difference in the 1990 estimate.

c. Fishing Mortality

No Standard: ***Engstrom-Heg et al. (1990) established no fishing mortality evaluation standards. However, fishing mortality estimates can allow for estimates of the fishing and natural components of total mortality.***

Tags observed on harvested lake trout in 1990, 1991 and 1997 creel surveys allowed for fishing mortality estimates. Annual exploitation rates were calculated as the expanded number of tagged fish in the estimated harvest divided by the number of fish tagged the previous year (Engstrom-Heg et al. 1990). Estimated exploitation rates remained fairly constant over the period, ranging from 0.08 in 1991 to 0.11 in 1997 (Table 43). There is concern that observed exploitation rates may be underestimated due to tag loss. Tag loss is known to occur in Lake Champlain lake trout but its magnitude has not been measured. Fabrizio et al. (1996) estimated that lake trout in Lake Superior tagged with Floy anchor tags (same tag used in Lake Champlain) lost them at an annual rate of 26%. Using this rate as a reasonable surrogate, exploitation rates increased to the range of 0.11 to 0.14 (Table 43).

Angler tag reporting rates were also estimated by dividing the actual number of tags reported by anglers (not observed in creel survey) from within the creel survey area and period each year by the estimate of tagged lake trout in the harvest. Reporting rates varied from 0.15 to 0.32 in the 3 years with data; however, reporting rates were nearly identical in the two lakewide survey years of 1990 and 1997 (Table 43). The lower rate in 1991 may possibly be a function of the creel survey covering only a smaller portion of the lake trout fishery areas, with resulting smaller sample size.

4. Catch per Unit of Effort Outside Zones 3A and 3B

a. Standard 1: ***A reduction in natural mortality of younger age classes of lamprey-vulnerable lake trout, as indicated by significantly increased gill net catch per unit of effort in areas outside of Zones 3A and 3B.***

Increased numbers of lake trout would allow the expansion of fishable lake trout populations into suitable habitat outside zones 3A and 3B, especially in zone 4. Gill net CPUE through time shows a general increase (Figure 17). Netting years 1982 through 1990 comprised the pre-control period, and the post-control data set was defined as 1991 through 1997. The average number of lake trout per net lift during the pre-control period was 1.77 (SD = 2.69), while the average post-control lake trout catch per net lift was 3.97 (SD = 4.63). A t-test was conducted on the pre-control versus post-control data. Catch per net lift increased significantly in the post-control period ($P = 0.000$). Results indicate this evaluation standard was met.

5. Growth

No Standard: ***Engstrom-Heg et al. (1990) established no evaluation standard for lake trout growth. Growth data were collected as part of the gill netting assessment and are presented here for general reference.***

Length-at-age data for Lake Champlain lake trout (Table 44) show generally good growth rates both before and after sea lamprey control, and are comparable to those in Plosila and Anderson (1985). There is a general trend of slightly decreasing length at age for most ages, however post-control average lengths at age still far exceed those of Finger Lakes strain lake trout in Seneca Lake (Engstrom-Heg and Kosowski 1990).

6. Salmonid Wounding Analysis

The sea lamprey control program will be considered effective at the biological level for lake trout if the following series of events is confirmed:

a. Standard 1: ***A reduction occurs in the number of parasitic lamprey wounds (Stages I-III) per hundred lake trout for a pooled population, or for a given age or size class. The post-treatment mean value must differ significantly at the 5% level*** **[$P \leq 0.05$]** ***from the baseline (1982 through 1991). Means for the post treatment years and the baseline need to be adjusted for the estimated relative number of vulnerable lake trout in the lake for each year.***

b. Standard 2: ***A corresponding decrease occurs in accumulated lamprey scars (Stage IV) for given age classes.***

The number of sea lamprey wounds and scars on salmonids measured in the eight year experimental program and in previous years helped determine improvements in quality of salmonids. A classification of wounds based on stages of healing is presented in Appendix H.

Sea lamprey wounding rates on lake trout were examined during gill-net sampling conducted by New York and Vermont fisheries personnel during 1982-1997 (Figures 18, 19 and 20 and Table 45). No attempt was made in this initial analysis to adjust for the relative number of lamprey-vulnerable lake trout in the lake each year due to highly variable and undeterminable survival rates prior to age 3, when they first became fully vulnerable to gill netting.

Prior to sea lamprey control, scars per 100 fish were high and variable (Figures 18 and 19). In theory, a reduction in wounds and scars attributed to sea lamprey control would not occur until 1991, at the earliest, after the first set of treatments in 1990. In 1991, sea lamprey wounding rates by lake trout size classes decreased in the three smallest size classes, and decreased for all size classes beginning in 1992 (Figure 18). After 1992, wounding rates were variable, but generally remained below pre-treatment levels. Scarring rates examined by lake trout size classes exhibited a trend similar to wounding rates (Figure 18), but with a one year delay. With all lake trout size classes combined (Figure 19), wounding rates decreased noticeably in 1992. Since then they have remained variable, but generally below pre-treatment levels. Scarring rates for all lake trout size classes combined also decreased markedly, but not until 1993. They have continued to exhibit a decreasing trend (Figure 19).

An independent samples t-test was performed for wounds per lake trout and attacks per lake trout for each size class and for all size classes combined for pooled pre-treatment (1982 - 1991) and post-treatment (1992 - 1997) samples (Table 46). The analyses for both scars and wounds per 100 lake trout for each of the five different size classes detected a significant decrease in the average number of wounds and scars in all size classes; < 432 mm, 433 - 532 mm, 533 - 633 mm, 634 - 736 mm, and 737 - 837 mm (maximum $P < 0.001$) (Table 46). A significant decrease in both wounds and scars also occurred when all size classes were combined (maximum $P = 0.022$) (Table 46).

Engstrom-Heg et al. (1990) recommended adjusting the wounding and scarring rates on lake trout for the relative number of lamprey-vulnerable lake trout in the lake each year. Because of the highly variable recruitment to the gill nets as age 3 fish, actual population estimates for each year’s netting were not possible. However, the average catch per net lift each year was used as a relative index or adjustment factor for population size. Each fish’s scars and wounds were multiplied by that year’s average zone 3A/3B CPUE (after adjusting for the high CPUE in 1984 and 1996) and then independent samples t-tests were conducted on the resulting scarring and wounding in each of the five size groups as in Table 46. Results (Table 47) indicate significant post-control reductions in wounding in the three smallest size classes. The same trend was evident for scarring. Of course, for this analysis to be truly meaningful the pre- and post-control periods would have to be identical except for the presence of sea lamprey control treatments. This is clearly not the case, as the lake trout population was likely building through this entire period. In addition, the earlier years (early 1980's) had a greater percentage of non-Finger Lakes strain lake trout, which are known to perform more poorly in the face of sea lamprey predation/parasitism (Schneider et al. 1996). In addition, it may be that the sea lamprey population had also increased during the pre-control period. Nest count data (Figure 9) demonstrate a possible increase in lamprey numbers in the late 1980's when the numbers of nests peaked during 1988 through 1991. Even if the sea lamprey population during the entire pre-control period was stable, the lake trout population certainly was not, and changes in sea lamprey behavior would be expected as a result of the changing prey-base. When salmonid numbers are relatively low, lamprey theoretically increase the duration, and presumably, the lethality of their attacks (Kitchell and Breck 1980). This results in depensatory lamprey-induced mortality, which increases disproportionately as the ratio of salmonids to lampreys decreases. As the salmonid/lamprey ratio increases, lamprey shift their foraging strategy to larger fish and shorter but more frequent attacks. Thus, wounding and scarring rates in the early 1980's would tend to be under-reported, since many of the smaller lake trout attacked would succumb to their lamprey wounds and thus not be available for capture in the gill nets. Higher rates of mortality on younger (and smaller) lake trout observed prior to sea lamprey control support this contention. The same would presumably be true for even larger non-Finger Lakes strain lake trout, which cannot sustain lamprey attacks at the same level as Finger Lakes strain fish, and/or are simply exposed to a greater probability of lamprey attack because of a differential temperature or habitat preference (Schneider et al. 1996). After sea lamprey control, when the sea lamprey population was suppressed and the lake trout population was also increasing, a shift to more frequent but less lethal attacks and a shift to larger salmonids would be expected. This shift towards more frequent attacks on larger fish would also tend to under-estimate the true impact of control. There is evidence of these shifts in the wounding data, and a shift towards lower wounding rates on the two smallest size classes of lake trout had begun even before sea lamprey control started in 1990 (Figure 18).

Sea lamprey wounding rates on lake trout, rainbow trout, brown trout, and landlocked salmon for each Lake Champlain management zone in which data were collected are presented in Appendix I. Overall, sea lamprey wounds were variable prior to control, rising gradually until 1992. Wounding decreased after 1992, but increased during 1996 and 1997. Each parameter for measuring sea lamprey wounding rates (i.e. wounds/100 fish, % fish w/attacks) is consistent in trends and among zones.

7. The Lake Trout Fishery

At the level of lake trout fishery value, the program is to be considered successful for lake trout if it is biologically effective, as described above, and if there are separable increases equal to or exceeding the following:

a. Standard 1: ***An increase of 25% or greater in number of lake trout with no reduction in average weight harvested; or***

b. Standard 2: ***An increase of 25% or greater in average weight of lake trout harvested; or***

c. Standard 3: ***An increase of 25% or greater in number of lake trout over 25 inches harvested as indicated by creel census and diary data.***

Creel Surveys

The lake trout fishery was assessed with open-water and winter creel surveys from 1990 through 1997 (Chipman 1999, Durfey 1997). Lake trout fishery-level evaluation Standards 1 and 3 were met and exceeded based on data from the 1990 and 1997 lakewide open water creel surveys (Table 48). Total catch (both released and harvested fish) of lake trout increased 76%, from an estimated 23,345 in 1990 to 41,162 in 1997, while average weight of harvested lake trout increased by 7%, exceeding the requirements of Standard 1. The proportion of examined lake trout in the harvest greater than 25" in total length increased 42%, from 20.0% in 1990 to 28.3% in 1997. The expansion of these proportions to their respective estimated harvests produced a 50% increase (Table 48); both results exceed the requirement for Standard 3.

Open water creel surveys rotated through four sections of Lake Champlain during the years between 1990 and 1997. Estimates from Zone 3A and 3B, where the lake trout fishery is most concentrated, show a strong increasing trend in catch and harvest through the period (Table 49).

In contrast, the increasing trend was not consistent in winter creel surveys conducted from 1991 through 1997 in Zones 2 and 4, where the most ice fishing occurs. Estimated ice-fishing catch increased dramatically in 1997 compared with 1991 on the New York side of Zone 2, and on the Vermont side of Zone 4; however, winter results in Vermont waters of Zone 2 varied widely (Table 50). This variability appears to be closely related to ice conditions, which regulate access to ice fishing. For example, the largest estimated catch on the Vermont side of Zone 2 occurred 1992, which was the only winter in the period with complete safe ice cover for the duration of the survey.

Angler Diary Lake Trout Catches

Angler diary cooperators returned their completed diaries at the end of each year's fishing season. Beginning in 1987, the information was entered into a computerized database. As a result the data presented here cover the period from 1987 to 1997. Because lake trout are not fully recruited to the fishery until Age 5 at the earliest, the pre-control period is defined here as 1987 through 1992, while the post-control period begins in 1993, three years after the initial sea lamprey control treatment. The number of angler diary cooperators varied from year to year, as did the amount of fishing effort expended by individual cooperators. Therefore, it was deemed most appropriate to look at catch rates as an index of the fishery. Also, because of a strong catch-and-release ethic among angler diary cooperators, the catch statistic was deemed most appropriate, where catch includes both harvested and released fish.

Angler diary catch rates (including harvested and released fish) for legal-sized lake trout show some improvement during 1987 through 1990, and then a relative stabilization for three years (Figure 21). During the post-control period, catch rates of legal-sized lake trout improved dramatically. Total catch rates of all lake trout and for lake trout larger than 25" also show similar trends (Table 51). An independent samples t-test resulted in significance levels for the two test statistics of 0.001 and 0.002 when comparing pre- and post-control mean catch rates. The post-control catch rate of lake trout greater than 25" represents a 126% increase over the baseline pre-control period, exceeding the 25% increase of Standard 3 above.

B. Landlocked Salmon

Abstract

Sea lamprey wounding rate reductions met pre-defined evaluation standards for landlocked salmon in the Main Lake basin, but not for the Inland Sea/Malletts Bay basins. Post-treatment (1993-98) wounding rate declines ranged from 40 to 74 percent for three size groups of salmon returning to the Willsboro Fishway (Boquet River); wounding rates declined 42 percent for harvested salmon checked during the 1997 Main Lake creel survey from 1990 rates. Wounding rates from Sandbar Bridge (Inland Sea) and Lamoille River (Malletts Bay) electrofishing samples did not show significant declines in any size groups, however.

Improved survival of adult salmon was evident from increased numbers returning to Main Lake tributaries. The median annual number of 1-lake-year and 2-lake-year salmon captured at the Willsboro Fishway increased from 5 to 29 and 1 to 8.5, respectively, in the post-treatment period. Concurrently, the total number of returning 3-lake-year salmon increased substantially, from 1 in the 8 years prior to 1993 to 15 in the 1993-98 period. Improvements were also found in Saranac River fall creel survey results in 1996 versus 1991, with a doubling in estimated numbers of 1-lake-year fish caught, from 80 to 157. Greater gains were estimated in 2- to 4-lake-year fish caught from the Saranac; estimated catch of 2-lake-year salmon increased from 16 to 77, and 3-lake-year catch increased from 8 to 33, while three 4-lake-year fish were caught in 1996 compared with none in 1991. These results exceeded the evaluation standard calling for at least a doubling of multiple lake-year salmon returning. Results of returns to the Lamoille River were ambiguous, due in part to river flow fluctuations exacerbated by hydropower-related manipulations, and did not meet the standard.

Little change in age-specific length or condition factors was found for landlocked salmon sampled throughout Lake Champlain, meeting the evaluation standard requiring no reduction of

more than 10% for these parameters. Condition factors from Main Lake creel surveys showed substantial annual variation in pre-treatment years (1990-92), making pre- and post-treatment comparisons difficult in this case.

Pre-defined evaluation standards were also met or exceeded for Main Lake landlocked salmon at the fishery level. The post-treatment Main Lake tributary catch per equivalent smolt stocked, estimated by fall Saranac River creel surveys, increased 3.2 times, from 0.011 % in 1991 to 0.035 % in 1996; the in-lake fishery responded similarly, from 0.52 % in 1990 to 1.63 % in 1997, a 3.1-fold increase, exceeding the standard of at least a doubling in catch per equivalent smolt. Little change was found in post-treatment catch per stocked smolt for the Inland Sea and Malletts Bay salmon fisheries. Clear shifts to greater proportions of 2-lake-year and older salmon were evident in the tributary catch from fall Saranac River creel surveys and angler cooperator diary data. A shift to larger, older salmon is also present, although not as pronounced, for Main Lake catches recorded in creel surveys and in the angler diary program.

1. Biological Level

a. Standard 1: *A significant reduction at the 5% level* [$P \leq 0.05$] *in the number of adult lamprey wounds per hundred fish for pooled Boquet river and/or Malletts Bay-Sandbar samples, or for age or size classes within these samples after both have been adjusted for estimated numbers of lamprey-vulnerable salmonids in the lake.*

Biological Standard 1 was assessed using lamprey wounding data for fall-run salmon collected at the Boquet River Willsboro Fishway from 1985 to 1998, and at Lamoille River and Sandbar Bridge by electrofishing from 1987 to 1997. Data from each site were pooled into pre-control (1992 and earlier) and post-control (1993 and later) periods. Additional wounding data were analyzed from angler-caught salmon examined in Main Lake open water creel surveys in 1990 and 1997. Sample sizes from other sampling efforts were generally too small to yield meaningful results. Lamprey wounding rates tend to be positively correlated with salmon size, so wounding rates were analyzed by size class.

For the Boquet River samples, the mean number of wounds per 100 fish decreased by 57, 40 and 74 percent respectively for the three size groups of salmon collected, and the differences were significant at the 5 percent level (Table 52).

Wounding rates of harvested salmon measured during Main Lake open water creel surveys in 1990 and 1997 showed a reduction similar to those observed from the Boquet River (Table 53). For the Main Lake creel survey samples, the mean number of wounds per 100 fish decreased by 53, 40, and 72 percent respectively for the three size groups of salmon collected. Although there was a reduction for the smallest two size classes the differences were not significant at the 5 percent level ($P = 0.255$ and $P = 0.10$, respectively). The wound rate in Main Lake creel sample declined for all sizes of salmon pooled together ($P = 0.024$) (Table 53).

The wound-reduction standard recommended adjusting attack rates for the estimated numbers of lamprey-vulnerable salmonids, with the intent of avoiding a mathematical decrease in attack rates resulting simply from increased stocking. Theoretically, an increase in the salmonid stocking rate with a constant number of lamprey attacks would reduce the number of attacks per salmonid. Table 54 lists the numbers of salmonid equivalents stocked in the Main Lake from 1983 to 1997. Mean number stocked for the period 1983 to 1991 and the period 1992 to 1997 provide a rough index for the pre- and post-control periods used in the analysis (there is a delay between stocking and when the salmonids become vulnerable to lamprey, thus the pre- and post-stocking years are earlier than the pre- and post- return years). The mean number of equivalents stocked was 6 percent greater in the pre-control period than the post-control period. Therefore, the substantial decline in lamprey attack rates was not an artifact of increased stocking; based only on stocking rates, a slight increase in attack rates would have been expected. The 6 percent difference is a rough estimate because the delay between stocking and vulnerability to lamprey is highly variable between species and size at stocking, and there is a carry-over effect as salmonids remain vulnerable for multiple years, especially lake trout. Given the very approximate nature of the stocking index, the above analysis of attack rates was not adjusted for the reduced stocking. This standard was met without the adjustment; the adjustment would have increased the statistical significance, but at the expense of introducing a variable that should be considered to be very approximate.

Following the above discussion, total equivalents stocked in the Inland Sea and Malletts Bay may serve as a better index for numbers of lamprey-vulnerable salmonids than in the Main Lake since long-lived lake trout are not stocked in these basins. Annual numbers of salmonid yearling equivalents stocked in the Inland Sea increased 5 percent in the 1991-96 post-control period (Table 55). Malletts Bay stockings increased by 8 percent (Table 56). Wounding rates were adjusted by these percentages in the Sandbar Bridge (Inland Sea) and Lamoille River (Malletts Bay) electrofishing samples.

For the Lamoille River samples that were adjusted for stocked rates, the mean number of wounds per 100 fish increased for the <432 mm, 432 - 532 mm, and 635 - 736 mm size classes by 123%, 75%, and 47%, respectively (Table 57). Mean number of wounds per 100 fish decreased for the 533 - 634 mm size class by 14%; however, the reduction in wounds was not significant
(*P* = 0.122). Similarly, wounds per 100 fish that were not adjusted for stocking rates increased for the <432 mm, 432 - 532 mm, and 635 - 736 mm size classes by 92%, 44% and 26%. Mean number of wounds per 100 fish for the 533 - 634 mm size class decreased significantly by 27% (*P* = 0.011).

For the Sandbar Bridge samples that were adjusted for stocking rates, the mean number of wounds per 100 fish increased for the <432 mm and 533 - 634 mm size classes by 120 and 10% (Table 58). Mean number of wounds per 100 fish decreased for 432 - 532 and 635 - 736 mm size classes by 19% and 24%; however the reductions in wounds were not significant
(*P* = 0.12, *P* = 0.169). Similarly, wounds per 100 fish that were not adjusted for stocking rates increased for the <432 mm and 533 - 634 mm size classes by 120% and 17%. Mean number of wounds per 100 fish decreased for 432 - 532 and 635 - 736 mm size classes by 12% and 19%. As with the adjusted rates the reductions were not significant (*P* = 0.203, *P* = 0.22).

The Lamoille River and Sandbar results suggest that wounding rates on landlocked salmon have not declined in Malletts Bay or the Inland Sea over the post-control period (does not meet criteria of Standard 1). These rates appear to be similar to or higher than 1984 levels (Plosila and Anderson 1985). Lack of treatment in Malletts Bay (Indian Brook/Malletts Creek) and recent growth in sea lamprey production from the Pike River, Quebec (Gersmehl 1994) may be limiting the impact of sea lamprey control in these basins.

b. Standard 2: ***A doubling of the number of 1-lake-year salmon returning to the Boquet, Saranac and Lamoille Rivers, followed in succeeding years by at least a doubling of numbers of 2- and 3-lake-year fish.***

Standard 2 was assessed from fall salmon returns to the Boquet River at the Willsboro Fishway, Saranac River fall 1991 and 1996 creel survey results, and fall electrofishing samples from the Lamoille River and Sandbar Bridge.

This standard was essentially met, or greatly exceeded at the Boquet River. The number of 1-lake-year returning salmon tripled, from a pre-control mean of 10.3 per year to 31.5 per year post-control (Table 59). Medians are a statistic considered preferable to means for data sets where one or a few extreme values could skew the data. The median number of 1-lake-year returns increased about six-fold, from 5.0 to 29.0 returns per year (Table 59). Pre-control returns of 1-lake-year salmon ranged from 0 to 35, in contrast to post-control returns ranging from 5 to 69 salmon per year (Table 60).

Mean annual returns of 2-lake-year salmon increased slightly, from 7.0 pre-control to 8.0 post-control; however, the median increase was substantial, from 1.0 per year pre-control to 8.5 per year post-control (Table 59). An analysis by year shows that an abundant return of 46 two-lake-year salmon in 1987 skewed the mean for the pre-control value (Table 60). The pre-control situation of one good year with seven very poor years causes the small increase in mean values to understate the improvement that occurred; the large increase in the median more accurately represents the significance of the improvement with control.

The number of three-lake-year salmon returning to the Willsboro fishway increased from one in the 8-year pre-control period to 15 in the 5 years following control; median numbers per year increased from 0.0 to 0.5 (Table 59). That differential would be increased by considering the time delay between control and production of 3-lake-year salmon. That is, 1993 returns were included in the post-control analysis, but 3-lake-year salmon in 1993 would have become vulnerable to lamprey attack early in 1991 when lamprey abundance was still relatively high. Thus, improvements in abundance of 3-lake-year salmon would not be expected until 1994, and indeed, that is when abundance increased (Table 60).

Returns to the Saranac River were estimated from angler-caught salmon in fall creel surveys in 1991 and 1996 (Durfey 1999). The number of harvested 1-lake-year salmon examined by creel clerks increased from four in 1991 to 23 in 1996. The number of 2-lake-year salmon sampled increased from none to one. There were no 3-lake-year salmon in the sample. However, there is a strong catch-and-release ethic among Saranac River anglers; thus limiting the number of fish actually observed by creel clerks. Therefore, ages were assigned to all salmon reported caught (both kept and released) by interviewed anglers by applying length-at-age and associated standard deviation estimates from combined 1993-96 fall nearshore electrofishing samples (Nettles 1996) to the length frequency distribution of the creel sample. The resulting age distribution percentages, multiplied by the estimated total catch, demonstrate a more than doubling of the numbers of each multiple lake-year class from fall 1991 to fall 1996 in the Saranac River. Estimated numbers of 1-lake-year fish caught nearly doubled, from 80 to 157 from 1991 to 1996 (Table 61). Greater gains were realized in 2- to 4-lake-year fish caught from the Saranac; estimated catch of 2-lake-year salmon increased from 16 to 77, and 3-lake-year catch increased from 8 to 33, while three 4-lake-year fish were caught in 1996 compared with none in 1991.

Lamoille River electrofishing results did not exhibit the clear post-control gains shown in the Boquet and Saranac Rivers. The mean number of 1-lake-year salmon collected per year post-control (1993-1997) increased by 73% (37.3 to 64.6) but the median value declined to half of pre-control (1987-1992) levels, from 28.5 to 14 (Table 62). Little change was apparent for 2-lake year salmon, but the median annual number of 3-lake-year specimens increased more than 3-fold, from 1.5 to 5 per year; no 4-lake-year or older salmon were present in the pre-control sample while two were present in the post-control sample (Table 62).

Annual numbers of salmon collected in the Lamoille varied more widely in the post-control period than in the pre-control period, from a high of 320 in 1993 to only 2 in 1996 (Table 63). It should be noted that sampling effort varied from year to year, and sampling conditions and resulting catchability undoubtedly varied within and between years (Statistical evaluation of this variability was not attempted, and would be problematic.). A major factor in this variation, however, appears to relate to fall river flows. A general trend is evident between annual numbers of salmon collected and September-October combined median flows measured at the USGS East Georgia gaging station from 1992 through 1997, but not prior to 1992 (Figure 22). The lower flow years were further exacerbated by alteration of peak power generation regimes in the 1990s at three dams between the East Georgia gage and Lake Champlain, which may have disrupted salmon migratory patterns into the sampling area. This was particularly evident in 1995, 1996 and 1997 when visual observations of generation patterns at Peterson Dam (the first upstream barrier on the Lamoille River) during electrofishing sampling periods often revealed greatly reduced flows. The periods of extreme low flows below Peterson Dam have confounded the evaluation of lamprey control impacts on salmon returns to the Lamoille River.

Landlocked salmon were also sampled by electrofishing at the Sandbar Bridge where lake currents simulate riverine conditions and attract spawning salmon. Returns to Sandbar may be more representative of actual changes in the Malletts Bay and Inland Sea salmon populations than Lamoille River returns, due to the absence of major river flow fluctuations. Post-control median annual numbers of 1-lake-year salmon collected at Sandbar increased 3.5-fold, from 21 to 74 per year, exceeding the 1-lake-year criterion of Standard 2; however, little change was detected for numbers of 2-lake-year or 3-lake-year fish (Table 64). Further, the number of 4-lake-year or older salmon in the Sandbar samples increased from none pre-control to 3 post-control (Table 64). The trend in numbers collected from year to year at Sandbar (Table 65) was similar to that for the Lamoille, but the magnitude of variation was not as great.

This analysis indicates that Biological Standard 2 was met and exceeded for the Main Lake landlocked salmon population based on returns to the Boquet and Saranac Rivers. This standard was only partially met for the Inland Sea and Malletts Bay based on returns to the Sandbar Bridge. Lamoille River returns were confounded by extreme hydropower-related flow alterations during the post-control period.

c. Standard 3: *No reduction of over 10% in either mean age-specific length or condition factor.*

Landlocked salmon returns to the Willsboro Fishway indicated that neither condition factor nor age-specific mean length were reduced by 10%. Mean lengths were essentially unchanged for 1-lake-year salmon, were reduced by 3 percent for 2-lake-year salmon, and increased by 2 percent for 3-lake-year salmon (Table 59). Condition factors were calculated by size groups and for males only. Females are likely to have widely varying condition factors depending on how close to spawning time they were captured. Condition factors increased 1 and 2 percent for two size groups (432 - 532 mm and 533 - 634 mm, respectively) and declined by 3 percent for the third size group (635 - 736 mm)(Table 66).

Fall Lamoille River and Sandbar Bridge electrofishing samples followed the same trend. Mean length of 1-lake-year Lamoille River salmon increased 3 percent in the post-control period, while lengths of 2- and 3-lake-year fish were essentially unchanged (Table 62). Similar results were obtained at Sandbar, where lengths of 1- and 2-lake-year salmon were nearly constant and a 3% decrease was observed for 3-lake-year fish (Table 64). Weights were not recorded for salmon collected at these locations.

This standard was also met for age-specific mean length of harvested salmon examined in creel surveys in both the Main Lake and Inland Sea/Malletts Bay basins. In the Main Lake, mean lengths increased 6 percent for 1-lake-year salmon and decreased 1% for 2-lake-year salmon (Table 67). Mean lengths at age decreased from 2 to 5 percent for measured Inland Sea/Malletts Bay salmon (Table 68).

Condition factors from creel survey salmon samples, and available data from salmon entered in the Lake Champlain International Fishing Derby (held annually in mid-June), showed mixed results in regards to Standard 3. Main lake creel survey condition factors in 1997 for salmon <432 mm and 432 to 532 mm were 33 and 20 percent less, respectively, than in 1990; however, 1997 condition factors were more similar to 1991 and 1992 samples, and 1990 values similar to those in 1994 through 1996; fishing derby condition factors showed a similar trend (Table 69). Given the year to year variation in both pre-and post-treatment years, it appears that factors other than sea lamprey control apparently affected Main Lake creel survey sample condition factors. In contrast, condition factors from 1997 Inland Sea/Malletts Bay creel survey samples increased between 7 and 14 percent from 1990 levels (Table 70).

These results indicate that mean age-specific lengths and condition factors of landlocked salmon did not show consistent reductions of 10% or more through the post-control period, thus meeting the criteria of Standard 3.

2. Fishery Level

a. Standard 1: *At least a doubling of total Main Lake tributary catch per equivalent smolt stocked*.

Saranac River creel surveys were conducted in spring and fall 1991 (pre-control) and in fall 1996 and spring 1997 (post-control) to address Fishery Standard 1 (Durfey 1999). Rate of return was calculated as the estimated catch of legal-sized salmon in the river divided by the total number of smolt equivalents stocked over the four years prior to the year of each creel survey. While conversion of different sizes of stocked salmon to smolt equivalents attempts to correct for differential survival of the younger, smaller fish, (particularly fry stocked in tributaries) it does not accommodate the additional time required for these fish to reach the fishery. To correct for this bias, the number of equivalent smolts stocked as fry in a given year were added into the second year following their stocking; the resulting annual adjusted smolt equivalents are given in Table 71. Fry stocking did not occur in the Inland Sea or Malletts Bay basins, so annual smolt equivalents stocked were not adjusted there.

The estimated catch of legal-sized salmon per equivalent smolt stocked in the spring Saranac River fishery declined from a 0.056% return in 1991 to 0.018% in 1997; however, the estimated fall catch increased substantially from 1991 to 1996 and the corresponding catch per equivalent smolt stocked increased 3.2 times from 0.011% in 1991 to 0.035% in 1996, easily surpassing the requirement of Standard 1 (Table 72).

The decline in the spring catch is disappointing, but spring runs appear to be more variable and weather-dependent than fall runs. Behavioral reasons for sporadic spring runs are largely unknown, whereas spawning is the primary reason for salmon to ascend tributaries in the fall. Further, it is not uncommon for a relatively poor spring fishery in the Saranac to be followed by a strong fall fishery (Durfey 1994, 1993, 1991). Nearshore electrofishing sampling has also demonstrated that poor spring catch rates can be followed by good catch rates the following fall (Nettles 1996). This evidence indicates that the spring tributary catch is not a reliable indicator of the relative condition of the lake's salmon population and fishery.

Salmonid angler diary cooperator data were pooled into pre-control (1987-1992) and post-control (1993-97) periods (Durfey 1999b). Mean fall catch rates of legal-sized salmon in Lake Champlain tributaries nearly doubled in the post-control period (Table 73), supporting the returns estimated for the Saranac River creel surveys and achievement of Fishery Standard 1.

Engstrom-Heg et al. (1990) recommended factoring lake salmon catch into the analysis in addition to tributary catch if a substantial lake fishery developed. Estimated salmon returns from the Main Lake open water fishery show a similar trend (Chipman 1999). Lake catch per equivalent smolt stocked was calculated using the adjusted total number of smolt equivalents stocked three years previous to each creel survey instead of four years, because verified or suspected 4 lake-year salmon were non-existent in open lake fishery. Estimated total catch of salmon more than doubled in the Main Lake, from 3,790 in 1990 to 8,496 in 1997; percent return per equivalent smolt stocked increased 3.1 times, from 0.52% in 1990 to 1.63% in 1997 (Table 74), nearly identical to the fall Saranac River return, and again easily surpassing the requirement of fishery Standard 1.

Landlocked salmon fisheries in the Inland Sea and Malletts Bay basins showed consistently higher returns than those estimated for the Main Lake, but do not appear to have significantly benefitted from sea lamprey control. Slight increases in estimated catch and percent return per equivalent smolt stocked were evident from 1990 to 1997, but the confidence intervals overlap (Table 74). These return rates are within the range of, or slightly higher than, returns estimated in 1982 and 1983 (Plosila and Anderson 1985). Direct comparisons are difficult because only harvested salmon were estimated in the 1982 and 1983 creel surveys, whereas 1990 and 1997 returns were based on total catch (harvested and released). Like the biological measures, the fishery results reflect the lower level of lamprey control achieved in these basins. The evaluation plan recognized that the above standards may not be applicable to the Inland Sea and Malletts Bay (Engstrom-Heg et al. 1990).

b. Standard 2: *A progressive increase in the proportion of older fish in the tributary catch after the initial increase in age 3+ (2-lake year) fish.*

The criteria for Standard 2 appear to have been met from fall Saranac River creel survey, angler cooperator diary, and Main Lake creel survey results. No 2-lake-year salmon were examined by creel clerks in the fall 1991 Saranac survey and one 2-lake-year fish was recorded in fall 1996 (Table 75). A clear shift to larger and presumably older salmon was more evident in the length distribution of all salmon caught (including those released by interviewed anglers) in the Saranac River fall fishery. From 1991 to 1997, numbers of legal-sized salmon recorded in all length classes increased, with the greatest shifts occurring in the larger, presumably older age groups (Figure 23). Further, salmon from 65 to 76 cm (likely 3 lake-year or older) were recorded in the 1996 fall catch, but were nonexistent in 1991 (Figure 23). Similar increases in larger, older salmon were evident in the length distributions of fish caught by angler diary cooperators from the pre-control (1987-92) to post-control (1993-97) period (Figure 24). A shift to larger, older salmon was also present, although not as pronounced, in Main Lake catches recorded in creel surveys (Table 76 and Figure 25) and the diary cooperator program (Figure 26).

c. Standard 3: *There is no serious negative impact on rainbow smelt population dynamics attributable to increased landlocked salmon predation that could not be compensated for by decreased stocking.*

Conclusions of a bioenergetics modeling study for top predators (salmonids and walleye) in Lake Champlain did not indicate that expected improvements in salmon survival following sea lamprey control would result in a serious negative impact on rainbow smelt populations (LaBar and Parrish 1995). The authors found that under the worst-case scenario of maximum predator population sizes or stocking rates, maximum growth rates and minimum mortality rates, the highest estimated total consumption of adult rainbow smelt would be 27% of the mean 1990-94 standing crop, and that reducing salmon (and brown and rainbow trout) stocking would be the best way to effect rapid change in consumption rates should future consumption rates be determined to seriously impact the smelt population, supporting a positive determination that Standard 3 was achieved. In light of these results and salmonid consumption studies from other waters, the Cooperative decided to reduce the risk of potential negative impacts in the future and reduced total annual Main Lake salmonid stocking rate objectives from 608,000 to 400,000 yearling/smolt equivalents, beginning in 1995 (Fisheries Technical Committee 1995).

C. Steelhead Rainbow Trout

Abstract

Evaluation criteria established for steelhead were not met. This was partly anticipated as steelhead were stocked in the lake in small numbers, survival appeared poor and pre-control data were lacking. In addition, post-treatment sample sizes were too small and inconsistent in location or time of year for statistical testing. There is some evidence, however, that this fishery is improving. Estimated steelhead catch in the Main Lake increased from 7 fish in 1990 to 106 in 1997. Sea lamprey wounds per 100 steelhead sampled in the Winooski River decreased 83% between pre- and post-control periods.

1. Biological Level

a. Standard 1: ***A significant reduction at the 5% level* [$P \leq 0.05$] *in the number of adult lamprey wounds per hundred fish for the pooled population, or for age or size classes within these samples after both have been adjusted for estimated numbers of lamprey-vulnerable steelhead rainbow trout in the lake.***

Biological Standard 1 was assessed using lamprey wounding data for spring-run steelhead examined during creel checks in the Winooski River from 1977 to 1984 (64 fish), and at the Winooski River fish lift from 1993 to 1997 (323 fish). The number of wounds per 100 fish decreased 83% for all size classes, however, the difference could not be tested for significance because wounds per individual fish were not available for the pre-control data (Table 77 and Appendix I). Additional wounding data was obtained from fish collected by a variety of methods throughout the experimental program. However, sample sizes from these sampling efforts were generally too small to yield meaningful results.

2. Fishery Level

a. Standard 1: ***At least a doubling of the catch of age 3+ fish in the Saranac River.***

Few steelhead were observed in either the pre-control (Spring and Fall 1991) or post-control (Fall 1996 and Spring 1997) Saranac River creel surveys. Estimated post-control steelhead catches demonstrated no improvement in the Saranac River steelhead fishery (Durfey 1999) (Table 78). Therefore, the steelhead fishery in the Saranac River did not meet the evaluation standard. Table 79 lists the ages of steelhead sampled by creel clerks during the creel surveys. Steelhead performance has been disappointing on the NY side of Lake Champlain.

Poor steelhead performance may be attributable to a greater vulnerability to death from sea lamprey attack relative to the other salmonids, or due to non-lamprey factors such as strain, stocking procedures, disease history, or the habitat in Lake Champlain.

Estimated steelhead catch in the Main Lake increased from 7 fish in 1990 to 106 in 1997 (Table 80). Although the Main Lake steelhead fishery was not considered as part of the established evaluation standard for the lamprey control program, this represents an 8-fold increase in catch per stocked fish.

D. Brown Trout

Abstract

Evaluation criteria established for brown trout were not fully met or could not be adequately evaluated. This was partly anticipated as brown trout were stocked in the lake in small numbers, survival appeared poor and pre-control data were lacking. In addition, post-treatment sample sizes were too small and inconsistent in location or time of year for statistical testing. There is some evidence, however, that this fishery is improving. Brown trout catches in the Main Lake, Inland Sea and Malletts Bay all showed increases. Although there was no measured improvement in brown trout survival, length-frequency distributions of all recorded browns in both the spring and fall post-treatment Saranac River creel surveys show increased numbers of larger (and presumably older) fish. Almost half the recorded catch in 1996 was longer than the largest recorded brown in 1991.

1. Biological Level

a. Standard 1: ***A significant (5% level)* [*P* $\leq$ 0.05] *decrease in lamprey wounds per hundred fish on age 2+ and 3+ brown trout.***

Wounding data used in the attempt to assess this evaluation standard originated from brown trout sampled by bottom trawling, gill netting and creel surveys in the Main Lake and tributaries from 1975 to 1984 (35 fish) and from Main Lake electrofishing, gill netting, creel surveys and the Winooski One Fish Lift from 1993 to 1997 (259 fish). A significant reduction in wounding was not able to be determined as pre- and post- treatment sample sizes were too small and samples were not consistent in location or time of year for statistical testing (Table 81 and Appendix I).

b. Standard 2: ***An increase in estimated survival between age 2+ and 3+ brown trout.***

Nearshore electrofishing surveys failed to measure an increase in survival of brown trout. Sample sizes limited the evaluation of survival rates, although 1997 spring nearshore sampling included six age 3+ fish representing a notable increase from other comparable samples (Table 82).

Chapman-Robson survival estimates on aged brown trout in the sample of fish handled by creel clerks during the spring Saranac River creel surveys also showed no improvement between the pre- and post-treatment samples (24% in 1991 versus 22% in 1997). Too few browns were sampled in the fall surveys to estimate survival. However, length-frequency distributions of all recorded browns in both the spring and fall (Figures 27 and 28, respectively) show increased numbers of larger and probably older fish. The fall 1996 post-treatment distribution in particular shows an expanded proportion of older fish. Almost half the recorded catch in 1996 was longer than the largest recorded brown in 1991.

2. Fishery Level

a. Standard 1: *An increase in catch per fish stocked, as indicated by creel census results.*

The number of browns sampled by creel clerks in the Saranac River was low in all years. Creel survey results indicated a reduction in catch of legal-sized brown trout in spring 1997 compared with spring 1991, however spring 1997 effort was much lower than in 1991 (Table 83). Catch per unit effort (CPUE) for anglers targeting trout and/or salmon increased in spring 1997 from 1991 levels (Table 84). Fall 1996 data showed a decline in CPUE from fall 1991, as did the catch of legal-sized brown trout. Length frequency data, however, show a much improved fishery in fall 1996 in terms of quality as noted above (Figure 28).

Pre- and post-control estimated catch of brown trout per fish stocked in the Main Lake also increased from 0.43% (98 fish) in 1990 to 0.65% (236 fish) in 1997 (Table 85). However, on the Saranac River, creel surveys showed a 28% reduction in catch of legal-sized brown trout per stocked fish in the fall of 1996 and spring of 1997 compared with spring and fall 1991 (Table 86).

Evaluation of Inland Sea and Malletts Bay brown trout catch used a comparison of 1993 and 1997 creel survey results. Brown trout were not stocked in these basins in 1988 or 1989, precluding evaluation based on the 1990 creel survey. Brown trout catch per stocked fish in 1997 was greatest in the Inland Sea showing a 23 fold increase compared to the 1993 estimate (Table 87). The 1997 estimated catch of 172 fish reflects a percent return of 2.81% per stocked fish. The brown trout fishery in Malletts Bay also showed an increase in catch per number stocked, however estimated catch was only 5 fish in 1997.

It is important to note that brown trout are not abundant in the Main Lake basin, comprising only about 9.5% of the total salmonids stocked there. This accounts for their low frequency in samples. Brown trout have been and continue to be scarce in the samples available for age analysis. Therefore, it is not possible to place much reliance on age analysis to evaluate changes in brown trout survival. Other indicators, such as the size at capture from creel data pre- versus post-sea lamprey control, provide a better measure of success of the experimental sea lamprey control program.

V. Impacts on Forage Fish

Abstract

Stepped-oblique, midwater trawls were used to sample smelt populations. Population parameters were compared to a set of pre-established evaluation standards to assess changes in smelt populations. Lake trout food habits were derived from information collected during gill net surveys of lake tout. Four of six evaluation standards indicated the experimental sea lamprey control program did not significantly impact the smelt population in Lake Champlain. Catch per unit of effort was not significantly lower ($P > 0.05$) than in the same months in previous years for the four consecutive years at all stations sampled. Length-at-age of smelt from midwater trawls in August indicated no significant increase ($P > 0.05$), nor was there an increase in mean length for all age classes combined. No 25% or greater decrease in survival rate (as compared to 1984, 1985 and 1987) accompanied by an increase in total mortality over the last four years of sampling occurred. Smelt angler catch rates demonstrated no significant change ($P > 0.05$), nor was there an increase in the average length of harvested smelt.

One evaluation standard that dealt with measuring change in prey species or size selection could not be fully evaluated. The Index of Relative Importance could not be calculated as prey in sampled stomachs were not weighed. Size selection results were ambiguous; mean number of large smelt per lake trout stomach decreased significantly in the post-control period at all Main Lake sites, but the mean number of small smelt per lake trout stomach did not. A sixth evaluation standard measuring changes in the sex ratio could not be evaluated because rainbow smelt sex could not be determined during the summer trawling period.

A. Background

This section of the report is based on the study titled, “Assessment of Rainbow Smelt Stocks During an Eight-Year Experimental Sea Lamprey Control Program on Lake Champlain” (LaBar 1999) and supplemental analyses of LaBar’s data performed independently by Vermont Department of Fish and Wildlife staff. The original LaBar document is attached as Appendix J.

Rainbow smelt stocks were monitored using stepped-oblique midwater trawling and hydro-acoustic assessment prior to and during an eight-year experimental program to chemically control sea lamprey populations in the Lake Champlain drainage. The objectives of the study were to:

- Determine the extent of changes in rainbow smelt population structure over the course of the study.
- Determine the extent of changes in smelt growth rates over the course of the study.
- Determine the extent of changes in diets of top predators from stomach samples taken by state and federal fisheries biologists.

Midwater trawling took place each year from 1990-1997 during the second two weeks in August. From 1990-1992, four sampling sites were utilized: Shelburne Bay, Juniper Island area (Juniper), Outer Malletts Bay, and the Northeast Arm (Inland Sea). In 1993, a fifth site, Barber Point, in the Main Lake, was added and maintained for the duration of the project. In 1998, the Vermont Department of Fish and Wildlife conducted the smelt sampling at the same stations using the same methods. At each site, four to eight stepped-oblique, midwater trawls were conducted each year. Approximately 200 rainbow smelt from each station each year were weighed, measured and aged. Predator food habits were derived from information collected by the Vermont Department of Fish and Wildlife during gill net surveys of lake trout.

Evaluation standards were developed in 1990 to determine if rainbow smelt populations were impacted by an increase in the number of predators following experimental sea lamprey control. These standards consider each sampling site equally without regard to basin location. However, it is noteworthy that the basins differ in species stocked, stocking rates, water chemistry, physical characteristics, species composition and levels of lamprey control. The basins are the Main Lake (Shelburne, Juniper and Barber Point), Malletts Bay, and the Northeast Arm (Inland Sea). Within the Main Lake Basin it appears that Juniper Island best represents that basin based on the physical characteristics of the station. The Shelburne station is very unique in that it samples a very narrow trough where smelt are concentrated, and it is the only station where substantial underwater currents have been observed.

LaBar (1999) states "rainbow smelt populations are noted for their volatility." Engstrom-Heg et al. (1990), further state that "populations of smelt have been observed to undergo extreme fluctuations in abundance, apparently unrelated to stock size, predation, competition, fishing intensity, or disease". Viewing the smelt sampling data that date back to 1980's, it appears that the evaluation was initiated at a peak (1990) in smelt population density in the Main Lake (Figures 29 - 32). LaBar (1999) also indicates "there seemed to be no synchrony in changes of catch rate by year between sites except in the Main Lake".

B. Catch Per Unit Effort

1. Standard 1: *Catch-per-unit-of-effort is significantly (5% level)* [$P \leq 0.05$] *lower at all sampling stations than in the same months as in previous years for the four consecutive years at all stations sampled.*

Catch rates (catch per 55 minute trawl = CPUE) were significantly different between years within sites and between sites within a year. They fluctuated from a low of 52 at Juniper in 1992 to a high of 3,553 in the Northeast Arm in 1995 (Table 88). Catch rates were highest in the Northeast Arm and Malletts Bay and lowest at Juniper in the Main Lake.

Mean CPUE decreased in the 1994-1997 post-control period at both Shelburne Bay and Juniper Island. In the Main Lake, this difference was statistically significant (5% level) only at the Shelburne Bay site (Table 89). CPUE declined significantly in Malletts Bay, but increased in the Northeast Arm. What was apparent were the substantial differences in CPUE by area, with Main Lake sites being lower than Malletts Bay and much lower than the Northeast Arm. If

CPUE is an index of population density, then population density varied by more than one order of magnitude between the Northeast Arm and Juniper (Tables 88 and 89).

Statistically significant ($P \leq 0.05$) decreases in CPUE occurred at two of the four individual sites monitored since 1990 when comparing the 1990-93 pre-control and 1994-97 post-control periods. However, no statistically significant decrease occurred at the remaining two locations. Thus, the threshold established by Standard 1 was not exceeded. The significant decrease in CPUE at the Shelburne Bay site and the nonsignificant decrease in the Juniper Island CPUE may be cause to evaluate the sampling stations presently used in the Main Lake and consider expanding sampling and adding stations in the southern and northern area of the Main Lake.

C. Prey Species and Size Selection

1. Standard 2: ***Salmonids and walleye show consistent and significant changes in selection of either prey species or sizes of prey selected. Emphasis will be placed on lake trout since data are lacking for other salmonids and walleye. A negative impact is considered to be when the Index of Relative Importance of smelt and unidentified fish for any of the predator species mentioned above falls below 80% during summer sampling periods.***

There were only sufficient data to analyze impacts on lake trout food habits and only on lake trout from the Main Lake. Insufficient numbers of walleye and salmon were collected to make comparisons in any of the three basins.

Lake trout stomachs with food for all of the years between 1992 and 1997 contained a predominance of rainbow smelt: 96% contained rainbow smelt larger than 3 inches, and 40% contained smelt less than 3 inches (3 inches and smaller represent YOY). Table 90 presents a listing of identified food items for lake trout stomachs containing food. There were significant differences in mean numbers of smelt >3 inches and smelt < 3 inches per lake trout stomach from lake trout examined over the study period from all zones in the Main Lake except for small smelt (< 3") in Zone 4. In zones 2 and 3 the mean number of small smelt (< 3") per lake trout stomach increased between pre-and post-control periods, and in all zones the mean number of large smelt (> 3") per lake trout stomach decreased (Table 91). LaBar (1999) noted that, except for the significantly lower values of 1996, numbers of large rainbow smelt per stomach were relatively stable from 1993 through 1997. This stability in the post-control period occurred at a level approximately 53 - 58% lower than the pre-control period mean values.

The Index of Relative Importance of smelt could not be calculated because, although the prey found in the stomachs were identified, counted and separated into length classes, they were not weighed. The weight of the prey must be known in order to determine the Index of Relative Importance.

While lake trout prey-species-selection has remained the same in pre- and post-control periods, a change in prey size selection has occurred. An increase in the incidence of smaller smelt (< 3") and decrease in the frequency of larger smelt (> 3") was clearly demonstrated.

However, smelt year class strength may influence lake trout prey size selection as it influenced LaBar's (1999) trawl catches. Mean length of trawl-caught smelt declined when a strong year class of age 1 or age 2 smelt was present. Further, this change in size selection cannot be interpreted as exceedence of a threshold because mean length-at-age has decreased, as discussed below.

D. Mean Length-at-Age

1. Standard 3: *Analysis of length-at-age of smelt caught in midwater trawls in August indicates a significant (5% level)* [$P \leq 0.05$] *change, and that mean length-at-age for all age classes has changed.*

A series of two-sample t-tests were conducted to compare mean length-at-age for years 1990 to 1993 with mean length-at-age for years 1994 to 1997. This comparison of length-at-age changes was calculated for each basin. There was no significant ($P \leq 0.05$) change in length-at-age for age 1 smelt in any of the basins but significant changes for ages 2 through 5 occurred in the Main Lake between the 1990-1993 and 1994-1997 periods. Post-control mean lengths-at-age at the two Main Lake sites (Shelburne and Juniper) were slightly greater for age 2 smelt and significantly lower for age 3-5 smelt (Table 92). In the Northeast Arm there were no significant changes for ages 1, 4 and 5, but there were significant changes (decreases) for ages 2 and 3. Malletts Bay showed significant changes (decreases) in ages 3, 4, and 5 and no change for ages 1 and 2.

Mean lengths of all age classes combined showed statistically significant decreases in all three basins (Table 93).

Standard 3 criteria anticipated that substantial predatory impacts would cause compensatory growth and mean lengths to be significantly greater, not smaller. Therefore, a reasonable conclusion relative to this standard would be that there has been no significant negative impact since average sizes decreased.

E. Survival Rate

1. Standard 4: *A 25% or greater decrease in survival rate at the end of the eight year sampling period compared to 1984-1985 and 1987 and accompanied by an increase in total mortality over the last four years of sampling.*

Annual mortality rate estimated by cohort analysis varied from a high of 0.96 in 1995 in Malletts Bay to a low of 0.17 at Barber Point in 1995 (Table 94). Average cohort mortality rates at the five sites for all years combined were between 0.54 at Juniper and 0.78 at the Northeast Arm. There was no clear trend of mortality rates either based on Chapman-Robson estimates or on cohort analysis (Table 95). Mortality rates were within the range of those seen on Great Lakes smelt stocks exposed to exploitation, but somewhat higher than what was seen in unexploited stocks. LaBar (1999) explained smelt survival rates are difficult to estimate accurately because of variability in year class production and a tendency for smelt to segregate by year classes.

Estimated smelt survival rate did not decrease by 25% or more. Therefore no significant impact due to elevated predation has occurred to the smelt forage base relative to Standard 4 (Table 96).

F. Angler Catch

1. Standard 5: *Angler/cooperators demonstrate a significant (5% level)* [$P \leq 0.05$] *change in catch per unit of effort and/or a significant change in size distribution of smelt caught.*

Winter creel survey data from 1991 through 1997 (Chipman 1999) indicated that smelt angler catch per unit effort varied widely, with no discernable trend. Vermont Main Lake (Zone 2) creel survey catch rates from anglers targeting smelt ranged from 3.0 to 13.9 fish per angler hour (Table 97); the 1991-93 and 1994-97 averages were 8.77 and 8.60, respectively (not significant). Smelt angler diary cooperator data show similar catch per unit effort trends, but very low numbers of cooperators through the period limit the utility of this data set (Sausville 1997). Variability in catch rates appears to be related to factors other than lamprey control. Ice condition, which limits angler access to smelt fishing areas during years with warmer winters, appears to be an important factor.

In the Main Lake, a significant, steady decline in mean length of harvested smelt measured in creel surveys was noted, from 196 mm in 1991 to 183 mm in 1997 (ANOVA, $P < 0.001$) (Figure 33). This decline corresponds with the noted declines in mean length at age at the Shelburne and Juniper sites (Table 92). No significant changes in mean length of angler-caught smelt were evident in the Northeast Arm (Figure 33). As noted in the discussion of Standard 3 above, it was anticipated that substantial predatory impacts would cause compensatory growth and mean lengths should be significantly greater, not smaller. The conclusion relative to this standard is that there has been no significant negative impact.

G. Sex Ratio

1. Standard 6: *The male:female ratio decreases consistently over the period of sampling. There is no baseline data on sex ratio of smelt in the lake, so the first two years of sampling will have to serve as baseline, and comparisons made with those years.*

When the evaluation standards were written it was not known if sex could be determined during the summer. Subsequent investigations determined that this was not possible, so this standard could not be evaluated.

H. Summary

A summary of evaluation standards results can be found in Table 98. Overall the project met four of the five standards that could be evaluated, and was inconclusive for the standard relative to changes in prey species-size selection. The sex ratio standard could not be evaluated.

VI. Benefit:Cost Analysis

No Standard: ***Engstrom-Heg et al. (1990) established no evaluation standards for the benefit:cost analysis.***

Abstract

This section of the report is based entirely on the study titled, *Benefit Cost Analysis of the Eight-Year Experimental Sea Lamprey Control Program on Lake Champlain* (Gilbert 1999) attached as Appendix K. This particular analysis was developed from the results of four other economic-related studies. These other studies include *Lake Champlain Angler Survey 1997* (Gilbert 1999b), *Impact of Additional Salmonid Angling on the Public and Private Infrastructure in Towns Bordering Lake Champlain, 1997* (Gilbert 1999c), *A Survey of the Fishing and Fishing-related Businesses Serving Lake Champlain Anglers* (Gilbert 1999d), and *Lake Champlain Boating and Fishing Access Site Descriptions and Inventory 1998* (Gilbert 1999e). Copies of these individual component studies are available from the Vermont Department of Fish and Wildlife, 111 West Street, Essex Junction, VT 05452.

A benefit:cost analysis was conducted at the beginning and the end of the eight-year (1990 through 1997) experimental sea lamprey control program (ESLCP) on Lake Champlain. The objectives of the study were:

- to establish the initial value of Lake Champlain fishing
- project value changes associated with levels of increased fishing quality
- measure the financial impact of anglers-related expenditures on local businesses
- measure public and private on-land infrastructure impacts of increased angler activity
- estimate the value received by non-users who wish to preserve and/or enhance quality fishing in the lake
- measure a broad range of administrative, environmental, landowner, and angler costs.

Actual benefits and costs were then determined for the eight-year period.

The ESLCP on Lake Champlain generated estimated 1990 discounted benefits of $29,379,211 and discounted costs of $8,447,011. This resulted in a net benefit of $20,902,200 and a benefit:cost ratio of 3.48:1. In addition to these benefits, continuation of the sea lamprey control program on Lake Champlain is expected to generate an additional 1,217,609 days of fishing annually and $4,150,768 in fishing-related expenditures.

The success of the eight-year ESLCP also induced the members of an estimated 32,528 households to increase their annual participation in water-based recreation on Lake Champlain by

219,564 days during the eight-year period and spend an additional $8,781,969 on these activities. If the program is continued, it is estimated that the members of 92,025 households currently recreating on Lake Champlain, and members of 58,542 households not currently recreating on Lake Champlain, will increase their annual participation by 1,546,784 days and generate an estimated $59,289,994 in additional annual water-based recreation expenditures.

The owners of the 98 fishing and fishing-related businesses serving Lake Champlain anglers were not able to estimate what percent of their $5,545,040 Lake Champlain-based 1997 gross fishing/fishing-related income is attributable to the ESLCP on Lake Champlain, but they voiced unanimous support for the program. Study results did show that 48.5% of these businesses expanded during the eight-year ESLCP and business-owners attributed 29.2% of the expansion directly to the program. Another 35.4% of the business owners plan further expansion and 21% of the planned expansion was directly attributable to the anticipated continuation of sea lamprey control on Lake Champlain.

It is evident that the eight-year ESLCP has had a major impact on Lake Champlain anglers and on current and future participants in water-based recreation on Lake Champlain. Anglers and other water-based recreationists placed a very high value on the eight-year ESLCP on Lake Champlain ($29,379,211 with a 3.48:1 benefit:cost ratio) and said that they would substantially increase their participation in angling and other water-based recreation activities if the program is continued. These findings suggest that the eight-year ESLCP on Lake Champlain was justified on economic grounds. Benefits greatly exceed costs. Continuation of the sea lamprey control program on Lake Champlain, however, will depend upon the importance of economic considerations in the overall decision process.

Figure 1. Diagram of sea lamprey ammocoete bioassay live cage used to assess TFM and Bayer 73 treatments on Lake Champlain streams and deltas (Kosowski et al. 1987).

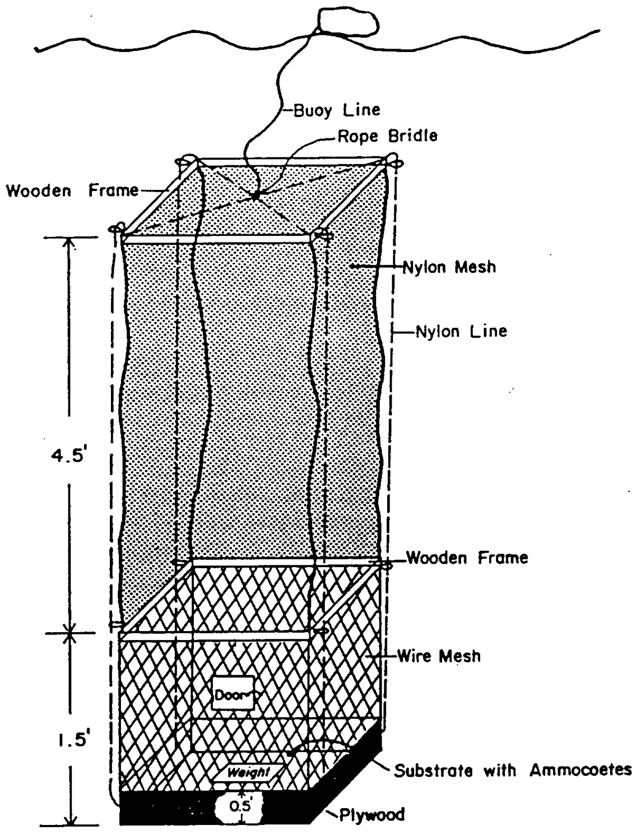


Figure 2. Numbers of spawning phase sea lamprey captured with portable assessment traps in three Lake Champlain tributaries, 1989 - 1997.

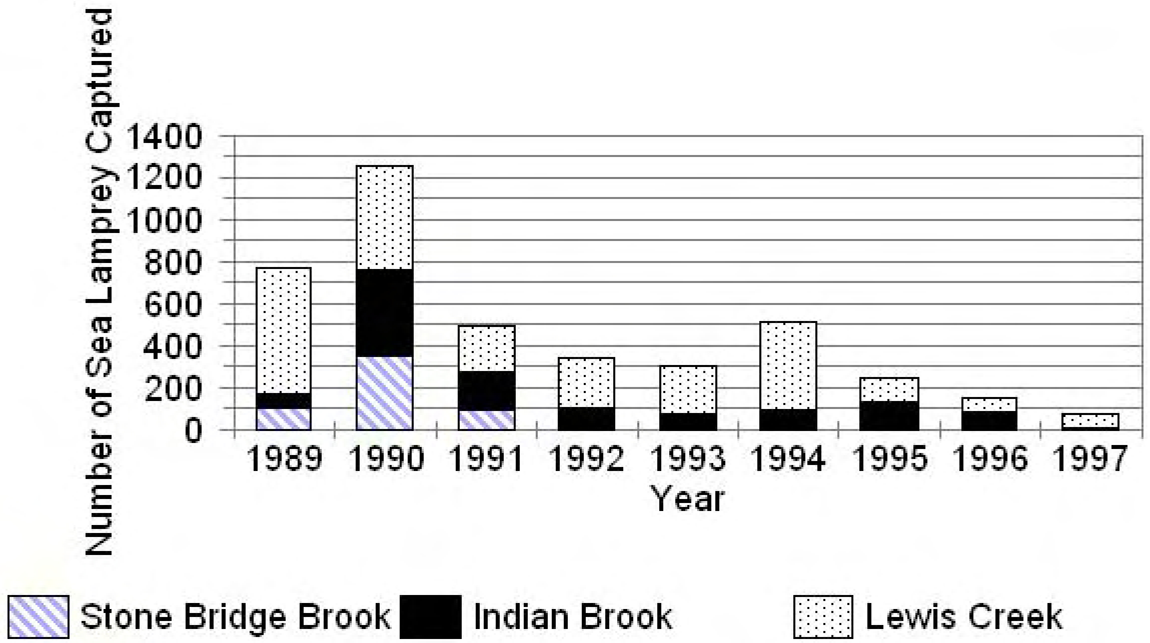


Figure 3. Sex ratio information collected from trapping data in Stone Bridge Brook. (Sample size is shown in the number above each bar.)

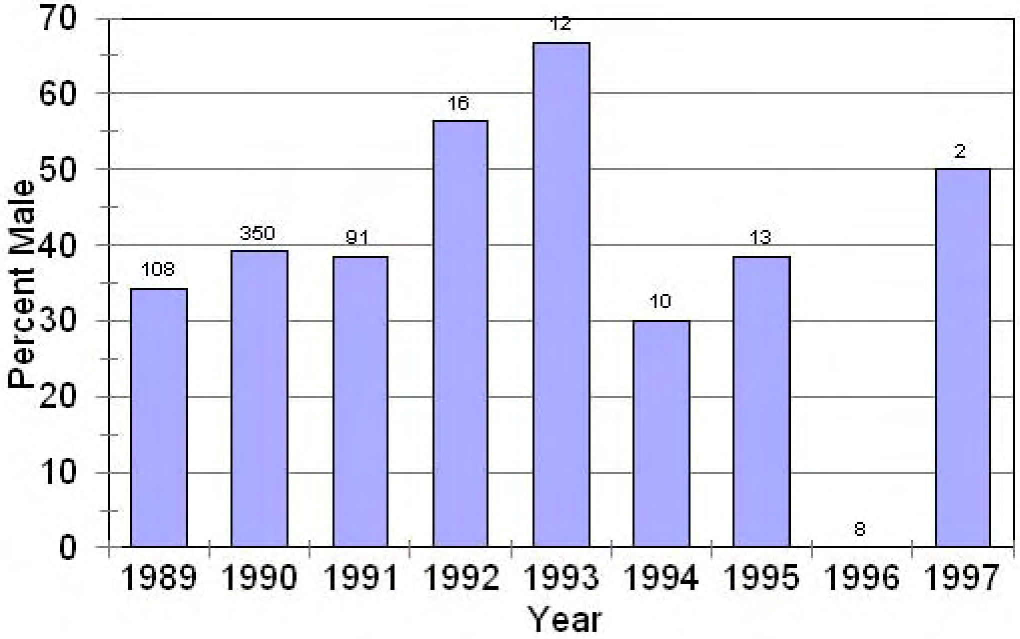


Figure 4. Sex ratio information collected from trapping data in Lewis Creek. (Sample size is shown in the number above each bar.)

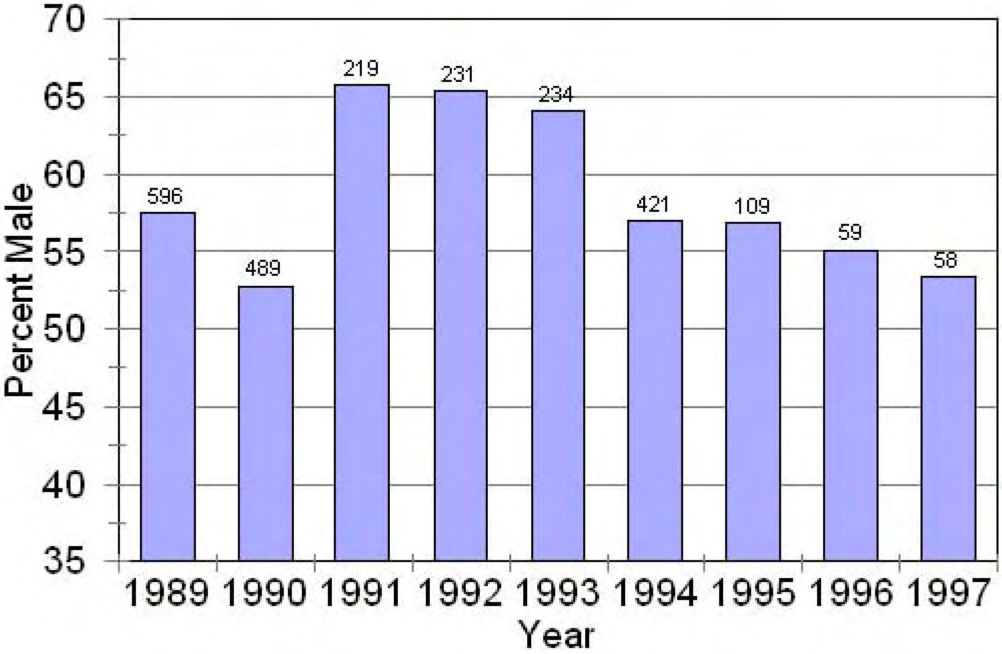


Figure 5. Sex Ratio information collected from trapping data in Indian Brook. (Sample size is shown in the number above each bar.)

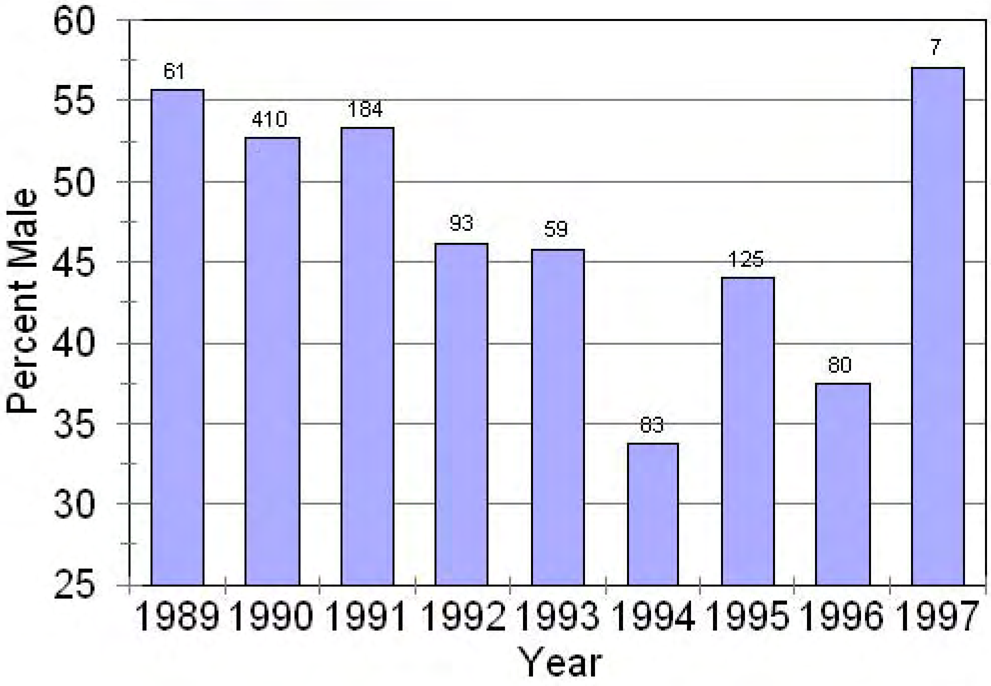


Figure 6. Average weight information collected from trapping data in Stone Bridge Brook. (Sample size is shown in the number above each bar.)

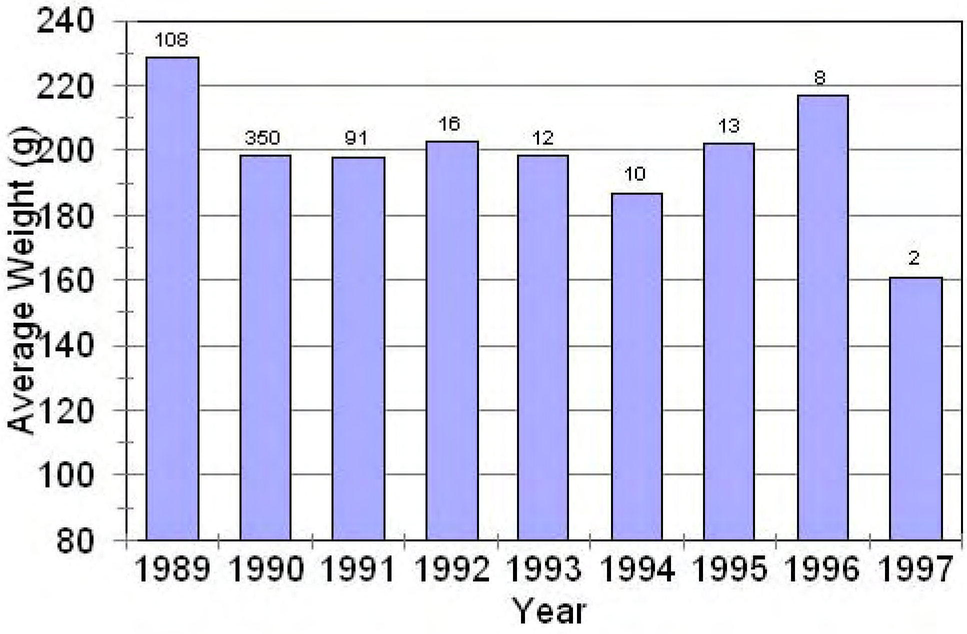


Figure 7. Average weight information collected from trapping data in Lewis Creek. (Sample size is shown in the number above each bar.)

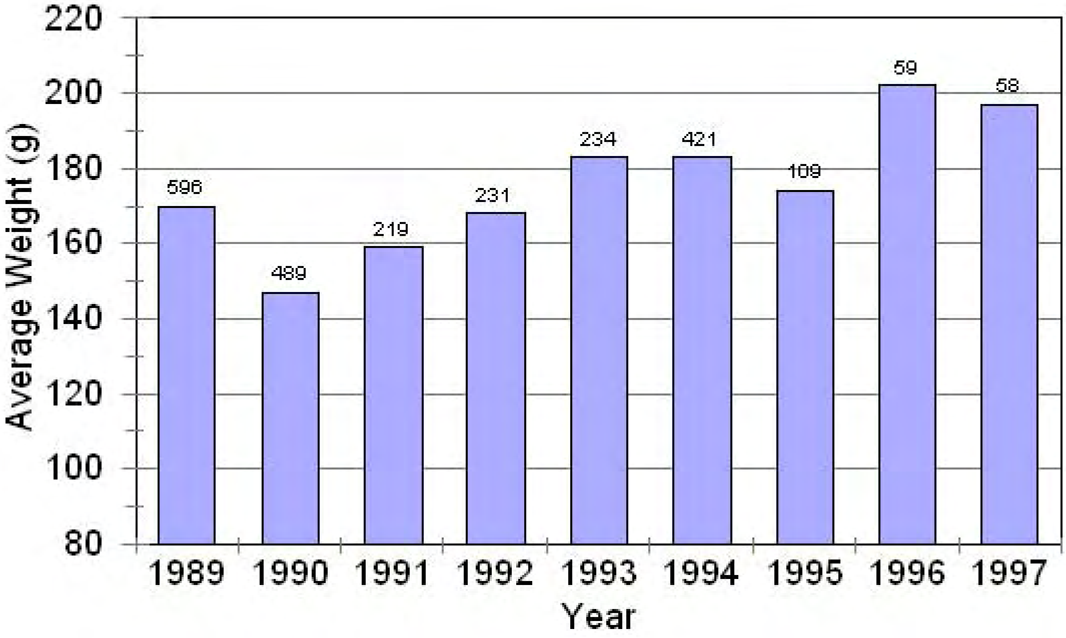


Figure 8. Average weight information collected from trapping data in Indian Brook. (Sample size is shown in the number above each bar.)

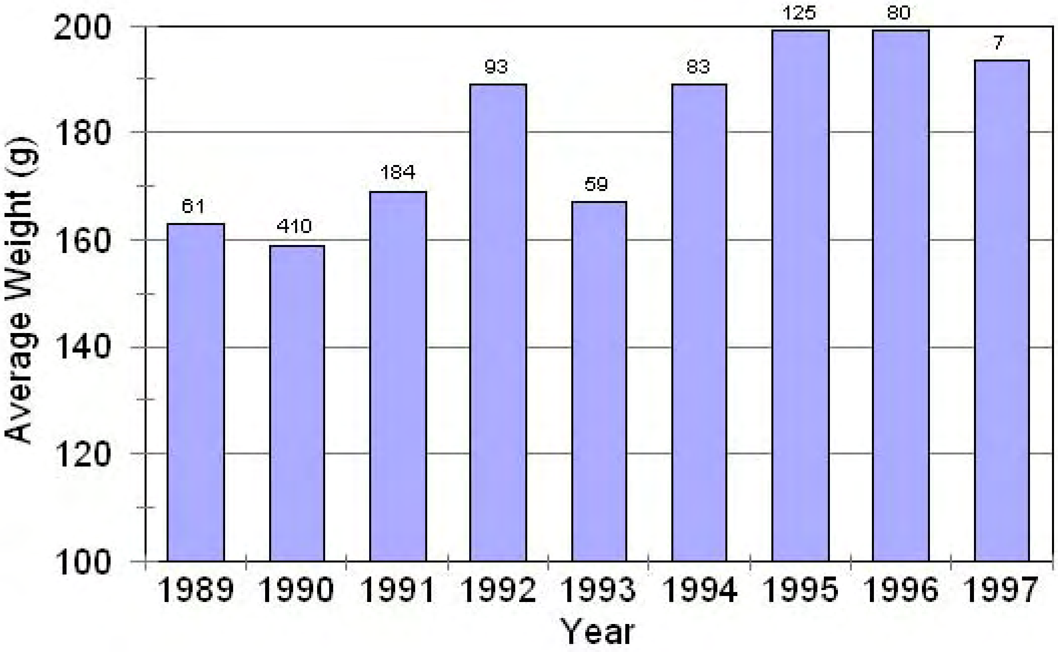


Figure 9. The total number of sea lamprey nests in index sections of ten Lake Champlain tributaries, 1983 - 1997.

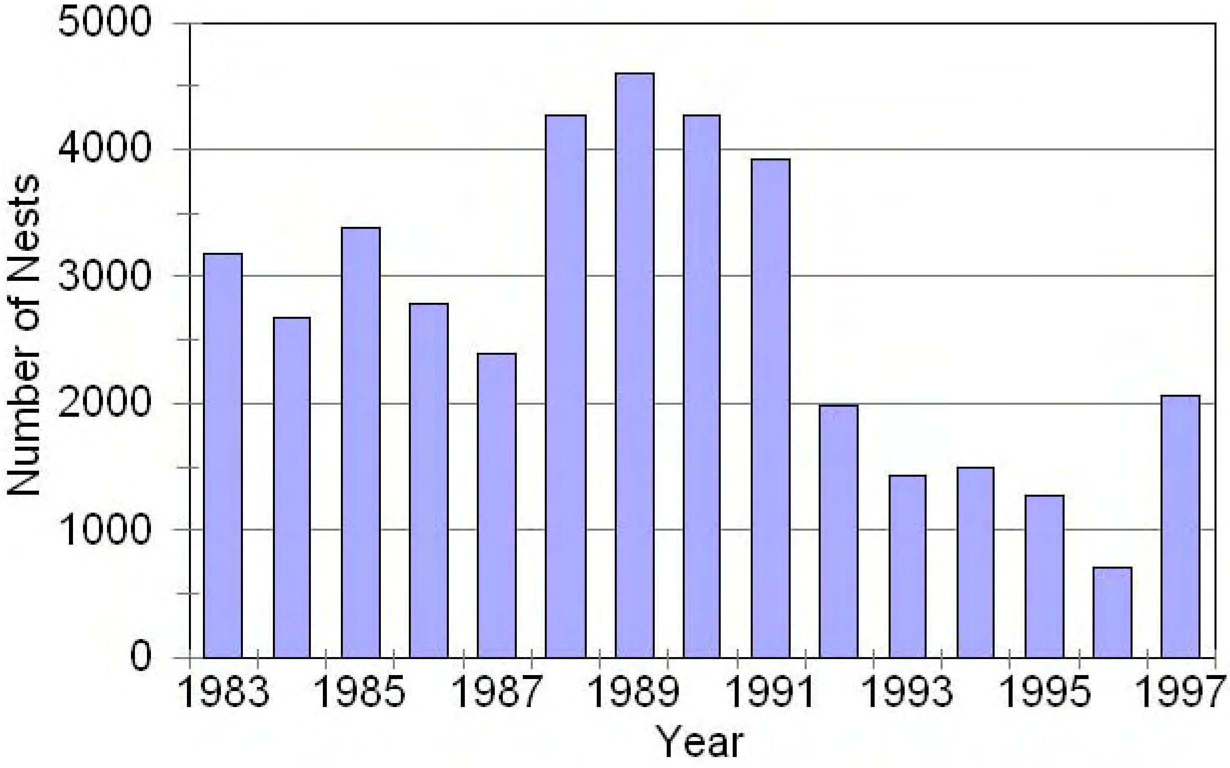
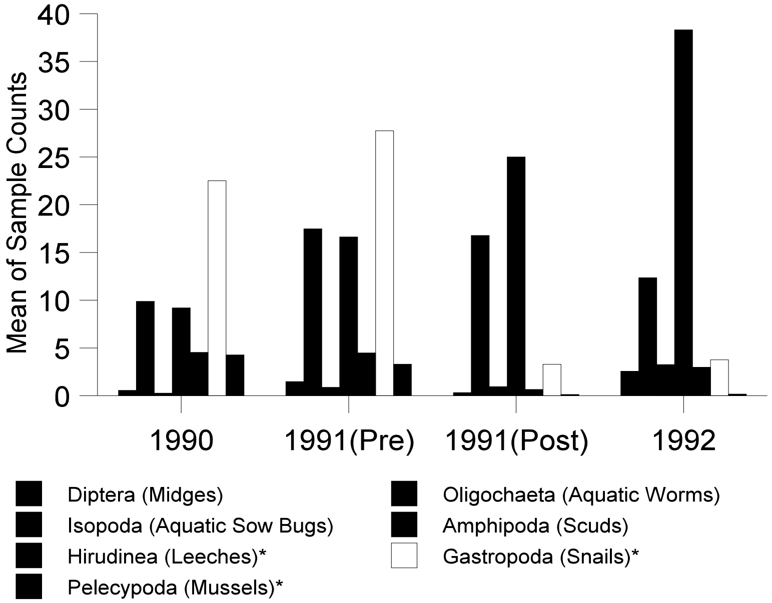
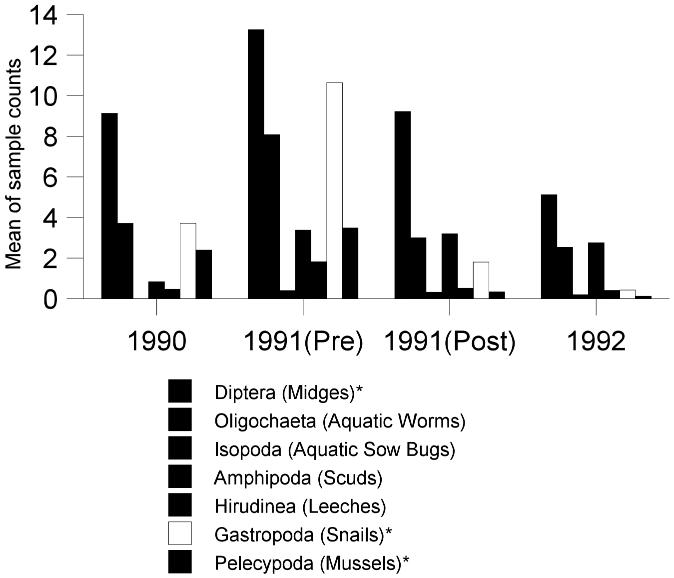


Figure 10. Mean counts of macroinvertebrate groups by year of sampling, with ‘Pre’ or ‘Post’ treatment status designated for 1991, for the Little Ausable delta (derived from Gruendling and Bogucki 1993b).



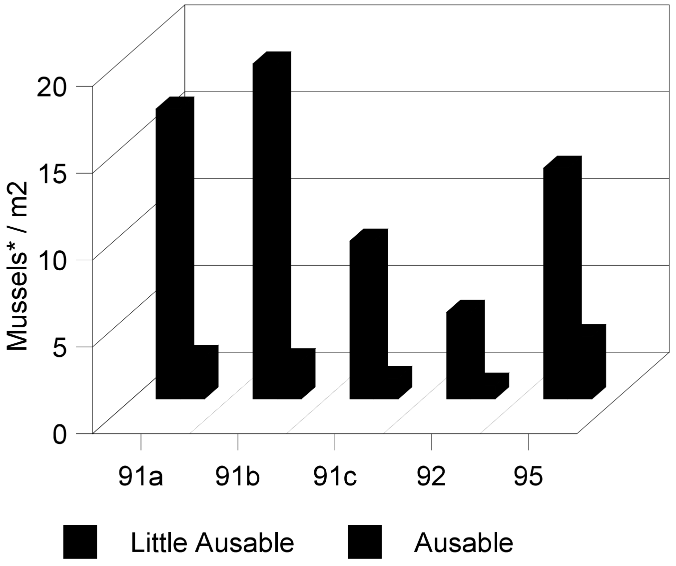
* Significant difference (lower in 1992 than in 1990) ($P \leq 0.05$)

Figure 11. Mean counts of macroinvertebrate groups by year of sampling, with ‘Pre’ or ‘Post’ treatment status designated for 1991, for the Ausable delta (derived from Gruendling and Bogucki 1993b).



* Significant difference (lower in 1992 than in 1990) ($P \leq 0.05$)

Figure 12. Combined mean counts of eastern elliptio and eastern lampmussels per square meter on the Little Ausable and Ausable deltas, by sampling period, where 91a and 91b are pre-treatment samples and others are post-treatment samples (derived from Gruendling and Bogucki 1993; Lyttle 1996).



* The combined density represents that of eastern elliptio and eastern lampmussel only. Eastern floater, giant floater and zebra mussels, first sampled/observed in 1995 are excluded from the density value.

Figure 13. Mean counts of gastropods per plot on the Little Ausable and Ausable deltas by sampling period, where 90 and 91a are pre-treatment samples and others are post-treatment samples (derived from Lyttle 1996).

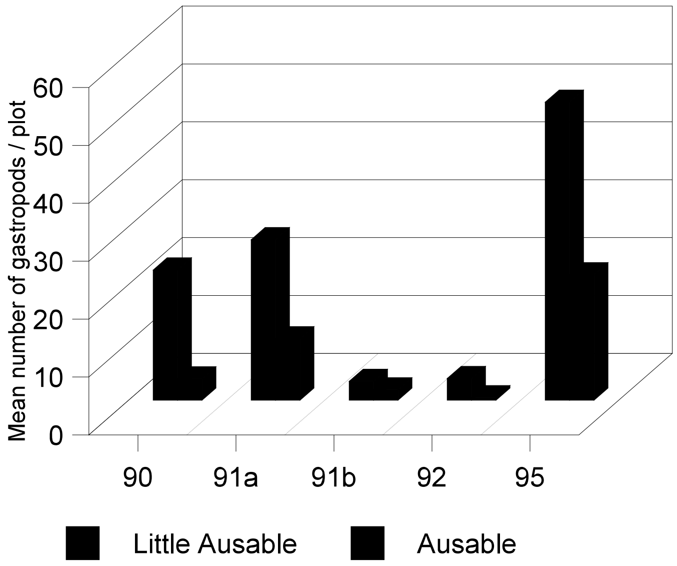


Figure 14. Average number of lake trout caught per net lift (with 95% confidence interval) through time in Zones 3A and 3B. "N" refers to the number of net lifts.

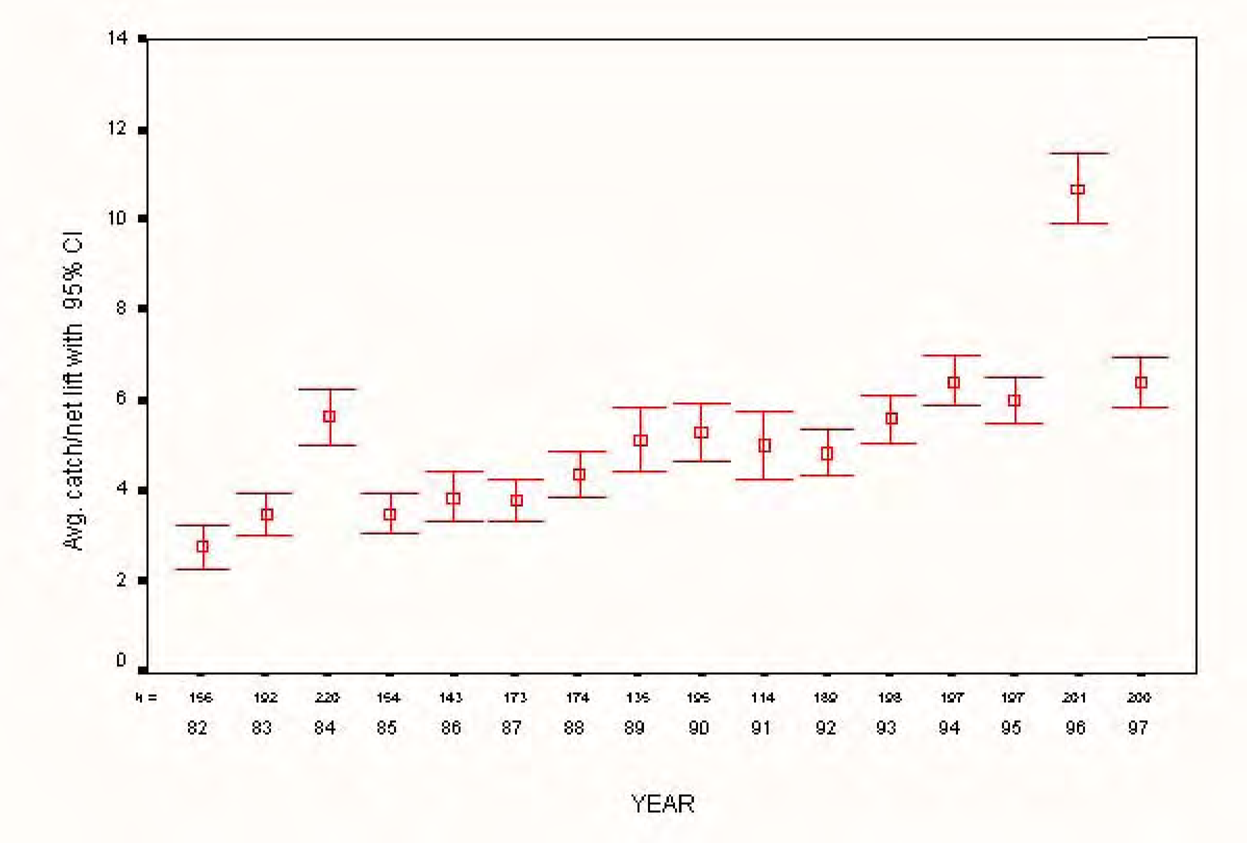


Figure 15. Observed and adjusted lake trout catch per net lift in Zone 3A & 3B, 1982 through 1997.

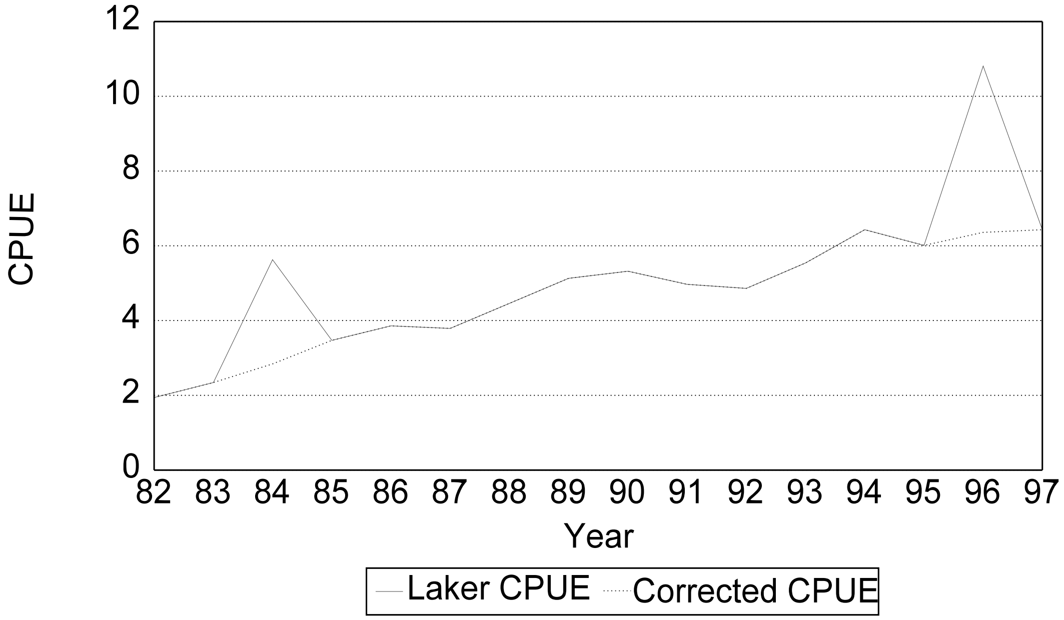


Figure 16. Typical catch curve for the gill nets used to sample the Lake Champlain lake trout population, 1982 thru 1997. Data here are averages across year classes of corrected numbers.

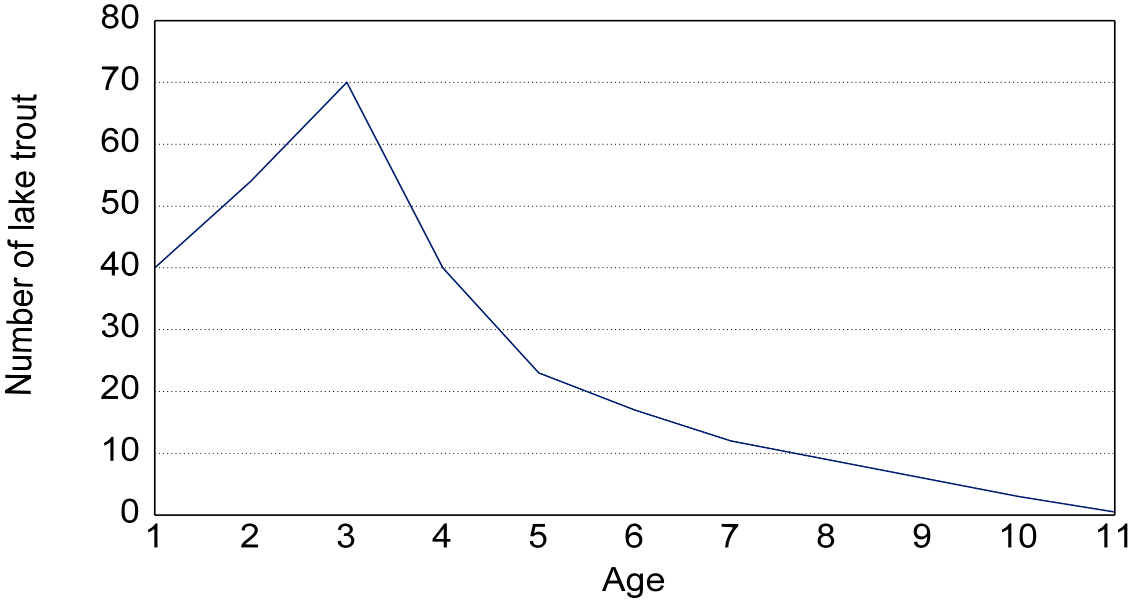
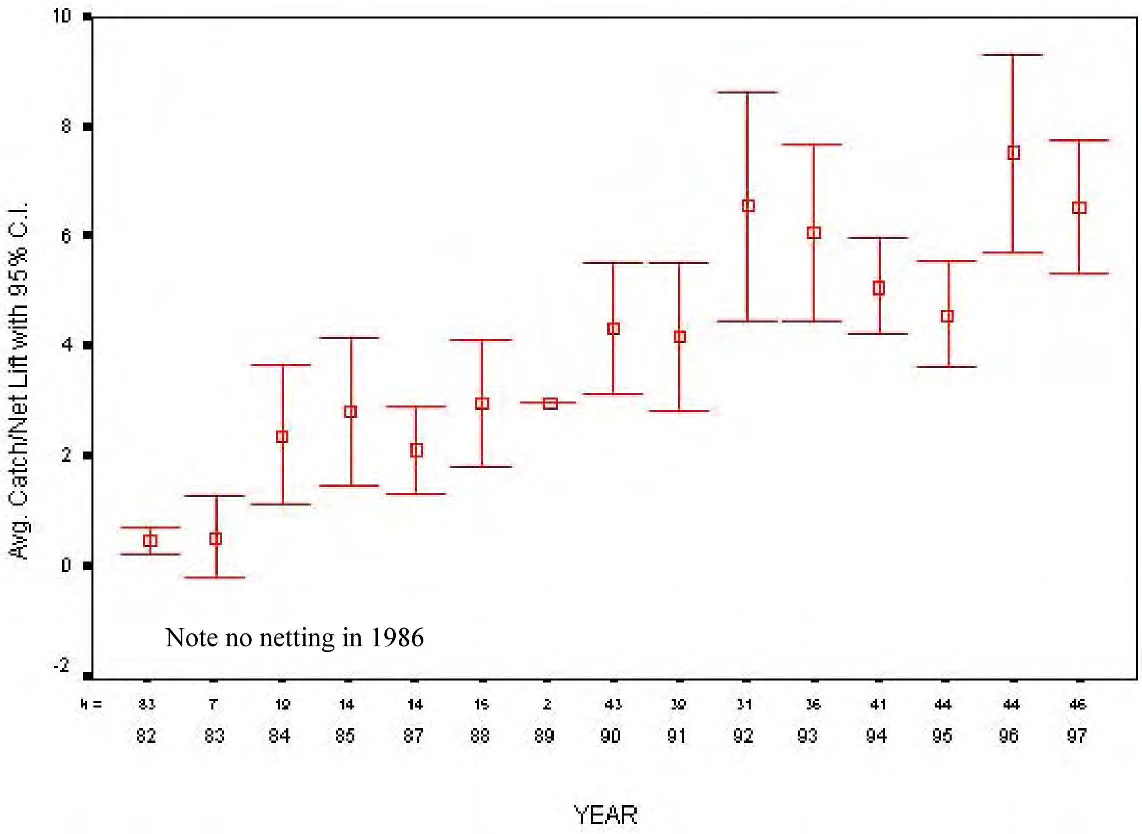
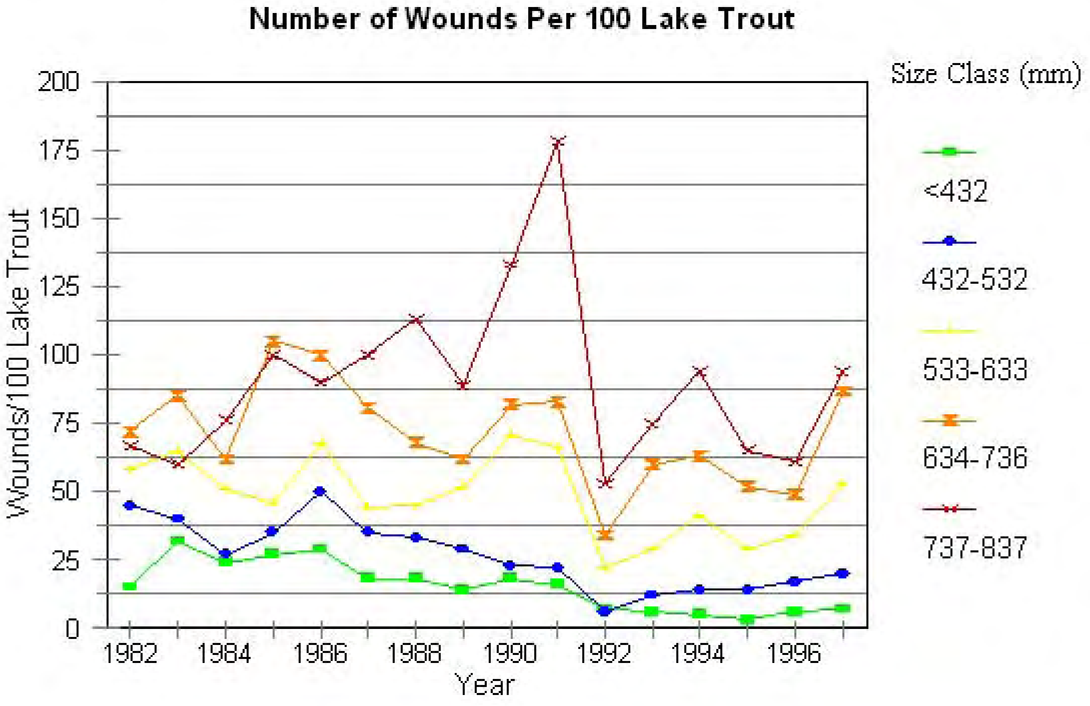


Figure 17. Average number of lake trout caught per net lift (with 95% confidence interval) through time outside of zones 3A and 3B. "N" refers to the number of net lifts.



Note no netting in 1986

Figure 18. Sea lamprey wounds and scars per 100 lake trout for 5 size increments, 1982 - 1997.



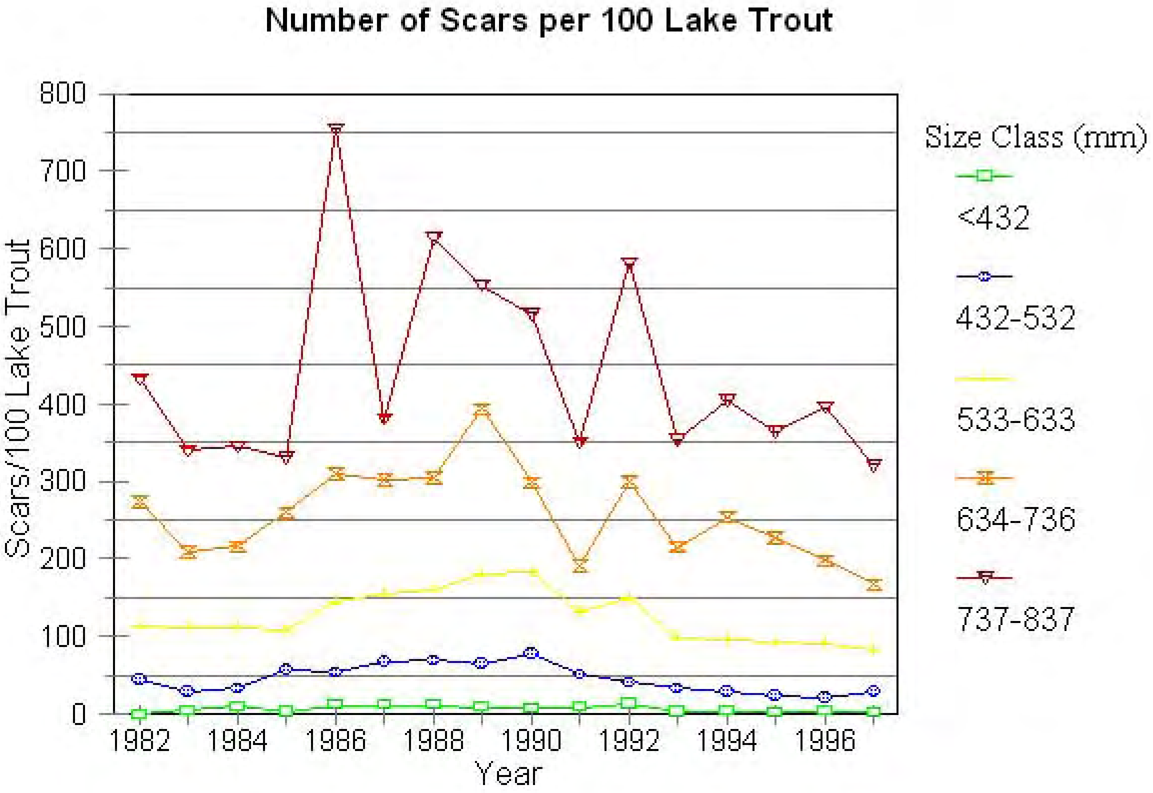
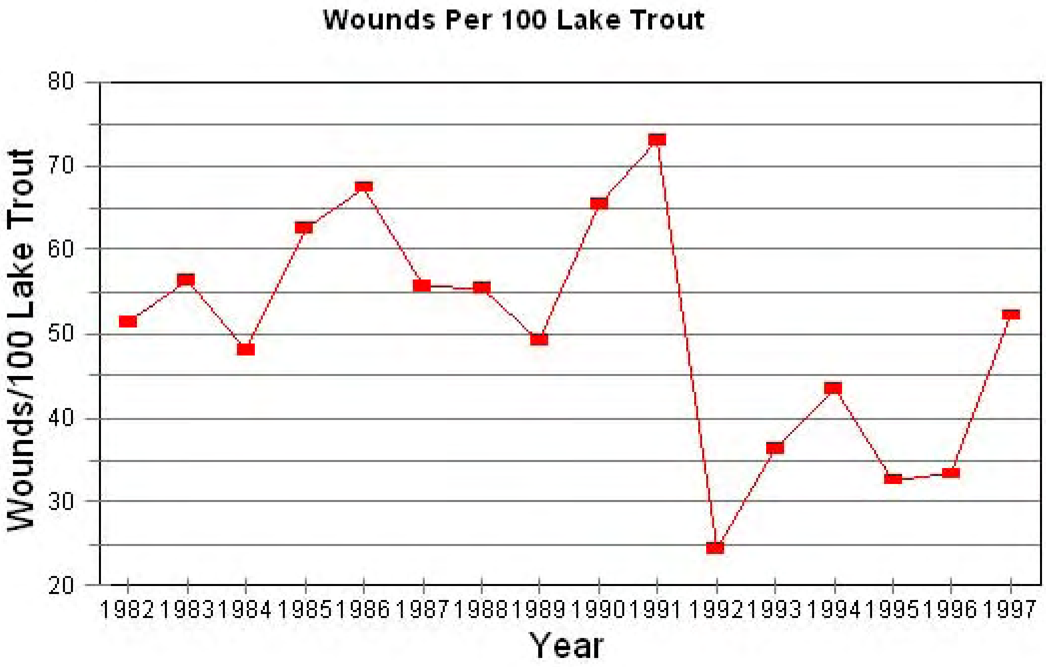


Figure 19. Sea lamprey wounds and scars per 100 lake trout for all size classes combined, 1982 - 1997.



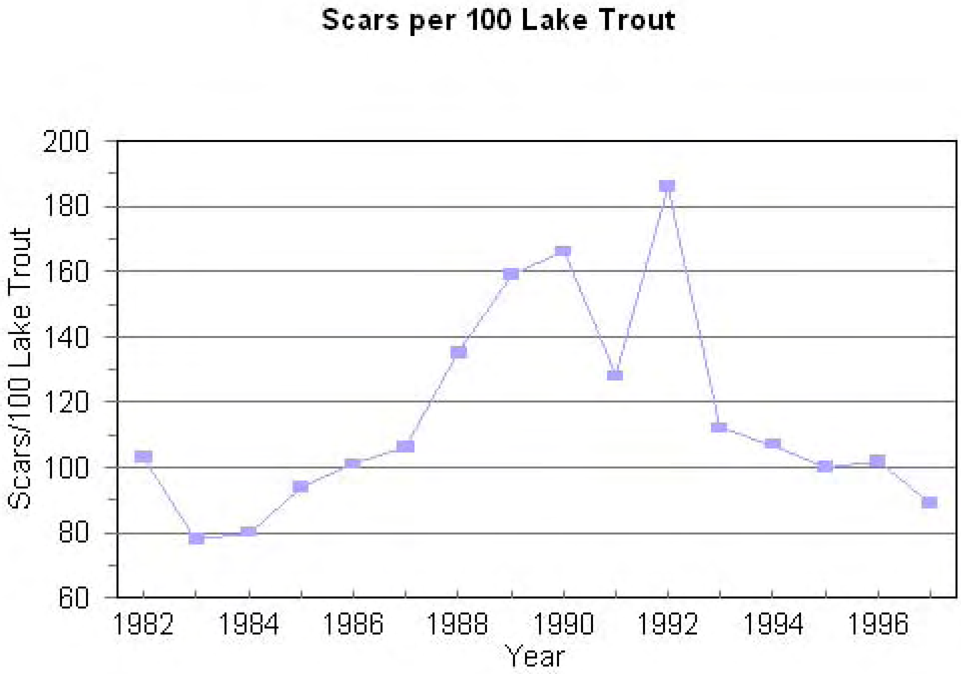


Figure 20. Sea lamprey attacks per 100 lake trout for all size classes combined, 1982 - 1997. An attack is defined as the sum of all wounds and scars.

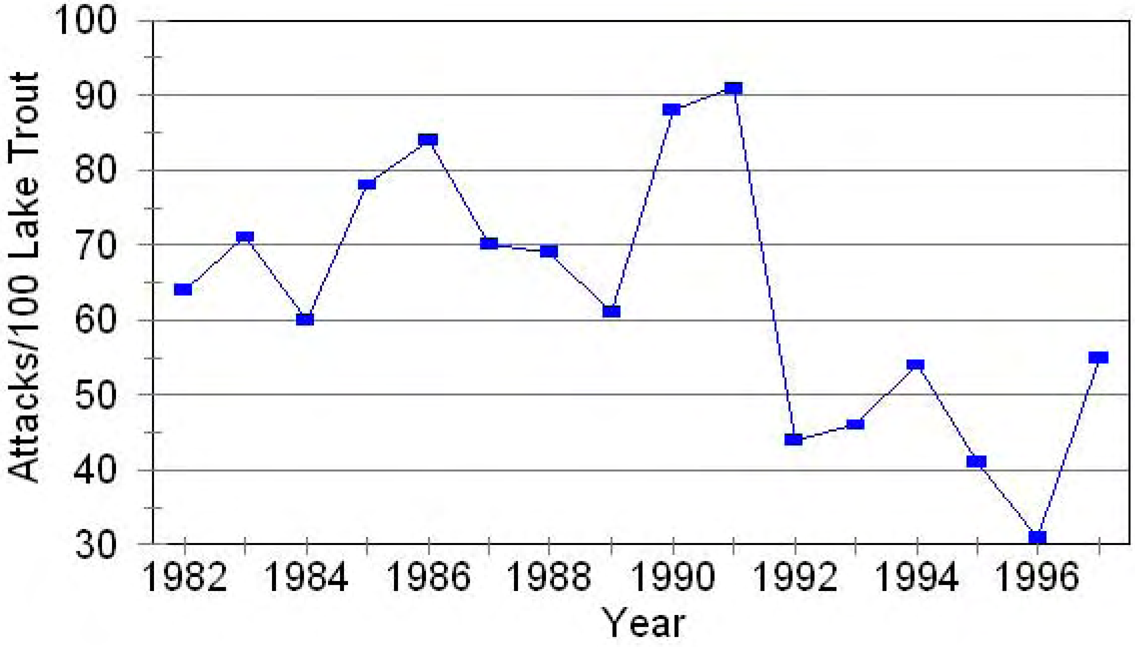
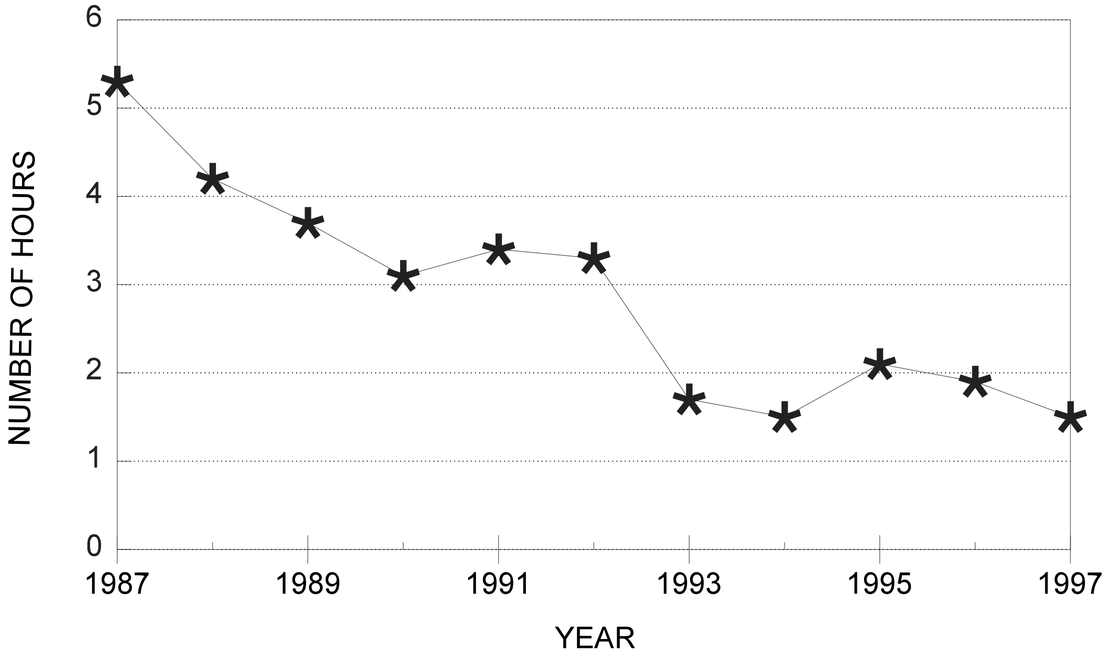


Figure 21. Number of hours of main lake fishing required to catch a legal-sized lake trout (years 1987 -1997).



These figures include trips where only lake trout were targeted.

Figure 22. Annual variation in numbers of fall-run landlocked salmon collected by electrofishing in the Lamoille River and combined September-October median flows measured at the USGS Lamoille River Gaging Station at East Georgia.

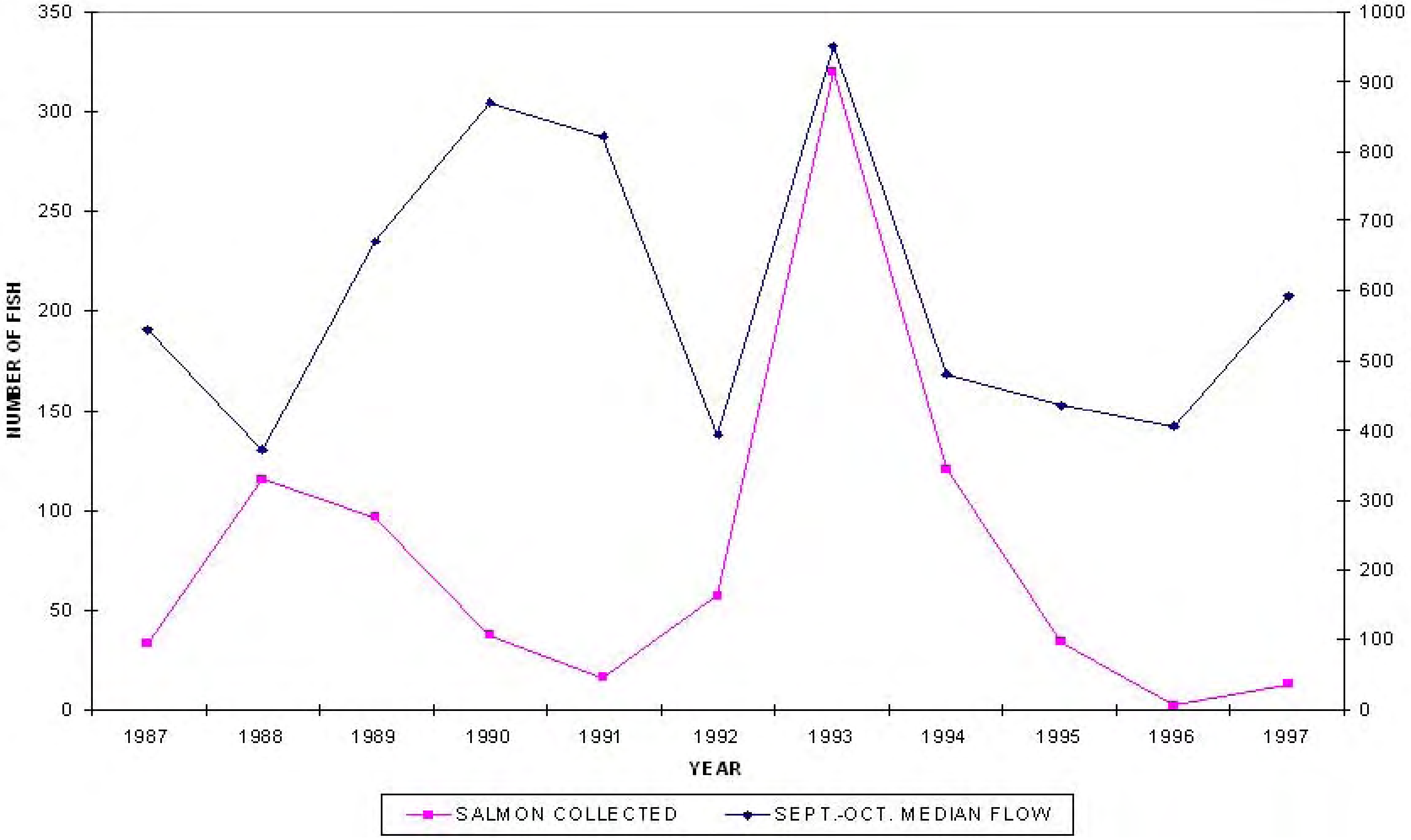


Figure 23. Length frequency distributions of recorded legal-sized landlocked salmon in fall 1991 and 1996 Saranac River creel surveys.

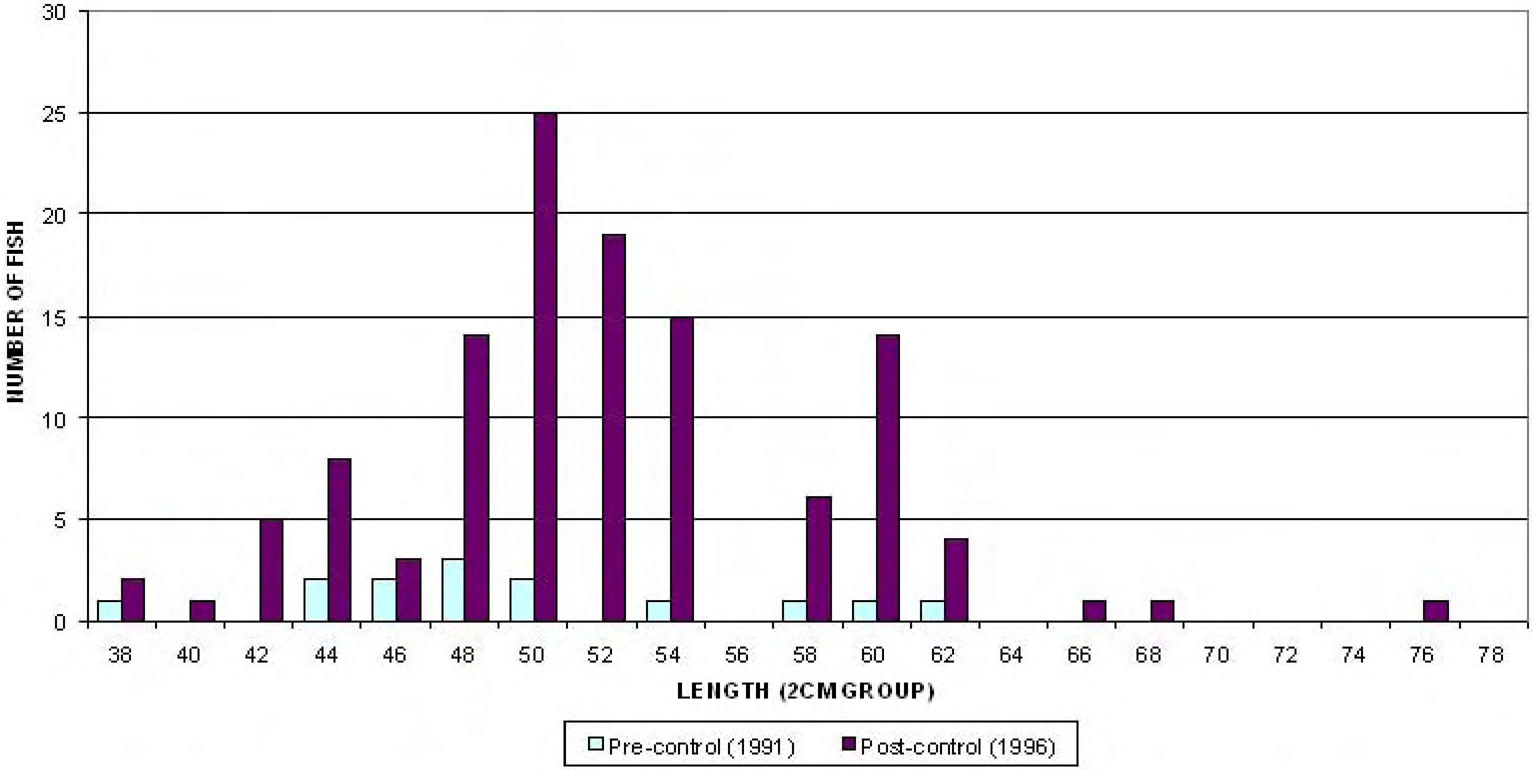


Figure 24. Pre-control (1987-92) and post-control length frequency distributions of legal-sized landlocked salmon caught in tributaries by salmonid angler diary cooperators

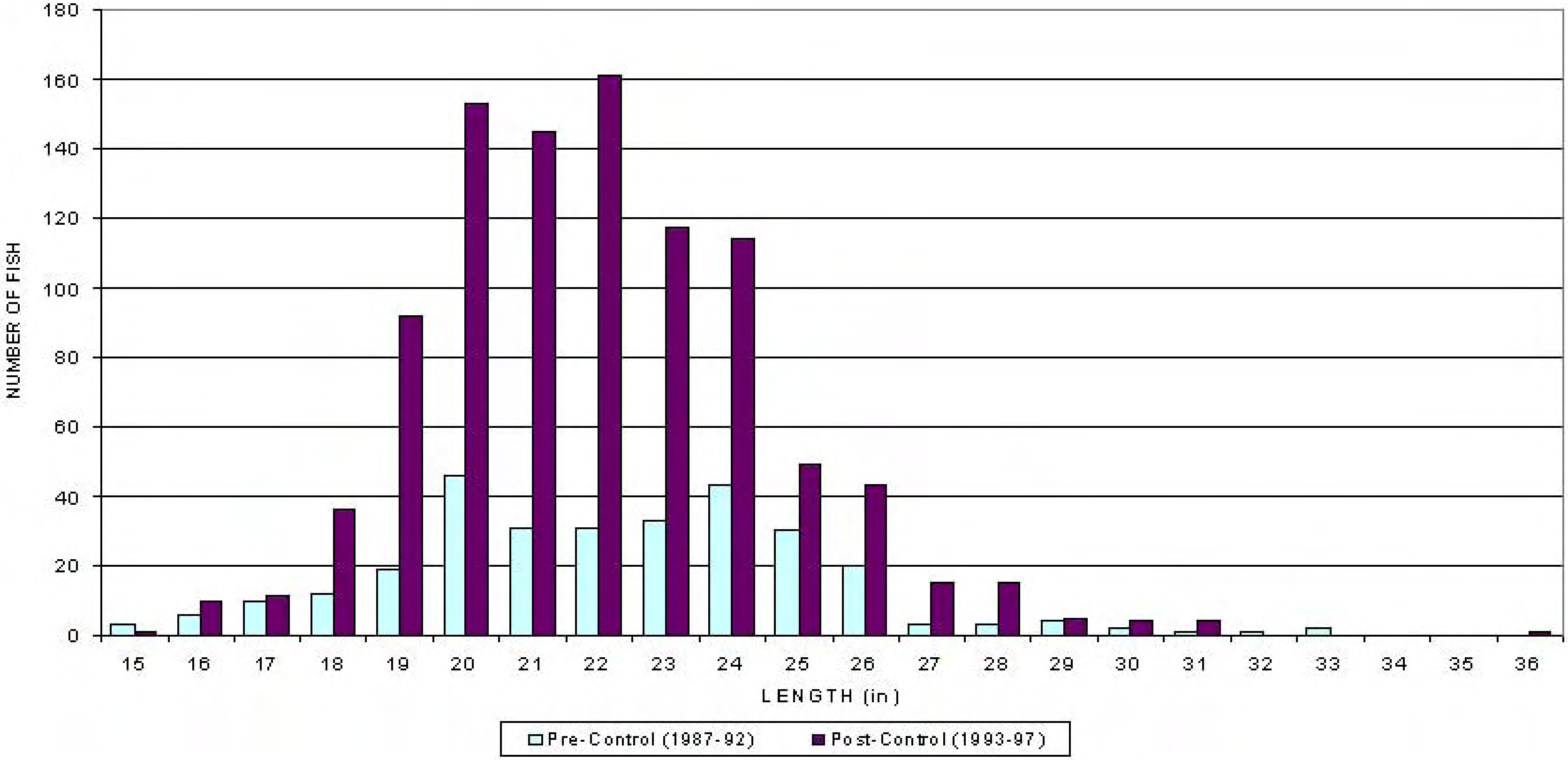


Figure 25. Length frequency distributions of recorded landlocked salmon in 1990 and 1997 Main Lake open water creel surveys.

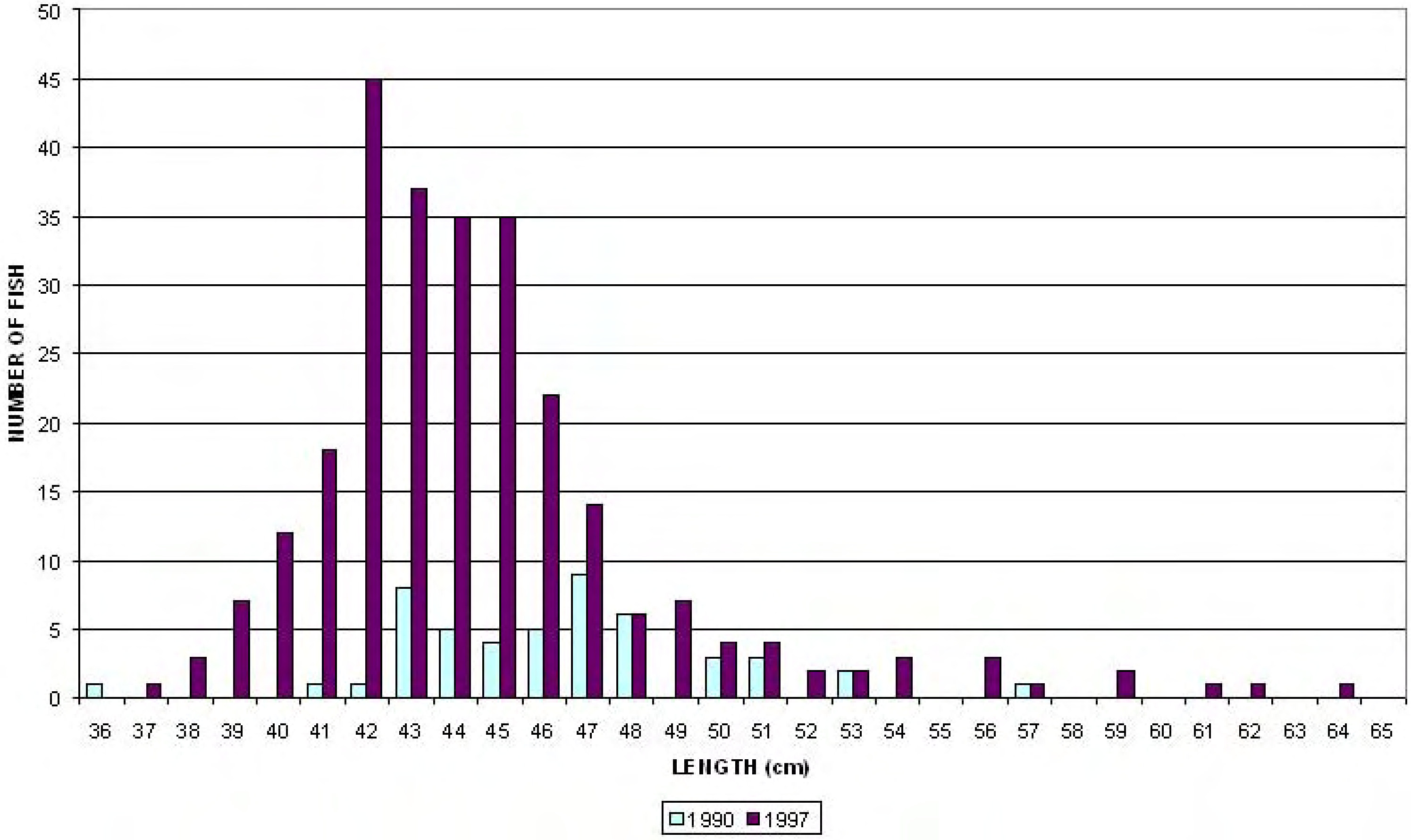


Figure 26. Pre-control and post-control length frequency distributions of legal-sized landlocked salmon caught in the Main Lake by salmonid angler diary cooperators.

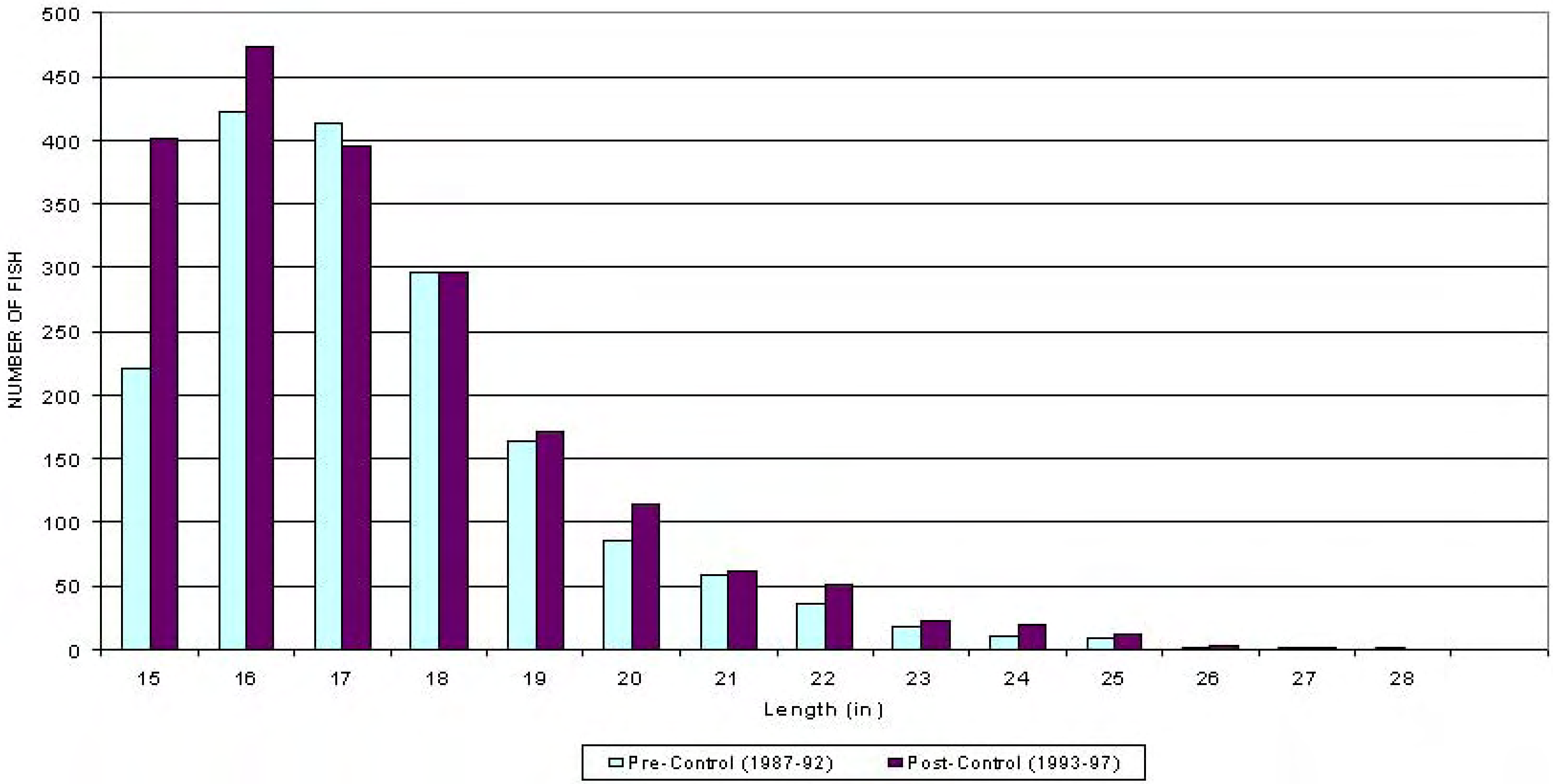


Figure 27. Length frequency distributions of all recorded brown trout from the Spring, 1991 and 1997 Saranac River creel surveys.

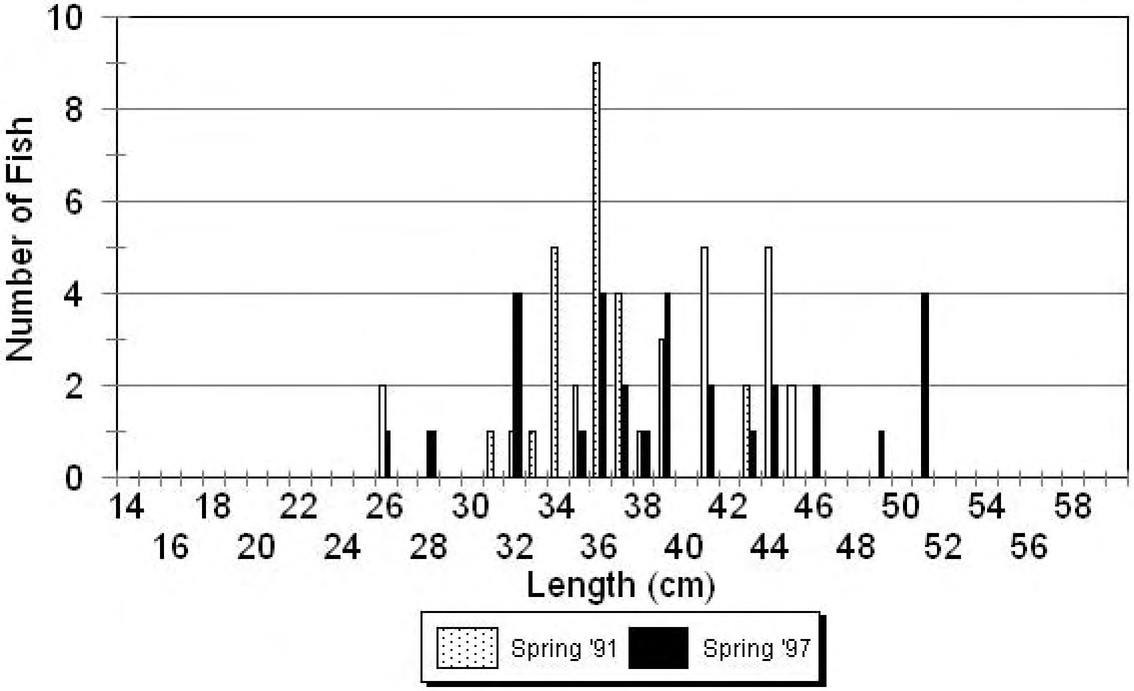


Figure 28. Length frequency distributions of all recorded brown trout from the Fall, 1991 and 1996 Saranac River creel surveys.

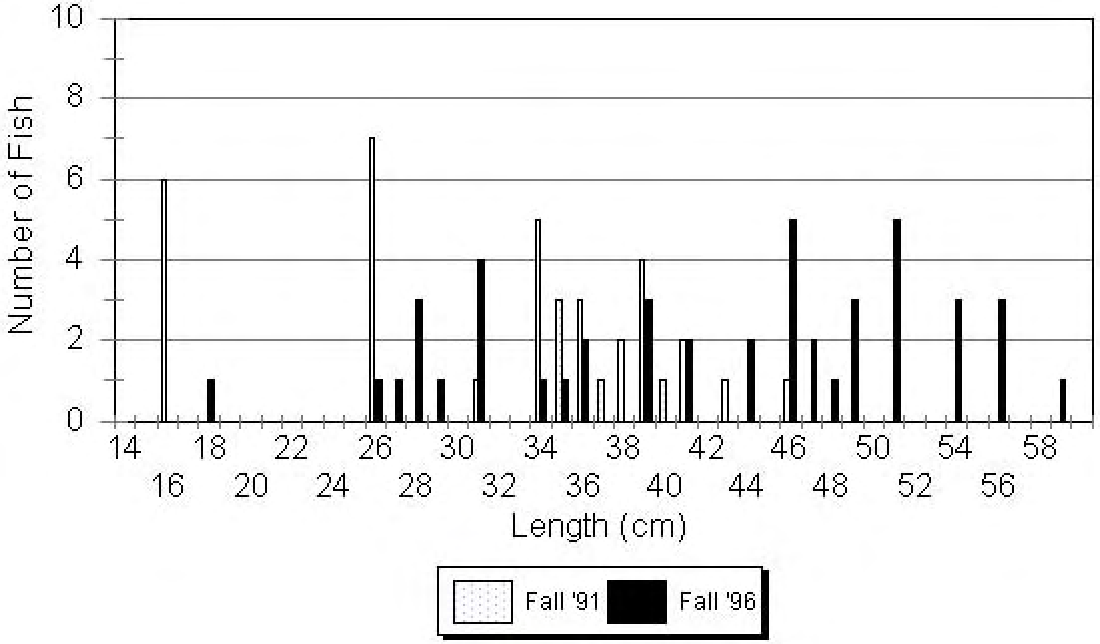


Figure 29. Total CPUE and CPUE of rainbow smelt greater than age 2 for Shelburne Bay, 1987 and 1990 - 1997. Age 3 and older smelt CPUE was plotted separately because smelt were not fully recruited to the sampling gear until age 3; their CPUE may be a more accurate index of population density.

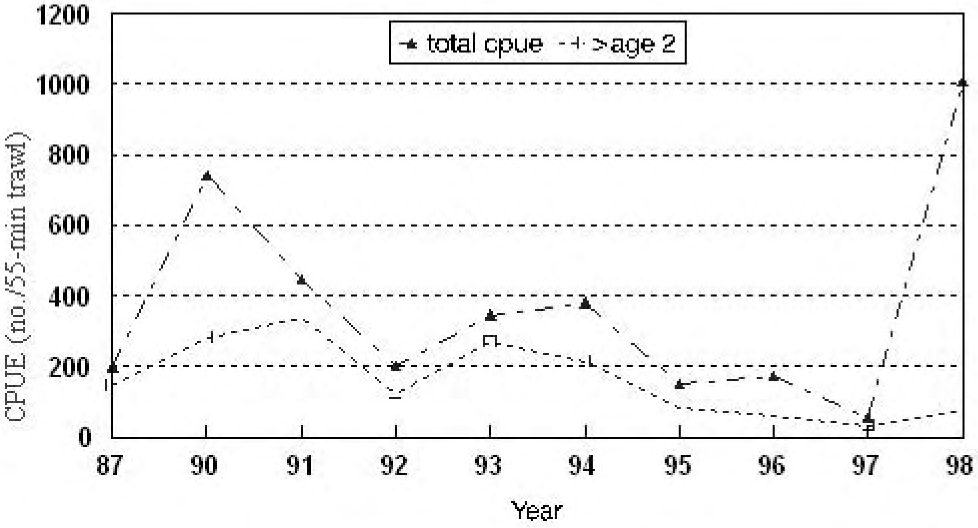


Figure 30. Total CPUE and CPUE of rainbow smelt greater than age 2 for Juniper Island, 1987 and 1990 - 1997. Age 3 and older smelt CPUE was plotted separately because smelt were not fully recruited to the sampling gear until age 3; their CPUE may be a more accurate index of population density.

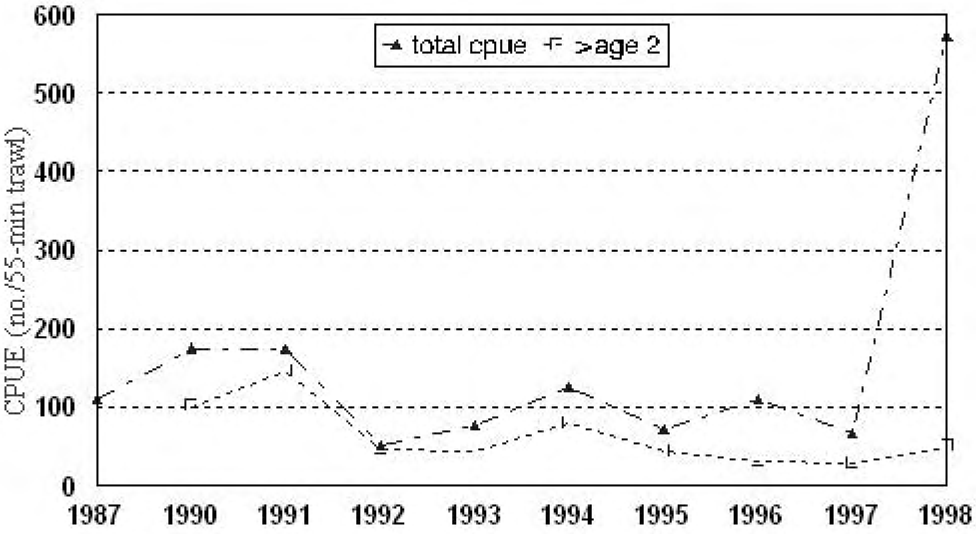


Figure 31. Total CPUE and CPUE of rainbow smelt greater than age 2 for Malletts Bay, 1987 and 1990 - 1997. Age 3 and older smelt CPUE was plotted separately because smelt were not fully recruited to the sampling gear until age 3; their CPUE may be a more accurate index of population density.

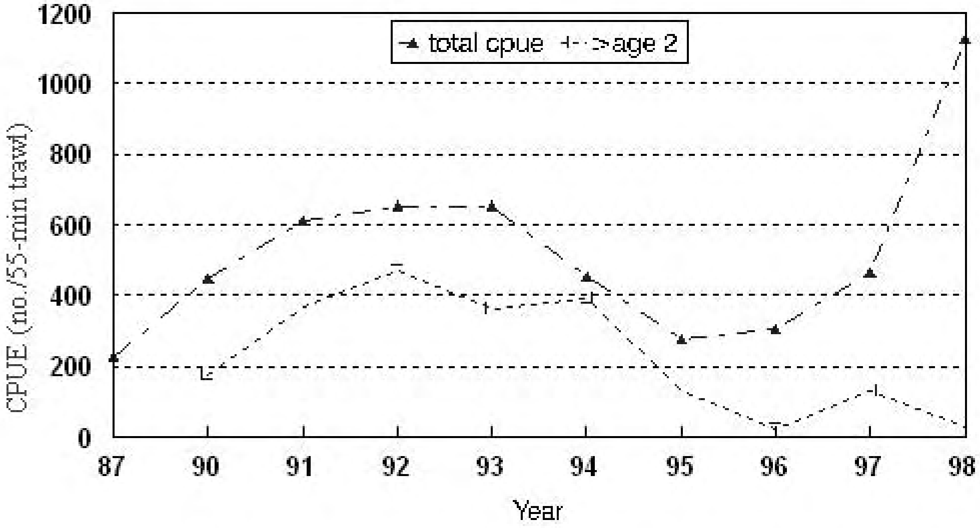


Figure 32. Total CPUE and CPUE of rainbow smelt greater than age 2 for the Northeast Arm, 1987 and 1990 - 1997. Age 3 and older smelt CPUE was plotted separately because smelt were not fully recruited to the sampling gear until age 3; their CPUE may be a more accurate index of population density.

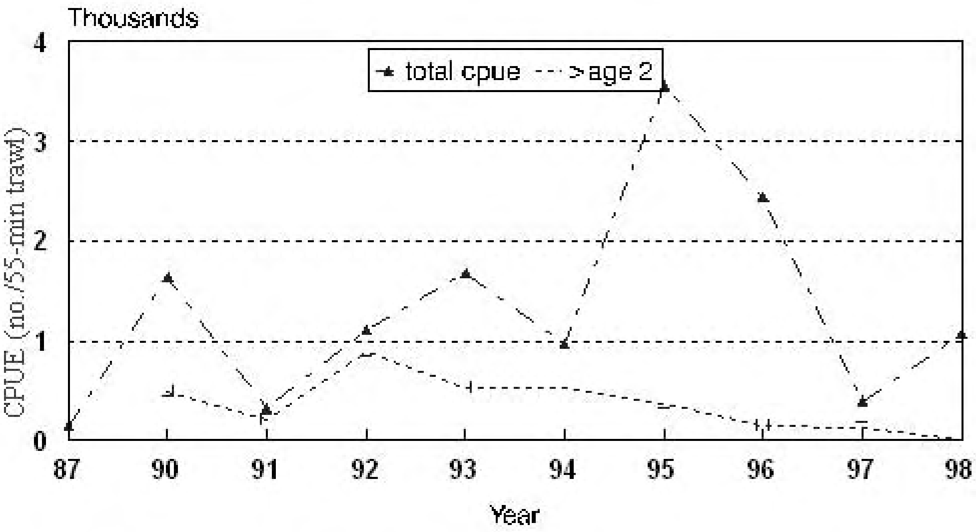


Figure 33. Mean length of angler-caught smelt measured in winter creel surveys in the Main Lake (Zone 2) and the Northeast Arm (Zone 5B), 1991-97 (Zone 5B was not surveyed in 1995 and 1996.).

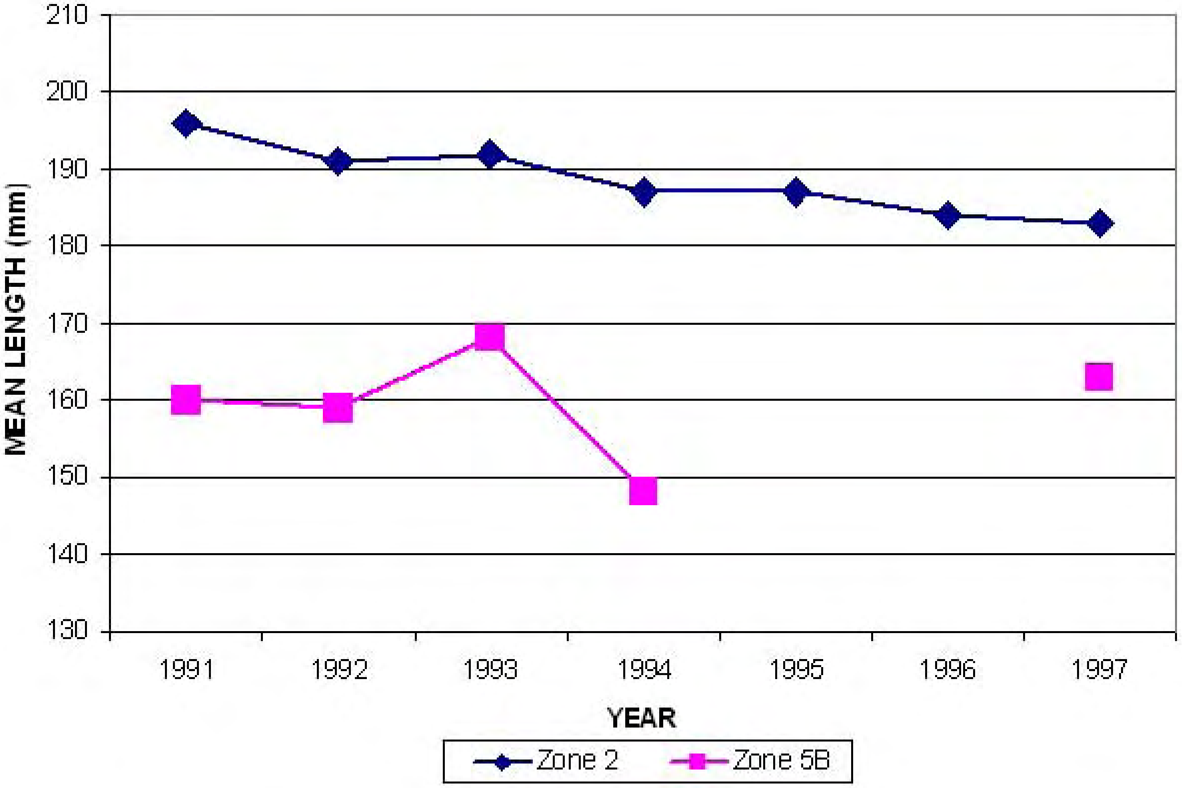


Table 1. Summary of lamprey mortality counts conducted post-treatment on Lake Champlain tributaries.

Treatment Year and River	Mortality Count All Lamprey	Mortality Count Sea Lamprey	Percent Sea Lamprey	Percent Sea Lamprey Transformers	Number of Sea Lamprey Transformers[a]
1990 Treatment					
Salmon River	64,853	64,828	99.96	20.02	12,976
Little Ausable River	122,530	122,456	99.94	25.65	31,411
Ausable River	36,699	24,506	66.78	9.43	2,310
Boquet River[b]	6,363	6,325	99.40	18.92	1,197
Beaver Brook	1,024	1,005	98.14	13.03	131
Putnam Creek	31,432	30,230	96.18	10.32	3,121
Lewis Creek	26,485	25,942	97.95	16.56	4,297
1991 Treatment					
Mount Hope Brook	27,145	26,970	99.36	15.77	4,252
Stone Bridge Brook	769	545	70.87	50.83	277
1992 Treatment					
Great Chazy River	132,993	132,796	99.85	31.41	41,706
Saranac River	394	394	100	0.76	3
Poultney River	298	197	66.11	0	0
Hubbardton River	182	182	100	4.40	8
1994 Treatment					
Salmon River	63,686	63,648	99.94	0.11	71
Little Ausable River	38,458	38,274	99.52	1.65	631
Ausable River	97,488	69,243	71.03	1.56	1,081
Boquet River	6,700	6,564	97.97	1.10	72
Putnam Creek	21,069	20,659	98.05	5.39	1,114
Lewis Creek	44,615	41,408	92.81	2.10	871
1995 Treatment					
Mount Hope Brook	11,323	11,308	99.87	12.67	1,433
Trout Brook	249	157	63.31	47.77	75
1996 Treatment					
Great Chazy River	22,724	22,712	99.95	1.74	395
Poultney River	9,308	6,759	72.61	14.63	989
Hubbardton River	20	20	100	0	0

[a] The numbers of sea lamprey transformers were derived by multiplying the proportion of transformers in random samples collected by mortality survey crews by the number of all lamprey mortalities observed.

[b] The sea lamprey mortality on the Boquet River certainly was greater than the recorded count because only portions of the river were surveyed. Observations made on the lower half of the river one day after treatment suggested the lamprey carcasses were distributed across the river in all sections. The mortality count for the Boquet River indicates that > 73% of the treatment mortality occurred in the lower portion of the river.

Table 2. Comparison of catch rates before and after treatment of residual sea lamprey collected between 1990 and 1996.

Treatment Year and River	Pre-treatment Survey Results Total Catch	Catch Rate CPUE[a]	Post-treatment Survey Results Total Catch	Catch Rate CPUE[a]	Percent Overall Reduction in Catch Rates	Number of Stations Sampled	Evaluation Criteria Achieved (Y/N)
1990 Treatment							
Salmon River	208	52	18	4.5	91.3	4	Y
Little Ausable River	598	66.4	8	.9	98.7	9	Y
Ausable River	31	7.8	18	4.5	41.9	4	N
Boquet River	--[b]	--[b]	99	12.4	--[b]	8	--[b]
Beaver Brook	--[b]	--[b]	20	20	--[b]	1	--[b]
Putnam Creek	198	66	14	4.6	92.9	3	Y
Lewis Creek	169	56.3	15	5	91.1	3	Y
1991 Treatment							
Mount Hope Brook	101	101	34	34	66.3	1	N
Stone Bridge Brook	232	116	0	0	100	2	Y
1992 Treatment							
Great Chazy River	562	80.3	7	1	98.8	7	Y
Saranac River	456	57	102	12.75	76.4	8	N
Poultney River	248	13	286	15	-15.3	19	N
Hubbardton River	72	7.2	2	0.2	97.2	10	Y
1994 Treatment							
Salmon River	1050	87.5	21	1.75	98	12	Y
Little Ausable River	684	85.5	16	1.5	95.7	11	Y
Ausable River	469	67	2	0.3	99.5	7	Y
Boquet River	170	24.3	25	3.6	81	7	N
Putnam Creek	922	84	285	25.9	69.1	11	N
Lewis Creek	544	49.5	20	1.81	96.3	11	Y
1995 Treatment							
Mount Hope Brook	216	31	8	1.14	96.3	7	Y
Trout Brook	80	10	0	0	100	8	Y
1996 Treatment							
Great Chazy River	561	80.1	0	0	100	7	Y
Poultney River	459	23	20	1	95.6	20	Y
Hubbardton River	18	1	1	0.125	94.4	8	Y

[a] CPUE refers to catch per unit effort equivalent to one half hour of electrofishing per standard-sized plot sampled.

[b] Due to flow conditions, pre-treatment surveys were not conducted in Beaver Brook and the Boquet River prior to the 1990 treatment.

Table 3. Post-treatment assessment surveys.

Stream	Survey Date	Number of re-established ammocoetes collected	Mean size, range (mm)	Ages
Lewis Creek	11/14/91	104	42 (27-57)	0+
Putnam Creek	11/19/91	25	28 (21-41)	0+
Little Ausable R.	11/20/91	63	26 (19-39)	0+
Salmon River	11/21/91	171	33 (18-49)	0+
Ausable River	11/18/92	27	64 (40-81)	0+, I+
Boquet River	11/19/92	2	61.5 (55-71)	I+
Mt. Hope Brook	12/01/92	3	42 (27-56)	0+
Stone Bridge Br.	08/30-09/02/93	0		
Beaver Brook	11/20/93	9	92.7 (86-98)	II+
Stone Bridge Br.	06/28-29/95	0		
Great Chazy R.	07/07/95	82	87 (43-103)	I+, II+
Poultney River	7/22-23/95	206	82 (46-104)	I+, II+
Saranac River	07/25/95	44	72 (44-87)	0+, I+, II+
Putnam Creek	06/28/98	112	64 (40-78)	
Salmon Creek	07/06/96	135	56 (12-76)	0+, I+
Little Ausable R.	07/26/96	26	48 (16-85)	0+, I+
Ausable River	07/15/96	74	30 (12-68)	0+, I+
Boquet River	08/14/96	4	65 (57-74)	I+
Mt. Hope Brook	08/28/96	1	42	0+
Poultney/Hub'ton	06/10,24/97; 07/8,22/97	0		
Great Chazy R.	07/30-31/97	0		
Lewis Creek	08/08/97	59	54 (42-92)	I+, II+
Stone Bridge Br.	09/11-12/97	0		
Trout Brook	09/19/97	0		

Table 4. Year class, age, mean size (mm) and growth rates (between years) at the end of the November growing season from re-established sea lamprey ammocoetes following TFM treatments (*indicates a treatment).

Salmon River	1990* (first treatment)	1991	1992	1993	1994*	1995	1996	1997
Age		0+	1+	2+	3+	0+	1+	2+
N		171	144	1148	481	4	131	269
Mean Size		33	64	90	115	33	65	93
Growth Rates (mm/yr)			31	26	25		32	28

Ausable River	1990* (first treatment)	1991	1992	1993	1994*	1995	1996	1997
Age		0+	1+	2+	3+	0+	1+	2+
N		52	125	389	166	25	9	40
Mean Size		40	64	101	117	35	80	105
Growth Rates (mm/yr)			24	37	16		45	25

Little Ausable River	1990* (first treatment)	1991	1992	1993	1994*	1995	1996	1997
Age		0+	1+	2+	3+	0+	1+	2+
N		1	161	682	1273	10	NA	12
Mean Size		27	62	89	111	37	62	84
Growth Rates (mm/yr)			35	27	22		25	22

Lewis Creek	1990* (first treatment)	1991	1992	1993	1994*	1995	1996	1997
Age		0+	1+	2+	3+	0+	1+	2+
N		103	149	382	3329			
Mean Size		42	80	102	122			
Growth Rates (mm/yr)			38	22	20			

Continued...

Table 4 (continued).

Putnam Creek	1990* (first treatment)	1991	1992	1993	1994*	1995	1996	1997
Age		0+	1+	2+	3+	0+	1+	2+
N		24	75	450	46	50	28	165
Mean Size		27	59	83	112	30	66	92
Growth Rates (mm/yr)		32 24 29 36 26						

Boquet River [a]	1990* (first treatment)	1991	1992	1993	1994*	1995	1996	1997
Age		0+	1+	2+	3+	0+	1+	2+
N		3	348	497	429			
Mean Size		30	55	84	112			
Growth Rates (mm/yr)		25 29 28						

Poultney River [b]		1991	1992*	1993	1994	1995	1996*	1997
Age				0+	1+	2+	3+	
N				10	85	145	361	
Mean Size				38	78	104	135	
Growth Rates (mm/yr)		41 26 31						

Great Chazy R. [c]		1991	1992*	1993	1994	1995	1996*	1997
Age				0+	1+	2+	3+	
N				14	43	314	523	
Mean Size				33	58	93	108	
Growth Rates (mm/yr)		25 35 15						

[a] Only residual animals were found during surveys conducted in 1995, 1996, and 1997, therefore growth rates could not be determined.

[b] No animals were collected during surveys conducted in 1997, following the 1996 treatment.

[c] Surveys conducted in the early summer of 1997, following the 1996 treatment, revealed only residuals, as young of the year were too small to be detected.

Table 5. Results of live cage bioassays used to monitor Lake Champlain sea lamprey control treatments with TFM on seven New York tributaries during 1990, 1994 and 1996 and to assess a pre-established evaluation standard relative to BAYER 73 effectiveness on delta areas of five New York tributaries during 1991 and four in 1995.

1990 TFM River / Delta	Number of Test Live-Cages Deployed	Number of Control Live-Cages Deployed	Number of Ammocoetes in Each Cage	Percent of Test Lamprey Killed	Percent of Control Lamprey Killed
Boquet	2	0	35 (20 am; 15 tr)[a]	100 & 87	n/a
Little Ausable	2	0	20	100	n/a
Ausable					
- North Fork	3	0	20 (10 am; 10 tr)[b]	75	n/a
- South Fork	4	0	20 (10 am; 10 tr)[b]	70	n/a

1994 TFM River / Delta	Number of Test Live-Cages Deployed	Number of Control Live-Cages Deployed	Number of Ammocoetes in Each Cage	Percent of Test Lamprey Killed	Percent of Control Lamprey Killed
Little Ausable	3	0	20	100	n/a
Ausable	3	0	20	100	n/a
Salmon	3	0	20	100	n/a

1996 TFM River / Delta	Number of Test Live-Cages Deployed	Number of Control Live-Cages Deployed	Number of Ammocoetes in Each Cage	Percent of Test Lamprey Killed	Percent of Control Lamprey Killed
Great Chazy	2	1	20	100	0
Poultney	4	1	20	100	0
Hubbardton	4	1	20	100	0

[a] Twenty ammocoetes and fifteen transformers were placed in these cages in 1990.
[b] Ten ammocoetes and ten transformers were placed in these cages in 1990.

Continued...

Table 5 (continued).

1991 Bayer River/ Delta	Number of Live Cages Deployed	Number of Lamprey Placed in Each Cage	Number of Live Lamprey Recovered	Number of Dead Lamprey Recovered	Percent of Lamprey Killed	Evaluation Standard Achieved
Ausable River	4	20	0	76	100	Y
Controls	1	20	19	0	0	
Saranac River	2	20	0	36	100	Y
Controls	1	20	18	0	0	
L. Ausable River	2	20	0	20	100	Y
Controls	1	20	20	0	0	
Salmon River	2	20	0	40	100	Y
Controls	1	20	18	0	0	
Boquet River	4	20	20	55	73	N
Controls	2	20	37	1	2.6	
Total	20	400	132	228	81	

1995 Bayer River/ Delta	Number of Live Cages Deployed	Number of Live Cages Recovered[c]	Number of Lamprey Placed in Each Live Cage	Number of Dead Lamprey Recovered[d]	Number of Live Lamprey Recovered	Percent of Lamprey Killed	Evaluation Standard Achieved
Ausable R.							
North Fork	4	2	20	38	0	100	Y
South Fork	3	3	20	51	4	93	Y
Salmon River	3	3	20	34	5	87	Y
Boquet River	3	3	20	60	0	100	Y
Saranac River	2	2	20	35	0	100	Y
Total	15	13	300	218	9	96	

[c] Two live cages were lost on the delta off the north fork of the Ausable River.
[d] Although 20 lampreys were placed in each live cage in some cases less than 20 were recovered.

Table 6. Numbers of sea lamprey collected with portable assessment traps from three Lake Champlain tributaries from 1989 - 1997.

Number of Sea Lamprey Collected				
Year	Stone Bridge Brook	Indian Brook	Lewis Creek	Total
1989	108	61	596	765
1990	350	410	489	1249
1991	91	184	219	494
1992	16	93	231	340
1993	12	59	234	305
1994	10	83	421	514
1995	13	125	109	247
1996	8	80	59	147
1997	2	8	58	68

Table 7. Trapping data collected from the permanent trap on the Great Chazy River in Champlain, New York for years 1993 - 1997.

Number of Sea Lamprey Collected	
Year	Great Chazy River
1993[a]	234
1994	--[b]
1995	1023
1996	1236
1997	223

[a] Portable assessment traps were unlikely to be as effective as the permanent trap installed in 1995.

[b] Data unavailable due to flood conditions.

Table 8. The number of sea lamprey nests in index stations of ten Lake Champlain tributaries during 1983-1997.

RIVER	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	ESA[a]
Great Chazy[b]	359	359	343	351	344	806	1192	842	851	619	139	89	13	21	5	Y
Salmon	326	198	251	250	185	319	352	212	200	169	126	254	168	74	103	N
Little	172	66	191	195	105	171	247	148	110	43	46	31	30	21	71	N
Boquet River	124	177	334	222	221	303	343	241	434	129	75	131	132	28	65	N
Putnam	496	466	828	626	513	1013	855	1010	791	407	316	286	343	233	599	N
Mt. Hope	121	72	36	76	40	37	108	53	53	10	13	22	10	43	37	N
Poultney	0	57	91	12	0	180	89	117	218	114	103	77	183	75	12	N
Lewis Creek	1326	1062	1098	883	790	1226	1137	1401	1066	401	549	464	223	107	975	N
LaPlatte	57	48	58	12	21	30	83	125	52	21	23	47	27	1	7	N
Pike River	198	175	153	165	180	186	198	124	149	74	44	87	140	100	194	N
TOTALS	3179	2680	3383	2792	2399	4271	4604	4273	3924	1987	1434	1488	1269	703	2068	

[a] Evaluation Standard Achieved

[b] Reductions in the nest count numbers for the Great Chazy River are a result of the completion of the sea lamprey barrier dam (1994) in the town of Champlain, NY, located downstream from the nest count index section.

Table 9. Percent change in mean nest counts during various post-control periods as compared to pre-control (1983 - 1991) mean nest counts for each of 10 Lake Champlain tributaries.

RIVER	1992 - 1994 [a]	1995 - 1997	1992 - 1997
Great Chazy River	-53%	-98%	-76%
Salmon River	-28%	-55%	-42%
Little Ausable River	-74%	-74%	-74%
Boquet River	-58%	-72%	-65%
Putnam Creek	-54%	-47%	-50%
Mount Hope Brook	-77%	-55%	-66%
Lewis Creek	-58%	-61%	-59%
LaPlatte River	-44%	-78%	-61%
Pike River	-60%	-15%	-37%
Poultney River	15%	6%	11%

[a] 1992 - 1994 capture effects of the first round of treatments in the experimental program.

Table 10. Mortality estimates for all lamprey species during the TFM treatments of Lake Champlain tributaries. Included are mortality estimates for sea lamprey, nontarget American brook, northern brook and silver lamprey.

Year	Stream	Total Mortality All Lamprey	Total Mortality Sea Lamprey	Total Mortality Brook Lamprey[a]	Total Mortality Silver Lamprey	% Sea Lamprey
1990	Boquet River	6,363	6,325	0	38	99.40%
	L. Ausable R.	122,530	122,456	74	0	99.94%
	Ausable R.	36,699	24,506	12,193	0	66.78%
	Salmon R.	64,853	64,828	25	0	99.96%
	Beaver Brook	1,024	1,005	0	19	98.14%
	Putnam Creek	31,432	30,230	0	1,202	96.18%
	Lewis Creek	26,485	25,942	0	543	97.95%
	1990 Totals	289,386	275,292	12,292	1,802	95.13%
1991	Stone Bridge Br.	769	545	0	224	70.87%
	Mt. Hope Br.	27,145	26,970	0	175	99.36%
	1991 Totals	27,914	27,515	0	399	98.57%
1992	Saranac River	394	394	0	0	100.00%
	Great Chazy	132,993	132,796	197 (NBL)	0	99.85%
	Poultney R.	298	197	0	101	66.11%
	Hubbardton R.	182	182	0	0	100.00%
	1992 Totals	133,867	133,569	197	101	99.78%
1994	Salmon River	63,686	63,648	38	0	99.94%
	Ausable River	97,488	69,243	28,245	0	99.52%
	Little Ausable R.	38,458	38,274	184	0	71.03%
	Boquet River	6,700	6,564	0	136	97.97%
	Putnam Creek	21,069	20,659	0	410	98.05%
	Lewis Creek.	44,615	41,408	0	3,207	92.81%
	1994 Totals	272,016	239,796	28,467	3,753	88.15%
1995	Mt. Hope Brook	11,323	11,308	0	15	99.87%
	Trout Brook	249	157	92	0	63.31%
	1995 Totals	11,572	11,465	92	15	99.08%
1996	Great Chazy R.	22,724	22,712	12 (NBL)	0	99.95%
	Poultney R.	9,308	6,759	0	2,549	72.06%
	Hubbardton R.	20	20	0	0	100.00%
	1996 Totals	32,052	29,491	12	2,549	92.06%

[a] All brook lamprey listed from the Great Chazy River in 1992 & 1996 were Northern brook lamprey; all others listed in the table were American brook lamprey.

Table 11. Estimates[a] of nontarget fin fish mortality, excluding native lamprey, associated with TFM treatments by species, water and treatment year.

	Boquet		Little Ausable		Ausable		Salmon		Beaver[b]	
Species	1990	1994	1990	1994	1990	1994	1990	1994	1990	Subtotal
Bowfin			6	2						8
Rainbow trout										0
Brown trout										0
Brook trout										0
Central mudminnow										0
Redfin pickerel										0
Grass pickerel										0
Northern pike			2	16	1					19
Muskellunge										0
Chain pickerel										0
Cutlips minnow										0
Brassy minnow										0
Silvery minnow										0
Golden shiner		2		1						3
Common shiner	1	1	1			1		10		14
Blacknose shiner										0
Spottail shiner				1						1
Rosyface shiner		1		1				1		3
Mimic shiner										0
Bluntnose minnow		1	1	4	12	1		1		20
Fathead minnow									1	1
Blacknose dace					1		1			2
Longnose dace		3			2		3			8
Creek chub				1						1
Fallfish		1	2	3		1	1	1		9
Pearl dace										0

[a] Nontarget fin fish mortality was assessed by actual counts over most treated stream sections. Exceptions were Ausable Chasm which is inaccessible and a 1700' segment of section 9 of the Great Chazy River, where counts of nontargets in two 50' transects were expanded to provide total mortality estimates for the segment in 1992. The actual-count technique produces a minimum-biased estimate of nontarget kill. Water clarity, light conditions, water depth, vegetation, substrate characteristics, etc., prevent detection of all affected organisms.

[b] Crews treated Beaver Brook only in 1990 during the eight-year experimental program period.

Continued...

Table 11 (continued).

	Boquet		Little Ausable		Ausable		Salmon		Beaver[c]	
Species	1990	1994	1990	1994	1990	1994	1990	1994	1990	Subtotal
Unidentifd. *Notropis*										0
Unidentifd. Cyprinid										0
Longnose sucker				1		1				2
White sucker	1			10			2	1	1	15
Yellow bullhead										0
Brown bullhead			1	28			18			47
Channel catfish										0
Stonecat			21	196			141	185		543
Tadpole madtom			6							6
Trout-perch										0
Banded killifish	1				21	1				23
Brook stickleback					10					10
Rock bass			3							3
Pumpkinseed	1			1						2
Bluegill				8						8
Smallmouth bass		1		1						2
Largemouth bass						2				2
Black crappie										0
Fantail darter						2				2
Tessellated darter[d]	2	5	5	24	7	16	1	1	6	67
Yellow perch										0
Log perch				23	9	82				114
Slimy sculpin				1						1
Unidentified fish		1				1				2

[c] Crews treated Beaver Brook only in 1990 during the eight-year experimental program period.

[d] There is possibility that some of these were misidentified, and may have been johnny darters.

Continued...

Table 11 (continued).

	Putnam		Lewis		Stone Bridge[e]	Mount Hope		Trout[e]	
Species	1990	1994	1990	1994	1991	1991	1995	1995	Subtotal
Bowfin		1	6			2			9
Rainbow trout		9							9
Brown trout		2							2
Brook trout		7					1		8
Central mudminnow		2				1	3		6
Redfin pickerel			2						2
Grass pickerel						4			4
Northern pike		1	23		5				29
Muskellunge									0
Chain pickerel			23	10		78	19		130
Cutlips minnow									0
Brassy minnow									0
Silvery minnow								35	35
Golden shiner			1	1		1			3
Common shiner			26	1	5				32
Blacknose shiner						1			1
Spottail shiner									0
Rosyface shiner									0
Mimic shiner		4							4
Bluntnose minnow					725				725
Fathead minnow									0
Blacknose dace	8	424	66		6	2	8	1	515
Longnose dace		2	53	2					57
Creek chub	1		11				4		16
Fallfish							7		7
Pearl dace							22		22

[e] Crews treated Stone Bridge and Trout Brooks only once each in 1991 and 1995, respectively during the eight-year experimental program period.

Continued...

Table 11 (continued).

	Putnam		Lewis		Stone Bridge[f]	Mount Hope		Trout[f]	
Species	1990	1994	1990	1994	1991	1991	1995	1995	Subtotal
Unidentifd. *Notropis*			2						2
Unidentifd. Cyprinid									0
Longnose sucker									0
White sucker	8	9	29		170	2	75	4	297
Yellow bullhead						9	12		21
Brown bullhead		3	18	6	3	14	8	17	69
Channel catfish									0
Stonecat									0
Tadpole madtom									0
Trout-perch			20						20
Banded killifish									0
Brook stickleback									0
Rock bass									0
Pumpkinseed						1			1
Bluegill									0
Smallmouth bass			1	2					3
Largemouth bass									0
Black crappie									0
Fantail darter									0
Tessellated darter[g]	2	3	114	4	64	14	35	1	237
Yellow perch			1	1		1			3
Log perch	4	22	248	26	7	10		1	318
Slimy sculpin		13					1		14
Unidentified fish						1			1

[f] Crews treated Stone Bridge and Trout Brooks only once each in 1991 and 1995, respectively, during the eight-year experimental program period.

[g] There is possibility that some of these were misidentified, and may have been johnny darters.

Continued...

Table 11 (continued).

	Saranac h	Poultney		Hubbardton		Great Chazy			All Waters
Species	1992	1992	1996	1992	1996	1992	1996	Subtotal	Grand Total
Bowfin							1	1	18
Rainbow trout	5							5	14
Brown trout								0	2
Brook trout	1							1	9
Central mudminnow							3	3	9
Redfin pickerel								0	2
Grass pickerel								0	4
Northern pike						1		1	49
Muskellunge						23	1	24	24
Chain pickerel								0	130
Cutlips minnow							5	5	5
Brassy minnow			1					1	1
Silvery minnow				1				1	36
Golden shiner								0	6
Common shiner						1	1	2	48
Blacknose shiner								0	1
Spottail shiner								0	1
Rosyface shiner		1						1	4
Mimic shiner								0	4
Bluntnose minnow			1			9		10	755
Fathead minnow			1					1	2
Blacknose dace								0	517
Longnose dace							1	1	66
Creek chub	2							2	19
Fallfish	1	1	1			3	2	8	24
Pearl dace								0	22

[h] Crews treated the Saranac River only in 1992 during the eight-year experimental program period.

Continued...

Table 11 (continued).

	Saranac[i]	Poultney		Hubbardton		Great Chazy			All Waters
Species	1992	1992	1996	1992	1996	1992	1996	Subtotal	Grand Total
Unidentifd. *Notropis*								0	2
Unidentifd. Cyprinid		1		1				2	2
Longnose sucker								0	2
White sucker			3			24	1	28	340
Yellow bullhead								0	21
Brown bullhead						41	5	46	162
Channel catfish							1	1	1
Stonecat	331					5,768	88	6,187	6,730
Tadpole madtom								0	6
Trout-perch								0	20
Banded killifish	1							1	24
Brook stickleback								0	10
Rock bass						1	11	12	15
Pumpkinseed				1				1	4
Bluegill		1						1	9
Smallmouth bass						2		2	7
Largemouth bass			1					1	3
Black crappie							1	1	1
Fantail darter						17	49	66	68
Tessellated darter[j]			9	1	1		3	14	318
Yellow perch								0	3
Log perch	32		4			561	28	625	1,057
Slimy sculpin								0	15
Unidentified fish								0	3

[i] Crews treated the Saranac River only in 1992 during the eight-year experimental program period.

[j] There is possibility that some of these were misidentified, and may have been johnny darters.

Table 12. Estimates[a] of nontarget macro-invertebrate and amphibian mortality associated with TFM treatments presented by species, water and treatment year.

	Boquet		Little Ausable		Ausable		Salmon		Beaver[b]	
Species	1990	1994	1990	1994	1990	1994	1990	1994	1990	Subtotal
Leech										0
Crayfish		1	4	8	2	6		4		25
Mussel			1	1						2
Red-spotted newt										0
Two-line salamander										0
Dusky salamander										0
Mudpuppy			3		35	22				60
Unident. salamander			3	12	4	30	9	6	2	66
Leopard frog										0
Frog tadpole		3		6	4	2		1		16
Frog adult		2		3		4				9
Unidentified worm										0

	Putnam		Lewis		Stone Bridge[b]	Mount Hope		Trout[b]	
Species	1990	1994	1990	1994	1991	1991	1995	1995	Subtotal
Leech									0
Crayfish	1	3	3						7
Mussel			8						8
Red-spotted newt						295	67		362
Two-line salamander						21	6		27
Dusky salamander					14				14
Mudpuppy	5		17	9					31

Unident. salamander	3	90	13	3					109
Leopard frog									0
Frog tadpole					364	6	1		371
Frog adult		3		5	1				9
Unidentified worm						1			1

[a] Nontarget invertebrate and amphibian mortality was assessed by actual counts over most treated stream sections. Exceptions were Ausable Chasm which is inaccessible and a 1700' segment of section 9 of the Great Chazy River, where counts of nontargets in two 50' transects were expanded to provide total mortality estimates for the segment in 1992. The actual-count technique produces a minimum biased estimate of nontarget kill. Water clarity, light conditions, water depth, vegetation, substrate characteristics, etc., prevent detection of all affected organisms. Only large macro-invertebrates such as crayfish and mussels were counted.

[b] Crews treated Beaver, Stone Bridge and Trout Brooks only in 1990, 1991 and 1995, respectively, during the eight-year experimental program.

Continued...

Table 12 (continued).

	Saranac[c]	Poultney		Hubbardton		Great Chazy			All Waters
Species	1992	1992	1996	1992	1996	1992	1996	Subtotal	Grand Total
Leech							1	1	1
Crayfish							4	4	36
Mussel	2						13	15	25
Red-spotted newt								0	362
Two-line salamander								0	27
Dusky salamander								0	14
Mudpuppy								0	91
Unident. salamander	4		2			1,209	442	1,657	1,832[d]
Leopard frog						1		1	1
Frog tadpole						1,460	3,614	5,074	5,461
Frog adult						4	11	15	33
Unidentified worm								0	1

[c] Crews treated the Saranac River only in 1992 during the eight-year experimental program.

[d] Most unidentified salamanders from the Great Chazy River were probably mudpuppies. Instead of all affected specimens, only representative samples were collected there. They have been sent to NYSDEC herpetologists for species identification. Please note that NYSDEC herpetologists have, in fact, identified many of the salamanders from other waters, which are listed above as unidentified. Most were not mudpuppies, but common salamanders such as the two-line salamander. The Breisch Amphibian Study (Breisch 1996) contains species identifications for most. Unfortunately, numbers of salamanders reported collected or observed by field assessment crews (above) do not always precisely correspond to the numbers reported identified by Breisch et al. Therefore, for the purposes of this table, no species listing was made.

Table 13. Target and nontarget lamprey mortality counts for 1991 Bayer 73 delta treatments.

River	Number of Shoreline Sections	Number of Gull Plots	Number of Sea Lamprey Observed	Number of American Brook Lamprey Observed	Percent Sea lamprey
Boquet River	4	4	19	0	100%
Salmon River	4	3	168	13	92.82%
Saranac River	4	2	229	0	100%
Ausable River	4	4	140	207	40.35%
Little Ausable	3	2	0	0	0%

Table 14. Target and nontarget lamprey mortality counts for 1995 Bayer 73 delta treatments.

River	Number of Shoreline Sections	Number of Sea Lamprey Observed	Number of American Brook Lamprey Observed	Percent Sea lamprey
Boquet River	4	2	0	100%
Salmon River	3	50	17	74.63%
Saranac River	2	2	0	100%
Ausable River	4	1905	1030	64.91%

Table 15. Numbers of dead nontarget finfish recorded in samples representing varying portions[a] of Bayer 73 (5% granular)-treated river deltas by species, delta and treatment year.

	Boquet		Ausable		Little Ausable	Salmon		Saranac		
Species	1991	1995	1991	1995	1991[b]	1991	1995	1991	1995	Total
Northern pike								1[c]		1
Golden shiner								2		2
Emerald shiner	13	22	44	100		2	1	3		185
Common shiner								4		4
Spottail shiner	52		5	2,100		8	2	1		2,168
Rosyface shiner							6			6
Sand shiner			1							1
Mimic shiner	56[d]	40	86[d]	9,200				3[d]	3	9,385
Blacknose dace	1									1
Longnose dace	47	4				25	5			81
Fallfish			2							2
Unidentifd. *Notropis*			20							20
Unidentifd. Cyprinid							8			8
White sucker						94		60		154

Black bullhead						1				1
Brown bullhead	2			5	6	4		2		19
Banded killifish	44	2	128	18,600		1	1,520	1		20,296
Rock bass						6		1		7
Lepomis spp.				7						7
Pumpkinseed					15			2		17
Bluegill					1		8	4		13

[a] This table presents qualitative information only, and it is <u>not</u> suitable for quantitative use. Due to survey / sampling problems, it substantially under represents mortality in 1991 on the Boquet Delta by approximately 7200 - 7300 fish, and on the Ausable Delta by more than 7500 - 8800 fish. Other data presentation problems may influence the accuracy of table content. Individual delta tables (Appendix E) more precisely describe sampling, data expansion, visual estimate and actual count methods.

[b] No Bayer 73 (5% Granular) treatment was conducted on the Little Ausable delta in 1995, because surveys indicated no recolonization had taken place. One of two shoreline sections surveyed in 1991 was surveyed intensively by staff from NYSDEC's Endangered Species Unit (ESU) for affected amphibians. Affected amphibians are reported separately in the Breisch Amphibian Study.

[c] This specimen was too deep for collection; species identification is probably correct.

[d] Species identification is tentative.

Continued...

Table 15 (continued).

Species	Boquet 1991	Boquet 1995	Ausable 1991	Ausable 1995	Little Ausable 1991[e]	Salmon 1991	Salmon 1995	Saranac 1991	Saranac 1995	Total
Smallmouth bass	4		6	2		10		2		24
Largemouth bass	9			8				1		18
Johnny darter							1			1
Tessellated darter	6[f]		60[f]	8				5[f]	3	82
Yellow perch	1		132	8	3	18		53		215
Log perch			1	2		1		1		5
Mottled sculpin						13	1			14
Slimy sculpin	18							2		20
Unidentified fish	2,170			137,500	7,500					147,170

[e] No Bayer 73 (5% Granular) treatment was conducted on the Little Ausable delta in 1995, because surveys indicated no recolonization had taken place. One of two shoreline sections surveyed in 1991 was surveyed intensively by staff from NYSDEC's Endangered Species Unit (ESU) for affected amphibians. ESU staff reported an estimated 5,000 - 10,000 small fish were killed due to the treatment near the shoreline section they surveyed. These are represented by the figure 7,500 in the table.

[f] These specimens, or a portion of them, may be johnny darters as they were originally identified as such.

Table 16. Numbers of dead nontarget invertebrate and amphibians recorded in samples representing varying portions[a] of Bayer 73 (5% granular)-treated river deltas by species, delta and treatment year.

	Boquet		Ausable		Little Ausable	Salmon		Saranac		
Species	1991	1995	1991	1995	1991[b]	1991	1995	1991	1995	Total
Crayfish	1				1					2
Snail							2			2
Mussel				22			10			32
Frog tadpole				1						1

[a] This table presents qualitative information only, and it is <u>not</u> suitable for quantitative use. Individual delta tables (Appendix E) more precisely describe sampling, data expansion, visual estimate and actual count methods.

[b] No Bayer 73 (5% Granular) treatment was conducted on the Little Ausable delta in 1995, because surveys indicated no recolonization had taken place. One of two shoreline sections surveyed in 1991 was surveyed intensively by staff from NYSDEC's Endangered Species Unit (ESU) for affected amphibians. Affected amphibians are reported separately in the Breisch Amphibian Study.

Table 17. Macroinvertebrate community metrics over a six year period from station 3.5 (riffle Habitat) on Lewis Creek, VT. Also included is the mean density of the TFM sensitive taxon Trichoptera *Chimarra* spp. (Fiske and Langdon 1994).

Date	1988	1989	1990B	1990A	1991	1992	1993
Density/2 min KN[a]	1898	3967	4025	4569	2526	2517	2244
Species Richness	41	50.5	67	54.5	47	44.1	42.5
EPT Richness	21.5	25.3	25.6	27.8	24.5	23.1	20.5
Bio Index (0-5)	1.95	2.10	2.26	2.18	1.77	1.77	2.22
Diversity	3.87	4.52	4.56	4.35	4.36	4.15	4.34
EPT/EPT& Chiro	0.95	0.87	0.84	0.78	0.96	0.88	0.69
% Dominant Taxa	20	16	24	19	24	19	19
Density *Chimarra* spp.	36	191	88	3[b]	45	65	56

[a] KN refers to Kick Net, the sampling technique used.

[b] Significantly different ($P < 0.05$) compared to all other years sampled using the Kruskal-Wallace statistic and the Student Newmens-Keuls test.

Table 18. Mean Index of Biotic Similarity (B) values between year contrast associations of dominant genera at station 3.5 (Fiske and Langdon 1994).

Contrast Associations	Before vs Before	Before vs After	After vs After
Mean B [a]	0.45	0.52	0.51
Range	0.39-0.49	0.41-0.62	0.42-0.65

[a] A mean B value is generated for each contrast association by comparing all possible combinations of years within a particular contrast association.

Table 19. Macroinvertebrate community metrics over a six year period from a clay bank habitat on Lewis Creek, VT. Also included is the density of the TFM sensitive taxa (Fiske and Langdon 1994). Superscripts indicate years that are significantly different from each other at an alpha level of $P < 0.05$ using the Kruskal-Wallace and Student-Newman-Keuls test.

Date	1988	1989	1990 B	1990 A	1991	1992	1993
Density/m^2	4,813^{93}	5,070^{9} 3	4,250^{93}	5,215^{93}	5,465^{93}	7,755^{93}	12,130
Richness	14.3^{92,93}	16^{92,93}	15^{92,93}	16.8^{92,93}	14.4^{92,93}	20.8	23.2
Diversity	3.10	3.30	3.18	3.30	2.89	3.21	3.39
% Dominance	26	19	21	19	26	27	25
Density *Hexagenia* sp.	137.5	115^{91}	180	70^{91}	273	178	85^{91}
Density *Phylocentropus* sp.	25$^{90A\&B}$	310	485	505	16$^{89,90A\&B}$	85$^{90A\&B}$	170
Density *Pisidium* spp.	587.5	760	290^{93}	660	279^{93}	217^{93}	1674

Table 20. Population parameters for the fish community at Lewis Creek, station 3.7, before and after the application of TFM (Fiske and Langdon 1994).

Parameters	1989	1990 B (before)	1990 A (after)	1991	1992
Species Richness	17	18	17	14	14
VTIBI[a]	39 (g-exc)	39 (g-exc)	39 (g-exc)	39 (g-exc)	41 (exc)
Total Density[b]	44.8	83.1	37.7	46.1	50.3
Total Density[c]	68.7	134.8	80.2	75.3	82.1[d]

[a] VTIBI values range from 9 (very poor) to 45 (excellent).

[b] Density equals numbers of fish collected in the first electrofishing pass converted to #s / 100 m^2.

[c] Density in #s / 100 m^2 from fish collected from two electrofishing passes.

[d] Value estimated from previous ratios of pass two numbers to total numbers.

Table 21. Results of 1992 mussel population monitoring in the Poultney River in conjunction with the TFM treatment of September 24, 1992 (Fichtel 1992).

	Bed # 90-08-02-02[a]		Bed # 90-09-06-02		Bed # 90-08-25-02	Bed # 91-07-28-01
Species	09/14/92	10/02/92	07/25/92	10/02/92	07/25/92	07/26/92
Elliptio complanata	659	982	323	200	1742	271
Lampsilis radiata	53	94	37	22	74	28
Strophitus undulatus	3	5	3	2	19	0
Lampsilis cardium	10	4	49	16	57	20
Anodonta grandis	1	0	1	1	13	6

Lasmigona costata	1	6	5	2	13	3
Lasmigona compressa	0	0	0	0	0	0
Potamilus alatus	2	2	6	4	7	5
Ligumia recta	0	0	2	0	1	0
Leptodea fragilis	3	4	10	9	20	11
Unidentif'd mussels	0	664	0	0	0	0
Total number	732	1761	436	256	1946	344
Number mussels/m^2	26.3	63.2	15.6	9.2	26.2	6.2

[a] This mussel bed was also monitored during TFM treatment.

Table 22. The macroinvertebrate community biometrics before and after TFM treatment of Trout Brook, Milton VT. Data represent the means (and percent standard error of the mean) of selected metrics from three replicate KN [kick net] samples (VTDEC 1996).

	Density	Richness	EPT	EPT/ Richness	Bio Index	EPT/ EPT&C	%Dominant Taxa
Before 9/5/95	861 (44%)	32.5 (9%)	5.4 (26%)	.16	2.61 (<1%)	.55 (1.8%)	27 Stenonema
After 9/15/95	1260 (14%)	41.7 (6%)	6.3 (19%)	.15	2.40 (<1%)	.67 (3.9%)	24 Stenonema

Table 23. The percent composition of the major groups of macroinvertebrates before and after TFM treatment of Trout Brook (VTDEC 1996).

	Coleoptera	Diptera	Ephem-eroptera	Trichoptera	Plecoptera	Odonata	Other
Before 9/5/95	1	54	41	<1	1	2	4
After 9/15/95	2	51	38	2	2	3	5

Table 24. The percent composition of the macroinvertebrate functional groups before and after TFM treatment of Trout Brook, Milton, VT. (VTDEC 1996).

	Collector Gatherer	Collector Filterer	Predator	Shredder Detritus	Shredder Herbivore	Scraper
Before 9/5/95	36	12	18	<1	5	27
After 9/15/95	25	17	16	5	2	26

Table 25. The percent composition of dominant macroinvertebrate taxa (genera) from Trout Brook before and after a TFM treatment (VTDEC 1996).

	Before - 9/5/95	After - 9/15/95
Diptera:		
Atherix sp.	10	6
Cricotopus sp.	5	2
Parametriocnemus sp.	13	6
Simulium spp.	7	14
Chrysops sp.	2	4
Tipula sp.	<1	5
Ephemeroptera:		

Baetis spp.	11	6
Stenonema sp.	27	24
Leptophlebiidae imm.	2	4

Table 26. Size classes of mudpuppy *(Necturus maculosus)* collected in special-effort surveys from the Ausable River, NY, following TFM applications, September 1990 and 1994 (derived from Breisch 1996).

Size Range	Number (%) Collected 1990[a]	Number (%) Collected 1994[b]
19 mm - 42 mm	17 (81%)	28 (67%)
62 mm - 101 mm		8 (19%)
117 mm - 135 mm	1 (5%)	2 (5%)
155 mm - 174 mm	2 (10%)	
237 mm - 295 mm	1[c] (5%)	4 (9%)

[a] Percentages were rounded to the nearest full unit. Four small mudpuppies observed dead in 1990 were not included in this table because they were in water too deep for collection.

[b] Percentages were rounded to the nearest full unit. Two stressed, but alive, adult mudpuppies were included in the 1994 length frequency summary.

[c] This stressed mudpuppy was revived in untreated water and released alive.

Table 27. Mean invertebrate sample counts and levels of significance of the Wilcoxon Rank Sum Test on the Little Ausable River Delta (derived from Gruendling and Bogucki 1993b).

	Date					Significance Level[a]		
	1	2	3	4				
Group	9/10/90	9/03/91	9/15/91	9/08/92		2 vs. 3	2 vs. 4	1 vs. 4
Diptera	0.55	1.48	0.32	2.56		0.0007	0.6701	0.2507
Oligochaeta	9.88	17.48	16.78	12.36		0.9367	0.0476	0.1247
Hirudinea	4.53	4.48	0.66	2.98		0.0001	0.0428	0.0283
Trichoptera	0.98	3.02	2.74	2.26		0.5904	0.0631	0.0060
Pelecypoda	4.27	3.30	0.12	0.16		0.0001	0.0001	0.0001

Gastropoda	22.51	27.74	3.28	3.76		0.0001	0.0001	0.0001
Isopoda	0.27	0.88	0.94	3.25		0.4741	0.0001	0.0001
Amphipoda	9.20	16.62	25.00	38.32		0.0517	0.0001	0.0001

[a] Level of significance of the Wilcoxon Rank Sum Test used to determine if the two distributions on specific dates are equal. Numbers in column headings correspond to numbers above dates in date columns. The Little Ausable delta was treated on September 10, 1991.

Table 28. Mean invertebrate sample counts and levels of significance of the Wilcoxon Rank Sum Test on the Ausable River Delta. (Derived from Gruendling and Bogucki 1993b).

	Date					Significance Level[a]		
	1	2	3	4				
Group	9/11/90	9/04/91	9/16/91	9/10/92		2 vs. 3	2 vs. 4	1 vs. 4
Ephemeroptera	1.50	0.94	0.85	0.90		0.4630	0.5804	0.0060
Diptera	9.13	13.25	9.22	5.12		0.0002	0.0001	0.0001
Hirudinea	0.47	1.82	0.52	0.41		0.0027	0.0009	0.3573
Oligochaeta	3.71	8.08	3.00	2.53		0.0007	0.0004	0.9592
Pelecypoda	2.39	3.48	0.34	0.12		0.0001	0.0001	0.0001

Gastropoda	3.71	10.64	1.80	0.43		0.0001	0.0001	0.0001
Isopoda	0.00	0.40	0.32	0.20		0.7441	0.1613	0.3269
Amphipoda	0.84	3.38	3.20	2.75		0.8705	.05411	0.0065

[a] Level of significance of the Wilcoxon Rank Sum Test used to determine if the two distributions on specific dates are equal. Numbers in column headings correspond to numbers above dates in date columns. The Ausable delta was treated on September 12, 1991.

Table 29. Mean unionid mussel sample counts and levels of significance of the Wilcoxon Rank Sum Test on the Little Ausable River (0.25 m^2 plots) and Ausable River (2.5 m^2 plots) Deltas (derived from Gruendling and Bogucki 1993b).

Delta	Species	Date			Significance Level[a]	
		1	2	3		
		9/07/91	9/13/91	9/11/92	1 vs. 2	1 vs. 3
Little Ausable	*Lampsilis r. radiata*	1.40	0.32	0.20	0.0001	0.0001
	Elliptio complanata	3.41	1.96	1.06	0.0001	0.0001
		9/08/91	9/15/91	9/14/92	1 vs. 2	1 vs. 3
Ausable	*Lampsilis r. radiata*	4.01	2.25	1.58	0.0001	0.0001

	Elliptio complanata	1.52	0.77	0.55	0.0002	0.0001

[a] Level of significance of the Wilcoxon Rank Sum Test used to determine if the two distributions on specific dates are equal. Numbers in column headings correspond to numbers above dates in date columns. The Little Ausable delta was treated on September 10, 1991 and the Ausable delta was treated on September 12, 1991.

Table 30. Summary of unionid mussel (Pelecypoda) percent mortality estimates on the Little Ausable River and Ausable River deltas following application of Bayer 73 lampricide as compared to pre-treatment conditions, September, 1991 (from Gruendling and Bogucki 1993b).

	Little Ausable River Delta		Ausable River Delta	
Mortality Estimates	*Lampsilis r. radiata*	*Elliptio complanata*	*Lampsilis r. radiata*	*Elliptio complanata*
Population (1 week post-treatment)	77%	42%	43%	49%
Population (1 year post-treatment)	86%	69%	71%	77%
Experimental Field Plot (3 days post-treatment)	77%	29%	53%	9%
Experimental Cage (3 days post-treatment)	94%	70%	74%	33%

Table 31. Results of mortality estimates for unionid mussels from the Little Ausable River Delta following Bayer 73 application. Cage experiments included 10 animals of each species. Field plots sampled 202 individuals of *Elliptio complanata* and 56 of *Lampsilis r. radiata* (from Gruendling and Bogucki 1993b).

Site	*Elliptio complanata*				*Lampsilis r. radiata*			
	Cage Experiments		Field Plots		Cage Experiments		Field Plots	
	Number	% Mortality	Number	% Mortality	Number	% Mortality	Number	% Mortality
1	10	100	17	52.9	10	100	12	91.6
2	10	50	30	23.3	10	80	7	42.8
3	10	100	11	63.6	10	100	1	100.0

4	10	100	7	71.4	10	100	5	100.0
5	10	100	7	71.4	10	100	3	33.3
6	10	100	8	62.5	10	100	3	100.0
7	10	20	22	36.3	10	100	6	83.3
8	10	30	33	6.0	10	90	4	100.0
9	10	30	37	16.2	10	80	12	58.3
10	10	70	30	16.6	10	90	3	100.0
Mean		70.0		29.2		94.0		76.8
Control	10	0	ND	ND	10	0	ND	ND

Table 32. Results of mortality estimates for unionid mussels from the Ausable River Delta following Bayer 73 application. Cage experiments included 10 animals of each species. Field plots sampled 33 individuals of *Elliptio complanata* and 387 of *Lampsilis r. radiata* (from Gruendling and Bogucki 1993b).

Site	*Elliptio complanata*				*Lampsilis r. radiata*			
	Cage Experiments		Field Plots		Cage Experiments		Field Plots	
	Number	% Mortality	Number	% Mortality	Number	% Mortality	Number	% Mortality
11	10	0	5	0	10	30	12	33.3
12	10	0	2	0	10	90	13	53.9
13	10	60	1	0	10	100	26	53.9

14	10	50	0	0	10	100	19	79.0
15	10	0	9	11.1	10	40	60	41.7
16	10	0	2	50.0	10	60	33	45.5
17	10	70	3	0	10	100	67	58.2
18	10	0	7	0	10	10	103	31.1
19	10	50	0	0	10	100	36	94.4
20	10	70	0	0	10	100	6	100.0
21	10	60	4	25.0	10	80	12	100.0
Mean		32.7		9.1		73.6		52.5
Control	10	0	ND	ND	10	0	ND	ND

Table 33. Native unionid species collected on the Ausable and Little Ausable deltas, June 1995 (Lyttle 1995).

Delta	Total Area Sampled	Standard Deviation	Eastern elliptio	Eastern lampmussel	Eastern floater	Giant Floater	Total # Mussels
Ausable	164.5 m^2	0.499	291	296	10	3	600
Little Ausable	39.5 m^2	0.495	497	30	6	1	534
Totals	204.0 m^2	NA	788	326	16	4	1134

Table 34. Minimum, maximum, mean and standard deviation of the number of gastropods collected in the five sampling periods taken on the Ausable and Little Ausable delta areas (Lyttle 1995).

Delta	Gastropods / plot	1990	1991A[a]	1991B[a]	1992	1995
Little Ausable	minimum #	8	0	0	0	0
	maximum #	57	71	13	15	821
	mean #	22.51	27.74	3.28	3.76	51.48
	standard deviation	12.8	16.9	3.1	3.6	121.1
Ausable	minimum #	0	0	0	0	0
	maximum #	19	45	11	7	147
	mean #	3.71	10.64	1.8	0.44	21.67
	standard deviation	4.5	12.7	3.0	1.3	34.4

[a] 1991A samples collected before Bayer 73 treatment; 1991B samples were collected after Bayer 73 treatment.

Table 35. Relative abundance and collection locations of mussel species found in Lake Champlain, 1995. Relative abundance categories based on number of mussels per site are abbreviated as follows: Rare (R) = 1-2, Uncommon (U) = 3-9, Common (C) = 10-20, Abundant (A)>20, S = shell. (Lyttle 1995).

Species abbreviations are as follows:

E.c. = *Elliptio complanata* (Eastern elliptio),
L.r. = *Lampsilis r. radiata* (Eastern lampmussel),
L.o. = *Lampsilis ovata* (pocketbook),
P.a. = *Potamilus alatus* (pink heelsplitter),
L.f. = *Leptodea fragilis* (fragile papershell),
P.c. = *Pyganodon cataracta* (Eastern floater),
P.g. = *Pyganodon grandis* (giant floater),
A.f. = *Anodontoides ferussacianus* (cylindrical papershell),
L.c. = *Lasmigona costata* (fluted-shell)

Site	State	Latitude	Longitude	E.c	L.r.	L. o	P.a.	L.f.	P.c.	P.g.	A.f.	L.c.
East Creek Delta	VT	43 49 58	73 22 37	A		R		R		R		

Chimney Point	VT	44 02 24	73 25 15	A	A	R	U					
Otter Creek Delta	VT	44 13 30	73 19 30	A	C	R	R	R		R		
Hawkins Bay[a]	VT	44 14 33	73 17 25	R	U	S						
Lewis Creek Delta[a]	VT	44 14 47	73 16 50	A	C	R	U		R			
S. Winooski Delta	VT	44 31 33	73 16 37	C	C	R		R				
N. Winooski Delta	VT	44 31 57	73 17 05	C	C	U	R	R				
Colchester Pt.	VT	44 33 46	73 18 25	C	C							
Whites Beach[a]	VT	44 37 15	73 19 50	A	A							
Cumberland Head	NY	44 41 35	73 23 34	R	U							
Isle La Motte[a]	VT	44 54 20	73 20 38	A	A							
Reynolds Point Bay	VT	44 54 32	73 20 13	A	U				R	R		
Windmill Pt.	VT	44 59 00	73 20 00	C	C							
Cooper Pt.	VT	44 54 00	73 19 04	C	U							
Sucker Brook	VT	44 54 09	73 18 23	A	U				R	R		
Allen Pt.[a]	VT	44 35 43	73 18 17	A	A							
N. Lamoille Delta[a]	VT	44 36 55	73 14 53	A	A	U	U	R				R
Great Back Bay	VT	44 36 20	73 13 53	A	A	S	R		S			
Paradise Bay	VT	44 39 02	73 15 30	A	U				R	R		

[a] At these sites the relative abundance categories of Rare to Uncommon were quantitative. At all other sites, the categories were based on an average number from three 10 m transects and a ½ hour random survey of the area to locate rare species.

Continued...

Table 35 (continued).

Site	State	Latitude	Longitude	E.c	L.r.	L.o	P.a.	L.f.	P.c.	P.g.	A.f.	L.c.
N. of Sandbar	VT	44 37 50	73 13 55	A	A					R		
Beech Bay	VT	44 37 55	73 20 45	U	U							
Rockwell Bay	VT	44 40 02	73 20 47	R	U							
Stone Br. Bk. Delta	VT	44 40 32	73 12 40	C	C				R		R	
Trout Brook Delta	VT	44 38 35	73 12 40	A	A							

Keeler Bay	VT	44 40 07	73 18 43	A	A				S	R		
Knight Pt.[b]	VT	44 46 06	73 17 51	A	A							
Ladd Pt.[b]	VT	44 46 09										
N. Hero School[b]	VT	44 51 04	73 16 03	A	A							
Savage Pt.	VT	44 50 11	73 17 29	A	A							
S. of Wagner Pt.	VT	44 54 35	73 16 07	A	A					R		
Stephenson Pt.	VT	44 55 15	73 14 20	A	A					R		
Maquam Bay “B”	VT	44 55 32	73 10 25	A	A				R			
Maquam Bay “A”	VT	44 55 53	73 11 50	A	A	R		S	R			
Ransoms Bay	VT	44 57 27	73 15 38	A	A							
Missisquoi Delta	VT	44 60 20	73 10 00	A	U							
Province Pt.[b]	VT	44 60 37	73 11 35	A	C							
South Bay	NY	43 34 52	73 26 25	R	R		R	R				
Ticonderoga Light.	NY	43 50 57	73 22 44	U	U		R	R		R		R
Putnam Cr. Delta	NY	43 57 25	73 24 11	A	A		R					
Beaver Brook Delta	NY	45 06 42	73 26 00	R	U					R		
Mullen Bay	NY	45 05 57	73 25 43	C	A				R			
Cole Bay	NY	44 08 26	73 25 35	R	C				R	R		
North West Bay	NY	44 11 17	73 25 50	C	A							

[b] At these sites the relative abundance categories of Rare to Uncommon were quantitative. At all other sites, the categories were based on an average number from three 10 m transects and a ½ hour random survey of the area to locate rare species.

Continued...

Table 35 (continued).

Site	State	Latitude	Longitude	E.c	L.r.	L. o	P.a.	L.f.	P.c.	P.g.	A.f.	L.c.
Young Bay	NY	44 09 33	73 24 21	U	R					R		
Boquet River Delta	NY	44 21 20	73 21 20	U	U					R		
Ligonier Pt.	NY	44 24 02	73 22 51	U	C							
Ltl. Ausable Delta[c]	NY	44 34 56	73 26 10	A	A				R			

N. Ausable Delta[c]	NY	44 33 58	73 25 17	U	U							
S. Ausable Delta[c]	NY	44 33 24	73 25 17	U	U				R	R		
Bluff Pt.	NY	44 38 51	73 26 10	U	C							
Jordan Point Bay	NY	44 52 06	73 19 35	A	U							
Salmon River Delta	NY	44 38 00	73 26 42	U	U				R			
Kings Bay	NY	44 56 53	73 22 45	C	U							
Great Chazy Delta	NY	44 55 02	73 24 97	A	A				R			

[c] At these sites the relative abundance categories of Rare to Uncommon were quantitative. At all other sites, the categories were based on an average number from three 10 m transects and a ½ hour random survey of the area to locate rare species.

Table 36. A combined list of gastropod species found on the Ausable and Little Ausable deltas, and other Lake sections in which they are found indicated with an "X". The Missisquoi Delta lake section is not included in this table (Lyttle 1995).

Gastropod species	Main Lake	Inland Sea	Malletts Bay	South Lake
Bithynia tentaculata	X	X	X	X
Birgella subglobosa	X			

Gyraulus deflectus	X	X		
Gyraulus parvus	X	X	X	
Gillia altilis	X	X		
Pseudosuccinea columella	X	X	X	X
Valvata tricarinata	X	X		
Valvata lewisi	X	X		
Valvata sincera	X	X	X	
Valvata bicarinata	X			
Lyogyrus pupoidea	X			
Amnicola limosa	X	X	X	
Amnicola grana	X			
Amnicola walkeri	X			
Promenetus exacuous	X	X		
Planorbella trivolvis	X	X	X	
Leptocosa convalta	X			
Physidae	X	X		
Helisoma anceps	X	X	X	
Helisoma companulata	X			
Helisoma trivolvis	X			
Fossaria sp.	X			
Campeloma decisum	X			
Stagnicola catascopium	X			

Table 37. Lake Champlain Main Lake lake trout stockings by year class. Percent Finger Lakes strain refers to the percent of equivalent yearlings comprised of Finger Lakes strain fish. A summary of lake trout stockings is provided in Appendix G.

Year Class	Total Number Stocked	Number Equivalent Yearlings Stocked	% Finger Lakes Strain		Year Class	Total Number Stocked	Number Equivalent Yearlings Stocked	% Finger Lakes Strain
1972	39000	39000	0		1985	166640	166640	100
1973	60340	60340	11		1986	212280	212280	100
1974	340703	140916	91		1987	159770	159770	35
1975	230911	160742	0		1988	158765	158765	100
1976	226748	159293	99		1989	124300	124300	100
1977	190709	190709	100		1990	240034	240034	100
1978	116573	116573	100		1991	204778	204778	100
1979	162322	118860	67		1992	170722	170722	100
1980	297437	271863	78		1993	197192	197192	100
1981	266302	266302	32		1994	105155	105155	100
1982	203400	203400	43		1995	68541	68541	100
1983	255504	176660	82		1996	69724	69724	100
1984	320088	212478	87		1997	87084	87084	100

Table 38. Summary of lake trout gill net sets by state and zone for the period 1982 through 1997.

	# Net sets in Zones 3A & 3B			# Net sets Outside Zones 3A & 3B	
Year	NY	VT	3A & 3B Total	VT Only[a]	Total lake trout catch
1982	83	73	156	83	476
1983	109	83	192	7	679
1984	108	112	220	19	1285
1985	82	72	154	14	582
1986	96	47	143	0	552
1987	96	77	173	14	686
1988	96	78	174	15	807
1989	96	39	135	2	699
1990	96	99	195	43	1225
1991	48	66	114	39	734
1992	96	93	189	31	1123
1993	96	100	196	36	1327
1994	95	102	197	41	1477
1995	95	102	197	44	1387
1996	96	105	201	44	2484
1997	96	104	200	46	1581

[a] except 1982, when NY had 33 net sets in Zone 2B.

Table 39. Total catch and capture status (gilled vs. not gilled) for lake trout by state for years 1986 through 1997.

CAPTURE STATUS	NEW YORK	VERMONT
GILLED	3,619 (64%)	6,663 (92%)
NOT GILLED	2,065 (36%)	583 (8%)

Table 40. Corrected numbers of lake trout by year class. Numbers have been corrected for gill net selectivity, swimming speed, the high '84 and '96 CPUE, and stocking levels of Finger Lakes equivalents. Non-Finger Lakes strains have been excluded where possible.

Year Class	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11
1979	17.89	13.22	7.75	6.49	2.85	2.36	1.28	0.22	0
1980	87.65	37.65	25.21	17.97	11.66	5.99	3.98	2.01	0
1981	172.96	59.52	33.55	16.43	12.06	10.14	4.91	4.22	2.27
1982	171.33	83.46	36.41	22.97	18.77	10.96	16.18	5.45	0.57
1983	72.06	36.31	21.90	11.94	9.37	9.98	5.05	2.34	0.75
1984	73.92	52.51	27.05	26.61	22.17	13.08	10.67	6.11	0.04
1985	34.18	28.96	24.09	17.29	10.94	8.93	5.72	2.55	0.45
1986	61.66	22.15	13.32	9.43	8.51	6.02	2.90	1.49	0.13
1987	65.88	39.60	25.06	18.13	12.42	8.85	5.04	2.58	
1988	33.46	33.36	17.03	13.97	10.16	6.17	5.32		
1989	38.92	28.75	23.37	20.06	15.06	11.86			
1990	54.75	47.30	22.99	17.21	13.88				
1991	72.34	35.28	24.36	17.12					
1992	53.16	39.52	22.13						
1993	47.92	46.23							

<u>Age 3 - 4 Survival</u>

Pre-Control (Year classes 1979 thru 1987) Average Survival = 0.35 SD = .07
Post-Control (Year Classes 1988 thru 1993) Average Survival = 0.44 SD = .06

Post-control survival represents a 25% increase over the pre-control period

H_o= Survival_{post} - $\text{Survival}_{pre} \leq 0$
t = 2.429 *P* = .015 (one -tailed)
H_1 = Survival_{post} - $\text{Survival}_{pre} > 0$

<u>Age 3 - 6 Survival</u>

Pre-control (Year Classes 1979 - 1987) Average Survival = 0.47 SD = .05
Post-control (Year Classes 1988 - 1991) Average Survival = 0.52 SD = .03

Post-control survival represents a 10% increase over the pre-control period

H_o= Survival_{post} - $\text{Survival}_{pre} \leq 0$
t = 1.602 *P* = .069 (one -tailed)
H_1 = Survival_{post} - $\text{Survival}_{pre} > 0$

<u>Age 5 - 9 Survival</u>

Pre-control (Year classes 1979-1985) Average Survival = 0.57 SD = .03
Post-control (Year classes 1986-1988) Average Survival = 0.58 SD = .01

Post control essentially unchanged from pre-control period (a 2% increase)

H_o= Survival_{post} - $\text{Survival}_{pre} \leq 0$
t = 0.542 *P* = .301 (one -tailed)
H_1 = Survival_{post} - $\text{Survival}_{pre} > 0$

Table 41. Corrected numbers of lake trout by netting year. Numbers have been adjusted for equal recruitment, and for gill net selectivity, swimming speed, the high '84 and '96 CPUE, and stocking of Finger Lakes equivalents. Non-Finger Lakes strain have been excluded where possible.

Netting Year	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
1997	70.39	67.91	29.31	16.66	17.85	21.45	11.19
1996	70.39	52.33	23.71	22.13	27.24	12.98	5.39
1995	70.39	34.33	29.56	36.28	21.38	9.46	3.31
1994	70.39	60.82	42.27	29.39	13.27	6.87	11.78
1993	70.39	52.00	35.83	19.37	9.72	18.39	10.16
1992	70.39	70.19	26.78	10.77	22.53	12.46	4.93
1991	70.39	42.31	15.21	35.61	21.11	9.75	6.65
1990	70.39	25.29	49.62	25.34	9.15	4.50	2.00
1989	70.39	59.65	25.76	11.66	7.71	4.13	3.20
1988	70.39	50.01	21.39	9.44	4.91	4.81	5.04
1987	70.39	35.47	14.96	6.69	9.36	9.29	0
1986	70.39	34.29	13.66	14.43	11.21	0	0
1985	70.39	24.23	20.25	25.54			
1984	70.39	30.24	30.50				
1983	70.39	52.02					

Age 3 - 4 Survival

Pre-control (netting years 1983 thru 1990) Average Survival = 0.35 SD = .08
Post-control (netting years 1991 thru 1997) Average Survival = 0.43 SD = .06

Post-control represents a 24% increase over the pre-control period

H_o : $\text{Survival}_{\text{post}}$ - $\text{Survival}_{\text{pre}} \leq 0$

t = 2.26 *P* = 0.021

H_1 : $\text{Survival}_{\text{post}}$ - $\text{Survival}_{\text{pre}} > 0$

Age 3 - 6 Survival

Pre-control (netting years 1985 thru 1990) Average Survival = 0.47 SD = .05
Post-control (netting years 1991 thru 1997) Average Survival= 0.51 SD = .03

Post-control represents a 9% increase over the pre-control period

H_o : $\text{Survival}_{\text{post}}$ - $\text{Survival}_{\text{pre}} \leq 0$

t = 1.98 *P* = 0.037

H_1 : $\text{Survival}_{\text{post}}$ - $\text{Survival}_{\text{pre}} > 0$

Age 5 - 9 Survival

Pre-control (netting years 1986 thru 1990) Average Survival = 0.51 SD = .06
Post-control (netting years 1991 thru 1997) Average Survival= 0.59 SD = .03

Post-control represents a 16% increase over the pre-control period

H_o : $\text{Survival}_{\text{post}}$ - $\text{Survival}_{\text{pre}} \leq 0$

t = 3.15 *P* = 0.005

H_1 : $\text{Survival}_{\text{post}}$ - $\text{Survival}_{\text{pre}} > 0$

Table 42. Estimated mortality of age 6-9 lake trout checked in 1990 and 1997 creel surveys, where N = number of lake trout in sample, Z_C and A_C = total instantaneous mortality rate and annual mortality rate, respectively, corrected for total yearling equivalents stocked, and Z_{FL} and A_{FL} = total instantaneous mortality rate and annual mortality rate, respectively, corrected for Finger Lakes strain equivalents stocked only.

Year (season)	N	Z_C (SE)	A_C	Z_{FL} (SE)	A_{FL}
1990 (open water)	223	1.53 (0.24)	0.88	1.16 (0.07)	0.79
1997 (open water)	461	0.49 (0.05)	0.39	0.49 (0.05)	0.39
1997 (winter)	153	0.35 (0.03)	0.30	0.35 (0.03)	0.30

Table 43. Estimated lake trout exploitation rates and angler tag reporting rates derived from tags recovered in 1990, 1991 and 1997 creel surveys, where N = number of harvested lake trout examined, N_T = number observed with tags from previous year, H_T = expanded number of tagged lake trout in harvest, u = annual exploitation rate, u_c = annual exploitation rate corrected for 26% annual tag loss (Fabrizio et al. 1996), TR = tags returned by anglers within creel survey area and period, R_{TR} = estimated tag reporting rate.

Tag year	No. tagged	Creel year	N	N_T	H_T	u	u_c	TR	R_{TR}
1989	346	1990	424	1	35	0.10	0.14	11	0.32
1990	349	1991	187	1	28	0.08	0.11	4	0.15
1996	892	1997	835	5	95	0.11	0.14	26	0.29

Table 44. Lake Champlain lake trout length (mm) at age statistics. Ages of fish were determined by analysis of fin-clip and length frequency data with scale reading in overlap areas.

Net							AGES						
Year		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1997	Number	16	51	163	294	187	284	314	147	89	17	4	6
	Avg Length	224	322	371	445	520	620	651	681	674	705	790	810
	std dev.	45	31	31	44	46	62	44	45	36	50	19	25
	Year Class	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985
1996	Number	39	67	347	371	475	602	288	155	47	55	14	
	Avg Length	236	311	384	467	556	632	669	675	691	731	750	
	std dev.	48	21	37	44	54	42	51	41	39	38	34	
	Year Class	1995	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984
1995	Number	12	81	186	245	358	205	135	44	61	40	2	
	Avg Length	220	311	378	471	576	651	653	662	699	733	798	
	std dev.	42	29	31	47	46	55	42	52	47	36	21	
	Year Class	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983
1994	Number	9	43	295	380	165	183	55	116	88	98	9	1
	Avg Length	200	302	374	479	571	622	653	682	696	712	767	801
	std dev.	32	49	37	53	51	49	54	37	40	31	27	
	Year Class	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982
1993	Number	8	53	300	118	153	95	177	140	196	39	1	2
	Avg Length	190	300	385	468	545	626	663	674	682	699	745	772
	std dev.	19	26	44	43	41	60	40	49	35	39		6
	Year Class	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981
1992	Number	6	55	110	179	103	161	167	237	61	22	10	
	Avg Length	215	330	392	469	552	614	664	677	685	725	750	
	std dev.	28	42	43	43	59	48	39	35	44	29	28	
	Year Class	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980
1991	Number	9	7	95	56	95	123	222	68	40	12		
	Avg Length	245	347	377	454	550	607	644	662	683	706		
	std dev.	67	34	37	46	35	50	36	48	45	30		
	Year Class	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979
1990	Number	5	48	148	167	207	400	116	51	29	30		
	Avg Length	225	321	382	473	552	616	650	668	701	681		
	std dev.	13	48	49	45	71	41	42	37	39	39		
	Year Class	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978
1989	Number	3	37	162	97	190	81	52	32	38	1		
	Avg Length	238	332	379	474	574	637	655	677	680	748		
	std dev.	21	35	35	47	53	59	61	41	35			
	Year Class	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977

Table 44 (continued).

Net							AGES						
Year		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII

1988	Number	3	43	108	295	151	79	47	60	7			
	Avg Length	251	317	400	492	583	629	662	674	720			
	std dev.	11	25	39	48	56	59	41	47	64			
	Year Class	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976
1987	Number	6	21	248	132	82	44	84	26				
	Avg Length	215	302	393	489	551	610	642	694				
	std dev.	17	35	42	47	50	58	49	43				
	Year Class	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975
1986	Number	11	69	151	108	65	92	34					
	Avg Length	209	295	405	483	566	616	688					
	std dev.	22	35	40	46	40	65	45					
	Year Class	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974
1985	Number	30	38	146	81	138	40	34	40	5		11	
	Avg Length	199	315	386	491	568	609	669	686	740		729	
	std dev.	20	35	40	38	40	36	28	29	17		28	
	Year Class	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973
1984	Number	14	97	395	314	91	128	28		27			
	Avg Length	228	303	384	487	566	680	691		720			
	std dev.	36	30	37	44	47	31	34		23			
	Year Class	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972
1983	Number	3	87	211	85	109	117	43	21				
	Avg Length	172	317	393	475	594	647	678	709				
	std dev.	21	26	36	56	32	37	31	35				
	Year Class	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971
1982	Number	5	88	44	82	163	42	2	48				
	Avg Length	175	301	388	508	591	644	703	689				
	std dev.	16	26	48	43	39	32	4	37				
	Year Class	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970

Table 45. Lamprey attack data for the Lake Champlain lake trout taken by New York and Vermont, 1982-1997.

Size Group Total Length (mm)	Year	Total Number of Fish	Wounding Rate (%)	Wounds Per 100 Fish
< 432	1982	110	12.7	15
(< 17")	1983	276	22.1	32
	1984	483	18	24
	1985	56	12.5	27
	1986	204	23	29
	1987	211	16.1	18
	1988	149	14.1	18
	1989	203	9.8	14
	1990	124	14.5	18
	1991	69	11.6	16
	1992	155	7.8	7
	1993	238	4.2	6
	1994	342	4.1	5
	1995	260	3.5	3
	1996	429	4.4	6
	1997	359	7.3	7
432-532	1982	69	39.1	45
(17.0 - 20.9")	1983	96	31.2	40
	1984	263	22.8	27
	1985	34	32.4	35
	1986	132	31.8	50
	1987	182	30.8	35
	1988	235	28.9	33
	1989	208	31	29
	1990	98	18.4	23
	1991	58	20.7	22
	1992	142	7.8	6
	1993	152	11.2	12
	1994	278	12.6	14
	1995	231	13	14
	1996	390	10.1	17
	1997	296	18.7	20
533-633	1982	166	42.8	58
(21.0 - 24.9")	1983	138	50	65
	1984	207	39.4	51
	1985	69	40.6	46
	1986	105	54.3	68
	1987	133	33.1	44
	1988	205	37.1	45
	1989	208	42.3	52
	1990	235	52.8	71
	1991	206	51	66
	1992	182	25.3	22
	1993	153	22.9	29
	1994	269	33.8	41
	1995	373	24.4	29
	1996	636	23.8	34
	1997	396	37.2	53

Continued...

Table 45 (continued).

Size Group Total Length (mm)	Year	Total Number of Fish	Wounding Rate (%)	Wounds Per 100 Fish
634-736	1982	86	51.2	72
(25.0 - 28.9")	1983	148	61.5	85
	1984	266	45.3	62
	1985	44	59.1	105
	1986	131	60.9	100
	1987	69	48	81
	1988	100	45.5	68
	1989	154	40.5	62
	1990	163	56.4	82
	1991	214	53.3	83
	1992	394	28.9	34
	1993	418	43.1	60
	1994	325	42.1	63
	1995	298	37.9	52
	1996	594	33.6	49
	1997	465	54.7	87
737-837	1982	3	33.3	67
(29.0 - 32.9")	1983	5	60	60
	1984	21	52.4	76
	1985	4	50	100
	1986	10	60	90
	1987	5	80	100
	1988	22	54.5	113
	1989	18	55.6	89
	1990	12	83.3	133
	1991	14	78.6	178
	1992	36	44.4	53
	1993	20	55	75
	1994	51	56.9	94
	1995	51	35.3	65
	1996	79	37.3	61
	1997	65	55	94

Table 46. A t-test ($P \leq 0.05$) comparing the number of sea lamprey wounds (I-III) and scars (IV) per hundred lake trout before sea lamprey control (1982-1991) and after sea lamprey control (1992-1997). The t-test was preformed for five size classes of lake trout and for all size classes combined.

	Wounds/100 Lake Trout					
	Size Class (mm)					Size Class (mm)
Year	<432	432-532	533-633	634-736	737-837	All Size Classes Combined
t stat	13.06	11.42	10.61	7.91	4.24	14.38
P-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Significant	yes	yes	yes	yes	yes	yes

	Scars/100 Lake Trout					
	Size Class (mm)					Size Class (mm)
Year	<432	432-532	533-633	634-736	737-837	All Size Classes Combined
t stat	4.66	10.73	13.14	6.62	2.76	2.00
P-value	<0.001	<0.001	<0.001	<0.001	<0.001	0.022
Significant	yes	yes	yes	yes	yes	yes

Table 47. Comparison of wounding and scarring on lake trout before (1982 - 1991) and after (1992 - 1997) sea lamprey control, after adjusting for the relative number of lamprey vulnerable lake trout in the lake each year. The adjustment was made by multiplying each fish's wounds and scars by that year's average catch per net lift in Zones 3A/3B, after correcting for the high CPUE in 1984 and 1996. The mean number of wounds and scars per fish reported here are not actual numbers; they are the result of multiplying the actual data by an index. For actual wounding and scarring rates refer to Table 45.

WOUNDS

Length Group	Period (Pre or Post Control)	N (# fish)	Mean (# wounds)	Std. Deviation	Post-Control Significantly Less than Pre- (*P* ≤ .05)
<432mm	Post (1992-97) Pre (1982-91)	2155 2338	0.3607 0.9068	1.6095 2.2774	Yes
432-532mm	Post Pre	1717 1555	.9412 1.4717	2.5641 2.6027	Yes
533-633mm	Post Pre	2329 2057	2.2107 2.5314	4.1387 3.4090	Yes
634-736mm	Post Pre	2852 1637	3.4508 3.3834	5.4040 4.3217	No
737-837mm	Post Pre	321 131	4.3412 4.9494	5.7253 5.3019	No

SCARS

Length Group	Period (Pre or Post Control)	N (# fish)	Mean (# wounds)	Std. Deviation	Post-Control Significantly Less than Pre- (*P* = .05)
<432mm	Post (1992-97) Pre (1982-91)	2155 2338	0.2386 0.3263	1.5592 1.3345	Yes
433-532mm	Post Pre	1717 1555	1.6742 2.3799	3.6256 4.0538	Yes
533-633mm	Post Pre	2329 2057	5.7865 6.4139	6.8076 6.3974	Yes
634-736mm	Post Pre	2852 1637	13.096 11.338	11.3918 9.5273	No
737-837mm	Post Pre	321 131	23.615 20.415	15.970 14.407	No

Table 48. Estimated lake trout catch and harvest (± 90% confidence intervals), average weight (lbs) of harvested lake trout and expanded number of lake trout >25" TL, from lakewide open water creel surveys in 1990 and 1997 (Chipman 1999).

	1990	1997	% Change
Estimated catch	23,345 ± 3,270	41,162 ± 4,999	+76[a]
Estimated harvest	14,381 ± 2,665	15,869 ± 1,933	+7
Harvested lake trout examined:			
No. weighed	395	747	
Avg. weight (SE)	3.92 (0.07)	4.18 (0.06)	+7[b]
No. measured (SE)	424	835	
% > 25" Total Length	20.0	28.3	+42[c]
Expanded No. in harvest > 25"	2,996	4,491	+50[c]

[a] Exceeds lake trout fishery-level evaluation standard 1.
[b] Does not exceed lake trout fishery-level evaluation standard 2.
[c] Exceeds lake trout fishery-level evaluation standard 3.

Table 49. Estimated lake trout catch and harvest (± 90% confidence intervals) from open water creel surveys in Zone 3A-B in 1990, 1991, 1995 and 1997 (Chipman 1999).

Year	Catch	Harvest
1990	13,145 ± 2,240	7,583 ± 1,592
1991	9,892 ± 1,729	5,299 ± 1,038
1995	18,245 ± 3,571	6,742 ± 1,555
1997	24,417 ± 4,485	9,145 ± 1,566

Table 50. Estimated lake trout catch and harvest (± 90% confidence intervals) and expanded number of harvested lake trout >25 in TL, from winter creel surveys in Zones 2 (entire) and 4 (South Hero to Isle LaMotte portion) from 1991 through 1997. Winter surveys were conducted in Vermont waters only, with the exception of Zone 2 in 1991 and 1997, when both Vermont and New York waters were surveyed (Chipman 1999, Durfey 1997).

Zone	Year	Estimated Catch	Estimated Harvest	No. Measured (% > 25" TL)	Expanded Harvest > 25" TL
2	1991 (VT)	558 + 245	442 + 261	56 (33.9)	150
	1991 (NY)	189 ± 150	113 ± 73 [a]	4 (22.2)	25
	1992 (VT)	1,885 ± 801	1,261 ± 465	269 (39.0)	492
	1993 (VT)	519 ± 167	499 ± 153	143 (35.7)	178
	1995 (VT)	323 ± 146	230 ± 184	91 (30.8)	71
	1996 (VT)	1,175 ± 531	683 ± 311	118 (28.0)	191
	1997 (VT)	261 ± 125	213 ± 102	61 (39.3)	84
	1997 (NY)	2,468 ± 1,224	1,068 ± 529 [a]	8 (8.6)	92
4	1991 (VT)	208 ± 210	205 ± 205	11 (36.4)	75
	1994 (VT)	726 ± 248	307 ± 117	122 (36.1)	111
	1997 (VT)	1,821 ± 1,477	528 ± 283	117 (24.7)	130

[a] Harvest was not estimated in the NY creel surveys, however an estimate of the catch of legal-sized lake trout was made and could be considered an equivalent statistic.

Table 51. Catch and effort statistics for Lake Champlain angler diary cooperators. These statistics include only main-lake trips where lake trout was the sole target. Catch per hour refers to the total catch (including harvested and released fish) of all lake trout while creel rate refers to only harvested lake trout. (One-tailed t-test used.)

YEAR	NUMBER OF TRIPS	NUMBER OF ANGLER HOURS FISHED	TOTAL LAKE TROUT CATCH	NUMBER OF LAKE TROUT > 25"	CATCH PER HOUR	LT > 25" CAUGHT PER HOUR	CREEL RATE
1987	369	5076	1036	156	0.20	0.03	0.14
1988	282	3459	980	67	0.28	0.02	0.17
1989	263	2844	811	72	0.29	0.03	0.17
1990	235	2594	839	130	0.32	0.05	0.16
1991	197	2133	641	145	0.30	0.07	0.16
1992	162	1204	391	84	0.32	0.07	0.13
1993	128	707	439	76	0.62	0.11	0.23
1994	114	862	631	80	0.73	0.09	0.24
1995	97	961	472	63	0.49	0.07	0.14
1996	90	980	560	98	0.57	0.10	0.16
1997	150	1159	829	164	0.72	0.14	0.20

Summary Statistics

Catch per Effort Statistic	Period (Pre or Post Control)	N	Mean	Std. Deviation	*P*-value (one tailed)
Catch per Hour	Post (1993-97) Pre (1987-92)	5 6	0.626 0.285	.102 .045	< .001
Catch per Hour of lake trout > 25"	Post Pre	5 6	.102 .045	.026 .022	.002

Table 52. Summary of sea lamprey wounding rates (wounds per 100 fish) by size group (mm TL) for adult landlocked salmon captured at the Willsboro Fishway pre- and post- sea lamprey control. (One-tailed t-test used.)

SIZE GROUP	PRE-CONTROL 1985-1992			POST-CONTROL 1993-1998			% CHANGE	*P*-VALUE
	N	MEAN	(SD)	N	MEAN	(SD)		
432-532	43	51	(80)	101	22	(46)	-57	0.014
533-634	80	73	(89)	157	44	(69)	-40	0.007
635-736	32	156	(146)	30	40	(62)	-74	<0.001

Table 53. Summary of sea lamprey wounding rates (wounds per 100 fish) by size group (mm TL) for adult landlocked salmon captured in the Main Lake during open water creel surveys pre- and post-sea lamprey control. (One-tailed t-test used.)

SIZE GROUP	PRE-CONTROL 1990			POST-CONTROL 1997			% CHANGE	*P*-VALUE
	N	MEAN	(SD)	N	MEAN	(SD)		
432-532	6	17	(41)	89	8	(31)	-53	0.255
533-633	40	25	(54)	138	15	(43)	-40	0.100
634-736	3	167	(58)	13	46	(78)	-72	0.013
All Sizes	49	33	(63)	240	14	(42)	- 42	0.024

Table 54. Salmonid yearling equivalents stocked in the Main Lake basin of Lake Champlain from 1983 to 1997.

YEAR	LAKE TROUT	LANDLOCKED SALMON	RAINBOW TROUT	BROWN TROUT	TOTAL YEARLING EQUIVALENTS
1983	223,100	245,600	30,500	66,900	566,100
1984	183,900	120,300	47,900	35,000	387,100
1985	185,600	214,100	82,000	25,200	506,900
1986	166,600	274,600	70,800	80,000	592,000
1987	212,300	207,900	75,300	26,600	522,100
1988	159,800	210,200	101,900	35,000	506,900
1989	158,800	216,600	23,000	20,000	418,400
1990	124,300	206,500	58,600	20,000	409,400
1991	240,000	212,900	58,200	36,400	547,500
1983-91 AVERAGE:					**495,156**
1992	204,800	262,700	98,600	38,000	604,100
1993	170,700	225,300	124,600	40,000	560,600
1994	197,200	156,100	108,200	38,500	500,000
1995	105,200	150,600	82,900	33,800	372,500
1996	68,500	223,100	41,500	36,500	369,600
1997	87,100	209,000	72,700	30,400	399,200
1992-97 AVERAGE:					**467,667**

Table 55. Salmonid yearling equivalents stocked in the Inland Sea basin of Lake Champlain from 1985 to 1996.

YEAR	LANDLOCKED SALMON	BROWN TROUT	RAINBOW TROUT	TOTAL YEARLING EQUIVALENTS
1985	48,300	11,700	2,900	62,900
1986	57,400	25,000	0	82,400
1987	42,900	10,000	2,000	54,900
1988	50,100	17,000	0	67,100
1989	45,000	0	0	45,000
1990	44,900	0	0	44,900
1991	45,800	4,300	0	50,100
1985-91 AVERAGE:				**58,185**
1992	58,200	10,800	0	69,000
1993	52,700	5,000	2,000	59,700
1994	39,200	6,600	2,100	47,900
1995	51,200	7,100	2,000	60,300
1996	61,900	6,000	1,000	68,900
1992-96 AVERAGE:				**61,160**

Table 56. Salmonid yearling equivalents stocked in the Malletts Bay basin of Lake Champlain from 1985 to 1996.

YEAR	LANDLOCKED SALMON	BROWN TROUT	RAINBOW TROUT	TOTAL YEARLING EQUIVALENTS
1985	9,500	12,000	7,500	29,000
1986	1,700	10,000	5,500	17,200
1987	9,800	10,000	10,500	30,300
1988	9,500	10,000	11,200	30,700
1989	11,000	0	0	11,000
1990	9,700	0	5,000	14,700
1991	20,100	5,000	0	25,100
			1985-91 AVERAGE:	**22,571**
1992	12,100	6,000	0	18,100
1993	14,000	5,000	5,000	24,000
1994	8,000	5,000	8,100	21,100
1995	14,300	5,100	9,500	28,900
1996	19,500	5,000	5,000	29,500
			1992-96 AVERAGE:	**24,320**

Table 57. Summary of sea lamprey wounding rates (wounds per 100 fish) by size group (mm TL) for adult landlocked salmon captured at the Lamoille River pre- and post-sea lamprey control. Data are presented both unadjusted and adjusted for changes in stocking rates as a surrogate for number of sea lamprey vulnerable salmonids in Malletts Bay. (One-tailed t-test used.)

Unadjusted for stocking rate changes.

SIZE GROUP	PRE-CONTROL 1986-1992		POST-CONTROL 1993-1997		% CHANGE	*P*-VALUE
	N	MEAN (SD)	N	MEAN (SD)		
<432	19	26 (45)	6	50 (55)	+ 92	0.149
432-532	200	32 (56)	262	46 (64)	+ 44	0.006
533-634	116	83 (93)	185	61 (71)	- 27	0.011
635-736	31	77 (92)	36	97 (113)	+ 26	0.220

Adjusted for stocking rate changes.

SIZE GROUP	PRE-CONTROL 1986-1992		POST-CONTROL 1993-1997		% CHANGE	*P*-VALUE
	N	MEAN (SD)	N	MEAN (SD)		
<432	19	26 (45)	6	58 (64)	+ 123	0.094
432-532	200	32 (56)	262	53 (74)	+ 75	<0.001
533-634	116	83 (93)	185	71 (82)	- 14	0.122
635-736	31	77 (92)	36	113 (131)	+ 47	0.107

Table 58. Summary of sea lamprey wounding rates (wounds per 100 fish) by size group (mm TL) for adult landlocked salmon captured at the Sandbar Bridge pre- and post-sea lamprey control. Data are presented both unadjusted and adjusted for changes in stocking rates as a surrogate for number of sea lamprey vulnerable salmonids in the Inland Sea Basin. (One-tailed t-test used.)

Unadjusted for stocking rate changes.

SIZE GROUP	PRE-CONTROL 1986-1992		POST-CONTROL 1993-1997		% CHANGE	*P*-VALUE
	N	MEAN (SD)	N	MEAN (SD)		
<432	17	0 (0)	17	12 (35)	+ 120	0.077
432-532	191	42 (79)	241	37 (55)	- 12	0.203
533-634	114	59 (75)	156	69 (95)	+ 17	0.180
635-736	47	104 (118)	29	84 (100)	- 19	0.220

Adjusted for stocking rate changes.

SIZE GROUP	PRE-CONTROL 1986-1992		POST-CONTROL 1993-1997		% CHANGE	*P*-VALUE
	N	MEAN (SD)	N	MEAN (SD)		
<432	17	0 (0)	17	12 (33)	+ 120	0.007
432-532	191	42 (79)	241	34 (52)	- 19	0.120
533-634	114	59 (75)	156	65 (90)	+10	0.280
635-736	47	104 (118)	29	79 (94)	- 24	0.169

Table 59. Number and mean lengths (mm) of 1-, 2- and 3-lake-year landlocked salmon collected in the Willsboro Fishway pre- and post-sea lamprey control.

LAKE AGE	STATISTIC	PRE-CONTROL 1985-1992	POST-CONTROL 1993-1998
1	N	82	189
	Mean N/year	10.3	31.5
	Median N/year	5.0	29.0
	Mean length (SD)	540 (41)	539 (40)
2	N	56	48
	Mean N/year	7.0	8.0
	Median N/year	1.0	8.5
	Mean length (SD)	628 (35)	610 (44)
3	N	1	15
	Mean N/year	0.1	2.5
	Median N/year	0.0	0.5
	Mean length (SD)	640 (-)	653 (39)

Table 60. Numbers and lengths (mm) of landlocked salmon returning to the Willsboro Fishway, 1985 to 1998, by age class.

		1 LAKE-YEAR		2 LAKE-YEAR		3 LAKE-YEAR	
YEAR	TOTAL NUMBER	N	MEAN LENGTH (SD)	N	MEAN LENGTH (SD)	N	MEAN LENGTH (SD)
1985	14	10	538 (29)	4	641 (22)	0	-
1986	36	35	543 (35)	1	668 -	0	-
1987	72	26	541 (55)	46	627 (33)	1	640 -
1988	7	3	556 (22)	4	622 (70)	0	-
1989	0	0	-	0	-	0	-
1990	0	0	-	0	-	0	-
1991	1	1	485	0	-	0	-
1992	7	7	520 (15)	1	625 -	0	-
1993	17	17	557 (32)	0	-	0	-
1994	40	12	538 (50)	20	598 (33)	8	640 (42)
1995	6	5	534 (43)	1	585 -	0	-
1996	53	45	520 (28)	7	599 (69)	1	675 -
1997	51	41	518 (31)	10	617 (33)	0	-
1998	85	69	560 (37)	10	638 (47)	6	667 (33)

Table 61. Estimated total catch by age (lake years) of landlocked salmon from fall 1991 and 1996 Saranac River creel surveys, based on age distribution of recorded fish caught. Age criteria are based on pooled length (mm) at age and variance data from fall nearshore electrofishing in years 1993-96.

LAKE YEAR	FALL 1991 CREEL SURVEY			FALL 1996 CREEL SURVEY			FALL 1993-96 ELECTROFISHING DATA	
	N	%	EST. CATCH	N	%	EST. CATCH	MEAN LENGTH (SD)	N
1	10	77	80	68	57	157	505 (38)	131
2	2	15	16	34	28	77	546 (35)	38
3	1	8	8	15	12	33	626 (16)	6
4	0	0	0	3	3	8	-	0
TOTAL	13	100	104	120	100	275		175

Table 62. Number and mean lengths (mm) of 1-lake-year and older landlocked salmon collected in the Lamoille River pre- and post-lamprey control.

LAKE AGE	STATISTIC	PRE-CONTROL 1987-1992	POST-CONTROL 1993-1997
1	N	224	323
	Mean N/year	37.3	64.6
	Median N/year	28.5	14
	Mean length (SD)	495 (36)	509 (36)
2	N	115	139
	Mean N/year	19.2	27.8
	Median N/year	16	15
	Mean length (SD)	587 (49)	584 (50)
3	N	14	21
	Mean N/year	2.3	4.2
	Median N/year	1.5	5
	Mean length (SD)	660 (48)	663 (43)
4+	N	0	2
	Mean N/year	0	0.4
	Median N/year	0	0
	Mean length (SD)	--	762 (40)

Table 63. Numbers and mean length (mm) at lake age for 1 lake-year and older fall-run landlocked salmon collected by electrofishing in the Lamoille River, 1987-1997.

YEAR	TOTAL NUMBER	1 LAKE-YEAR N	1 LAKE-YEAR MEAN LENGTH (SD)	2 LAKE-YEAR N	2 LAKE-YEAR MEAN LENGTH (SD)	3 LAKE-YEAR N	3 LAKE-YEAR MEAN LENGTH (SD)	4+ LAKE-YEAR N	4+ LAKE-YEAR MEAN LENGTH (SD)
1987	33	11	502 (29)	22	593 (41)	0		0	
1988	115	96	484 (35)	15	611 (62)	4	682 (38)	0	
1989	96	50	513 (43)	44	590 (44)	2	640 (106)	0	
1990	37	18	505 (32)	13	553 (42)	6	641 (20)	0	
1991	16	11	488 (28)	4	619 (26)	1	646 (-)	0	
1992	57	39	492 (21)	17	568 (51)	1	745 (-)	0	
1993	320	255	512 (37)	54	566 (52)	10	665 (37)	1	790 (-)
1994	120	41	504 (34)	72	595 (46)	6	663 (51)	1	733 (-)
1995	34	14	486 (28)	15	596 (40)	5	657 (52)	0	
1996	2	2	494 (30)	0		0		0	
1997	13	13	486 (33)	0		0		0	

Table 64. Number and mean lengths (mm) of 1-lake-year and older landlocked salmon collected at the Sandbar Bridge pre- and post-lamprey control.

LAKE AGE	STATISTIC	PRE-CONTROL 1987-1992	POST-CONTROL 1993-1997
1	N	209	311
	Mean N/year	34.8	81.6
	Median N/year	21	74
	Mean length (SD)	502 (33)	508 (36)
2	N	111	88
	Mean N/year	18.5	14.8
	Median N/year	16.5	16
	Mean length (SD)	596 (52)	595 (53)
3	N	15	6
	Mean N/year	2.5	1.2
	Median N/year	1	1
	Mean length (SD)	676 (46)	656 (54)
4+	N	0	3
	Mean N/year	0	0.6
	Median N/year	0	1
	Mean length (SD)	--	730 (95)

Table 65. Numbers and mean length (mm) at lake age for 1 lake-year and older fall-run landlocked salmon collected by electrofishing at the Sandbar Bridge, 1987-1997.

		1 LAKE-YEAR		2 LAKE-YEAR		3 LAKE-YEAR		4+ LAKE-YEAR	
YEAR	TOTAL NUMBER	N	MEAN LENGTH (SD)	N	MEAN LENGTH (SD)	N	MEAN LENGTH (SD)	N	MEAN LENGTH (SD)
1987	51	23	508 (22)	28	589 (36)	0		0	
1988	151	103	509 (31)	38	601 (57)	10	684 (33)	0	
1989	26	18	474 (41)	7	600 (55)	1	708 (-)	0	
1990	53	36	499 (27)	14	552 (35)	3	625 (67)	0	
1991	24	19	483 (21)	5	626 (56)	0		0	
1992	30	10	512 (36)	19	618 (46)	1	715 (-)	0	
1993	166	138	521 (29)	23	590 (47)	4	646 (59)	1	780 (-)
1994	74	39	513 (38)	33	603 (58)	1	638 (-)	1	790 (-)
1995	66	48	496 (34)	16	615 (41)	1	715 (-)	1	620 (-)
1996	25	25	491 (27)	0		0		0	
1997	77	61	490 (39)	16	566 (54)	0		0	

Table 66. Mean condition factors (K) by size group (mm TL) estimated for adult male landlocked salmon captured at the Willsboro Fishway pre- and post-sea lamprey control. K= (weight/length^3) x 10^5.

SIZE GROUP	PRE-CONTROL (1985-1992)		POST-CONTROL (1993-1998)	
	N	K (SD)	N	K (SD)
432-532	27	0.94 (0.10)	63	0.96 (0.08)
533-634	39	0.95 (0.09)	105	0.96 (0.08)
635-736	18	1.03 (0.10)	24	1.00 (0.08)
737-837	0	-	1	1.00 -

Table 67. Mean length (mm) by age (lake-year) of harvested landlocked salmon examined in 1990 and 1997 Main Lake open water creel surveys.

LAKE-YEAR	1990		1997	
	N	MEAN LENGTH (SD)	N	MEAN LENGTH (SD)
1	46	416 (29)	243	440 (25)
2	3	547 (20)	21	540 (38)
3	0	-	2	616 (9)

Table 68. Mean length (mm) by age (lake-year) of harvested landlocked salmon examined in 1990 and 1997 Inland Sea/Malletts Bay open water creel surveys.

	1990		1997	
LAKE-YEAR	N	MEAN LENGTH (SD)	N	MEAN LENGTH (SD)
1	36	454 (24)	3	431 (26)
2	9	533 (25)	4	525 (58)
3	1	638 -	1	617 -

Table 69. Mean condition factors (K) by size group (mm TL) estimated for harvested landlocked salmon examined in Main Lake open water creel surveys and from salmon entered in the annual Lake Champlain International Fishing Derby. K= (weight/length^3) x 10^5. (Derby data for 1992 were not available and creel surveys were not conducted in the Main Lake in 1993).

SIZE GROUP	SOURCE	1990		1991		1992		1993	
		N	K (SD)	N	K (SD)	N	K (SD)	N	K (SD)
<432	Creel	6	1.24 (0.25)	3	0.82 (0.05)	5	0.82 (0.07)		n/a
	Derby	0	-	0	-		n/a	0	-
432-532	Creel	36	1.05 (0.21)	9	1.06 (0.33)	30	0.89 (0.13)		n/a
	Derby	2	1.31 (0.05)	3	0.92 (0.10)		n/a	5	0.88 (0.09)
533-633	Creel	2	0.91 (0.28)	1	0.97 -	3	1.12 (0.15)		n/a
	Derby	1	1.14 -	1	1.14 -		n/a	11	1.15 (0.13)
634-736	Creel	0	-	0	-	0	-		n/a
	Derby	0	-	0	-		n/a	0	-

SIZE GROUP	SOURCE	1994		1995		1996		1997	
		N	K (SD)	N	K (SD)	N	K (SD)	N	K (SD)
<432	Creel	0	-	0	-	0	-	93	0.83 (0.14)
	Derby	0	-	0	-	0	-	0	-
432-532	Creel	2	1.18 (0.36)	6	1.03 (0.40)	2	0.90 (0.01)	145	0.84 (0.14)
	Derby	3	0.96 (0.10)	0	-	0	-	0	-
533-633	Creel	4	1.09 (0.09)	1	1.17 -	1	1.05	12	0.98 (0.07)
	Derby	30	1.05 (0.11)	12	1.16 (0.09)	4	1.12 (0.03)	3	1.01 (0.18)
634-736	Creel	0	-	0	-	0	-	1	1.15 -
	Derby	3	1.07 (0.12)	8	1.15 (0.07)	1	1.03 -	1	1.17 -

Table 70. Mean condition factors (K) by size group (mm TL) estimated for harvested landlocked salmon examined in Inland Sea/Malletts Bay open water creel surveys in 1990 and 1997.

SIZE GROUP	1990		1997		% CHANGE
	N	K (SD)	N	K (SD)	
432-532	3	0.96 (0.15)	0	-	-
533-634	26	1.02 (0.20)	3	1.16 (0.38)	+ 14
635-736	4	0.97 (0.11)	3	1.04 (0.09)	+ 7
737-837	1	1.12 -	0	-	-

Table 71. Annual number of landlocked salmon smolt equivalents, adjusted for fry numbers, stocked in the Main Lake basin of Lake Champlain. Yearling equivalents representing fry stocked in a given year were added to the smolt equivalent number two years following their original stocking year.

YEAR	ORIGINAL NUMBER SMOLT EQUIVALENTS	ADJUSTED NUMBER SMOLT EQUIVALENTS
1987	207,900	237,500
1988	210,200	274,900
1989	216,600	209,700
1990	206,500	209,200
1991	212,900	226,900
1992	262,700	242,300
1993	225,300	225,300
1994	156,100	172,600
1995	150,600	138,100
1996	223,100	210,500

Table 72. Estimated legal-sized landlocked salmon catch (± 90% CI) and percent return per smolt equivalent stocked[a] from spring and fall Saranac River creel surveys.

YEAR	SPRING CATCH ± 90% CI	SPRING % RETURN	FALL CATCH ± 90% CI	FALL % RETURN
1991	518 ± 16	0.056	104 ± 78	0.011
1996/97	136 ± 15	0.018	275 ± 166	0.035[b]

[a] Return is the estimated catch divided by of total number of smolt equivalents (adjusted for fry stocking) stocked in the Main Lake basin over the previous four years, expressed as a percentage.

[b] 3.2-fold increase in fall return. Exceeds Salmon Fishery Standard 1.

Table 73. Comparison of angler diary cooperator fall catch rates of legal-sized landlocked salmon in Lake Champlain tributaries. (One-tailed t-test used.)

PERIOD	MEAN CATCH PER ANGLER HOUR	SD	*P*-VALUE
Pre-control (1987-92)	0.085	0.036	0.021
Post-control (1993-97)	0.166	0.074	

Table 74. Estimated landlocked salmon catch and percent return per smolt equivalent stocked[a] from lake-wide open water creel surveys by lake basin.

BASIN	YEAR	CATCH ± 90% CI	% RETURN
Main Lake	1990	3,790 ± 1,726	0.52
	1997	8,496 ± 1,325	1.63[b]
Inland Sea	1990	2,776 ± 986	2.01
	1997	3,330 ± 1,065	2.19
Malletts Bay	1990	477 ± 380	1.58
	1997	919 ± 691	2.20

[a] Return is the estimated catch divided by of total number of smolt equivalents (adjusted for fry stocking) stocked in the respective basin over the previous three years, expressed as a percentage.

[b] 3.1-fold increase in Main Lake return. Exceeds Salmon Fishery Standard 1.

Table 75. Age distribution (lake-years) of harvested landlocked salmon examined in fall 1991 and 1996 Saranac River creel surveys.

	FALL 1991		FALL 1996	
LAKE-YEAR	N	%	N	%
1	4	100	23	95.8
2	0	0	1	4.2
3	0	0	0	0

Table 76. Age distribution (lake-years) of harvested landlocked salmon examined in 1990 and 1997 Main Lake open water creel surveys.

LAKE-YEAR	1990		1997	
	N	%	N	%
1	46	93.8	243	91.4
2	3	6.2	21	7.9
3	0	0	2	0.7

Table 77. Pre- and post-sea lamprey control wounds per 100 steelhead rainbow trout captured during creel surveys and in the fish lift on the Winooski River.

Period	Number of Fish	Wounds/ 100 Fish	% Change
Pre-Treatment 1977-1984	64	72	83% reduction
Post Treatment 1993-1997	323	12	

Table 78. Steelhead rainbow trout catch and effort statistics with associated 90% confidence intervals from spring and fall Saranac River creel surveys. Spring expansion dates are from March 1 to June 15, and those for fall are from September 1 to November 30.

SPRING FISHERY					FALL FISHERY			
YEAR	Month	Total Effort (angler hours)	Steel-head Catch	Legal-sized Steel-head	Month	Total Effort (angler hours)	Steelhead Catch	Legal-sized Steelhead
1991	March	1582 ± 764	0	0	Sept	721 ± 321	57 ± 64	11 ± 18
	April	8462 ± 2779	27 ± 34	27 ± 34	Oct	2380 ± 995	299 ± 222	172 ± 204
	May	5679 ± 1540	45 ± 67	45 ± 67	Nov	584 ± 220	116 ± 136	0
	June	2783 ± 1341	0	0				
1997/96	March	1392 ± 1959	0	0	Sept	1608 ±1581	19 ± 23	3 ± 4
	April	3174 ± 1117	13 ± 19	12 ± 19	Oct	2010 ± 517	33 ± 25	16 ± 11
	May	2591 ± 615	0	0	Nov	455 ± 233	0	0
	June	1174 ± 1429	0	0				

Table 79. Ages of steelhead sampled by creel clerks during the spring and fall Saranac River creel surveys.

	Spring 1991			Fall 1991		
	Age 2+	Age 3+	Age 4+	Age 2+	Age 3+	Age 4+
Number of steelhead	1	0	0	0	2	1
	Spring 1997			Fall 1996		
	Age 2+	Age 3+	Age 4+	Age 2+	Age 3+	Age 4+
Number of steelhead	1	0	0	1	0	0

Table 80. Estimated catch and harvest (± 90% confidence intervals) of steelhead and catch per stocked fish in the Main Lake in 1990 and 1997. (No steelhead were caught in the Inland Sea or Malletts Bay.)

Year	Catch	Harvest	No. Examined		Catch per Stocked Fish
			Age 2	Age 3	
1990	7 ± 11	7 ± 11	1	0	0.03%
1997	106 ± 82	57 ± 58	10	0	0.25%

Table 81. Pre- and post-sea lamprey control wounds per 100 brown trout.

Period	Number of Fish	Wounds/ 100 Fish	% Change
Pre-Treatment 1975-1984	35	40	12.5% decrease
Post Treatment 1993-1997	259	35	

Table 82. Age 2 and 3 brown trout sampled in Lake Champlain-Main Lake by sampling method and year of capture.

A. From fall nearshore electrofishing samples

Year	# age 2	# age 3
1993	2	0
1994	4	0
1995	3	0
1996	0	0
1997	0	0

B. From spring nearshore / tributary electrofishing samples

Year	# age 2	# age 3
1993	2	2
1994	14	2
1995	6	0
1996	1	0
1997	8	6

C. From open water creel survey - Main Lake

Year	# age 2	# age 3
1997	6	0

D. From Saranac River spring creel survey

Year	# age 2	# age 3
1991	12	5
1997	11	4

E. From Saranac River fall creel survey

Year	# age 2	# age 3
1991	4	1
1996	5	0

Table 83. Brown trout catch and effort statistics with associated 90% confidence intervals from spring and fall Saranac River creel surveys. Spring expansion dates are from March 1 to June 15, and those for fall are from September 1 to November 30.

SPRING FISHERY					FALL FISHERY			
YEAR	Month	Total Effort (angler hours)	Brown trout Catch	Legal-sized Brown trout	Month	Total Effort (angler hours)	Brown trout Catch	Legal-sized Brown trout
1991	March	1582 ± 764	127±69	127±69	Sept	721 ± 321	102 ± 125	52 ± 53
	April	8462 ± 2779	106±34	106±34	Oct	2380 ± 995	186 ± 189	186 ± 189
	May	5679 ± 1540	33 ± 37	33 ± 37	Nov	584 ± 220	204 ± 239	197 ± 240
	June	2783 ± 1341	0	0				
1997/96	March	1392 ± 1959	23 ± 20	23 ±20	Sept	1608 ±1581	100 ± 198	95 ± 198
	April	3174 ± 1117	30 ± 22	23 ± 20	Oct	2010 ± 517	68 ± 50	51 ± 44
	May	2591 ± 615	17 ± 13	13 ± 12	Nov	455 ± 233	11 ± 17	9 ± 17
	June	1174 ± 1429	0	0				

Table 84. Estimated catch rates (number of fish per angler-hour) and associated 90% confidence interval for brown trout caught in spring 1991, 1997 and fall 1991, 1996 creel surveys of the Saranac River by anglers targeting salmonids.

Year	Spring	Fall
	Catch rate	Catch rate
1991	0.02 ± 0.01	0.09 ± 0.07
1997/96	0.04 ± 0.02	0.04 ± 0.03

Table 85. Estimated catch and harvest (± 90% confidence intervals) of brown trout and catch per stocked fish in the Main Lake in 1990 and 1997.

Year	Catch	Harvest	No. Examined Age 2	Age 3	Catch per Stocked Fish
1990	98 ± 56	97 ± 56	3	1	0.43%
1997	236 ± 99	165 ± 83	21	0	0.65%

Table 86. Estimated catch and harvest of brown trout and percent return per stocked fish from spring and fall Saranac River creel surveys.

Year	Estimated Catch	Estimated Harvest	No. Examined Age 2	Age 3	Percent Return per Stocked Fish[a]
Spring '91	266	189	12	5	1.44×10^{-4}
Fall '91	492	151	4	1	
Spring '97	70	22	11	4	1.03×10^{-4}
Fall '96	179	15	5	0	

[a] Return here was expressed as catch per unit of effort of legal-sized browns, rather than estimated catch or harvest, to accommodate a large difference in angling effort between Spring '91 and Spring '97.

Table 87. Estimated catch and harvest (± 90% confidence intervals) of brown trout and catch per stocked fish in the Inland Sea and Malletts Bay in 1993 and 1997. (No brown trout were stocked in the Inland Sea or Malletts Bay in 1989 and no harvest was observed in 1990.)

Basin	Year	Season	Catch	Harvest	No. Examined		Percent return per stocked fish
					Age 2	Age 3	
Inland Sea	1993	Open	13 ± 10	13 ± 10			
		Ice	0	0			
		Total	13	13	0	0	0.12%
	1997	Open	120 ± 72	72 ± 60			
		Ice	52 ± 26	47 ± 54			
		Total	172	119	16	2	2.81%
Malletts Bay	1993	Open	3 ± 4	3 ± 4	0	0	0.05%
	1997	Open	5 ± 8	5 ± 8	0	0	0.10%

Table 88. Rainbow smelt catch per unit of effort by site and year in stepped-oblique, midwater trawls. The last column was calculated as 95% CI/mean *100 (LaBar 1999).

Site	Year	N	CPUE ± 95% CI	CI% of Mean
Shelburne	1987	19	200 ± 54	27
	1990	2	741 ± 38	5
	1991	8	445 ± 150	34
	1992	8	205 ± 52	25
	1993	5	347 ± 19	5
	1994	7	381 ± 181	47
	1995	7	153 ± 53	35
	1996	8	172 ± 63	31
	1997	8	56 ± 2	3
				Mean = 24
Juniper	1987	15	110 ± 29	26
	1990	2	175 ± 39	22
	1991	7	173 ± 16	9
	1992	8	52 ± 13	25
	1993	4	76 ± 10	13
	1994	3	126 ± 23	18
	1995	4	72 ± 38	46
	1996	4	111 ± 54	49
	1997	4	66 ± 35	53
				Mean = 29
Malletts Bay	1987	4	230 ± 136	59
	1990	8	448 ± 66	15
	1991	5	614 ± 355	58
	1992	8	654 ± 202	31
	1993	8	654 ± 192	29
	1994	8	451 ± 111	25
	1995	8	278 ± 96	34
	1996	7	305 ± 70	23
	1997	8	465 ± 117	25
				Mean = 33

Continued...

Table 88 (continued).

Site	Year	N	CPUE ± 95% CI	CI% of Mean
Northeast Arm	1987	2	139 ± 139	100
	1990	4	1628 ± 57	3
	1991	8	324 ± 76	23
	1992	8	1103 ± 218	20
	1993	8	1674 ± 52	3
	1994	8	977 ± 214	22
	1995	8	2440 ± 1179	48
	1996	8	3553 ±1455	41
	1997	8	398 ± 92	23
				Mean = 31
Barber Point	1987	2	139 ± 13	9
	1993	2	126 ± 51	40
	1994	4	315 ± 212	67
	1995	4	202 ± 77	38
	1996	4	79 ± 22	28
	1997	4	124 ± 55	44
				Mean = 38

Table 89. A comparison by Mann-Whitney U test ($P = 0.05$) of rainbow smelt catch per unit effort by station before sea lamprey control (1990-1993) and after sea lamprey control (1994-1997). One tailed test: H_0: $CPUE_{pre} \leq CPUE_{post}$ or H_1: $CPUE_{pre} > CPUE_{post}$.

Station	Pre-control	Post-control	*P*-value (1-tailed)	Significant
Shelburne Bay	366	186	<0.001	yes
Juniper Island	109	92	0.304	no
Main Lake[a]	245	154	0.002	yes
Malletts Bay	590	380	<0.001	yes
Northeast Arm	1119	1842	0.078	no

[a] Main Lake is an average of individual Shelburne Bay and Juniper Island CPUE's. Barber Point was not included in this analysis because of the lack of pre-control data (sampling was initiated at Barber Point in 1993).

Table 90. Mean number of food items by category and zone per lake trout stomach for those lake trout stomachs that had food. Food categories that appeared only sporadically were not included in this analysis (LaBar 1999).

Year	Zone	N	Smelt<3"	Smelt>3"	Sculpin	Cisco	Y.Perch
1992	2	202	0.58	2.74	0.01	0	0.01
1993	2	70	1.43	1.70	0.03	0.01	.0.03
1994	2	64	0.47	1.95	0	0.03	0
1995	2	388	1.09	2.35	0.07	0	0.07
1996	2	69	1.86	0.34	0	0.03	0
1997	2	48	.035	1.58	0.25	0.06	0.02
1992	3	433	0.20	3.01	0.02	0	0.02
1993	3	333	0.70	2.05	0.21	0.03	0.21
1994	3	428	0.66	2.35	0.28	0	0.28
1995	3	332	1.06	2.25	0.08	0	0.08
1996	3	486	1.86	0.33	0.05	0.02	0.05
1997	3	388	1.09	1.47	0.14	0.06	0.14
1992	4	15	0.13	1.53	0	0	0
1993	4	13	1.46	2.23	0	0	0
1994	4	27	0.15	1.67	1.15	0.07	1.14
1995	4	34	2.20	1.38	0.68	0	0.67
1996	4	19	1.05	0.42	0	0	0
1997	4	63	1.16	0.68	0.02	0.05	0.02
Total		3430	0.95	1.19	0.12	0.01	0.02

Table 91. A comparison by Mann-Whitney U test ($P = 0.05$) of mean number of rainbow smelt per lake trout stomach by size class and zone before sea lamprey control (1992-1993) and after sea lamprey control (1994-1997). One tailed test: H_0: $\text{smelt}_{\text{pre}} \leq \text{smelt}_{\text{post}}$ or H_1: $\text{smelt}_{\text{pre}} > \text{smelt}_{\text{post}}$.

Zone Size	Pre-control	Post-control	*P*-value (1-tailed)	Significant	H_0: accept or reject
Zone 2					
<3"	0.48	0.67	0.03	yes	accept
>3"	2.16	1.02	<0.001	yes	reject
Zone 3					
<3"	0.32	0.71	<0.001	yes	accept
>3"	2.01	0.89	<0.001	yes	reject
Zone 4					
<3"	0.58	0.69	0.18	no	accept
>3"	1.44	0.60	<0.001	yes	reject

Table 92. A comparison of rainbow smelt mean length-at-age (mm) before sea lamprey control (1990-1993) and after sea lamprey control (1994-1997). Normal data were compared by t-test (*P* = 0.05) while non-normal data were compared by Mann-Whitney U test. Two tailed test: H_0: $\text{smelt}_{\text{pre}} = \text{smelt}_{\text{post}}$ or H_1: $\text{smelt}_{\text{pre}} \neq \text{smelt}_{\text{post}}$.

Shelburne				
Age Class	Pre-control	Post-control	*P*-value	Significant
1	108.3	106.9	0.199	no
2	122.8	129.9	<0.001	yes
3	150.3	147.1	<0.001	yes
4	167.5	152.2	<0.001	yes
5	185.3	162.7	<0.001	yes

Juniper				
Age Class	Pre-control	Post-control	*P*-value	Significant
1	120.5	116.9	0.549	no
2	125.3	128.0	0.431	no
3	154.8	146.3	<0.001	yes
4	172.4	154.2	<0.001	yes
5	188.4	165.0	<0.001	yes

Malletts Bay				
Age Class	Pre-control	Post-control	*P*-value	Significant
1	107.8	109.1	0.983	no
2	119.8	118.2	0.056	no
3	135.3	124.4	<0.001	yes
4	152.3	123.3	<0.001	yes
5	171.3	135.5	<0.001	yes

Continued.....

Table 92 (continued).

Northeast Arm				
Age Class	Pre-control	Post-control	*P*-value	Significant
1	113.3	109.1	0.100	no
2	123.7	120.9	0.003	yes
3	134.4	127.9	<0.001	yes
4	141.3	144.8	0.589	no
5	Sample size too small for statistical testing.			

Table 93. A comparison of rainbow smelt mean length (mm) by station before sea lamprey control (1990-1993) and after sea lamprey control (1994-1997). Normal data were compared by t-test ($P = 0.05$) while non-normal data were compared by Mann-Whitney U test. Two tailed test: H_0: $smelt_{pre} = smelt_{post}$ or H_1: $smelt_{pre} \neq smelt_{post}$.

Station	Pre-control	Post-control	*P*-value	Significant
Shelburne Bay	142.6	135.7	<0.001	yes
Juniper Island	154.5	139.4	<0.001	yes
Malletts Bay	131.1	118.5	<0.001	yes
Northeast Arm	130.7	118.3	<0.001	yes

Table 94. Rainbow smelt annual mortality rates of cohorts (A_Z) calculated from linear regression of cohort and annual mortality of year catches (A_{CR}) calculated by Chapman-Robson method.
Z = total instantaneous mortality rate and R^2 = variance of Z (LaBar 1999).

Cohort Year	Site	Z	R^2	A_Z	A_{CR}
1990	Shelburne	0.94	0.93	0.61	0.56
1991	Shelburne	1.21	0.97	0.71	0.74
1992	Shelburne	0.94	0.99	0.62	0.50
1993	Shelburne	0.71	0.99	0.51	0.69
1994	Shelburne	1.43	0.80	0.77	0.51
1995	Shelburne	0.20	0.99	0.18	N/A
1990	Juniper	N/D	N/D	N/D	N/D
1991	Juniper	1.21	0.88	0.71	0.75
1992	Juniper	0.81	0.83	0.56	0.63
1993	Juniper	0.48	0.93	0.39	0.53
1994	Juniper	0.94	0.98	0.61	0.47
1995	Juniper	0.60	0.88	0.45	0.41
1990	Malletts Bay	0.91	0.81	0.60	0.59
1991	Malletts Bay	1.37	0.92	0.75	--
1992	Malletts Bay	1.30	0.77	0.73	0.34
1993	Malletts Bay	1.63	0.91	0.81	0.57
1994	Malletts Bay	1.54	0.97	0.79	0.61
1995	Malletts Bay	3.22	0.99	0.96	N/A
1990	NE Arm	1.64	0.75	0.81	0.67
1991	NE Arm	2.37	0.98	0.91	--
1992	NE Arm	2.49	0.90	0.92	0.93
1993	NE Arm	1.67	0.99	0.82	0.75
1994	NE Arm	1.88	0.97	0.85	--
1995	NE Arm	0.49	0.22	0.39	N/A
1990	Barber Pt.	N/D	N/D	N/D	--
1991	Barber Pt.	N/D	N/D	N/D	--
1992	Barber Pt.	2.04	0.98	0.87	0.62
1993	Barber Pt.	1.48	0.99	0.78	0.42
1994	Barber Pt.	0.75	0.80	0.53	0.39
1995	Barber Pt.	0.18	0.95	0.17	0.18

Table 95. Summary of rainbow smelt mortality rates by station for the last four sampling years during the sea lamprey control program. Mortality = 1 minus the survival rate as calculated by the Chapman/Robson method. N/D = inadequate data to calculate estimate.

Station	1994	1995	1996	1997
Shelburne Bay	0.510	N/D	0.733	0.607
Juniper	0.410	0.590	0.838	0.547
Malletts Bay	0.610	N/D	0.570	0.650
Northeast Arm	N/D	N/D	N/D	0.743

Table 96. Comparison of mean survival rates of rainbow smelt as calculated by the Chapman/Robson method by station before sea lamprey control (1984, 1985 and 1987) and after sea lamprey control (1994-1997).

Station	Pre-treatment	Post-treatment	Percent change
Shelburne Bay[a]	0.260	0.390	50
Juniper[b]	0.266	0.403	52
Malletts Bay[c]	0.259	0.406	57
Northeast Arm[c]	0.290	0.256	-12

[a] Pre-treatment data from 1985 & 1987.

[b] Pre-treatment data from 1984 &1985.

[c] Pre-treatment data from 1985 only.

Table 97. Targeted smelt catch per unit effort (fish per angler hour ± SE) from winter creel surveys conducted from 1991 through 1997. Northeast Arm creel surveys were not conducted in 1995 and 1996.

YEAR	MAIN LAKE (ZONE 2)	NORTHEAST ARM (ZONE 5B)
1991	9.41 ± 0.78	7.16 ± 1.14
1992	13.89 ± 0.82	6.02 ± 1.19
1993	3.00 ± 0.35	3.75 ± 0.91
1994	11.13 ± 1.04	7.32 ± 1.31
1995	4.14 ± 1.10	--
1996	11.73 ± 1.05	--
1997	7.40 ± 0.73	6.01 ± 0.79

Table 98. Summary of the six evaluation standards established to determine if smelt were negatively impacted by eight years (1990-1997) of experimental sea lamprey control.

Standard	**Passed/Failed**[a]				
	Shelburne Bay	**Juniper Island**	**Malletts Bay**	**Northeast Arm**	**All Locations**
1. CPUE	failed	passed	failed	passed	passed
2. Prey selection	inconclusive	inconclusive	n/a	n/a	inconclusive
3. Length-at-age	passed	passed	passed	passed	passed
4. Survival rate	passed	passed	passed	passed	passed
5. Angler catch[b]	passed	passed		passed	passed
6. Sex ratio	unknown	unknown	unknown	unknown	unknown

[a] A failure to meet the standard indicates sea lamprey control may have negatively impacted the smelt population.

[b] These specific locations were not directly sampled during the evaluation of angler smelt catches. Angler smelt catches were monitored in the Main Lake (which includes Shelburne Bay and Juniper Island) and in the NE Arm.

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APPENDIX A

A Comprehensive Plan for Evaluation of an Eight Year Program of Sea Lamprey Control in Lake Champlain

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A COMPREHENSIVE PLAN FOR EVALUATION OF AN EIGHT YEAR PROGRAM OF SEA LAMPREY CONTROL IN LAKE CHAMPLAIN

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INTRODUCTION

An assessment plan is a necessary part of any proposal for experimental sea lamprey control in Lake Champlain, and is implicit in the description of the proposed action and program objectives, which call for assessing the magnitude of benefits by comparing post-control data on fish populations and fisheries to pre-control data. This will include verification of an abrupt and substantial reduction in abundance of sea lampreys, monitoring the effects of this reduction on fish populations, fisheries use and value, and providing a data base for formulation of long-range policy and management strategies for minimizing the effects of sea lampreys in Lake Champlain. Intensive monitoring will begin one year before the first treatment, and end three years after the second, but it does not stand in isolation. It will build on continuous study programs initiated in 1977 (Plosila and Anderson, 1985; Gersmehl and Baren, 1985), and will be followed by reduced monitoring of sea lamprey, salmonid, and smelt populations.

GOALS AND OBJECTIVES OF ASSESSMENT PLAN

The program goal is to provide sufficient information on the effectiveness of chemical treatment in reducing sea lamprey abundance and bringing about beneficial responses in Lake Champlain fish populations and sportfisheries by the end of the eight-year evaluation period, to provide an adequate basis for the formulation of long-term policy and strategy for the mitigation of the adverse effects of sea lampreys in Lake Champlain. This information will be evaluated in conjunction with other pertinent factors, including environmental compatibility, cost-effectiveness, regulatory requirements of the several jurisdictions having authority over the Lake Champlain watershed, and public demand.

Program objectives include the following:

a. Estimate the reduction in the sea lamprey populations following each chemical treatment, and monitor changes in sea lamprey abundance throughout the evaluation period.

b. Assess the response of Lake Champlain salmonid populations and sportfisheries to an effective reduction in sea lamprey abundance.

c. Document changes in the incidence of sea lamprey wounding and scarring on Lake Champlain salmonids.

d. Assess the effects of sea lamprey reduction and subsequent changes in predatory fish populations on forage fish populations, with particular emphasis on rainbow smelt.

e. Assess the effects of lampricides on the biota of selected wetlands.

f. Provide an analysis of the economic impacts of the experimental program.

EVALUATION FRAMEWORK

The Lake Champlain assessment will of necessity take the form of a before-after comparison. Because Lake Champlain is a unique body of water with respect to size, morphometry and biota, experimental concepts involving control or reference bodies of water are not applicable. Nevertheless, comparisons with conditions in other bodies of water have some value for general orientation. Data from Lake George, which lacks sea lampreys, and from Seneca and Cayuga Lakes, which are currently being evaluated for the effects of lamprey control, may provide some useful reference points.

Lake Champlain is a well-studied body of water with several on-going fisheries studies. See Plosila and Anderson (1985), Gersmehl and Baren (1985), and this plan for a detailed description of historical data, and of data being collected as part of the pre-treatment phase of the evaluation. A lakewide census of all Lake Champlain fisheries during the year of first treatment (Year T) and again seven years later (Year T + 7) will be designed to provide information on economic impacts as well as changes that have oocurred in the fishery. A detailed description of each part of the assessment follows.

PART I.

SALMONID POPULATION AND SPORTFISHERY ASSESSMENT:

Overview

To assess the effects of experimental lamprey control on Lake Champlain salmonid populations and fisheries, it will be necessary to describe the improvements in the value of these fisheries that can reasonably be expected to result from lamprey control, to specify levels of improvement that will (a) indicate success of the program, and (b) justify its continuation, and to layout a program for measuring these improvements, should they occur.

In qualitative terms, we can expect the lake trout fishery to be affected as follows:

1. A decrease in wounding and scarring is to be expected.

2. It is likely that there will be increased survival of younger lamprey-vulnerable fish (ages 3 through 5), resulting in proportionally increased recruitment to the fishery.

3. There may be a measurable increase in survival of older lake trout, which would result in progressively greater numbers of older fish, as shown in the table on p. 84 in Plosila and Anderson (1985). It should be emphasized, however, that the rates and numbers in this table are hypothetical, and that we do not yet have a firm handle on lake trout survival rates. It is quite possible that the 45% figure in this table is an underestimate resulting from the inclusion of the weak 1976 class as the third point in a 3-point series. If such a decrease does occur, it will eventually result in higher proportion of older fish in the catch, given a constant rate of exploitation.

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* This section was prepared by Robert Engstrom-Heg, Research Scientist III, N. Y. S. Department of Environmental Conservation, Bureau of Fisheries, Stamford, New York.

4. Increased recruitment into the fishery could lead to an intensified fishery, with an increased substained catch of younger lake trout, or if exploitation stays near the present level, in an increased catch per unit of effort.

5. There may be further expansion of fishable lake trout populations into seemingly suitable habitat outside areas 3A and 3B, particularly in Zone 4.

6. Based on what are already good growth rates, no effect on lake trout growth is anticipated.

The effect on the landlocked salmon fishery is less predictable. To date, an acceptable in-lake fishery has developed in the Inland Sea, where lamprey activity is lighter. A Main Lake salmon fishery also exists in Shelburne Bay and the mouth of Otter Creek but it is variable. Main Lake tributary fisheries operate primarily on initial spawners, about 3/4 of which have spent only two growing seasons in the lake. The rate of repeat spawning and apparently of post-spawning survival is extremely low. The degree to which this situation may result from lamprey attacks on recently spawned fish is not known. If this is a serious factor, it can be expected that lamprey control will result in a dramatic increase in the number of older, larger fish entering the tributary fisheries. Very little can be deduced from currently available data regarding in-lake survival of sexually immature and maturing fish. The age composition of the spawning runs in both the Boquet and Lamoille Rivers resembles a catch curve for a population with about 25% annual survival. This would be compatible with:

(1) A situation in which annual inlake survival at ages 2, 3, 4, 5, etc., was about 50%, and about 50% of the remaining fish matured each year, which, given the numbers stocked and the numbers returning to the Willsboro fishway, would suggest poor early survival (between smoltification and recruitment to lamprey predation) as the main factor preventing establishment of a better fishery,

OR

(2) A situation in which in-lake annual mortality was higher, and the proportion of the remaining fish that matured increased with age, in which case the heavy mortality might occur at an older age and be attributible to lampreys. Without adequate data on

both the spawning run and the in-lake population, it is not possible to distinguish between these scenarios. If the latter situation is true, lamprey control could result in an increased population of age 2, 3, and 4 fish, with development of a significant in-lake fishery in the Main Lake and possibly in Malletts Bay. Growth is already good, so increases in catch of larger fish would result from increased longevity. Since the data base will be derived from a relatively small number of fish, and since the fishery appears to be well below its potential value, a marginal improvement in the fishery for this species would not be acceptable. We would be looking for a clear-cut shift in age composition, tag returns, etc., that would render statistical testing essentially superfluous.

The situation with steelhead trout is somewhat parallel to that for landlocked salmon, but is complicated by an extremely spotty stocking history. Healthy steelhead of appropriate size and origin have frequently not been available in recommended numbers. A significant fishery has developed only in the Saranac River. Mortality beyond age 2 appears to be very high. Expansion of the fishery and increased catches may result from an improved stocking regime without lamprey control, but a strong shift toward greater survival of age 3 and older fish, accompanied by a reduction in lamprey activity, would indicate that lamprey control was working.

Extremely limited data on brown trout in Lake Champlain suggest that early survival may be poor, as indicated by the sparse numbers in the fishery and the sampling efforts, but that survival of age 2+ and older fish may be acceptable, with some fish surviving to age 5+. Lamprey attack rates on brown trout are comparable to those on other salmonids in the Main Lake, but if this interpretation of the survival data is correct, lamprey control may not significantly improve the fishery. If an improvement does occur, it will be difficult to assign it with any certainty to lamprey control.

EVALUATION STANDARDS

To evaluate the success of the lamprey control program in improving the salmonid fisheries, it will be necessary to determine whether it is effective at the biological level, and whether observed biological changes lead to measurable improvements in fishing quality. A decision to continue the program would be dependent on the magnitude of the improvements, costs, and any negative effects. For the salmonid phase, effects on all species would have to be considered.

For lake trout, the program will be considered to be effective at the biological level if the following series of events is confirmed:

1. A reduction in the number of adult lamprey wounds (Stages I-III) per hundred lake trout for the pooled population, or for given age or size classes, so that the post-treatment mean value differs significantly at the 5% level from the baseline (1977 or 1982 through year T + 1) value, after both have been adjusted for the estimated relative number of lamprey vulnerable lake trout in the lake for each year.

2. A corresponding decrease in accumulated lamprey scars (Stage IV) for given age classes.

3. A reduction in natural mortality of younger age classes of lamprey-vulnerable lake trout, as indicated by:

    a. A 25% or greater reduction in the estimated total instantaneous mortality rate from age 3 to age 4, as compared to the mean for the baseline period. (Equivalent to an approximate increase in survival of 0.10 for baseline survival in the 0.30 to 0.50 range. This standard is proposed because we do not yet have good estimates of the baseline value. It will work whatever it turns out to be).

    b. A significant (5% level) decrease in the log-linear slope of the catch curve for ages 3-5 or 3-6 in pooled gill net data after correction for selectivity (year T + 3 and beyond, as compared with the baseline years). Further events that would be indicative of a higher degree of biological effectiveness include:

        1. A decrease in estimated instantaneous natural mortality rates for older, fully-recruited lake trout. Minimally, these rates should not show a significant increase.

2. Significantly increased gill net catch per unit of effort in areas outside Zones 3A and 3B.

At the level of lake trout fishery value, the program will be considered successful for lake trout if it is biologically effective, as described above, and if there are separable increases of 25% or greater in:

1. Number of lake trout with no reduction in average weight harvested; <u>OR</u>

2. Average weight of lake trout harvested; <u>OR</u>

3. Number of lake trout over 25 inches harvested, as indicated by creel census and diary data.

For <u>landlocked salmon</u> the program will be considered to be effective at the biological level if the following events are confirmed:

1. A reduction in the number of adult lamprey wounds (Stages I-III) per hundred fish for pooled Boquet River and/or Malletts Bay-Sandbar samples, or for age or size classes within these samples, so that the post-treatment mean values differ significantly at the 5% level from the baseline value, after both have been adjusted for estimated numbers of lamprey-vulnerable salmonids in the main lake or in Malletts Bay (see Figure 1 for locations of tributaries and lake basins).

2. A doubling of the number of 1-lake-year salmon returning to the Boquet, Saranac and Lamoille Rivers followed in succeeding years by <u>at least</u> a doubling of the numbers of 2- and 3- lake-year fish.

3. No reduction of over 10% in either mean age-specific length or condition factor.

These criteria may not be applicable to the Inland Sea, where both lamprey activity and the intensity of the in-lake fishery appear to be increasing, along with an apparent drop in survival to age 3+ and older. Here the program would be considered effective if lamprey attack rates dropped to the 1982 levels, and if post-treatment creel census data showed age-specific catches per number stocked at least as good as the mean values for 1982 and 1983.

At the level of fishery value, the program will be considered successful for landlocked salmon if it is biologically effective, as described above, and if:

1. There is at least a doubling of total Main Lake tributary catch per equivalent smolt stocked.

2. There is a progressive increase in the proportion of older fish in the tributary catch after the initial increase in age 3+ fish.

3. There is no serious negative impact on rainbow smelt population dynamics attributable to increased landlocked salmon predation that could not be compensated for by decreased stocking.

If increased population density results in a shift of the fishery from the tributaries to the lake, lake catches, as indicated by creel census results will have to be factored into items 1 and 2. Measurable improvements in the Malletts Bay and/or Inland Sea landlocked salmon fisheries attributable to lamprey control would be additional indicators of success.

For <u>steelhead trout</u>, effectiveness would be indicated by a decrease in lamprey wounding as described under (1) for lake trout and landlocked salmon, combined with at least a doubling of the catch of age 3+ fish in the Saranac River. Other improvements and expansions of the steelhead fishery may occur, but would be ambiguous with respect to evaluating lamprey control.

<u>Effect of lamprey control on brown trout</u> cannot be evaluated except in the vaguest kind of way without better data on the age composition of the pre-treatment population. Minimally there should be evidence of:

1. A significant (5% level) decrease in lamprey wounds per 100 fish on age 2+ and 3+ brown trout.

2. An increase in estimated survival between age 2+ and 3+.

3. An increase in catch per stocked fish, as indicated by creel census results.

EVALUATION OUTLINE

I. LAKE TROUT

A. AVAILABLE BASELINE DATA

1. Gill net data:

a. 1977-1980 SERIES:

500 ft., 3, 3 1/2, 4, 5, 6, OR 475 ft.

1, 1 1/2, 2, 2 1/2, 3, 3 1/2, 4, 4 1/2, 5, 5 1/2, 6

NUMBER OF SETS

YEAR	ZONES 3A & 3B	NORTH OF 3A & 3B	SOUTH OF 3A & 3B
1977	50	24	4
1978	60	41	15
1979	44		17
1980	43	28	18

b. 1982-1985 SERIES:

400 ft.

2 1/2, 3, 3 1/2, 4, 4 1/2, 5, 5 1/2, 6

1982	141	8	33
1983	192		
1984	221	21	7
1985	154		

Data includes age, mark, length, weight, sex, lamprey attacks.

2. Creel census data:

   a. Partial creel census in 1979, 1980.

   b. Complete summer Vermont creel census for New York and Vermont portions of Main Lake (Zone 3) in 1985 & 1986, including separate data for diary cooperators.

3. Diary data

YEAR	NUMBER OF ACTIVE COOPERATORS, FISHING SALMONIDS
1977	7
1978	13
1979	14
1980	12
1981	39
1982	50
1983	62
1984	65

4. Trawl data:

   1977-1980 - Total of 49 young lake trout taken. May not be of much value.

B. COMPLICATING FACTORS

1. Stocked lake trout have come from several strains and sources, of which the Finger Lakes strain is probably the most reliable. The 1975 stocking of Michigan and Lake George fish apparently had little survival to maturity.

2. While most stocked fish have been fin-clipped, there has really been no effective differential marking of strains. Where strains have been differentially marked, there have always been other lots with the same mark within two years of the same age. Lake trout are

difficult to age.

3. Preliminary attempts to draw catch curves from gill net data show that when the data are corrected for stocking of Finger Lakes yearlings <u>only</u>, the points fall in line better and the estimated survivals are more reasonable than when total yearling equivalents are used. This would suggest a preponderence of Finger Lakes fish in the gill net catches, but other strains probably contributed <u>something</u>. It will take some refined scale reading and analysis to come up with a reasonable estimate of <u>what</u>.

4. Fish stocked in the north end of the lake (Zones 4A & 4B) may or may not contribute significantly to the population in the central part of the lake. Some of these fish have been differentially marked, but could be confused with other lots within 2 years of the same age having the same mark.

5. Analyses to date have not provided reliable estimates of survival and total mortality. It should be noted that the Chapman-Robson estimator is simply a tool for analyzing a catch curve, and that it will not yield results that differ much from other analyses of the same curve. The estimate given on p. 37 of Plosila and Anderson (1985) is based on C/E for ages 5-7 in 1982-83 and 6-8 in 1983-84, both of which include the weak 1976 year class as the oldest age group. Similar analyses of other catch-curve segments (1984-85, age 5-8 for instance) yield quite different results. Reliable survival estimates based on gillnet data will have to await correction of the data for selectivity and for differences in efficiency between years.

6. There are no data that will yield direct estimates of fishing mortality, though it may now be possible to tag enough fish to obtain such estimates. It may be possible to make very indirect estimates from catch curves, stocking rates, and creel census and diary data.

7. Without good estimates of total and fishing mortality, it will not be possible to separate out natural mortality and to determine whether it falls below baseline values during the post-treatment period.

C. PROGRAMS TO BE CONTINUED OR INITIATED:

1. Stocking and marking:
Annual stocking of 225,000 Finger Lakes strain yearlings, marked with single fin clips on a 5-year rotation. Procedures as in 1984 and 1986.

2. Gillnet sampling:

a. Zones 3A and 3B

	3A		3B			
New York	48	+	58	=	106	Sets
Vermont	33	+	71	=	104	Sets
TOTAL	81	+	129	=	210	Sets

Numbers are based on the number that would have been needed in 1985 to estimate the mean catch/lift within 25% at the 5% level for a given zone within a given state. Use present nets (8 panels, 2 1/2-6") with spreader bars. Set on contours as in 1982-85. Record data as in 1982-85, except that "gilled" fish should be distinguised from "toothed/tangled" fish. If it should prove necessary to cut back this schedule, reductions should be in the same proportion for each zone.

b. Alternate year monitoring at approximately one set per 1000 acres of water 50 feet or deeper:

Zone					
			3C	-	12 sets
2B	-	7 sets	4A	-	9 sets
2C	-	2 sets	4B	-	12 sets

3. Diary cooperator program:
Continue present system. Try to expand to 100 cooperators.

4. Creel Census: Open water censuses (Chipman 1990)for all species will be conducted during the year of the initial lampricide treatment (Year T) and again after a lapse of 7 years (Year T + 7). The census for salmonids will follow the format used by Vermont in the 1985 and 1986 Main Lake censuses. A winter creel census will be conducted for lake trout in Zone 2.

5. Tagging: Attempts to tag lake trout caught in 6" mesh gillnets during the spawning season have resulted in unacceptably high mortalities. There is a possibility that satisfactory numbers of lake trout can be taken by electrofishing or other means. The minimal goal will be 400 fish annually, but if fish are available, as many should be tagged as can be reasonably obtained.

D. ANALYTIC APPROACHES

1. Gillnet data:

a. Selectivity curves will be developed for the currently used gillnets, using the method of Holt (1963) as modified by Olsen and Tjensland (1963) for fish that are caught by more than one means, with correction for increase in swimming speed with fish length, as described by Rudstam et al. (1984).

b. Similar curves will be developed for the nets used in 1977-80.

c. Gillnet data will be sorted by length and corrected for selectivity.

d. Gillnet data will be sorted by length, mark and age. Selectivity corrections will be applied to obtain estimates of C/E for age classes, and where possible for differentially marked lots.

e. C/E values will be weighed by numbers stocked, and plotted as catch curves for each sampling year. Survival will be estimated from 1977 and later year classes, using the truncated Chapman-Robson estimator and/or least-squares analysis, with separate estimates for age 5+ and older fish. Approximate corrections will be developed for differential early survival of 1974, 1976 and any other unusually weak or strong year classes.

f. Annual gillnet catches will be weighed for the apparent efficiency of each year's effort, based on the catch of age 4-9 fish as compared with estimated numbers in the lake (from stocking and catch-curve survival estimates). Catch curves will then be plotted for year-to-year survival of each year-class.

2. Diary data:

Reported lake trout catches will be sorted by reported mark and length, assigned to year classes, and as nearly as possible, plotted as a catch curve for each year, and compared with the corresponding estimates from gillnet, derby and creel census data.

3. Creel census data:

Lake trout checked in the 1985, 1986 and following censuses will be sorted by mark, length and age, and a catch curve plotted for each year, to be compared with corresponding curves from gillnet and diary data. These data will also be used to check the quality of mark recognition by diary cooperators.

4. Modelling and synthesis:

a. The 1974 brood year (90,969 Finger Lakes yearlings, marked Ad) appear to have had unusually good early survival. It would not be amiss to assign these fish a trial annual survival of S=0.80 from age 1+ to 2+ and from age 2+ to 3+. The 1976-brood fish appear to have had about 1/4, and later brood years about 1/2 this survival. If this is assumed, and combined with survival rates from corrected gillnet data for older fish, it is possible to make decent approximations of the numbers of recruited lake trout present in the central main lake each year (the biggest element of uncertainty is the contribution of non-Finger Lakes stocking). The 1985 and 1986 main lake creel census should yield estimates of total and age-specific catch, which can be expressed as percent of the approximated populations for these years. The same could be done for the projected censuses in year T and beyond. Since catches by diary cooperators are separated out in the census results, it may be possible to expand diary catches for non-census years to obtain estimates of total catch for these years.

b. Presence of tagged fish will remove some of the "fog" from this process.

(1) For a census year, the expended number of tagged fish taken, divided by the number of tags placed the previous year, is an estimator of annual fishery mortality.

(2) This can be used to estimate the reporting rate for tags returned by mail.

(3) The proportion of tagged fish in the known catch (diary can be used to expand the unrecorded catch if a constant reporting rate is assumed).

(4) Given a series of tagging years which may be rather short in Lake Champlain, the Youngs (1972) matrix method can be used to estimate the minimum exploitation rate and possibly annual survival (the latter appears to be more affected by aberrant data points). If the proportion of tags reported can be estimated, this also provides a direct estimate of the full exploitation rate. Youngs' (1974) method of estimating proportion of tags reported works well only if natural mortality is nearly constant, and can be very misleading if natural mortality fluctuates, or if it is increasing or decreasing. With a creel

census, however, it should be possible to estimate tag reporting from the proportion of tagged fish in the diary catch (assuming 100% reporting) and the ratio of reported non-diary tag returns to estimated non-diary catch.

$$R = \frac{Tnd\ Cd}{Td(C-Cd)} \times 100$$

where R = % tag reporting by non-diary anglers

Td = tags reported by diary cooperators

Tnd = tags reported by others

Cd = catch by diary cooperators

C = estimated total catch (from census)

c. Discrepancies between these various estimates will serve as "red flags" to alert us to errors and distortions. Some of the shakier estimates (e.g. number of recruited fish available, based on assumed early survival rates) may be adjusted upward or downward to conform with the tag return and creel census data. The end result will be a series of estimates of total, fishery and natural mortality compatible with:

(1) Stocking history and reasonable early survivals;

(2) Catch curve analysis of gillnet and creel census data;

(3) Tag return data. Depending on how well the data sources agree, these may be presented as single point estimates with confidence limits, or as ranges of possible values.

5. Lamprey attack data:

(1) Data from each source (summer and fall gillnets, creel census), will be sorted by age and by length.

(2) For each data set, attack rates (as lesions of each category per 100 fish) will be computed for each age class and for each 50mm length class.

(3) Accumulation of wounds and scars will be traced and plotted for each year class.

(4) Number of wounds on surviving lake trout will be estimated for each year (= sum of (wounds per fish x estimated number in age class)).

II. LANDLOCKED SALMON

A. AVAILABLE BASELINE DATA:

1. Boquet River spawning run monitoring 1977-1980 (netting and creel survey) 1981-1985 (collection at Willsboro fishway) (39 - 163 fish per year).

2. Diary data: Some going back to 1977. More extensive since 1981. 1984 data represents 626 trips targeted on landlocked salmon in the tributaries, 174 in the Inland Sea, 95 in the Main Lake and 10 in Malletts Bay.

3. Fishway tagging 1981-1985

   a. returns at fishway

   b. tag recoveries from diary cooperators, creel census and mail returns.

4. Creel census data

   a. 1979 census, Saranac River

   b. Vermont censuses

      Inland Sea: 1982, 1983, 1984, 1987

      Malletts Bay: 1977, 1982, 1983, 1987

      Main Lake - VT & NY: 1985, 1986

5. Derby data:

LCI Derby 1982, 1983, 1984

1982 - 77 fish examined

1983 - 115 fish examined

1984 - 47 fish examined

6. Electrofishing data:

Sandbar Bridge

1982 - 30 fish examined

1983 - 53 fish examined

1985 - 54 fish examined

1986 - 101 fish examined

Lamoille River

1983 -

1985 - 34 fish examined

1986 - 115 fish examined

B. COMPLICATING FACTORS

1. In the absence of an effective sampling program or significant fishery for landlocked salmon in the Main Lake, pratically all survival data has to come from spawning run fish in the tributaries. Without at least some data on the in-lake population, it is not possible to estimate the proportion of fish at each age that the make the spawning migration (as opposed to the age composition of the spawning run, which is easy), or rates of in-lake mortality.

2. Straying: Some stocked lots appear to have been already imprinted on other waters at the time of stocking, and to have shown poor returns to the stocked waters. Pre-smolts stocked in the lake may spawn anywhere.

3. Differential marking: The problem here is not so much distinguishing year classes, as with lake trout, as distinguishing different lots stocked in different locations.

4. Small sample sizes: Except possibly for diary fish reported from the Inland Sea, sample sizes have been small enough to make accurate interpretation difficult. Obviously it is hard to lay hands on a large sample of landlocked salmon in Lake Champlain under present conditions. We will probably have to live with this.

C. PROGRAMS TO BE CONTINUED OR INITIATED

1. Stocking and Marking:

   a. Boquet River: 200,000 fry
      45,000 smolts

   b. Saranac River: 15,000 smolts

   c. Ausable River: 20,000 smolts

   d. Inland Sea: 50,000 smolts

   e. Mallette Bay: 10,000 smolts

   f. Main Lake: 135,000 smolts

   A portion of the salmon stocked in the Main Lake will be fin-clipped (LV) to indicate stocking location. Over a 9-year period, marked fish will be stocked at one location for 3 years, at a second location for 3 years, and at a third location for 3 years. Saranac River stockings will be fin-clipped (RV), and Boquet River smolts will be given an adipose fin clip. In alternate years, all stocked salmon will be fed or immersed in tetracycline to provide a fluorescent mark on the scales to improve the accuracy of age determinations.

2. Willsboro Fishway monitoring and tagging: Continue as in 1981-85. A special effort should be made to pinpoint the location (above fishway, below fishway, location in lake) and date of recovery for each returned tag.

3. Creel Census:

   a. Lakewide censuses in years T and T + 7;

   b. Creel census on the Saranac River (new) March-mid June and September-November. Diary cooperators should be tallied separately.

4. Other sampling: An attempt will be made to obtain age and maturity data on a reasonably large sample (100+ fish) of in-lake landlocked salmon in the main lake (seining or electrofishing of "spring" fish at tributary mouths, and creek census observations). An attempt should be made to sample spawning-run fish from Inland Sea stocks for age composition.

D. ANALYTIC APPROACHES

1. Data on all directly observed fish samples to be sorted by finclip, probable origin, age, and stream-lake life history.

2. For in-lake samples, data will be plotted as catch curves by number of years in the lake (rather than age). Weighting for number stocked will be complex, but should be attempted. Analysis of curves as for lake trout.

3. Boquet River tag returns (if we get enough) should be analyzed for contribution of in-lake and spring and fall tributary fishing to fishing mortality.

4. Saranac River diary and expanded creel census catches will be used to obtain an expansion factor for diary data on other tributaries, and to estimate total tributary catches. This of course assumes a similar ratio of diary to non-diary catch on all tributaries. We will probably have to live with this.

5. A similar expansion from diary data will

be used to estimate total catch in the Main Lake, Malletts Bay, and the Inland Sea for non-census years.

6. Where enough consistent data can be obtained (minimally for the Boquet River-Main Lake and Inland Sea populations), models of population structure and life history will be constructed, similar to those for lake trout.

7. Lamprey attack data will be analyzed as for lake trout, but by "smolt class" rather than year class.

III. STEELHEAD TROUT

A. AVAILABLE BASELINE DATA:

1. USFWS creel checks, mainly in Winooski River, 1977-1984. Total of 64 fish measured and examined for lamprey attacks.

2. Miscellaneous sampling in Main Lake and NY tributaries 1977-1984. Total of 38 fish measured and examined.

3. Angler diary data: Length data recorded on 176 fish, 1981-1983.

4. Creel census data: As for landlocked salmon. Numbers taken were small in all cases.

B. COMPLICATING FACTORS:

1. As of 1984, there was practically no fishery directed primarily toward steelhead trout. The population is apparently too sparse to arouse much interest.

2. The complex and often unsuccessful stocking history has already been mentioned. It may not be possible to separate gains resulting from improved stocking from those resulting from lamprey control.

C. PROGRAMS TO BE CONTINUED OR INITIATED

1. Stocking and marking.

<u>New York Streams</u>

Saranac River: 45,000 yearlings

Ausable River: 15,000 yearlings

Salmon River: 5,000 yearlings

<u>Vermont Streams</u>

Lewis Creek: 20,000

Mill River: 2,000

Lamoille River: 10,000

Winooski River: 33,000

Fish should be yearlings from anadromous or lake-run strains. Consistency is desirable. Stocking should be geared to projected availability.

2. Other: To the extent that steelhead become important, they will appear in the sampling programs aimed at landlocked salmon. Steelhead data, provided there is enough, can be handled in the same way as landlocked salmon data.

D. ANALYTIC APPROACHES

As for landlocked salmon, to the extent possible. Lamprey attack data as for the other species.

IV. BROWN TROUT

A. AVAILABLE BASELINE DATA:

1. Nearshore gillnet sampling 1982 and 1984, essentially unsuccessful.

2. Miscellaneous New York sampling 1975-1984. Total of 35 fish examined.

3. Diary data:

   1981-1983 Main Lake: 184 fish measured

   1981-1983 Inland Sea: 72 fish measured

4. Creel census data: As for landlocked salmon. Numbers have been relatively small.

5. A few fish examined in Vermont derby monitoring and electrofishing.

B. COMPLICATING FACTORS:

The brown trout population is clearly sparse. Early survival may be poor. Not much can be learned unless we can get a large enough sample to estimate the age composition of the Main Lake and Inland Sea stocks. We need to be alert to possible seasonal concentrations of these fish.

C, D. PROGRAMS TO BE CONTINUED OR INITIATED; ANALYTIC APPROACHES

A total of 20,000 yearling brown trout will continue to be stocked at a single location near Plattsburgh in New York. Depending upon availability and size of fish, Vermont may substitute 30,000 landlocked salmon for 30,000 brown trout. Unless a way is found to sample seasonal brown trout concentrations, the sampling program will be confined to fish occurring incidentially in other sampling programs. Shifts in age composition, apparent survival, and lamprey attack rate will be monitored to the extent possible, given small sample sizes.

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PART II.

LAKE CHAMPLAIN SEA LAMPREY CONTROL EVALUATION PLAN: EFFECTS ON THE SEA LAMPREY POPULATION*

The goal of this evaluation plan is to describe the changes in the Lake Champlain sea lamprey population that result from lamprey control.

Evaluation efforts will be keyed toward documenting changes in characteristics in the sea lamprey population before and after sea lamprey control is implemented. The sea lamprey control program is expected to affect the sea lamprey population as follows:

- Abundance of sea lamprey larvae will be dramatically reduced in all streams and deltas treated with lampricides.
- Abundance of spawning phase sea lampreys will be substantially reduced.
- Abundance of parasitic phase sea lampreys will be substantially reduced.

Discussion of sampling approaches to determine the effectiveness of the lampricide treatment as well as changes in various indices for the sea lamprey population is presented in the following section.

SEA LAMPREY POPULATION MONITORING

I. LARVAL SEA LAMPREY

A. Immediate measures to assess the effectiveness of the first and second rounds of chemical treatments will include the following:

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* This section has been prepared by Mr. John Gersmehl, U.S. Fish and Wildlife Service, Montpelier, Vermont.

1. <u>Bioassay with caged ammocetes on the delta areas of Lake Champlain treated with Bayer 73 and in lower portions of the TFM treated streams having long stretches of slow moving water.</u>

   To measure the effectiveness of sea lamprey control efforts on the delta areas of the five New York delta areas scheduled for aerial application of granular Bayer 73, caged ammocetes will be placed within and around the periphery of the areas prior to treatment. Caged ammocetes placed in adjacent non-treated areas will serve as the control animals for the bioassay. Live and dead ammocetes will be counted the day after treatment.

   In streams where long stretches of slow moving water occur in the lower reaches, caged ammocetes will be placed at various locations to ascertain whether a lethal dose of TFM reaches the lowermost sections colonized by sea lamprey larvae.

   The five delta areas in which caged ammocetes will be placed include: the Saranac, Salmon, Little Ausable, Ausable and Boquet Rivers. Rivers in which caged ammocetes will be placed include the Great Chazy River, Putnam Creek, Mount Hope Brook in New York; Lewis Creek and Indian Brook in Vermont; and the Poultney River on the New York-Vermont border.

2. <u>Surveys immediately post-treatment on each stream to determine treatment effectiveness.</u>

   Collections of dead and dying lamprey larvae will be made at several key index sites on each stream during and immediately after the treatment. Laboratory analyses of the samples will be made to determine the species composition, length frequency and percent undergoing transformation.

   In each stream, electrofishing surveys focusing on prime ammocete habitat will be made to determine treatment effectiveness in terms of the survival of residual sea lampreys.

B. In order to assess the effectiveness of each round of lampricide application and the recovery of ammocete populations, measures of larval assessment which will be implemented after the initial and second round of chemical treatments, include the following:

1. <u>Residual sea lamprey abundance</u>

   Following each round of chemical treatments, electrofishing surveys will be initiated to determine the effectiveness of the control efforts in terms of the presence or absence of residual sea lamprey ammocetes at index sites within each stream. Post-treatment surveys will be made by electrofishing in the streams and by the use of Bayer 73 on the deltas.

2. <u>Reestablishment of larvae</u>

   In late summer of the year following the first round of chemical stream treatments, surveys will be conducted to document whether or not larval sea lamprey reestablishment has occurred in treated streams. Reestablishment surveys using Bayer 73 on the delta areas will start in year (2) following each treatment.

3. <u>Monitoring of growth rates</u>

   Commencing with the reestablishment surveys, samples of sea lamprey larvae will be collected annually in mid to late summer to document growth so that predictive estimates on the initiation of metamorphosis can be made.

C. Past measures of larval assessment will be continued throughout the experimental control program. These include:

1. <u>Relative abundance of sea lamprey ammocetes and transformers.</u>

   In order to determine treatment success and the recovery rate of the larval population, electrofishing gear will be used to make relative abundance estimates of larvae and transformers at established index stations on all sea lamprey producing streams targeted for chemical control.

2. Surveys in streams negative for sea lamprey but with larval habitat.

Presence or absence surveys will continue as in the past in tributaries of Lake Champlain in which larval habitat is present but where populations of sea lampreys have not been established. A minimum of 10 streams will be checked each year.

II. SPAWNING PHASE SEA LAMPREY:

A. Past measures of spawning phase sea lamprey assessment to be continued throughout the experimental control program include:

1. Relative abundance of adults in index streams.

Using portable assessment traps at barriers in some streams and fyke nets in others, attempts will be made to collect adult lampreys to continue the data series on relative abundance of spawning run sea lampreys.

Streams in which sea lamprey adults will be collected include the following:

Main Lake Basin	Lewis Creek
Malletts Bay	Indian Brook & Malletts Creek
Inland Sea	Stone Bridge Brook

2. Indirect indices of population abundance via size, sex ratio information.

Incidental to the collection of relative abundance data during sea lamprey spawning run surveys on Lake Champlain tributaries, length/weight and sex ratio data will be collected and analyzed before and after control, looking into the possibility that these parameters will change with a decrease in the sea lamprey population size.

The source of this data will be the collections made in the streams listed in (1) above.

3. <u>Index of levels of spawning activity by making nest counts on Lake Champlain tributaries.</u>

Using standardized techniques developed on Great Lakes tributaries, sea lamprey nest count surveys will be made at index stations on 10 Lake Champlain tributaries in order to continue long term baseline data before chemical treatment and to measure changes in the levels of spawning activity of sea lamprey after control is implemented.

Streams in which nest counts will be made include the following:

Main Lake Basin	Great Chazy River Salmon River Little Ausable River Boquet River Lewis Creek LaPlatte River
South Lake Basin	Putnam Creek Poultney River Mount Hope Brook
Missisquoi Bay	Pike River

III. PARASITIC PHASE SEA LAMPREY

A. Measures of parasitic phase sea lamprey assessment made in the past that will be continued throughout the experimental control program include:

1. <u>Collections of parasitic phase sea lampreys from charter boats, fishing derbies, and individual fishermen cooperators.</u>

Collection of parasitic phase sea lampreys from anglers will continue throughout the evaluation period. Individual angler cooperators will be furnished specimen jars which will be collected by the U.S. Fish & Wildlife Service at monthly intervals to document growth rate changes which are expected to occur as a result of sea lamprey control. Weekly collections of parasitic phase sea lampreys at the Burlington boat launch will continue as in the past. The very successful program of rewarding anglers for turning in parasitic phase sea lampreys obtained during the Lake Champlain International (LCI) Fishing Derby held annually in mid-June will continue. The rewards are sponsored by the LCI Derby Committee.

EVALUATION STANDARDS

Success of the lamprey control program will be evaluated in terms of the measurement of 1) changes in survival and growth rates of lake trout, landlocked Atlantic salmon, and other fish species, 2) changes in sea lamprey attack rates as indicated by scars and wounds, and 3) changes in parameters of the sea lamprey population. Details of the salmonid and walleye assessment plan for Lake Champlain are covered at pages 3 to 32. Evaluation of the response of the sea lamprey population to chemical treatment will be covered here.

For the sea lamprey evaluation phase, it is anticipated that experimental control will result in:

1. A dramatic reduction in larval sea lamprey populations in treated streams.

   A stream TFM treatment will be considered "successful" if post-treatment population densities at index stations, as indicated by relative abundance or removal type population estimates, do not exceed 10 percent of pre-treatment values.

In the upper Great Lakes reduction in larval sea lamprey populations as a result of chemical control on the order of 90-95 percent are considered typical in a successful stream treatment. Due to the relatively short river stretches which will be treated it is reasonable to expect reductions in sea lamprey larval populations of that magnitude.

2. Significant reductions in larval sea lamprey populations on delta areas treated with Bayer 73.

A delta Bayer 73 treatment will be considered "successful" if caged ammocete mortalities exceed 50 percent in at least 85 percent of the targeted area, and if mean mortality within the 50+ percent zone exceeds 85 percent. Treatments that kill significant numbers of ammocetes but that fall short of this standard will be considered to be "partly successful".

*Note: True mortality rates for free-swimming ammocetes will probably be higher than for caged animals, since the cages completely protect the ammocetes from bird and fish predation.

The successful evaluation standard for post-treatment Bayer 73 surveys in succeeding years will be a low proportion of residual sea lamprey ammocetes in the collections.

3. Substantial reductions in the numbers of adults spawning in Lake Champlain tributaries.

Present methods used to count spawning phase sea lampreys measure relative abundance. The theory is that annual catches of sea lampreys, taken consistently from the same site or group of sites during the same time of the year, will show long-term changes in the population. After chemical lamprey control was implemented in the late 1950's in Lake Superior, lakewide catches of spawning run sea lampreys at electr~~ical barr~~iers dropped to and remained at between 10 and 20 percent of pre-control levels.

80-90% Red.

Since longterm intensive monitoring has been accomplished in only one sea lamprey spawning stream in the Main Lake basin of Lake Champlain (Lewis Creek) it would be presumptive to try to relate changes in the magnitude of the sea lamprey run in one stream to changes on a lakewide basis. Beginning in 1987, more intensive monitoring in Indian Brook and Stone Bridge Brook which are the major sea lamprey producers of Malletts Bay and the Inland Sea respectively, will provide additional baseline data against which to measure the effectiveness of sea lamprey control in terms of reductions in the numbers of spawning adults in each basin.

4. A reduction in the numbers of sea lamprey nests tallied at index sites on Lake Champlain tributaries to 20 percent of pre-control values.

Although the technique of making nest counts in tributaries has not been validated, experience on the Great Lakes suggests that if stream-sited methods which are aimed at assessing spawning phase sea lamprey populations, are carried out on a large number of streams, the total lakewide values are indicative of changes in the population as a whole.

PART III

ASSESSMENT OF THE IMPACT OF EXPERIMENTAL SEA LAMPREY CONTROL ON SMELT POPULATIONS OF LAKE CHAMPLAIN *

I. Overview

Among other program objectives of the strategic plan for the development of salmonid fisheries on Lake Champlain (Lake Champlain Fish and Wildlife Policy Committee and Technical Committee 1977) was the maintenance of a rainbow smelt (*Osmerus mordax*) sport fishery of 100,000 lb per year. Consideration of smelt in this coldwater fishery plan is vital for two reasons: 1) smelt are expected to provide the principal forage base for the stocked salmonids, and 2) the winter smelt fishery presently provides both recreational and local economic values. Lake Champlain fishery managers have ascribed substantial increased mortality of salmonids to parasitism by sea lamprey (*Petromyzon marinus*) (Plosila and Anderson 1985). One expectation of the proposed experimental lamprey control program on Lake Champlain is increased survival of these predators, and thus increased utilization of their forage base, the rainbow smelt.

Knowledge of smelt population response to increased predation will assist fishery managers in making appropriate adjustments in salmonid stocking and harvest rates toward the goal of optimal yields, while preventing serious impacts to forage stocks (Hatch *et al*. 1981, Kircheis and Stanley 1981, Plosila 1982, Heist and Swenson 1983). The response of a prey population stressed by predation may be increased growth rates, increased fecundity, earlier maturation, shifts in age composition, reduced densities, and changes in spatial distributions (Stewart, *et al*. 1981). Reduction in the utilization of smelt by salmonids, or increased growth rates of competing prey species may also suggest an overstressed forage population (Stewart, *et al*. 1981).

Kirn and LaBar (1990) studied rainbow smelt in Lake Champlain from in 1984 and 1985. The objectives were the development of a technique for consistently and effectively sampling rainbow smelt, the determination of food habits of major salmonid and walleye predators, and a comparison of smelt population parameters at six sampling stations in management zones 3A and 3B. This overview of the current status of Lake Champlain smelt populations comes primarily from their study as well as a review of the literature, especially from the Great Lakes.

They used a mid-water trawl which was 5 m square at the mouth, made in square shape with all four sides alike. Dogears, boson and square were made of 15 cm (6 in) stretch mesh with No. 18 thread, the upper body of 10 cm (4 in) stretch mesh with No. 15 thread, and the lower body of 5 cm (2 in) stretch mesh with No. 12 thread. The upper funnel was of 3.8 cm (1 1/2 in) stretch mesh with No. 9 thread, the lower funnel of 3 cm (1 1/4 in) stretch mesh and No. 9 thread, and the codend was of 3.5 cm (1 3/8 in) mesh and No. 18 thread. The net had a liner in the codend of No. 147 knotless nylon with a mesh size 1.2 cm (1/2 in) stretch. Legs were 12 m (40 ft) long. Otter boards were 1 x .5 m flat rectangles. Small vaned depressors were fixed on the bottom legs just ahead of the foot rope. The foot rope was chained for weight and the head rope was buoyed.

Net depth and water temperature were monitored by means of a pressure/temperature sensitive ultrasonic transducer attached to a port bridle of the net. A hydrophone was deployed over the side of the boat on a long pipe so that it was about 1 m below the surface and 1.5 m outboard of the boat. An onboard digital monitor gave continuous readings of temperature and pressure when the net was deployed.

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* This section has been prepared by Dr. George LaBar, Wildlife and Fisheries Biology Program, University of Vermont, Burlington, Vermont.

Their oblique trawling protocol consisted of deploying the net to the desired depth, then retrieving it in step-wise fashion. The net was fished 5 min at a depth, then moved up 3 m (by retrieving about 12 m of cable) and fished 5 min, moved up again, etc., until a depth of 10 m below the surface was reached. The net was then retrieved as quickly as possible. When the water was greater than 45 m, the net was generally fished starting at 35 m, then brought up to 10 m. When the water was less than 45 m deep, the net was generally started fishing at 25 m and then brought up to 10 m. Time of trawling thus varied from a maximum of 55 min to a minimum of 40 min. Catch rates were adjusted to catch per 55 min of trawling. Replicate tows were made at each station on the same night, with one tow made in one direction and the other in the opposite direction on approximately the same track. Towing speed was 2.5 knots.

Kirn and LaBar (1990) found that oblique trawls provided consistent catches and length distributions of smelt, as well as sufficient samples for biological information. Oblique midwater trawling also avoided potential sampling errors introduced by the vertical migration behavior of rainbow smelt. Oblique midwater trawls were fished at the sampling sites in the Main Lake during August and October, 1984, and during April, June, August, and October of 1985. Total catches of smelt from replicate oblique trawls were generally consistent, except during the early spring when smelt were concentrated in-shore for spawning. Greatest catches of rainbow smelt were generally associated with shallow sites regardless of sampling period although there were some exceptions. August catches were distinctly higher in shallow sites whereas the pattern was not as clear in June or October, when the lake was not as distinctly thermally stratified. These findings are consistent with observations of Great Lakes smelt populations (Ferguson 1965, Gray 1979, Crowder 1980, Heist and Swenson 1983). Heist and Swenson (1983) reported highest densities and abundance of smelt in shallow waters (<50 m) of Lake Superior, while at greater depths, densities were low and stable. They suggested nearshore distributions of rainbow smelt were associated with warmer temperatures and daily vertical movements.

April trawl catches in Lake Champlain tended to be more variable than those from other periods of the year, both between sites and between replicates. The highly variable catches among sites in April were probably a result of the nocturnal spawning habits of rainbow smelt (Scott and Crossman 1979). The effect of shoreward spawning movements on abundance measurements led Argyle (1982) to recommend fall surveys because of more predictable locations of rainbow smelt. Seasonal peaks in CPUE occurred in August, with October being second highest. Analysis of variance of trawl catches did not reveal differences in CPUE between management zones or among sampling periods within zones.

Peaks of smelt CPUE in August observed in this study were also reported in Lake Erie (Ferguson 1965). Increasing water temperatures and thermal stratification were cited as the major factors initiating the return of smelt to deeper waters and increasing tendencies to form schools. During the summer months in Lake Erie, both yearling and adult smelt were observed to move into the thermocline, becoming more vulnerable to trawling gear (MacCallum and Regier 1970). Thermal stratification of Lake Champlain was not observed during trawl sampling in 1985 until August, when increased catches reflected recruitment of yearling smelt to the trawl. Increased catches of yearling smelt were probably the result of immigration rather than attaining a gear selective size threshold.

Spatial and seasonal distribution of rainbow smelt has been associated with water depth (Plosila 1982), temperature preference and thermal structure (Ferguson 1965, Crowder et al. 1981, Argyle 1982, Heist and Swenson 1983), food availability (Foltz and Norden, 1977), and light intensity (Ferguson 1965, Gray 1979, Argyle 1982, Heist and Swenson 1983). MacCallum and Regier (1970) suggested the spatial distribution of smelt in Lake Erie was affected by a complex interaction of factors rather than a simple temperature preference. Size or age class partitioning of smelt has been documented in response to the above factors (MacCallum and Regier 1970, Argyle 1982, Plosila 1982), serving to complicate relative abundance estimates.

Replicate oblique trawls in Lake Champlain provided reasonably consistent length distributions of rainbow smelt (Kirn and LaBar 1990). Kolmogorov-Smirnov comparisons of length distributions from replicate tows showed 6 of 31 comparisons to be significantly different ($p < .05$). However, statistical and practical differences may not necessarily coincide. Some of the 6 comparisons of length distributions shown to be significantly different were nearly undistinguishable graphically, indicating that they were probably declared to be different because the sample size (200 smelt measured from each trawl) was so high. Only 2 of 31 comparisons were found to be significantly different when tested at $p < 0.01$. Mean length-at-age was generally uniform among the six sample sites for each sampling period. Of 211 possible pairwise comparisons (Fishers LSD) of mean length-at-age among sites, only 15 (7.1%) differed significantly at $p<0.05$. Further examination of these differences did not indicate a consistent pattern of variation among sites.

Chi-square analyses of Lake Champlain rainbow smelt age composition and length distribution indicated significant variation among sites, among depths, within depths, between zones, between areas, and within areas (LaBar and Kirn 1986). There was no systematic association of these parameters with depth or location. Ages 1 to 3 accounted for approximately 90% of the total catch in all sampling periods. Although yearling fish comprised a substantial proportion of the total catch, smelt generally were not fully recruited to the midwater trawl until age 2.

Length at age in April 1985 (LaBar and Kirn 1986) was far less than in either winter of 1929 (Greene 1930) or winter 1950 (Zilliox and Youngs 1958). At age 2, smelt in 1985 were about 50 mm shorter than in either 1929 or 1950 (Table 14). Our 5-year old fish were generally shorter than 2-year old smelt in these previous studies. However, our calculated length-at-age was about the same as calculated by Plosila and Trost (1977). The length-weight relationships in October of 1984 and 1985 were virtually identical and also substantially different than Green (1929) or Zilliox and Youngs (1958). In a review of rainbow smelt population dynamics, Dunstall (1980) cited Lake Champlain populations as possessing the highest reported growth rates. Although growth was consistent between 1929 and 1950 surveys (Greene 1930, Zilliox and Youngs 1958), recent studies (Plosila and Trost 1977; LaBar and Kirn 1986) revealed substantially smaller adult rainbow smelt (i.e. ages 2 and over). The argument that our observed growth rates reflect different sampling methods or times of the year is negated by the fact that October growth rates were nearly identical to April growth rates, and that Plosila and Trost (1977) found even slower growth for age 2 and 3 rainbow smelt than we did. The very large difference in length-at-age (about 38%, 45%, and 49% respectively for ages 2-4) cannot be explained by aging differences either. Neither our nor Plosila's and Trost (1977) 4-year old fish overlapped in length with either Green's (1930) or Zilliox and Young's (1958) 2-year old rainbow smelt.

Survival estimates from annual changes in CPUE of individual age classes were consistent for August and October trawls, averaging 0.41 and 0.36 respectively and generally decreasing with age.

LaBar and Kirn (1986) analyzed stomach contents from 506 lake trout (Salvelinus namaycush), 70 Atlantic salmon (Salmo salar), and 91 walleye captured in zones 3A and 3B during 1984-85. Rainbow smelt was the predominant prey taxon identified in all species. A modification (Kirn, et al. 1986) of Pinkas', et al. (1971) Index of Relative Importance (IRI') was used to rank the dietary importance of prey items. This index combined weight and frequency of occurrence as follows:

$$IRI' = \%WT \times \% FO$$

where IRI' = Index of Relative Importance, %WT = percentage of the total identifiable prey weight of all stomachs observed and %FO = percentage of stomachs which contain a designated prey taxon. The IRI' is presented as a percentage of the total IRI' for the all stomachs.

Rainbow smelt and unidentified fish accounted for greater than 95% of the total Index of Relative Importance (IRI') of prey identified in lake trout and Atlantic salmon in 1984-85, and in walleye in 1985. Yellow perch (Perca flavescens) and rainbow smelt comprised 13.4% and 10.8% of the total prey IRI', respectively, for walleye in 1984, while unidentified fish accounted for 79.7%.

Only lake trout were sampled sufficiently to further examine food habits by date and length intervals. Rainbow smelt were consistently the most important prey taxon identified in all date and size class intervals. Other prey taxa (excluding unidentified fish) accounted for >5% IRI in only two date intervals during 1984-85. These were sculpin (Cottidae), 10% IRI' in early April, and yellow perch, 11% IRI' in early May. Smelt and unidentified fish comprised > 95% IRI for all length intervals examined.

Regression analysis revealed no significant relationship between predator length and prey length for lake trout, Atlantic salmon, or walleye. Further analysis of predator length and rainbow smelt length gave similar results. R-squared values provided from these regression analyses ranged from 0.1 to 0.34.

Lake Champlain Atlantic salmon preyed on smaller size classes of smelt than did lake trout or walleye (LaBar and Kirn 1986). Although sample sizes of Atlantic salmon and walleye were small, length distributions of smelt observed as prey clearly showed this tendency. Mean standard length of smelt observed in stomachs of Atlantic salmon was 70 mm with 72% smaller than 80 mm, while smelt consumed by lake trout and walleye averaged 123 mm with less than 1% smaller than 80 mm. Preference for smaller prey was also reflected in the greater utilization of invertebrates by Atlantic salmon than their counterparts.

Mean length-at-age has been used to examine stock structure of various fish species (Ihssen et al. 1981, Gulland 1983, Luey and Adelman 1984). Changes in exploitation rates (e.g. predation) may enhance the usefulness of population parameters for stock identification by sharpening distinctions between stocks through altered selection pressures (Ihssen et al. 1981, Luey and Adelman 1984). Although differences in length-at-age between stocks may be viewed as an increase in genetic complexity and population stability (Luey and Adelman 1984), it would also serve to complicate the use of population parameters to assess the smelt population response to increased predation pressures. Uniform estimates of mean length-at-age among the six sampling sites, particularly in April when spawning behavior would serve to separate stocks, failed to indicate the existence of discrete populations of rainbow smelt in the Main Lake (Ihssen et al. 1981, Gulland 1983, Luey and Adelman 1984). Jilek et al. (1979) reported comparable and consistent growth rates among five spawning populations, suggesting a thorough mixing of rainbow smelt in Lake Superior. Luey and Adelman (1984) used estimates of growth, fecundity, and length distributions to identify three discrete spawning stocks of rainbow smelt in Western Lake Superior, while complimentary genetic evidence was provided by Schreiner et al. (1984).

Size and age distributions are generally regarded as poor parameters for stock identification, as large and systematic differences may exist between locations (Gulland 1983). Length and age distributions of rainbow smelt in Lake

Champlain (LaBar and Kirn 1986) were variable among locations, revealing no systematic differences. Daily movements of smelt are suspected to influence these observations.

Populations of rainbow smelt have been observed to undergo extreme fluctuations in abundance, apparently unrelated to stock size, predation, competition, fishing intensity, or disease (Smith 1972, Havey 1973, Kircheis and Stanley 1981, Selgeby 1985), limiting their reliability as a primary forage species in some situations (Lackey 1969, Kircheis and Stanley 1981). Yearly variations in year class strength, as observed by Kirn and LaBar (1990) have been documented in other systems (Ferguson 1965, Leach and Nepzky 1976, Murawski and Cole 1978, Dunstall 1980, Frie and Spangler 1985). As spawning stocks of rainbow smelt are generally dominated by two and three year old fish (Dunstall 1980), a weak year class may leave the population vulnerable to unfavorable environmental conditions and predation (Stewart et al. 1981, Frie and Spangler 1985).

Survival rates estimated by Kirn and LaBar (1990) were comparable to estimates from rainbow smelt populations in Lake Huron and Lake Superior prior to salmonid stocking programs (Frie and Spangler 1985). Survival estimates of Lake Huron smelt changed from 10% during periods of an intensive dipnet fishery, to 33% during periods of no commercial fishing and few predators, to 15% during high predator abundance. Lake Superior smelt populations revealed a decrease in survival from 43% to 20% as lake trout biomass increased (Frie and Spangler 1985).

In summary, a potentially unstable rainbow smelt population dominates the forage base for stocked salmonids in the Main Lake of Lake Champlain. At present stocking rates, the smelt population does not appear to be adversely impacted, as indicated by low growth and mortality of smelt, and excellent growth of trout and salmon (Plosila and Anderson 1985). However, dramatic increases in abundance and survival of salmonids anticipated from proposed sea lamprey control (Plosila and Anderson 1985), and variable year class strength of rainbow smelt, coupled with other density independent mortality factors could result in serious declines in smelt stocks (Stewart et al. 1981, Frie and Spangler 1985). A rapid switch to alternate forage species could result in depression of these stocks as well (Stewart et al. 1981). Rapid prey switching, however, was not observed with declining alewife populations in Lake Michigan (Crowder 1985, Eck and Brown 1985), or rainbow smelt populations in Lake Superior (Selgeby 1985). Salmonids continued to prey on these species after they became less abundant and smaller in size. Frie and Spangler (1985) used higher growth and mortality rates, lower male/female ratio, lower abundance, and lower modal spawning ages to distinguish populations of rainbow smelt during intensive exploitation from those after exploitation.

Therefore, several variables can be examined which will give credible circumstantial evidence that there are indeed changes in the smelt populations and that these changes are likely to have resulted from changes in predator abundance:

1. changes in catch per unit of effort of smelt in midwater trawls taken at standard sampling stations and at the same times of the year over several years;

2. changes in catch rates and/or in size distributions of angler-caught smelt;

3. changes in food habits of salmonids and walleyes;

4. changes in age class structure of smelt;
5. changes in sex ratio of smelt;
6. changes in survival rates of smelt;
7. changes in spawning ages of smelt;
8. changes in growth rates and condition of predators.

II. Goal

The goal of the proposed work is to determine by January 1, 1998, whether stocking levels of or harvest rates for salmonids and or walleye on Lake Champlain should be adjusted as a result of observed changes in rainbow smelt populations during the experimental sea lamprey control program.

II. Objectives

1. Measure changes in catch per unit of effort of rainbow smelt using oblique midwater trawling at various stations on Lake Champlain.
2. Determine if there are changes in prey selection either by species or by age or size class by salmonids and walleye.
3. Determine if there are significant changes in the age and size structure, growth rates and/or sex ratio of smelt taken in midwater trawls.
4. Determine if there are significant changes in survival rates of rainbow smelt taken in midwater trawls.
5. Determine if there are significant changes in catch rates, total harvest, and/or size distribution of angler-caught smelt in the winter fishery.

III. Evaluation Standards

The following evaluation standards will be used to determine if rainbow smelt populations have been impacted by an increase in the number of predators following experimental sea lamprey control:

1. Catch-per-unit-of-effort as described in the methods section of this document is significantly (5 % level) lower at all sampling stations than in the same months as in previous years for the four consecutive years at all stations sampled.
2. Salmonids and walleye show consistent and significant changes in selection of either prey species or sizes of prey selected. Emphasis will be placed on lake trout since data is lacking for other salmonids and walleyes. A negative impact is considered to be when the Index of Relative Importance of smelt and unidentified fish for any of the predator species mentioned above falls below 80% during summer sampling periods.
3. Analysis of length-at-age of smelt caught in midwater trawls in August indicates a significant (5% level) change, and that mean length-at-age for all age classes has changed.

4. A 25% or greater decrease in survival rate at the end of the eight year sampling period compared to 1984-1985 and 1987 and accompanied by an increase in total mortality over the last four years of sampling.

5. Angler/cooperators demonstrate a significant (5% level) change in catch per unit of effort and/or a significant change in size distribution of smelt caught.

6. The male:female ratio decreases consistently over the period of sampling. There is no baseline data on sex ratio of smelt in the lake, so the first two years of sampling will have to serve as baseline, and comparisons made with those years.

V. APPROACH

Evaluation Standard 1-Catch-Midwater Trawl: Replicate stepped-oblique midwater trawls will be taken in August at the following stations because August samples have given the most consistent results in the past:

1. One station in area 2B, between Westport and Crown Point;
2. Juniper Island;
3. Shelburne Bay;
4. One station in area 4B, near Cumberland Bay;
5. One station in the Inland Sea;
6. One station in Malletts Bay;

Numbers of fish caught will be adjusted to catch per 55 minutes trawling time, as indicated above.

Evaluation Standard 2-Predator Food Habits: Stomachs from lake trout, Atlantic salmon and walleye will be collected from a variety of sources in alternate years of the study beginning in 1988: during creel census, at the Lake Champlain International fishing derby, from any gill netting being done, by collection at fishing access sites, and through cooperation of fishing guides and cooperators. A minimum of 100 stomachs with food per species per season should be collected, with a goal of 200 per species per season. However, it must be realized that will be very difficult with Atlantic salmon. A special effort will be made through Trout Unlimited to enlist the cooperation of several anglers in both New York and Vermont known to consistently take Atlantic salmon. Stomachs will be preserved in formalin, contents identified to species level where possible, and standard length of all smelt in stomachs will be taken. IRI' will be calculated for each food category for each predator species (Kirn, et al. 1986) as follows:

$IRI' = \% \text{ WT X } \% \text{ F.O}$ where

% WT - percentage of total identifiable prey weight of all stomachs examined, and % F.O.= percentage of stomachs examined which contain the designated prey category.

Evaluation Standard 3-<u>**Length-at-age of smelt**</u>: In each of the midwater trawls, otoliths will be taken from 100 of the 200 smelt measured. After removal, they will be stored for a minimum of one month in a 2:3 glycerol:alcohol mixture as indicated in Jerald (1983). In the first year of the study, 100 otoliths will be sent to an expert from the Great Lakes familiar with smelt otolith aging for verification of aging. Further verification of the aging technique will be a comparison of length distributions with age distributions. It is likely, however, that only the first annulus will be able to be verified in this manner, as there is a great deal of overlap among length-frequency distributions between older age classes.

All fish thus measured and aged will be divided in to 5 mm increment size classes, and mean length by age class will be compared using one way analysis of variance after testing for normality and equal variance. Length-at-age will be tested using Fisher's LSD multiple comparison procedure (BMDP Statistical Software 1983).

Evaluation Standard 4-<u>**Survival rates**</u>: Survival rates will be estimated from CPUE of age classes caught in midwater trawls in October (Ricker 1975).

Evaluation Standard 5-<u>**Angler/Cooperator catch**</u>: Winter creel census will be carried out in year 1 and year 7 of the experimental program. Winter creel surveys were carried out in 1987 and 1988 (LaBar 1989) in three areas with emphasis on Vermont: Crown Point, Potash Bay, and Shelburne Bay. Additional effort and personnel will be required to determine total effort and catch in both New York and Vermont. In addition, if midwater trawling or the diary cooperator program indicates that there are major decreases in CPUE, growth rates or there are major changes in salmonid growth rates or condition factor, additional winter creel census may have to be added. This proposal and its associated costs do not provide for that contingency. Diary cooperators on both sides of the lake will be sought with a target of a minimum of 25 active anglers. During the winter creel census of 1987 and 1988 we will try to recruit these active anglers.

A roving creel census (Malvestuto, et al. 1978, Malvestuto 1983) will partition sampling areas, week days and times of the day. All weekends will be sampled during the ice-fishing period. Because of the number of anglers who fish from shanties, two types of angler counts will be made: direct counts made while interviewing anglers and automobile counts. Data obtained during these creel surveys will include catch rates and length distribution of the catch. In addition, creel clerks will obtain samples of smelt either by donations from anglers or by purchase from anglers for age and sex analysis.

Evaluation Standard 6-<u>**Sex ratio**</u>: Gonads will be taken from the 100 smelt caught in midwater trawls in August that will be used for aging, and sex will be determined if possible. As indicated above, 1987 and 1988 will serve as the baseline data to which subsequent years will be compared.

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PART IV.

A BENEFIT-COST ANALYSIS OF THE SEA LAMPREY CONTROL PROGRAM FOR LAKE CHAMPLAIN *

PURPOSE OF THE STUDY

The purpose of this study is to estimate the total benefits and costs of the eight year experimental sea lamprey control program being proposed by the Lake Champlain Salmonid/Sea Lamprey Subcommittee for Lake Champlain. Unlike most benefit/cost studies that are initiated to determine if a proposed project is economically feasible, this study will attempt to evaluate the success of an ongoing project by measuring the resultant benefits and costs. The benefits will result from the expected increase in the quantity and quality of fish available for harvest and the costs from the administration and operation of the program, environmental damage, temporary water use losses by landowners in lampricide treatment areas, and losses to certain anglers (eg., reduced smelt catches as a result of the larger salmonid population). The net benefits (benefits minus costs) will measure the economic success of the program.

This study is unique because it consists of two, nearly identical studies of the same sea lamprey control program. The first study will be conducted in year one of the program to: 1) establish the initial value of Lake Champlain fishing, 2) project value changes associated with levels of increased fishing quality, 3) measure the financial impact of anglers' fishing-related expenditures on local businesses, 4) measure public and private on-land infrastructure impacts of increased angler activity; 5) estimate the value received by nonusers who wish to preserve and/or enhance quality fishing in the lake, and 6) measure a broad range of administrative, environmental, landowner, and angler costs. The second study will be conducted in year seven of the control program. It will repeat the evaluations undertaken in year one and will measure actual changes in benefits and costs over the interim six year period.

A particularly important aspect of this dual study format is that it provides an opportunity to test the reliability of year one projections and change in user (fishing) and nonuser (preservation) values and expenditures levels resulting from the associated net change in the quantity and quality of fish available for harvest. It also permits adjustment of value estimation procedures and thereby enhances the accuracy of year seven projections of future value charge. This ability to measure current change and predict future change in user and nonuser values that result from incremental changes in the quantity and quality of the fishery, is essential in evaluating management decisions. Brown et al. (1982) aptly expressed the importance as follows:

> "The crucial importance of knowing how marginal changes in fish and game abundance affect the value of sport fishing and hunting can hardly be overemphasized. Without this knowledge, an efficient allocation of public funds and natural resources cannot expect to be achieved. As just one example, if fish catch is unrelated to the value of salmon-steelhead sport fishing in the Pacific Northwest, then there is no need for public expenditures on fish hatcheries and stream improvement to enhance salmon-steelhead runs, at least so far as angler benefits are concerned. On the other hand, if there is a strong positive relationship between fish catch and the benefits from salmon-steelhead sport fishing, then a considerable use of public resources to protect and/or enhance salmon-steelhead runs can be justified."

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This study will provide such values and thereby permit those responsible for the management of the Lake Champlain fishery to determine if their lamprey control program is economically justified. It will also enable them to determine economically optimum lamprey control levels.

Another unique feature of this study is the use of two state-of-the-art methods to estimate the current and future value of the fish resource. Since each method has certain inherent strengths and weaknesses, it will be possible to structure the analysis in such a way that each method will be used to its optimum advantage. For example, the travel cost method functions most effectively when respondents are all on single purpose trips (eg., fishing) and have highly varied travel distances. The effectiveness of the contingent value method is not compromised by respondents on multipurpose trips and the accuracy of its estimates is enhanced when the respondents are very familiar with the resource (eg., persons who live in close association with the resource). In this example, accuracy would be enhanced by using the TCM in the first case and CVM in the second.

To summarize, this research proposal advocates the use of complete pre-control/post-control benefit-cost analyses of the proposed sea lamprey control program for Lake Champlain. It will employ state of the art forms of the travel cost and contingent value methods to generate net economic values for user and nonuser groups in each of the study years. Changes in net economic value resulting from expected increases in the quality of the fishery resource, will also be estimated. The accuracy of year one estimates will be tested in year seven and the refined estimation techniques will be used to estimate the net values of anticipated post-year seven improvements in the quality of the Lake Champlain fishery. In addition to these value estimates, the study will also provide estimates of the financial impact of angler expenditures on local and state economies. The measurement of these impacts is very important to financial planners and others involved in the economic development of the Greater Lake Champlain Region.

OBJECTIVES

The primary objective of this study is to estimate the benefits and costs that will result from the proposed eight year experimental sea lamprey control program on Lake Champlain. More specifically:

1. To estimate the net economic value (benefits minus costs) of fishing on Lake Champlain in year one of the study and to predict the changes in net value that will occur as a result of the lamprey-control-induced changes in the quantity and/or quality of the fishery.

2. To estimate the net economic value of fishing on Lake Champlain in year seven of the study and to estimate the lamprey-control-induced change in net value that is expected to occur in the quantity and/or quality of the fishery over the six year period.

3. To estimate the total fishing-related expenditure of Lake Champlain anglers in years one and seven of the lamprey control program and to measure the gross changes in expenditures between these two periods.

4. To estimate the financial impact of fishing-related expenditures of Lake Champlain anglers on businesses (ie., marinas, tackle/bait shops, fishing charter services, etc.) and on state and local taxes in New York and Vermont in years one and seven of the lamprey control program and to measure changes in the size and gross sales of existing businesses and the growth of new businesses over the six year period.

5. To estimate the net value of the Lake Champlain fishery to the non-fishing public in New York and Vermont in years one and seven of the lamprey control program and to measure the changes in value that may occur as a result of lamprey control-induced changes in the quantity and/or quality of the fishery over the interim six year period.

6. To determine current capacity and capacity limits of critical public infrastructure (roads, parking, boat launching facilities, sanitation facilities, etc.) and private support facilities (motels, restaurants, marinas, boat rental/repair, etc.) in shore and near-shore towns bordering Lake Champlain and planned changes in infrastructure and private support facility capacities over the next five years.

METHODS

This study will utilize several techniques to estimate the benefits and costs associated with the proposed sea lamprey control program on Lake Champlain. There will be a mail survey of anglers; shore and near-shore towns, and town and regional chambers of commerce; a telephone survey of people living within the Lake's "zone of influence"; a personal interview survey of businesses that benefit from angler expenditures and a mail survey of landowners along treated streams who may have incurred treatment-related costs. There will also be an analysis of a broad range of monetary and nonmonetary costs associated with the lamprey control program.

Mail Survey of Anglers

The mail survey will be conducted during years one and seven of the sea lamprey control program. The year one survey will consist of a systematic random sample of 4000 anglers from the previous year creel survey (approximately 5% of Lake Champlain anglers). All year one respondents will be resampled in year seven along with 2000 randomly selected anglers from the preceding year creel survey. The resampling of year one respondents will provide us with a unique opportunity to measure actual changes in: 1) expenditure levels, 2_) value of the fishing opportunity, and 3) levels of participation. These changes, in combination with the information obtained in the year seven random survey of anglers, should provide an effective measure of the lamprey control-induced change in the value, financial impact and level of participation of Lake Champlain anglers.

Anglers contacted during each creel survey will be given an information sheet that will describe the mail survey and indicate that they may be included in the sample. They will also be given a form that they can use to record information (e.g., number of trips, trip expenses, etc.) that will be required in the mail survey. The surveys will be conducted in mid-November and will request information on the entire year's fishing activity. A postcard "reminder" will be sent to non-respondents one week after the initial mailing and a second questionnaire will be mailed to those who have not responded by the end of the third week. A 10% survey of non-respondents will be initiated three weeks after the second mailing.

The questionnaire will obtain detailed fishing-related expenditure data, travel cost and travel distance data, information on willingness-to-pay for incremental increases in the quality of the fishing experience, socioeconomic data, and participation and attitudinal data on Lake Champlain fishing. It will request this information for each of the fishing seasons (ie., ice, spring, etc.) and by fishing species groups (ie., salmon/lake trout, walleye, smelt, etc.)

Mail Survey of Towns

The mail survey of all town planning departments in shore and near-shore towns on the New York and Vermont sides of Lake Champlain will be conducted during years1 and 7 of the sea lamprey control program. Towns to be included in the survey will be indentified through the use of maps and telephone contacts with regional planning commissions.

The planning departments in the selected towns will then be mailed a questionnaire that will request information on current public infrastructure capacity by season and/or month and, general capacity limits. The planners will also be asked to identify and describe any critical infrastructure limitations that currently exist. A follow-up telephone interview will be conducted two weeks after the initial survey. It will be used to request survey information from nonrespondents and to obtain additional information from respondents who either identified critical infrastructure limitations or provided incomplete information on the mail survey.

The data obtained from the questionnaires, and follow-up interviews of town planners, will be analyzed and compared with the projected Lake-wide distribution of the projected 65,000 increase in angler days. All public infrastructure found to be currently at or near capacity, and all infrastructure that would reach or exceed capacity as a result of the projected increase in angler days, would be analyzed and mapped.

Mail Survey of Chambers of Commerce

The mail survey of chambers of commerce will be conducted during years 1 and 7 of the sea lamprey control program. All local and regional chambers of commerce in the immediate vicinity of Lake Champlain will be mailed a questionnaire. This questionnaire will request information on capacity and current occupancy/use rates, by season, of motels/hotels, camp/guest house rentals, restaurants, boat rentals, fishing charters and marinas. A follow-up telephone interview will be conducted two weeks after the initial mailing to solicit survey information from nonrespondents.

The capacity data obtained from the local and regional chambers of commerce will be compared with current and projected demand for private support facilities/services to determine if limitations exist and/or would occur as a result of the projected increase in fishing activity. Identified limitations will be analyzed and mapped.

Expenditure Data. The detailed expenditure information requested in the questionnaire will be used to develop average and total expenditure figures for species and season categories in each of the study years. These data will subsequently be used to estimate the financial impact (initial expenditures and multiplier effects) on the Lake Champlain regional economy and tax benefits to state (New York and Vermont) and local governments. A comparative analysis of changes in expenditure patterns for the six year period between the first and second survey will be undertaken in year seven. This analysis will document change but it will not establish a definitive relationship between the sea lamprey control program and the distribution or magnitude of angler expenditures. This is due to the fact that it will be extremely difficult to segregate sea lamprey control effects from other factors (ie., normal growth in fishing activity, better access to the lake, economic conditions, publicity, etc.) that affect angler numbers and expenditure levels. Nevertheless, respondents will be asked to identify any specific changes in their expenditure patterns attributable to the control program.

Travel Cost Method. The travel cost and travel distance information requested in the questionnaire will be used, in conjunction with other data, in the Travel Cost Method (TCM) to generate a net economic value for various categories of fishing on Lake Champlain. The TCM will be used because it is a market-based method that utilizes marketed inputs (travel and associated costs) and levels of participation (number of visits to the site) to derive a functional demand curve for a non-marketed recreation resources -- in this case, various categories of Lake Champlain fishing. The demand curve permits the estimation of net value or net willingness-to-pay (sum of producers' and consumers' surpluses) which is the relevant measurement of value for both market and non-market goods.

The TCM demand curves generated for this study will provide net values for various fishing categories (ie., ice fishing for trout and salmon, spring walleye fishing, etc.) in each of the study years. They will also be used in conjunction with actual and predicted changes in the quantity and quality of fish available for harvest to estimate the net value of the sea lamprey control program. This will be accomplished by using actual and predicted increases in the quantity and quality of fish available for harvest as demand shifts. The resultant increase (decrease) in producer and consumer surplus will represent the value of the control effort.

Contingent Value Method. One of the deficiencies of the TCM is its ability to adequately handle multipurpose or multidestination trips (eg., trip to Lake Champlain to fish for lake trout and attend a family reunion and/or fish for salmon in Lake Willoughby). The TCM relies on travel and associated trip costs to estimate demand so multipurpose/multidestination trips present a serious cost allocation problem. In order to deal with this problem, and enhance our ability to estimate value changes in the quality of the fishing experience, the contingent value method (CVM) will also be used in this study. In the CVM, respondents are asked about their willingness-to-pay for a hypothetical (contingent) change in a particular resource or activity. This direct approach provides valuable information on the respondents demand for the resource (activity) and is not constrained by multipurpose trips, etc., since questions can be phrased to obtain the desired information. The principal shortcoming of this method is the hypothetical nature of the situation, so questions must be carefully designed.

The willingness-to-pay questions in the questionnaire will be designed to elicit net fishing values of anglers on multipurpose and/or multidestination trips and net values of existing and improved fishing conditions for all respondents. These latter values will subsequently be compared with TCM values to judge the consistency of the two methods.

Socioeconomic, Attitudinal and Participation Information. The socioeconomic, attitudinal, and participation information requested in the questionnaire will serve a variety of functions. It will be used 1) to develop a profile of anglers engaged in various fishing activities, 2) to determine angler attitudes regarding fishing regulations, access to Lake Champlain, adequacy of support facilities (ie., fishing charters, bait shops, marinas, etc.), quality of the fishing experience, etc, 3) to determine if increases in angler-days are the result of new entrants or anglers currently fishing in other lakes and streams, 4) to test the significance of various factors (eg., income, fish catch, years of fishing experience, etc.) in explaining variation in the number of annual fishing trips to Lake Champlain, annual days of participation, quality of the fishing experience, fishing-related expenditure levels, etc., and 5) in the Travel Cost Method to estimate the net values of various Lake Champlain fishing activities.

Telephone Survey

The purpose of this survey is to obtain information on the value nonanglers receive from the existence of the Lake Champlain fishery and from the expected and realized improvements in the quality of the fishery as a result of the Sea Lamprey Control Program. The survey will consist of a random sample of 400 heads of households living within an approximate 50 mile radius of Lake Champlain. Names and telephone numbers will be randomly selected from appropriate New York and Vermont telephone directories or purchased from a company that generates stratified random lists. Sampling by trained University of Vermont interviewers will occur over a one week period in March of years one and seven of the lamprey control program.

Respondents will be asked to respond to a series of general questions and statements about Lake Champlain, the lake fishery, and the sea lamprey problem. They will also be asked specific questions regarding any option, existence, or bequest values (see the discussion of these values in the accompanying Review of Literature) they may receive. The responses to the general questions and statements will establish the respondents knowledge and attitudes on the fishery and sea lamprey problem and will be used to evaluate the reliability of the respondent's value estimates to the option, existence, and bequest questions. These latter values will be used to establish mean, nonuser (preservation) values for the lake fishery and to measure the change in these values resulting from the Sea Lamprey Control Program.

The option, existence, and bequest values will be estimated using the contingent valuation approach utilized by Welsh, Loomis and Gilman (1984) to measure wilderness preservation values resulting from incremental increases in wilderness protection. An iterative bidding process will be used to determine a respondent's maximum annual willingness-to-pay for maintaining the current lake fishery and for three incremental increases in the quantity and quality of fish available for harvest. Respondents will be asked to allocate their maximum willingness-to-pay in each of the four categories among option, existence, and bequest values. A nonbias tax on all citizens will be designated as the payment vehicle to minimize free-rider problems and to avoid strategic bias against the type of payment.

Option, existence, and bequest values for all households in the lake's zone of influence will be developed through the use of an econometric model of the form recommended by the Water Resources Council:

$$WTP = f(Q, S, T, R)$$

where Q = the quantity and quality of the fishery; S = socioeconomic variables, T = taste and preference variables; and R = information relevant to the recreation use of the lake.

Stepwise regression will be used to develop a statistical willingness-to-pay function with unbiased estimates. The model will produce regressive coefficients of relevant variables for option, existence, bequest, and combined values. It will show how changes in the relevant independent variables (eg., income, knowledge of the sea lamprey problem, etc.) affect the value of the four dependent variables (ie., option, existence, etc.). These data will subsequently be used to estimate household and total values, by value category, for all households in the study area.

Survey of Businesses

The purpose of this personal interview survey is to document any change in the sales volume of a select group of businesses that will provide goods and services to Lake Champlain anglers during years one and seven of the sea lamprey control program. The businesses will consist of fishing charters, boat dealers, boat rentals, marinas, and bait and tackle shops. These particular businesses were selected because they provide the best opportunity to identify anglers' expenditures. Other businesses (eg., motels, restaurants, service stations, liquor stores, supermarkets, etc.) benefit from angler expenditures but it is extremely difficult, or impossible, for them to estimate the volume of business derived from anglers. Detailed expenditure information obtained from anglers will, nevertheless, provided gross estimates of the financial benefit to these businesses.

The survey, conducted in years one and seven of the sea lamprey control program, will identify all of the selected businesses in New York and Vermont towns or cities bordering on Lake Champlain. All fishing charters and a stratified 50% random sample of boat dealers, boat rentals, marinas, and bait and tackle shops will be personally interviewed. During year one, the interviewer will request information on gross sales to anglers and the percent of gross sales to anglers. The owners/managers of the sampled businesses will also be asked to respond to a series of questions and statements designed to determine their knowledge and attitudes on the sea lamprey problem, the control program, the current and future importance of angler expenditures on the local economy, etc.

In year seven, the personal interviews will be repeated using the same questionnaire and businesses selected in year one. Also interviewed will be the owners of new businesses of the type selected in year one. The sampling procedure will be the same as in year one. A comparison of the responses to the year one and year seven interviews will reveal the change in gross sales to anglers, percent of gross sales to anglers, and the change in owner/manager awareness of the economic importance of fishing to the local economy. It should be noted, that this study of businesses will not measure the impact of the sea lamprey control program on gross sales since many factors (ie., increase in the number of anglers, better fishing access, fishing regulations, etc.) may have contributed to the change in business volume. Information on angler-generated gross sales can, nevertheless, be analyzed in conjunction with town specific expenditure data obtained from anglers and estimated control-generated increases in the quality of the fishery to provide estimates of the percentage of gross sales attributable to sea lamprey control.

Cost Study

The analysis of costs associated with the sea lamprey control program will include administrative costs, environmental costs, costs to landowners on treated sections of streams, and costs incurred by anglers. Other, less definable costs, will be omitted because their estimation cost will be prohibitive.

Administrative Costs. Administrative costs will be estimated from records maintained by the agencies involved in the program. The actual costs of special equipment, chemicals, etc. will be tabulated along with an appropriate "use" cost for other equipment used in the control program. Labor costs for persons involved in the administration and operation of the program will be evaluated at appropriate wage rates. Costs of contracted research to support the control program, including this study, will be valued at the contracted price.

Environmental Costs. The evaluation of environmental costs will be difficult since information on the detrimental effects of the lampricide and the associated costs are not fully understood. Some desirable fish species and insect larvae will be killed or injured and water quality will be temporarily impaired. The value of this loss, even if carefully estimated, will be difficult to determine since no market exists to value these resources. What is the loss (cost) associated with the destruction of a certain number of American Brook Lamprey, a desirable species of lamprey, in a section of stream treated with lampricide? The answer is difficult since this lamprey has no current use value. The evaluation technique, therefore, will be to list all of the identified detrimental effects of the control program on the environment and to attach values in some cases (eg., loss of 5000 walleye fingerlings that can be valued on the basis of their replacement cost), value linkages in others (temporary break in a critical food chain), and a numerical listing when no value indicators exist.

Landowner Costs. Landowner costs (e.g., water treatment, temporary loss of stream water use, etc.) during and after stream/river treatment with lampricide will be estimated through the use of a 10% mail survey of streamside landowners one month after lampricide treatment. Non-respondents will be resampled two weeks after the first mailing. A 10% telephone survey of non-respondents will be conducted three weeks after the second mailing. Landowners will be asked to list and, where appropriate, to quantify all costs (monetary and nonmonetary) that they incurred as a result of the lampricide treatment. Average landowner costs will be determined and expanded by the total number of landowners to get the total landowner cost of the control program.

Angler Costs. Costs incurred by anglers as a direct result of the sea lamprey control program will be included in the expenditure survey discussed above. Anglers will be asked to list any specific costs directly attributable to the control program. These costs would then be included as a cost of the control program. The remaining expenditures (e.g., food, transportation, bait, etc.) will not be included since their relationship to the control program is indeterminable.

REVIEW OF LITERATURE

Travel-Cost Method.

A number of refinements have been made in the travel-cost method of estimating recreation demand since its initial application by Harold Hotelling in 1949 and the formulation of the basic model by Clawson in 1959. Researchers have included substitute site effects in the model (e.g., Burt and Brewer, 1971; Cichetti, Fisher, and Smith, 1976; Peterson et al., 1984; and Rosenthal, 1985), the value of time (e.g., Cesario and Knetsch, 1970; Cesario, 1976; Wilman, 1980; McConnell and Strand, 1981; Smith, Desvousges and McGivney, 1983), congestion effects (e.g., McConnell and Duff, 1976; Wetzel, 1977; Deyak and Smith, 1978; Cesario, 1980; and Hof and Loomis, 1983), and numerous other improvements in the basic function of the model (e.g., Allen, Stevens, and Barrett, 1981; Loomis, 1982; Peterson et al. 1984; and Rosenthal, Loomis, and Peterson, 1984). These refinements have greatly improved the theoretical accuracy of the model, reduced criticism relating to its many assumptions, and facilitated its wide acceptance as the method of choice for estimating the demand curve (value) for a recreation site (U.S. Water Resources Council, 1979).

In addition to the theoretical improvements in the TCM, there have been several attempts to test the ability of the TCM to produce valid demand curves. Perhaps the most notable attempt was made by Bishop and Heberlein (1979). The authors conducted three surveys of hunters who had received free goose hunting permits in 1978. First, a cash offer was made for their free permits ranging from $1 to $200--they had the option to keep the permit or the money. Second, a mailed questionnaire was designed to elicit hypothetical willingness-to-sell and willingness-to-pay responses regarding the 1978 permit. Third, a mailed questionnaire was designed to secure information necessary to develop a travel-cost demand curve. Results indicated that the TCM value was 29 percent below the actual cash value estimate and 114 percent above the hypothetical (CVM) willingness-to-pay value. Since the cash value figure was influenced by the nature of the simulated market (i.e., dollars used were provided rather than earned; expenditure range was limited to $1-$200, etc.), it is not possible to make any definitive statements about the ability of the TCM to produce a competitive market demand curve.

There have been several other attempts to test the reliability of TCM values by initiating TCM and CVM value comparisons on the same data set (Thayer, 1981; Desvousges, Smith, and McGivney, 1983; Seller, Stoll, and Chavas, 1984), with various levels of observed value compatibility. The problem with all of these comparisons is that no definitive statement can be made regarding the accuracy of the derived values in duplicating competitive market values. These studies are only able to test for value consistency among several nonmarket valuation methods.

Several studies utilized the TCM in the valuation of sport fishing. Some applied the TCM and CVM to the same data set to test the consistency of the resultant values (Desvousges et al., 1983; Loomis and Brown, 1985; Sorg and Loomis, 1984). Loomis and Brown (1985) found that CVM values for trout fishing were approximately one-third lower than TCM values. Desvousges (1983) found differences that exceeded those observed by Loomis. Other studies focused on modifications of the basic TCM to enhance the value estimation capability of the model. Strong (1983) used a semilog functional form of the TCM demand equation in his empirical study of salmon and steelhead fishing. Garifo (1984) found that by analyzing contingency tables with the log linear technique that recreation trips for fishing in the Northeast first rose and then fell as income rose.

There were also direct applications of the TCM to value specific fishing resources. Brown et al. (1982) used TCM to estimate the value of sport-caught salmon and steelhead. He found that fishing success was a demand shifter--increasing the catch by one fish was valued at $55 for salmon and $74 for steelhead. Vaughn and Russell (1982) used TCM to estimate the value of a day of freshwater recreational fishing differentiated by fish species being sought. This refinement of the traditional TCM attempted to account for the influence of fish species available on the demand function for fishing days. Results indicate that this approach provides a simple way to incorporate site characteristics (fish species available) into the travel cost framework. The authors found that an increase of one fish per angler above the mean catch (4.7 fish) raised the average willingness-to-pay from $15.60 to $15.95.

One of the most comprehensive and complete applications of the TCM to the valuation of fishing was undertaken by Sorg, Loomis, Donnelly, and Peterson (1986). Their study attempted to produce theoretically correct values and values acceptable to several agencies by using state of the art TCM and CVM in conjunction with standard statistical technique, in the valuation of cold and warm-water fishing in Idaho. The authors estimated the net economic value of a cold water fishing trip to an angler and to the nation is $42.93 ($25.55 per day) and $42.00 ($26.36 per day) for a warm water fishing trip. The comparable CVM values for cold and warm water fishing are $22.52 and $16.35 respectively. A comparison of the TCM values to other TCM studies revealed a great deal of similarity. The $25.55 per day value for cold water fishing in this study compared favorably with the $19.49 found by Vaughn and Russell (1982), the adjusted $22.39 found by Martin, Gum and Smith (1974) and the $24.00 found by Miller and Hay (1984). The authors' general conclusion was that the travel cost method's principal advantage over the CVM was its reliance on actual behavior, applicability to all single purpose trips taken during the season, and ability to predict how many additional trips would be taken if the number of cold and warm water fish harvested increased by a specified amount. They also concluded that no method is superior in all cases but that both (TCM and CVM) tend to yield consistent, nonidentical results.

One of the most important recent developments in the TCM from a practical, application point of view, is the User's Guide to Rocky Mountain Travel-Cost Model (RMTCM): Software for Travel Cost Analysis by Rosenthal, Donnelly, Schiffhauer, and Brink (1986). This interactive menu-driven program consists of four modules: 1) data input; 2) data modifications; 3) regression analysis; and 4) report writing. It graphs "second stage" demand curves and estimates consumer surplus.

This literature review reveals that the travel-cost model has been refined to the point where it has few serious methodological problems. There are still some uncertainties regarding an appropriate way to value time, how to deal with multi-purpose trips, etc., but these can be temporarily handled through consistent use and should ultimately be solved with further research. What is clearly lacking is research aimed at verifying the ability of the TCM to produce competitive market-equivalent demand curves (value) for site-specific recreation opportunities. It is natural to expect recreation researchers to concentrate on perfecting the method before seriously evaluating the results. Recreation managers, however, who are currently using TCM valuation, need some assurance that the resultant values closely approximate the market values. It is, therefore, important that equal and concurrent effort be directed toward market verification of TCM-derived values. Results obtained in both endeavors will be mutually beneficial in improving the methodology.

Contingent Value Method

One of the early advocates of the contingent value approach to nonmarket benefit estimation was Ciriacy-Wantrup (1952). He postulated that individuals could be asked how much money they would be willing to pay for successive units of a collective extra-market good and that the result would correspond to a market demand schedule (Ciriacy-Wantrup, 1952).

This hypothetical approach to nonmarket valuation was subsequently challenged by Paul Samuelson (1954). Samuelson felt that people would react strategically to questions involving the value of revealed preferences (i.e., state values that would enhance their individual position). He also concluded that it was impossible to define an unambiguous "best state" in the absence of market prices that reflect individual preferences.

These objections to soliciting revealed preference information from individuals by Samuelson set the stage for a great deal of investigation into a host of perceived problems in the theory and application of the precursor to the CVM. Davis (1963) was one of the first researchers to use the revealed preference approach in a major study (The Value of Outdoor Recreation. An Economic Study of the Maine Woods). Later, Knetsch and Davis (1966) compared the revealed preference approach, Willingness to Drive, and TCM using the same data set. They found a very close "fit" among the values which led them to conclude that the approach showed promise as a method for estimating the benefits of recreation.

Bohm (1971) was the first researcher to specifically test for Samuelson's strategic bias objection. Bohm's experiments with survey methods resulted in the rejection of the strategic bias hypothesis. Vernon Smith (1977) later supported this finding in his report of experimental evidence.

These early applications and testing of the revealed preference approach (willingness-to-pay) led to the development of the current CVM by Randall et al. in 1974. Randall's contribution was to impose a rigorous structure on the survey in which willingness-to-pay questions were posed within the context of a contingent market. The survey, called a "bidding game," attempted to elicit behavioral rather than attitudinal revelations of individual preferences.

The formulation of the basic CVM format by Randall et al. resulted in the increased application of the method in a variety of nonmarket situations (Walsh et al., 1978; Bishop and Heberlein, 1979; Daubert and Young, 1981; Thayer, 1981; Desvousges, Smith, and McGivney, 1983; Crocker, 1984) and a concerted effort to test the strategic bias problem that still persisted in the minds of many researchers (Brookshire et al., 1976; Rowe et al., 1980; Mitchell and Carson, 1981). The general conclusion of each of these investigations was that strategic bias does not appear to significantly influence an individual's expressed willingness-to-pay for nonmarket goods and services.

The widespread application of the CVM and the research into the strategic bias question led to the discovery of other methodological and bias problems. One of the most obvious, and still largely unresolved problems involving CVM, is hypothetical bias. This bias arises because of the hypothetical nature of the market and payment. Freeman (1979) and Feenberg and Mills (1980) concluded that individuals will not invest the time and energy necessary to accurately respond to a hypothetical situation. More recent investigations by Rowe and Chestnut (1983), Schulze et al. (1981), Thayer (1981) and Bishop and Heberlein (1979) have helped to clarify the nature of hypothetical bias but have offered little to modify the effects.

Another area of CVM investigation involves the consumers perfect knowledge paradigm that assumes the consumer is aware of all alternative goods and services, prices, saving, purchase alternatives, etc. Studies by Schulze et al. (1983), Sorg and Brookshire (1984) and Blumburg (1984) suggest that respondents are aware of income trade-offs when willingness-to-pay bids are made. Blumburg (1984) and Walbert (1984) found that the introduction of alternatives resulted in a significant change in a individual's willingness-to-pay. These same researchers, along with Desvousges et al. (1983) and Schulze et al. (1983) further concluded that the bidding process results in significantly higher bids for the CVM commodity than a single request for maximum willingness-to-pay.

Three other areas of concern in the application of the CVM are starting point bias, information bias and vehicle bias. Starting point bias hypothesizes that the selection of the starting bid in the CVM bidding process will influence an individual's ultimate willingness-to-pay. Randall et al. (1978), Brookshire, Randall and Stoll (1980), Brookshire, D'Arge, Schulze and Thayer (1982) investigated the existence of starting point bias and Rowe et al. (1980), Brookshire et al. (1980 and 1981), Thayer (1981) and Sorg and Brookshire (1984) explored alternative valuation mechanisms to avoid the starting point bias. The general conclusion was that starting point bias did significantly affect willingness-to-pay and that payment cards appear to reduce starting point bias especially when an iterative bidding process is used.

Information bias is a compendium of biases emanating from the CVM survey process. It includes such things as: 1) the type and manner in which pre-survey information is provided, 2) type and manner in which the questions are phrased, 3) demeanor of the interviewer, etc. Research on information bias was conducted by Rowe et al. (1980), Brookshire et al. (1981), Cronin (1982) and Schulze (1983). The results of studies by the above researchers suggest that information bias exists but it is difficult to propose questions for its reduction since its components are so diffuse.

Lastly, vehicle bias relates to the form in which an offered payment would be made and its effect on willingness-to-pay. That is, it could be in the form of an increased tax payment, entrance fee, special assessment, etc. Vehicle bias was researched by Randall et al. (1978), Brookshire et al. (1980), Rowe et al. (1980), Brookshire et al. (1981), Greenley et al. (1981), Cronin (1982) and Daubert and Young (1981). Research results support the hypothesis that the vehicle selected will affect willingness-to-pay, but the researchers were not able to suggest a neutral or unbiased vehicle for eliminating this problem.

The Contingent Value Method has gained widespread acceptance in recent years and is the method of choice in evaluating nonsite-specific, nonmarket values. The methodology is well established. Researchers have identified the major biases and problems and have offered ways to minimize them. Users of CVM can be confident that the state of the art application of CVM will produce acceptable and useful values of nonmarket goods and services.

Gross Expenditure Method

The Gross Expenditure Method is one of the oldest and most controversial methods used in the valuation of public hunting and fishing. The controversy stems, not from methodological deficiencies, but from the often incorrect use of the derived hunting and/or fishing-related expenditures (ie., transportation, fishing rods, bait, etc.) as direct measures of activity value. Activity-related expenditures are the costs incurred to participate in an activity, not the value of the activity itself. Since an individual willingly incurs these costs, it might logically be assumed that the activity must, at least, be worth an amount equal to the expenditure. There are several errors in this assumption. First, an individual may feel that the activity was not worth what he or she spent to participate. Second, it would be incorrect to assume that a person who incurs high participation costs as a result of having to travel further, live in a motel, purchase necessary equipment, etc., values the activity more than a person not facing these costs. Third, expenditures measure what a person actually spends to participate in an activity and not what he or she would be willing-to-pay rather than give up that activity. Lastly, gross expenditures do not measure the losses that would occur if the activity were eliminated or the quantity or quality of the activity increased (Knetsch and Davis, 1966). If the activity were eliminated, the same level of expenditure might be shifted to other activities.

It should not be construed from this discussion that expenditures play no role in the evaluation of hunting and fishing activities. Expenditures are very important inputs in all major recreation activity (site) evaluation methods in use today (ie., travel cost, contingent value, hedonic methods) and are important in their own right in measuring the financial impact of activity-related expenditures on local and state economies (Rosenthal, Loomis, Peterson, 1984). It is this latter use that has made this method so popular with wildlife administrators and politicians. They like the fact that real, measurable dollars are used as the basis of the valuation rather than less tangible and hypothetical estimates of willingness-to-pay. According to Clawson and Knetsch (1966), such estimates are also likely to yield large values that give the impression of a large and profitable activity-related business.

The Gross Expenditure Method has a long history of use by federal and state fish and wildlife agencies (Wallace, 1956; McConnen, 1960; Davis, 1965; Walter and Birch 1966; Gilbert, 1970; Garrett, 1970; Horvath 1974; Gilbert, 1975 and 1985; Dwyer et al, 1977; U.S. Fish and Wildlife Service, 1970, 1975, 1983) continues to be used by the U.S. Fish and Wildlife Service (1986), State of Vermont (1986) and other states interested in measuring the financial impacts of various site-specific activities on their economies. The only significant changes in the method that have occurred over this long period of use are: 1) refinements in the way expenditure data are requested to insure that only the activity-related portion of the expenditure is listed (Gilbert, 1971; Horvath, 1974); 2) the inclusion of certain "hidden" expenditures (eg., real transportation cost vs. actual purchases of gas and oil) that were previously omitted (Sorg, Loomis, Donnelly and Peterson, 1986); and 3) better specificity on where expenditures are actually made so that impacts on specific towns can be estimated.

Preservation Value

The inclusion of preservation values (option, existence, and bequest) in the valuation of a resource is appropriate since the value of a resource is equal to the sum total of individual willingness-to-pay for the resource. Until Weisbrod (1964) suggested the inclusion of option values in the valuation of natural environments in 1964 and Krutilla (1967) advocated the inclusion of existence values in 1967, the valuation of natural environments was largely limited to the estimation of user values.

The introduction of option, existence, and bequest value expanded the scope of the valuation process to include public nonuse values. Option value is the annual willingness-to-pay for the option of possible future use. Existence value is the willingness-to-pay for the assurance that the resource will be protected even though use of the resource is not anticipated. Bequest value is willingness-to-pay for the satisfaction derived from preserving a natural resource for future generations. Initial research on these values centered on the validity of their theoretical construct (see Long, 1967; Krutilla, 1967; Cichetti and Freeman, 1971; Schmalensee, 1972; Meyer, 1974; and Bohm, 1975). It was generally concluded that the importance of these values is "conditioned" by the nature of the resource being valued (ie., its uniqueness, vulnerability, etc.) and the care that is taken to avoid double-counting. For example, Smith (1983) in a later study found that option value becomes significant under conditions of uncertain future supply. Demand and existence value is affected by the uniqueness and reproductivity of the resource, but that the resource need not be irreplaceable.

Following the initial theoretical investigations, research effort was directed at developing techniques for measuring preservation values. Since preservation values are not revealed through expenditures, travel or other observable means, researchers relied on the contingent valuation method to measure these values. Bradford (1970) developed the theoretical basis for applying CVM and Brookshire, Randall, and Stoll (1980) extended the theory to a general conceptual model that included the entire value flow of a resource. The most recent and complete estimation of preservation values was undertaken by Walsh, Loomis, and Gillman. The authors estimated the preservation value of increments in wilderness protection and adopted an empirical procedure to explore the effects of a large number of socioeconomic and preference variables on willingness-to-pay for preservation values. Their results indicate that the estimation of nonuse preservation values represent a substantial contribution to the present value of benefits estimated by the traditional travel cost method.

There have been several attempts to measure the preservation values of wildlife. Miller (1981) and Miller and Menz (1979) examined the notion that existence value can be meaningfully expressed by including stock (number of species) in the specification of individual utility functions. In other words, the existence value an individual derives from threatened wildlife is a function of the stock of that resource. Their findings suggest that the expression of existence value as a stock argument in a utility function is lacking since it fails to account for the value associated with merely knowing of the continued existence of a wildlife species.

The most complete and useful attempt to measure the option and existence value of wildlife was provided by Brookshire, Eubanks, and Randall. The authors developed a "modification of the contingent value approach to estimate option price and existence value for specific natural resources whose future supply is uncertain." They focused their research on the uncertainty of supply or willingness-to-pay for programs that would increase the certainty of supply of game populations. Study results demonstrate the feasibility of producing conceptually sound empirical estimates of nonuser values using the contingent value approach. The contingent markets performed reliably and individual willingness-to-pay estimates exhibited the expected relationships with respondents income and age.

The overall conclusion to be drawn from existing research on preservation values is that people are willing-to-pay for the "protection" of threatened resources and that contingent market estimates of option, existence, and bequest values should be added to the consumer surplus of user value to determine the total economic value of the resource.

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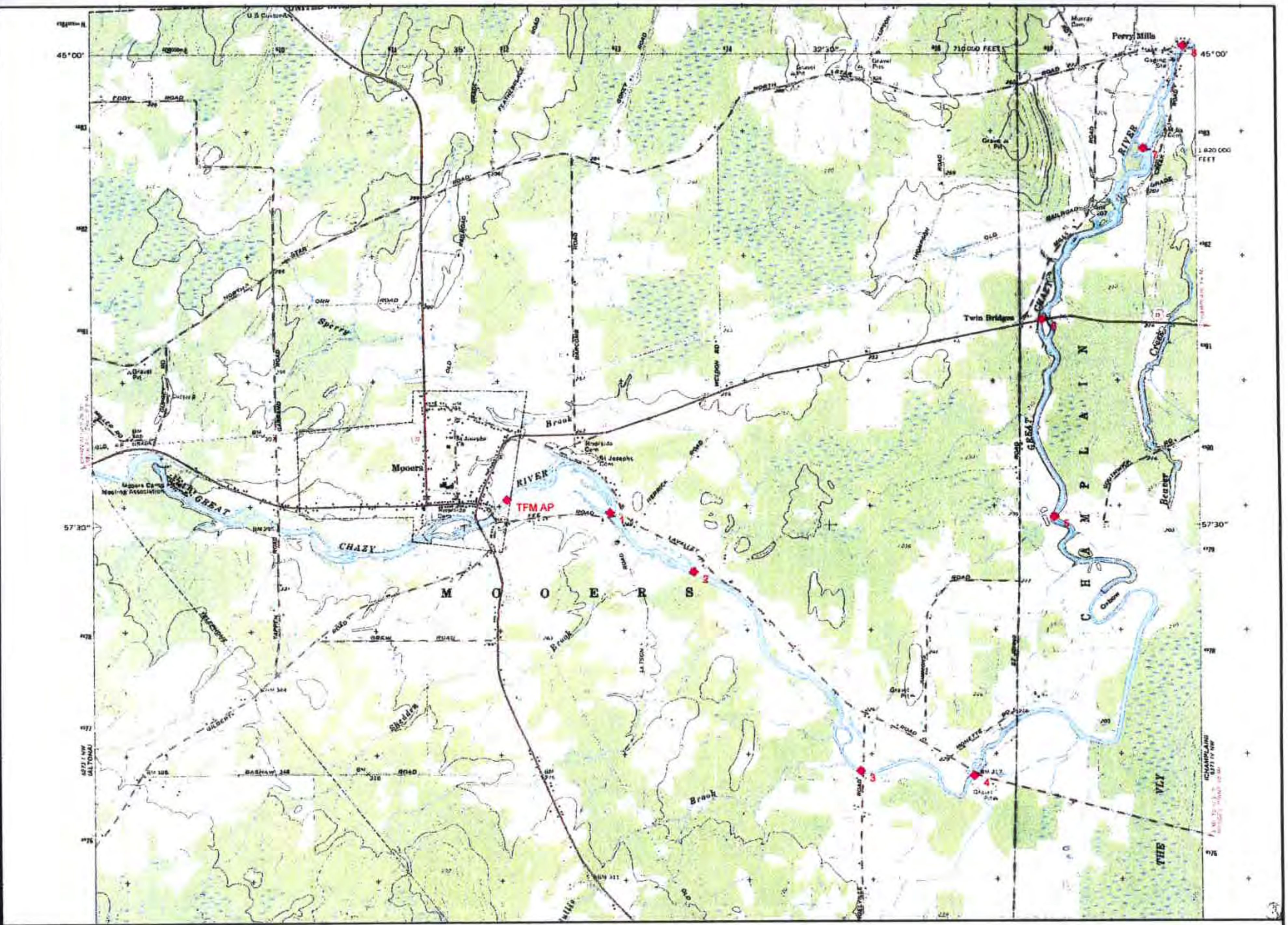
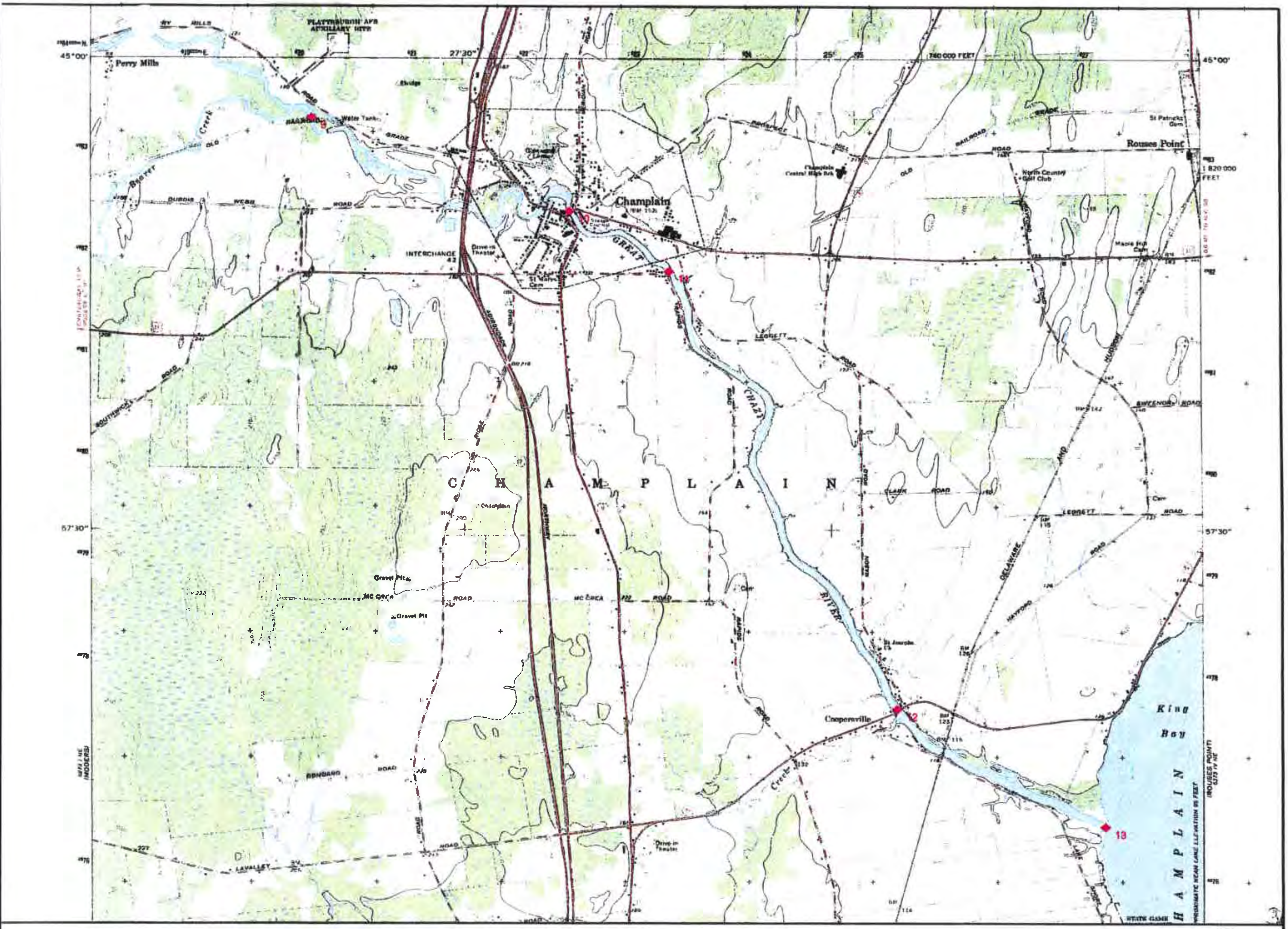
APPENDIX B

Stream Treatment Maps



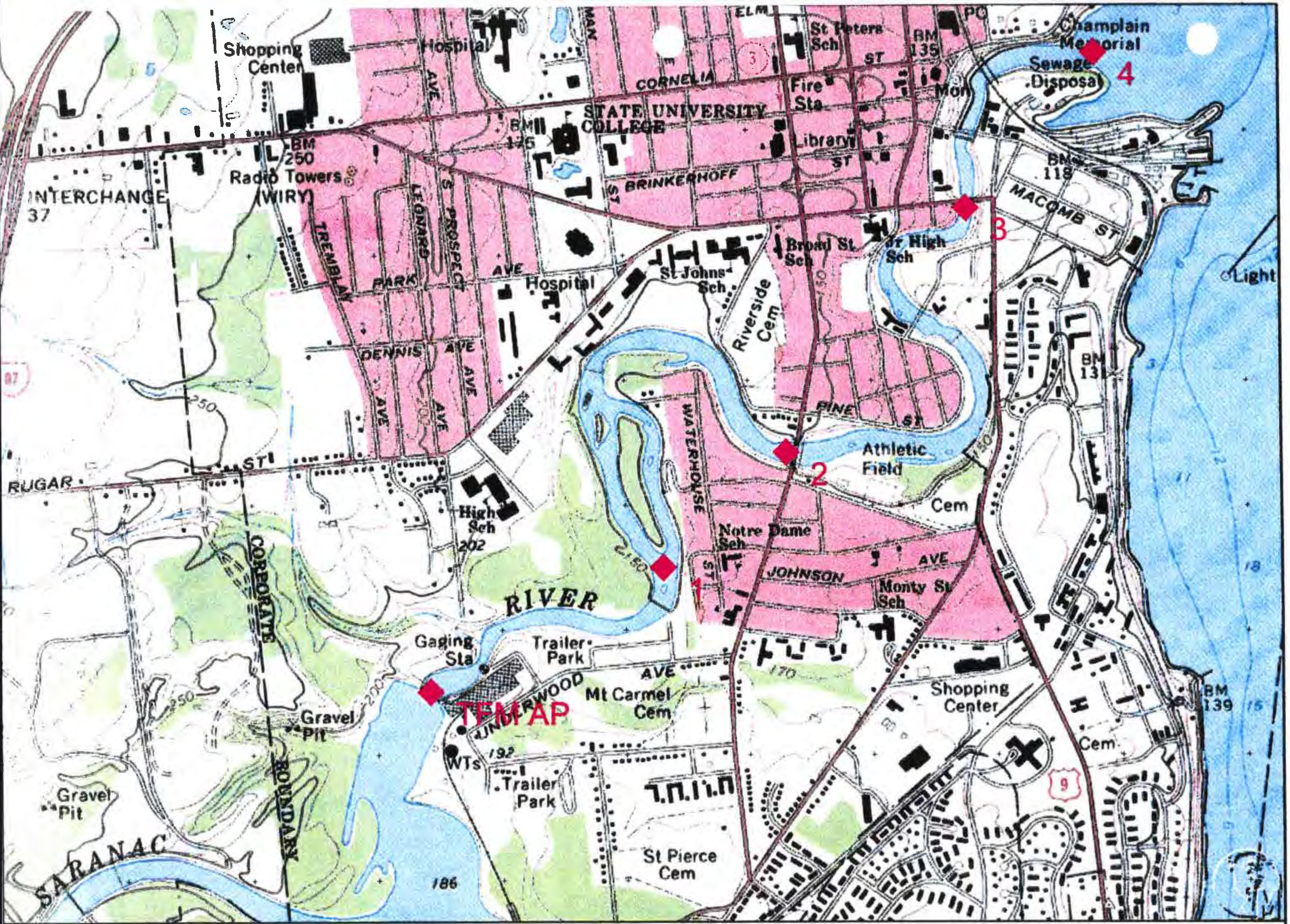
Name: MOOERS
Date: 11/5/98
Scale: 1 inch equals 3636 feet

Location: 044° 57' 49.7" N 073° 33' 48.0" W
Caption: Great Chazy River
Mortality count sections - Map 1



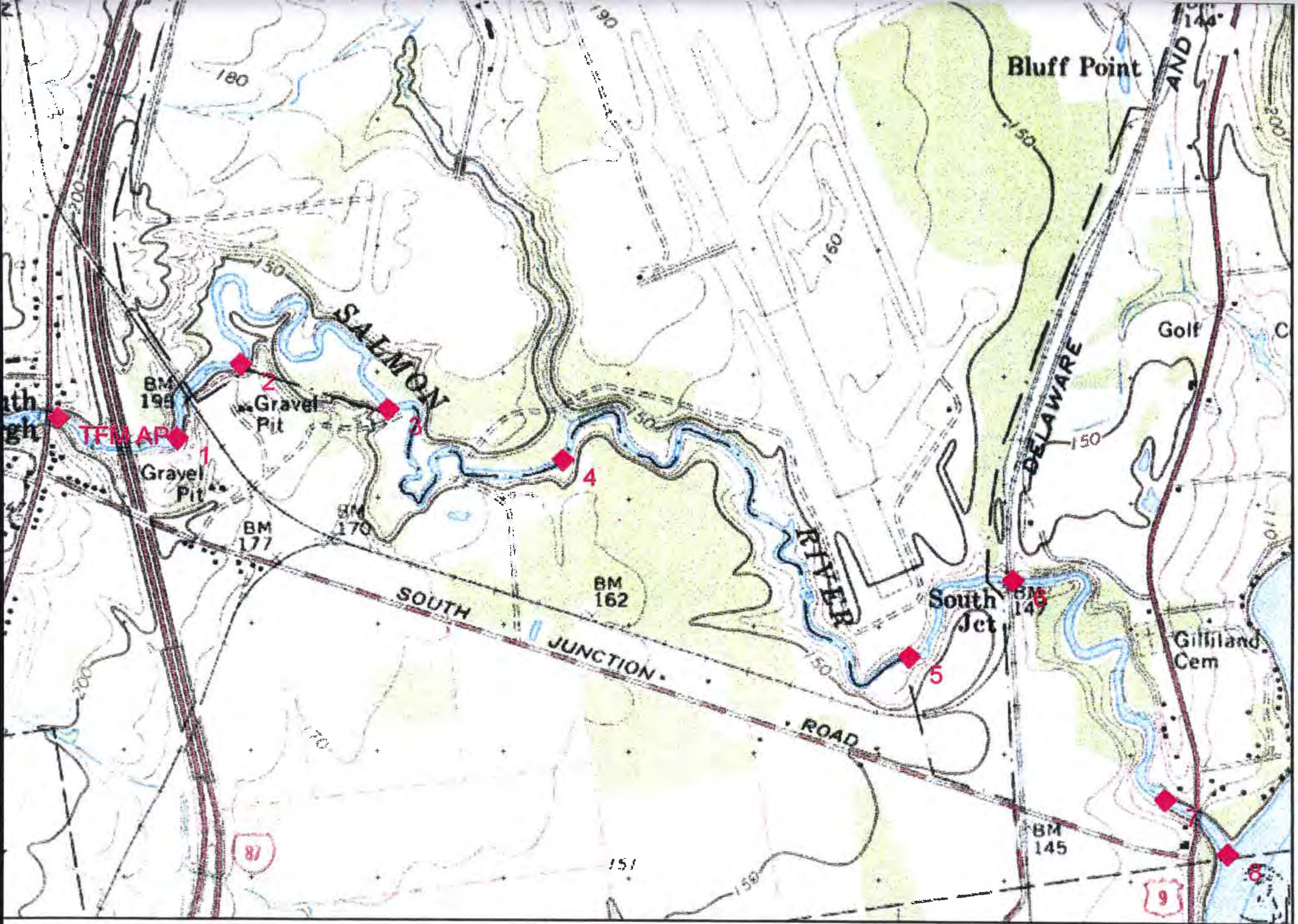
Name: CHAMPLAIN
Date: 11/5/98
Scale: 1 inch equals 3636 feet

Location: 044° 57' 50.7" N 073° 26' 18.1" W
Caption: Great Chazy River
Mortality count sections - Map 2



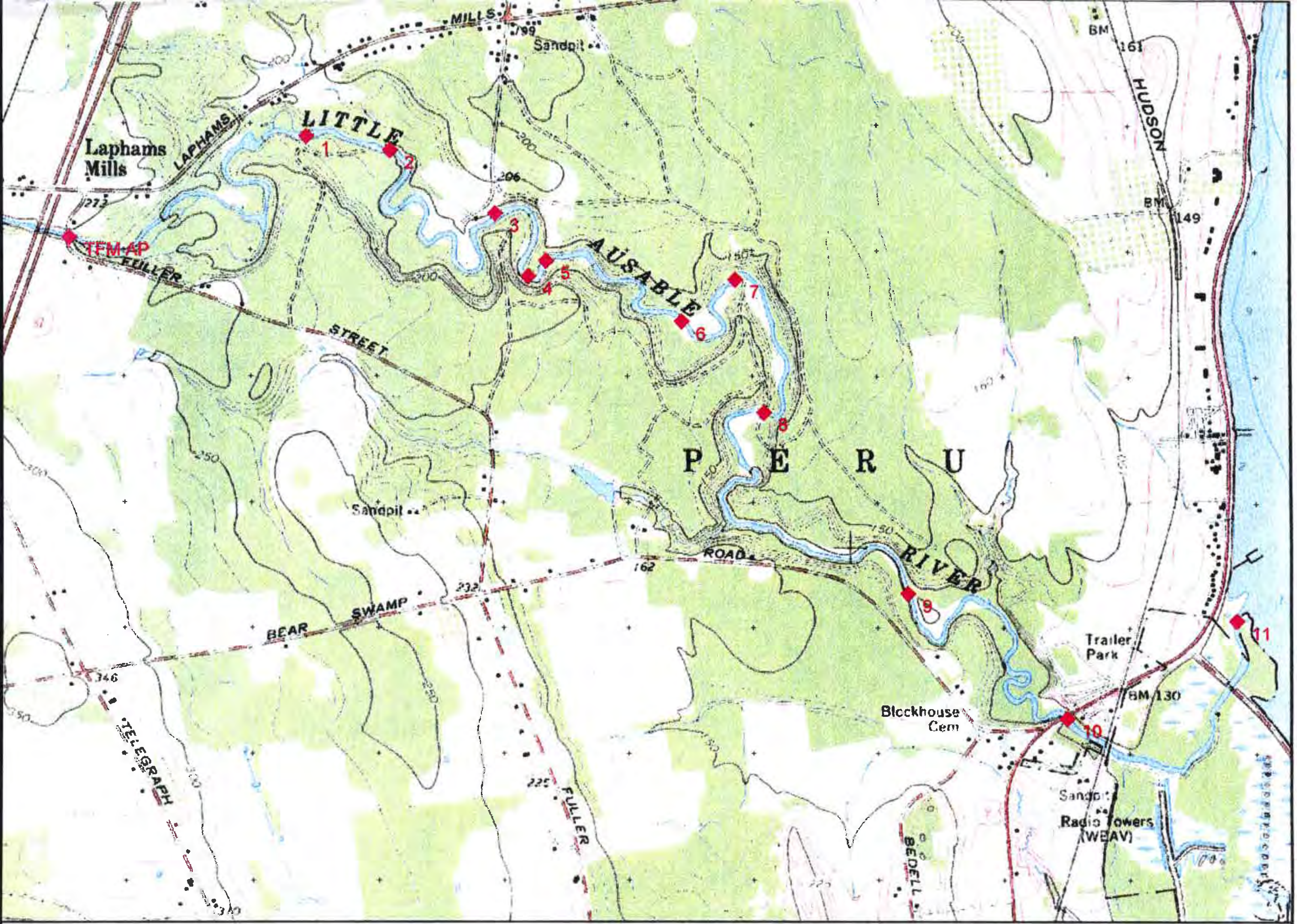
Name: PLATTSBURGH
Date: 1/19/99
Scale: 1 inch equals 1333 feet

Location: 044° 41' 15.6" N 073° 27' 53.6" W
Caption: Saranac River
Mortality count sections



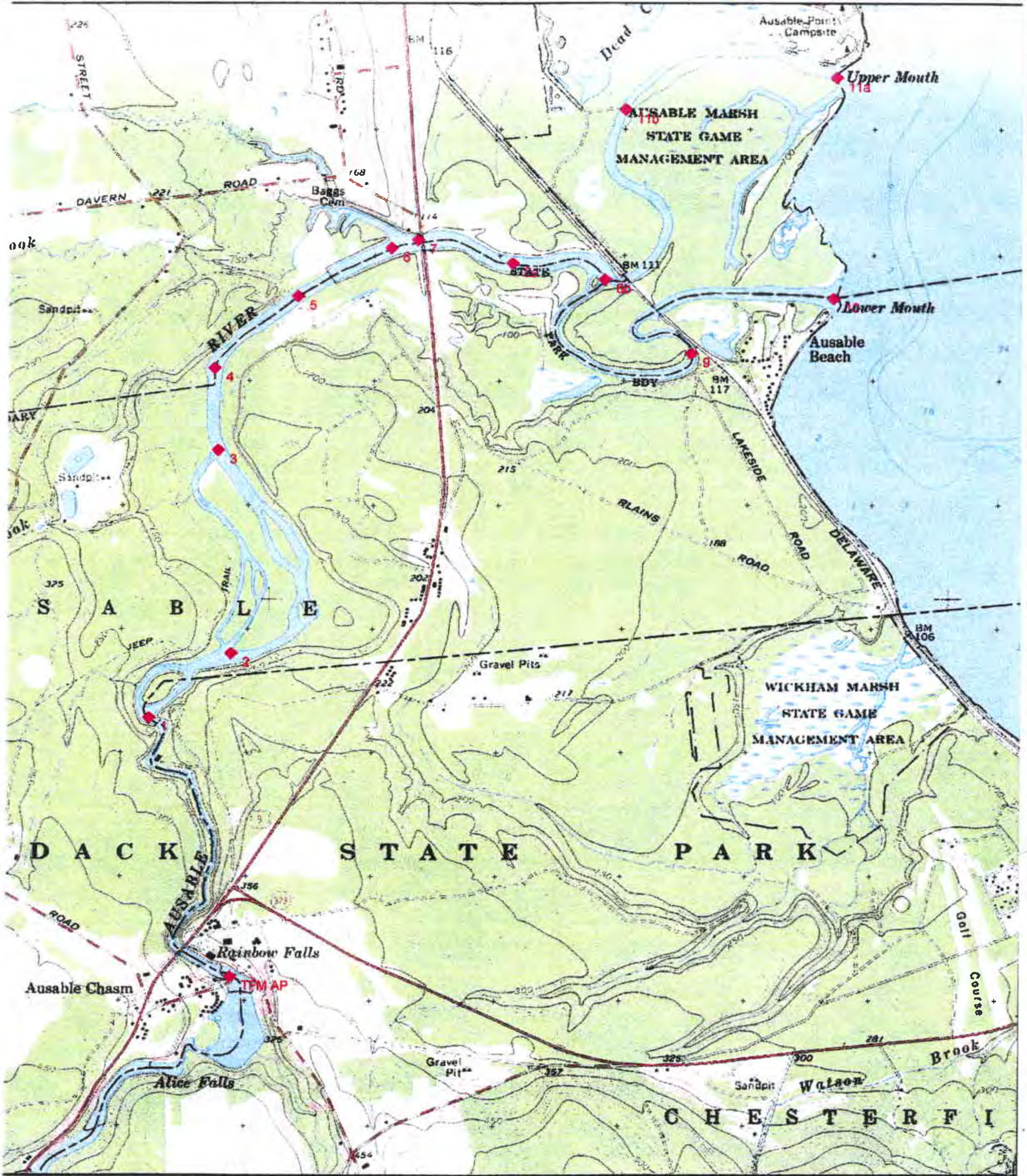
Name: PLATTSBURGH
Date: 11/4/98
Scale: 1 inch equals 1142 feet

Location: 044° 38' 12.1" N 073° 28' 01.9" W
Caption: Salmon River
Mortality count sections



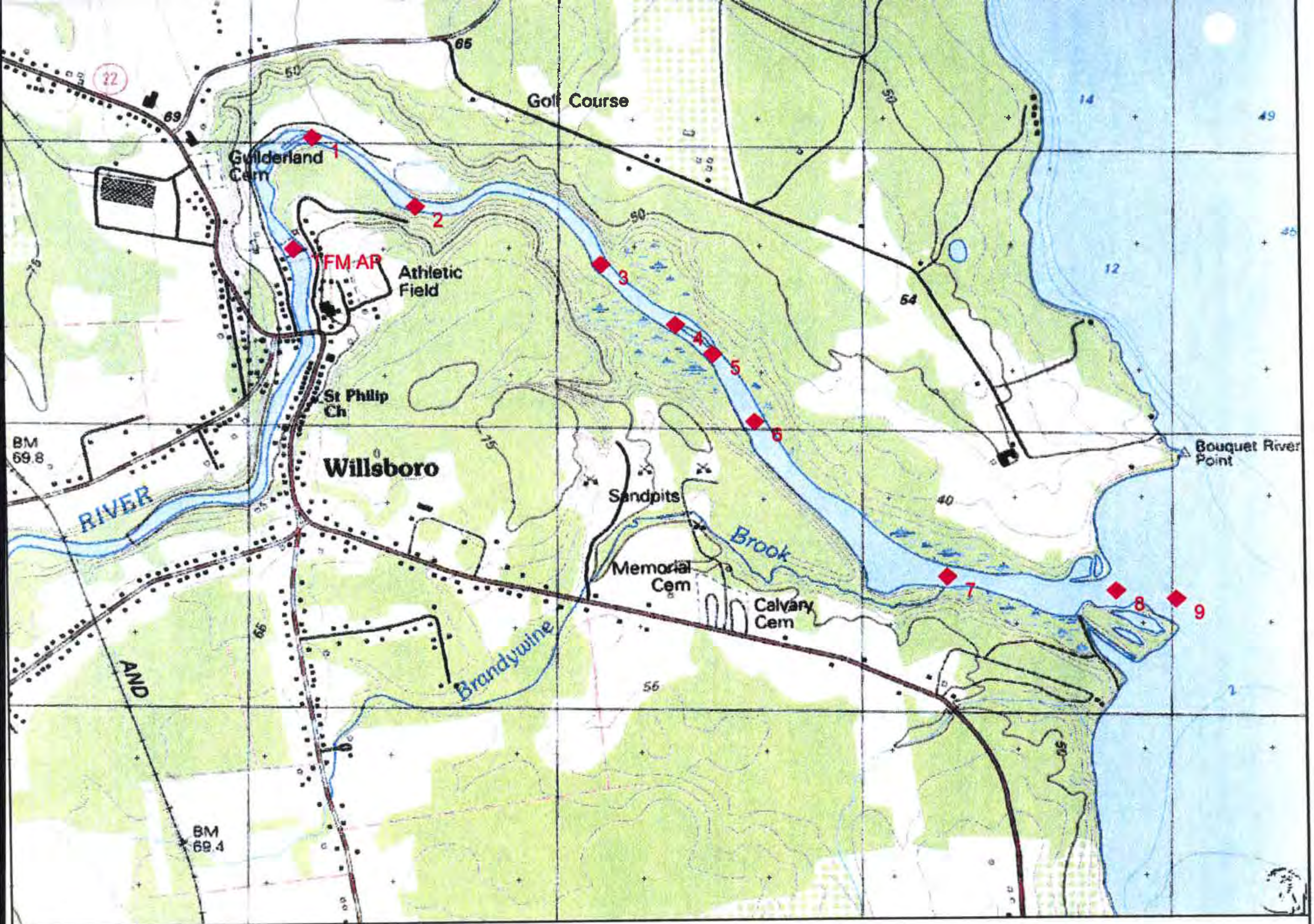
Name: KEESEVILLE
Date: 11/4/98
Scale: 1 inch equals 1600 feet

Location: 044° 35' 10.9" N 073° 28' 06.5" W
Caption: Little Ausable River
Mortality count sections



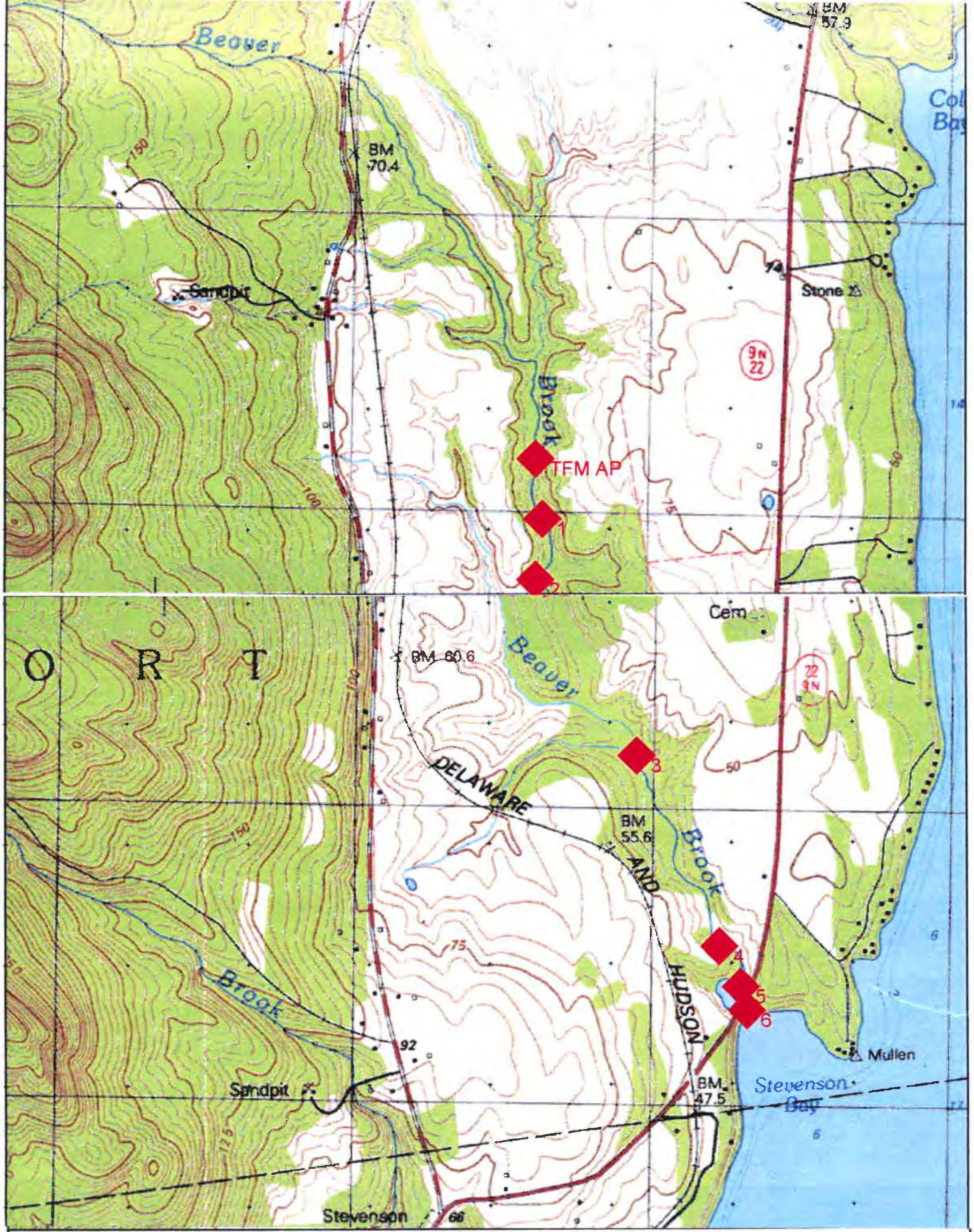
me: KEESEVILLE
Date: 11/4/98
Scale: 1 inch equals 2000 feet

Location: 044° 32' 31.3" N 073° 26' 36.8" W
Caption: Ausable River
Mortality count sections



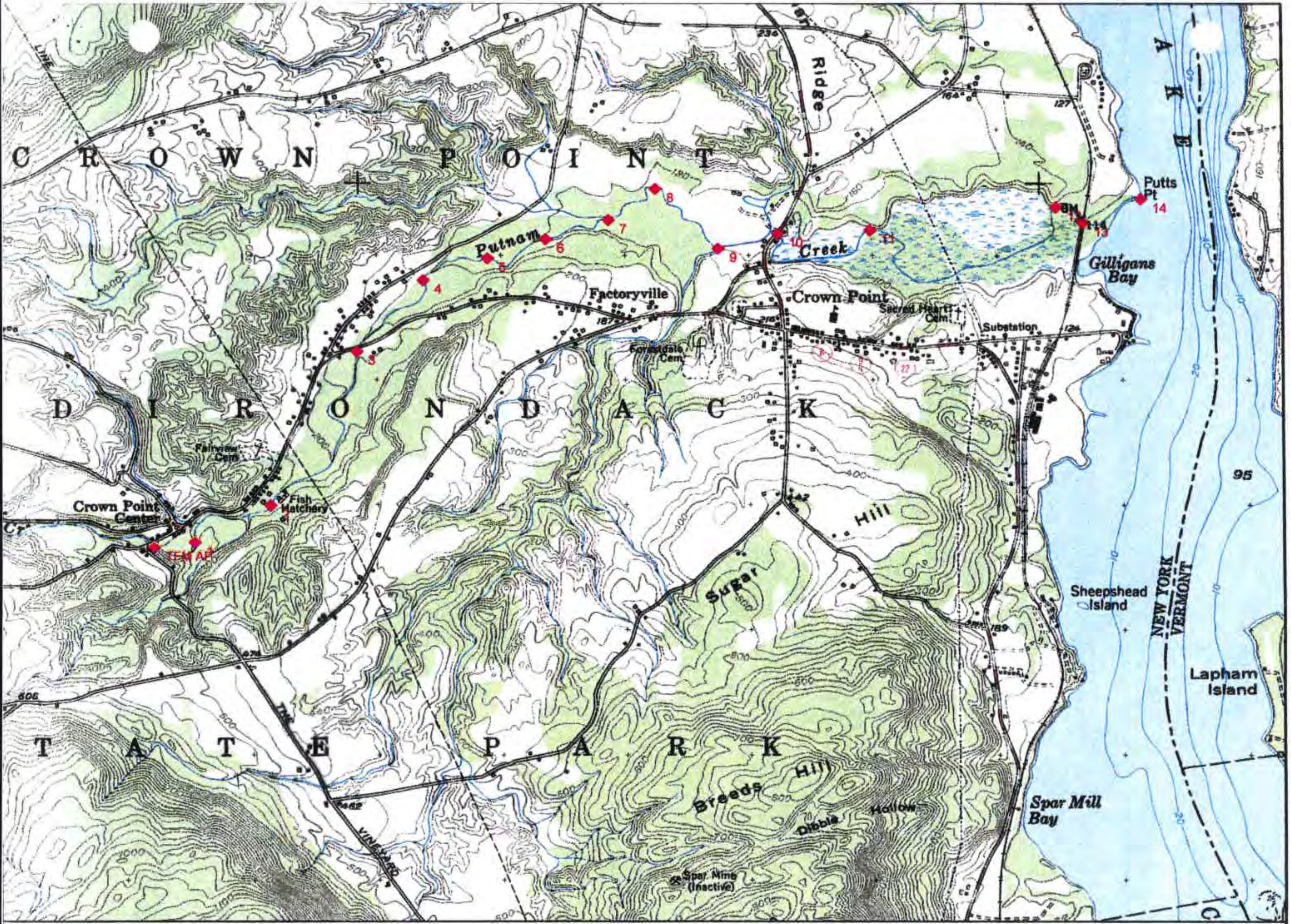
Name: WILLSBORO
Date: 11/23/98
Scale: 1 inch equals 1333 feet

Location: 044° 21' 34.7" N 073° 22' 38.2" W
Caption: Boquet River
Mortality count sections



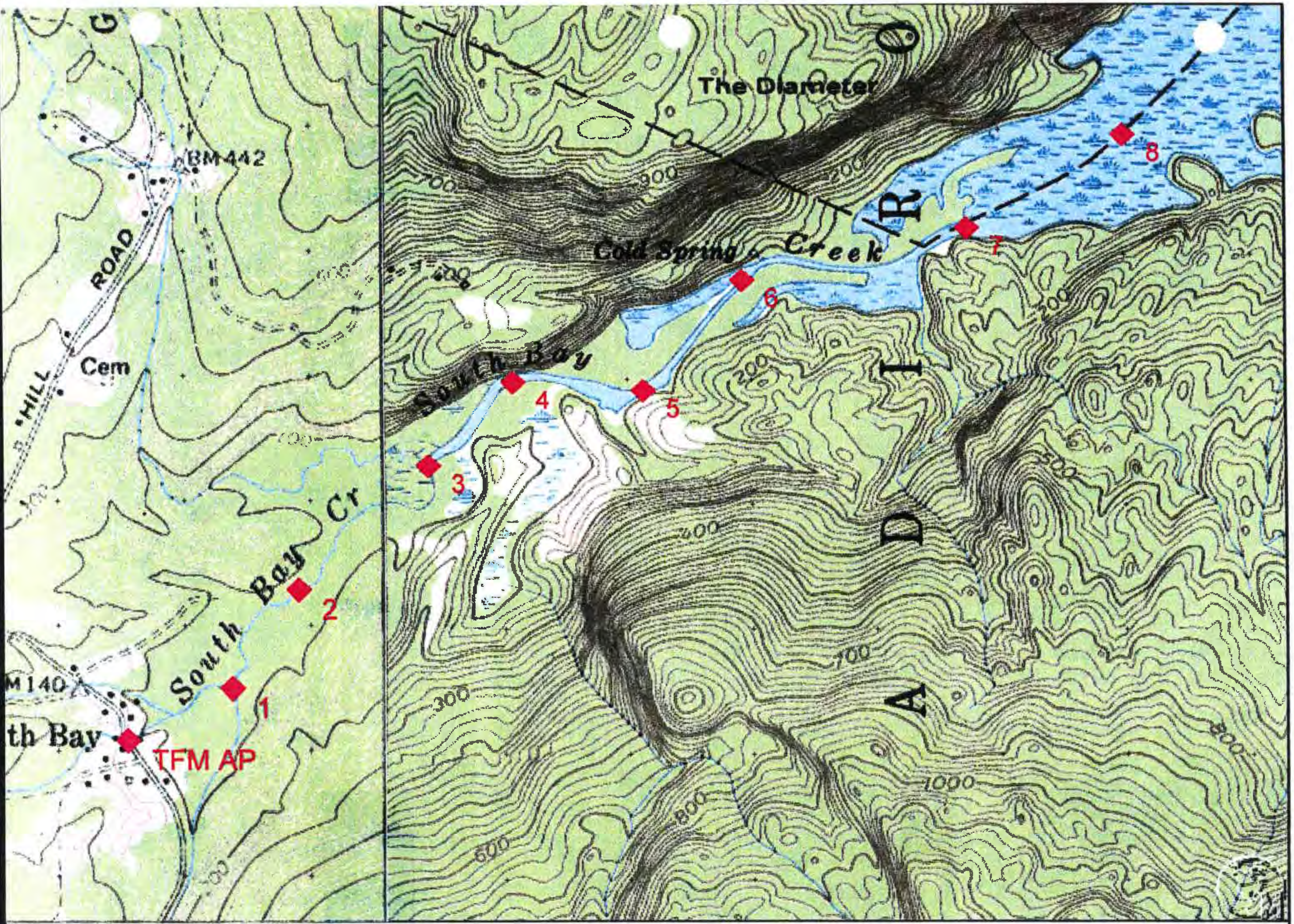
Name: PORT HENRY
Date: 10/14/99
Scale: 1 inch equals 1333 feet

Location: 044° 06' 38.9" N 073° 26' 41.5" W
Caption: Beaver Brook
Mortality count sections



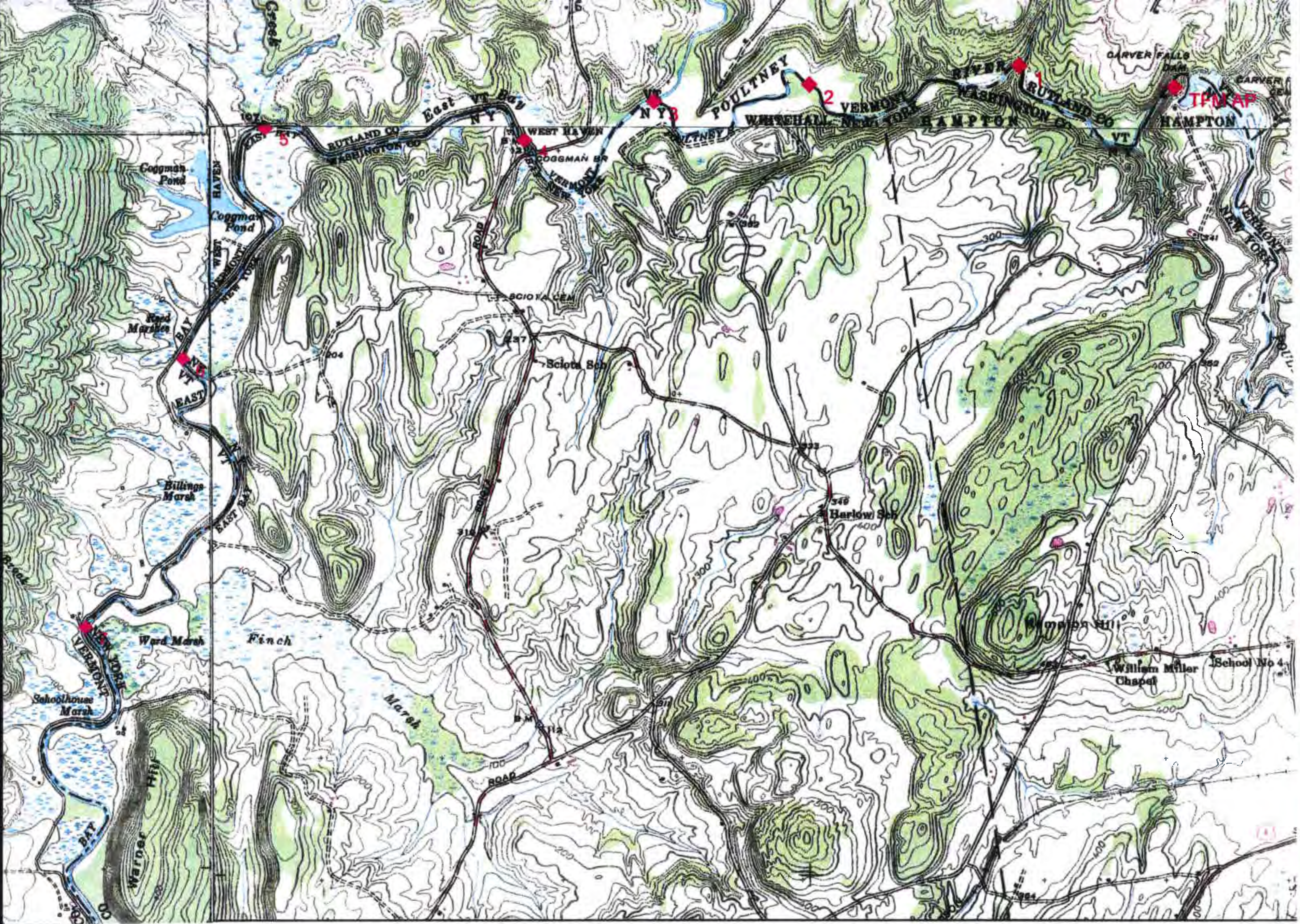
Name: CROWN POINT
Date: 11/23/98
Scale: 1 inch equals 2000 feet

Location: 043° 56' 40.9" N 073° 26' 27.7" W
Caption: Putnam Creek
Mortality count sections



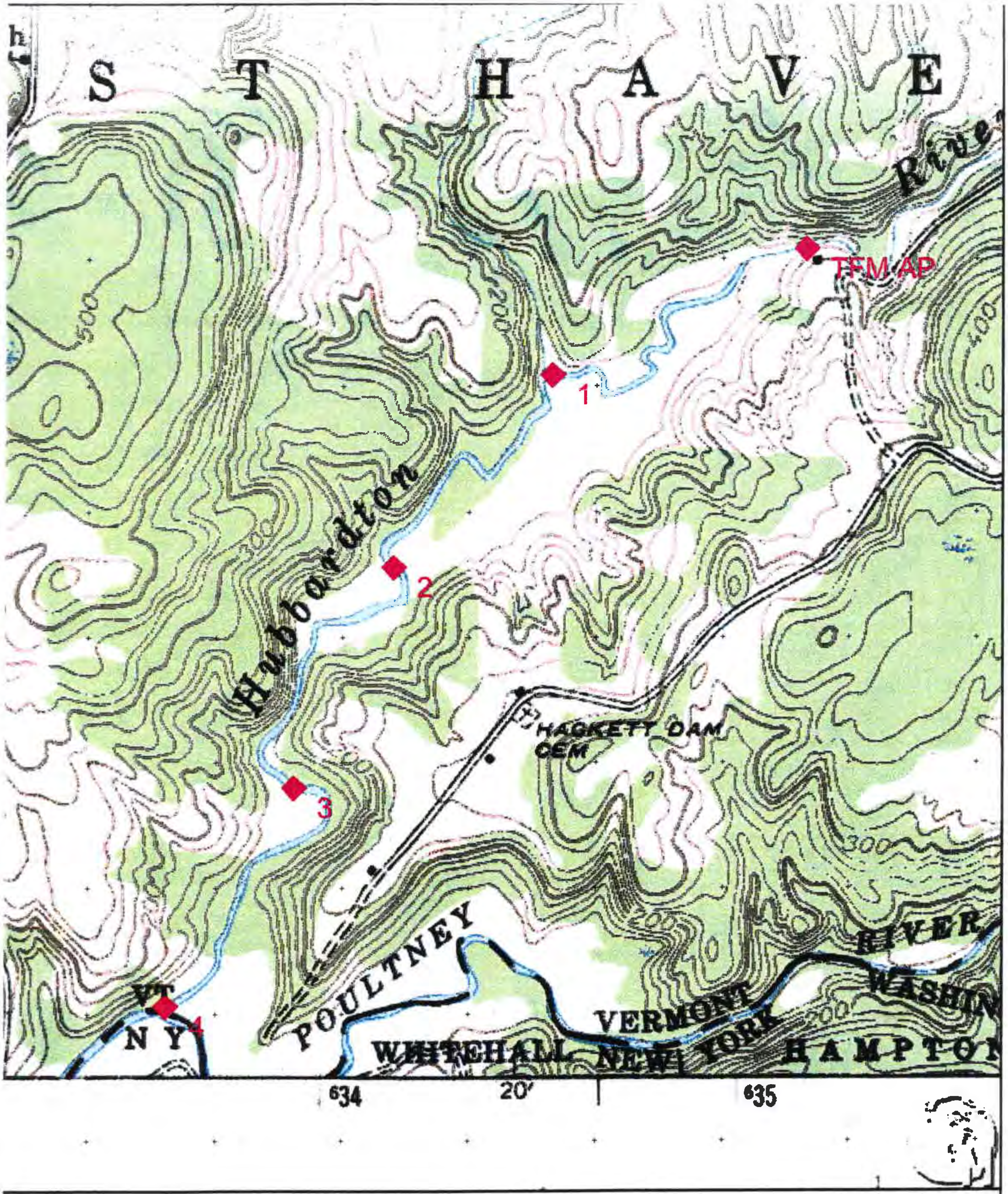
Name: WHITEHALL
Date: 11/4/98
Scale: 1 inch equals 1000 feet

Location: 043° 31' 40.9" N 073° 29' 31.5" W
Caption: Mount Hope Brook
Mortality count sections



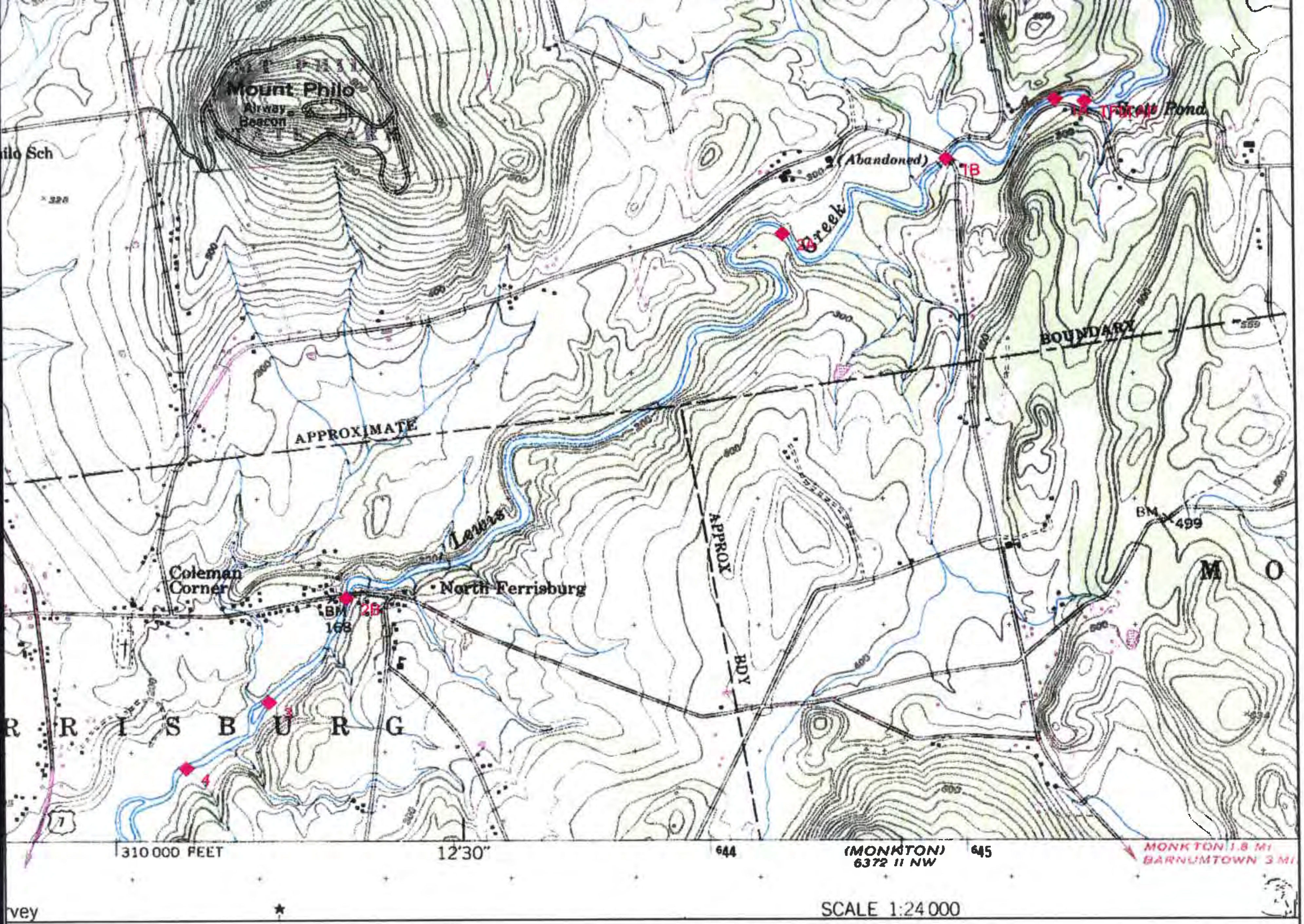
Name: THORN HILL
Date: 1/12/99
Scale: 1 inch equals 2222 feet

Location: 043° 36' 20.2" N 073° 20' 28.4" W
Caption: Poultney River
Mortality count sections



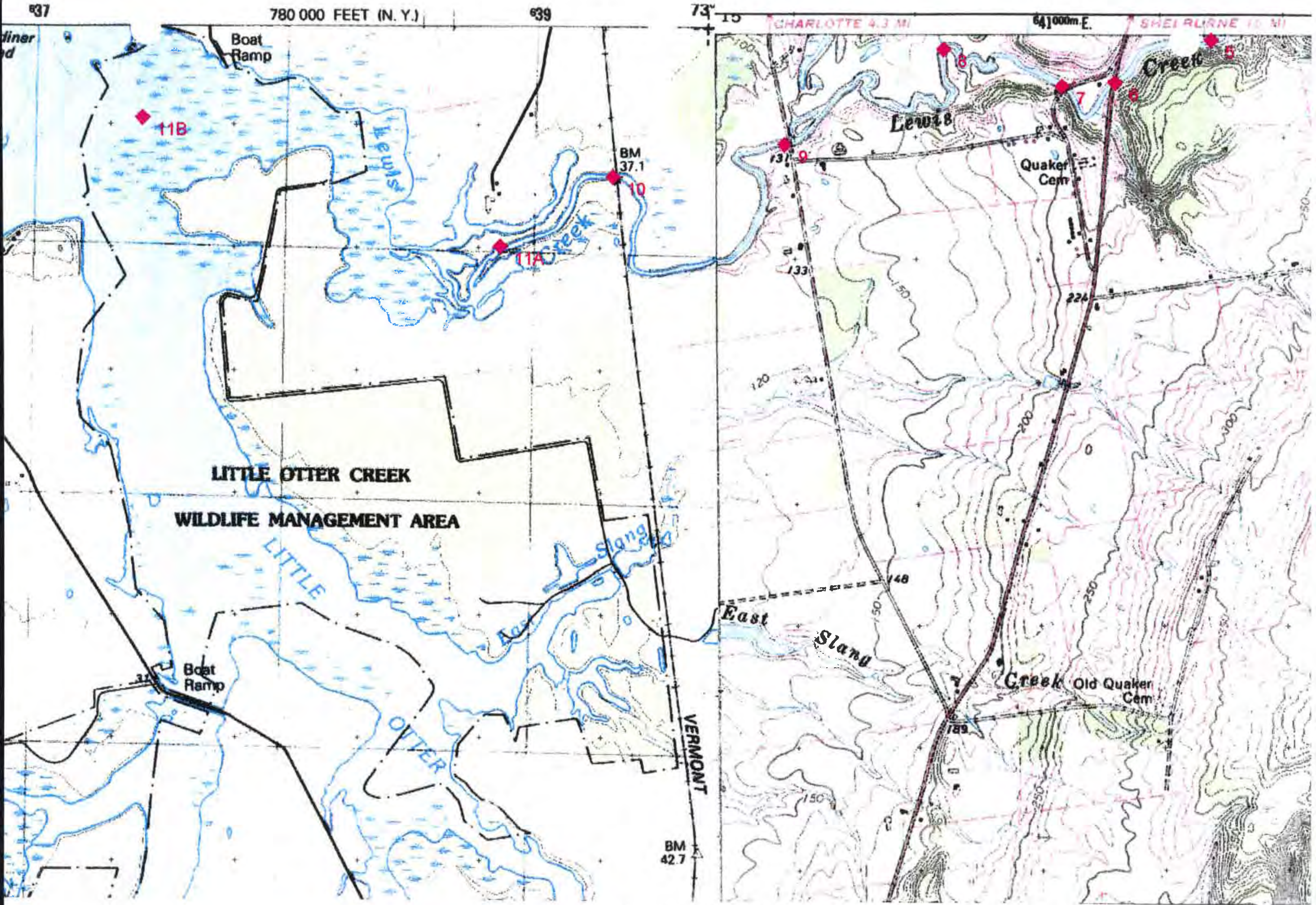
am ENSON
ate: 1/12/99
cale: 1 inch equals 1000 feet

Location: 043° 38' 07.7" N 073° 20' 03.3" W
Caption: Hubbardton River
Mortality Count Sections



Name: MT PHILO
Date: 11/23/98
Scale: 1 inch equals 1600 feet

Location: 044° 15' 53.0" N 073° 11' 56.8" W
Caption: Lewis Creek
Mortality count sections - Map 1

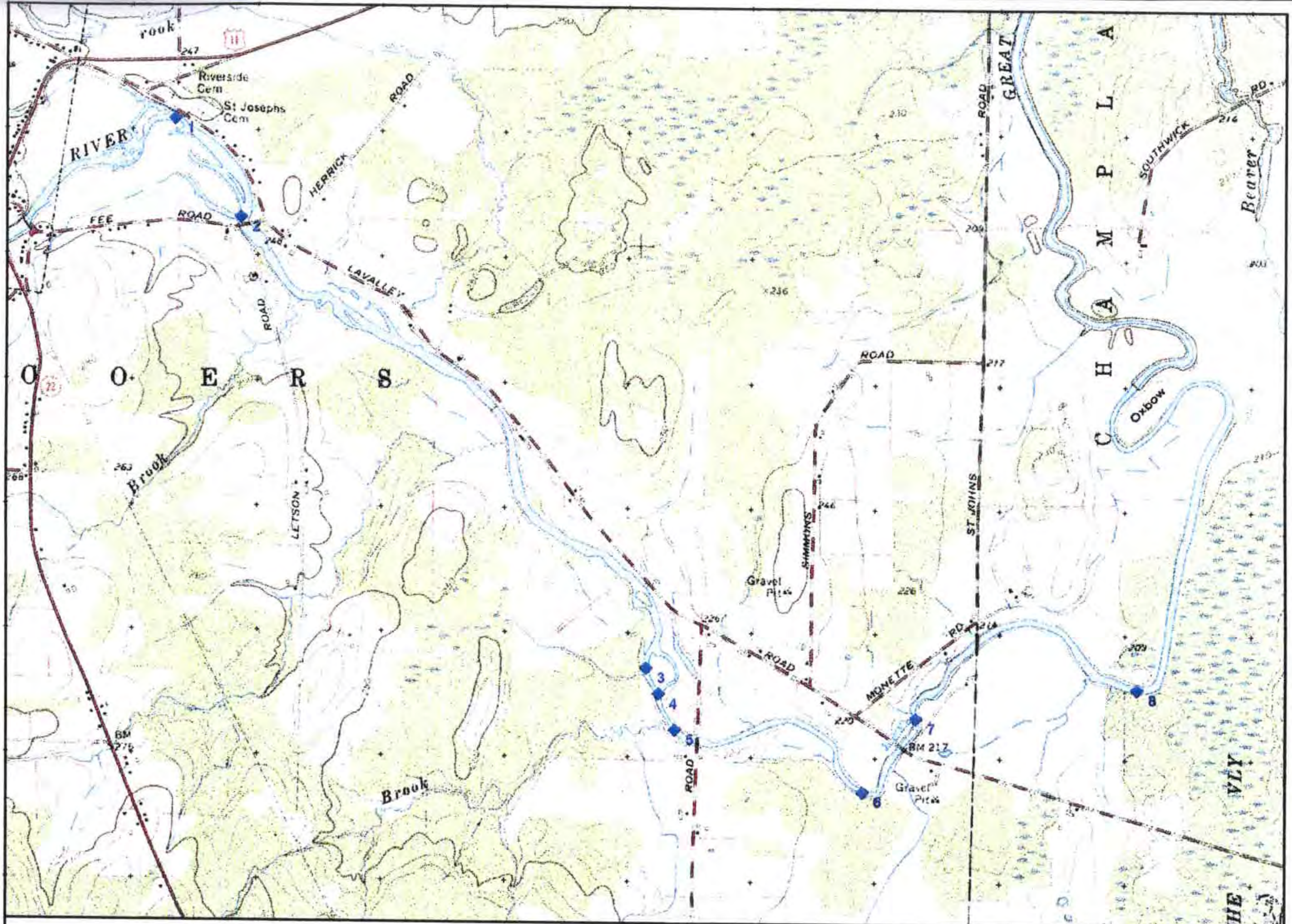


Name: MONKTON BORO
Date: 12/9/98
Scale: 1 inch equals 1626 feet

Location: 044° 14' 03.5" N 073° 14' 20.1" W
Caption: Lewis Creek
Mortality count sections Map - 2

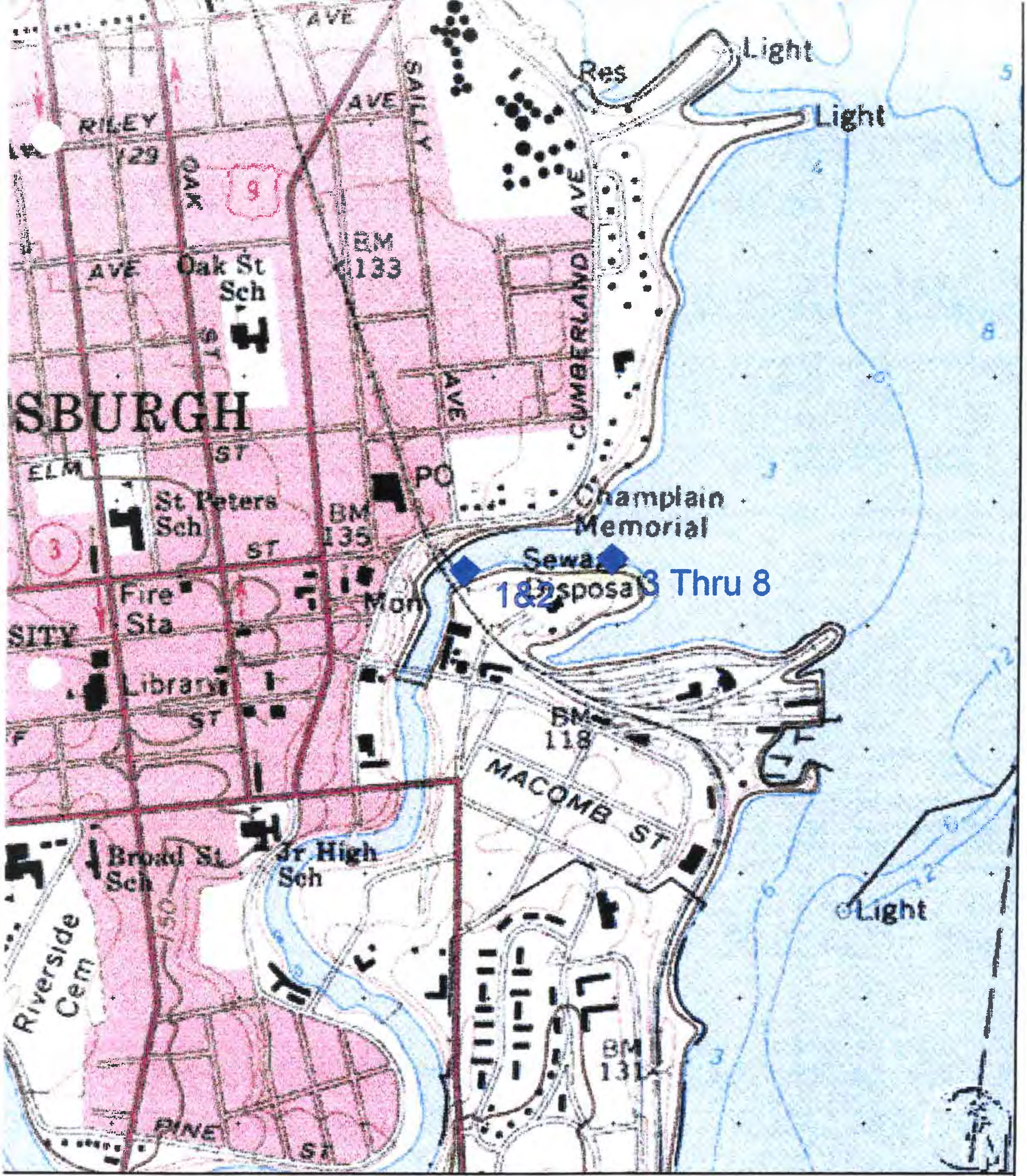
APPENDIX C

Stream Location Maps
(Index Stations)



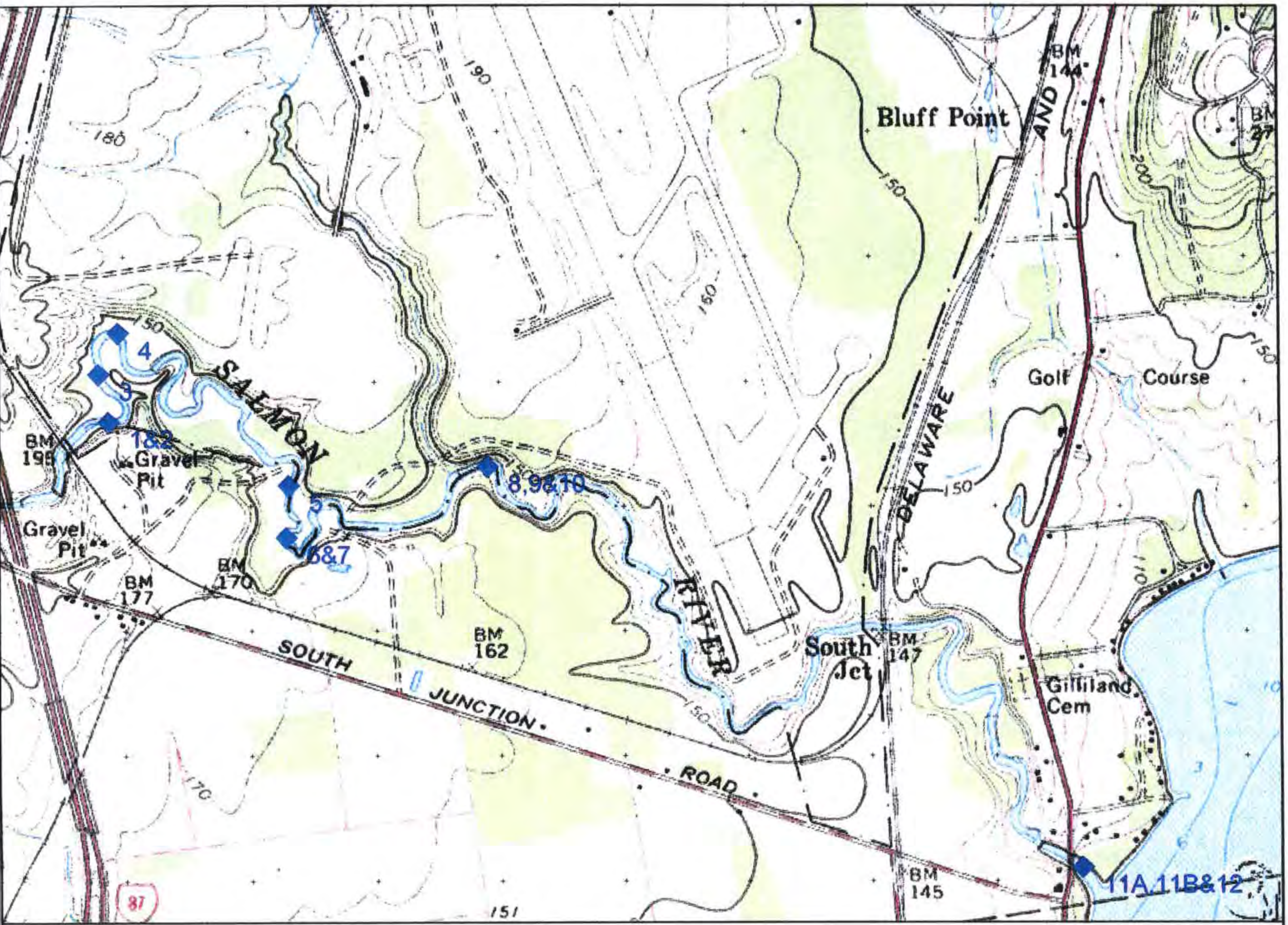
Name: MOOERS
Date: 10/26/98
Scale: 1 inch equals 2000 feet

Location: 044° 56' 55.1" N 073° 32' 29.2" W
Caption: Great Chazy River
electrofishing index stations



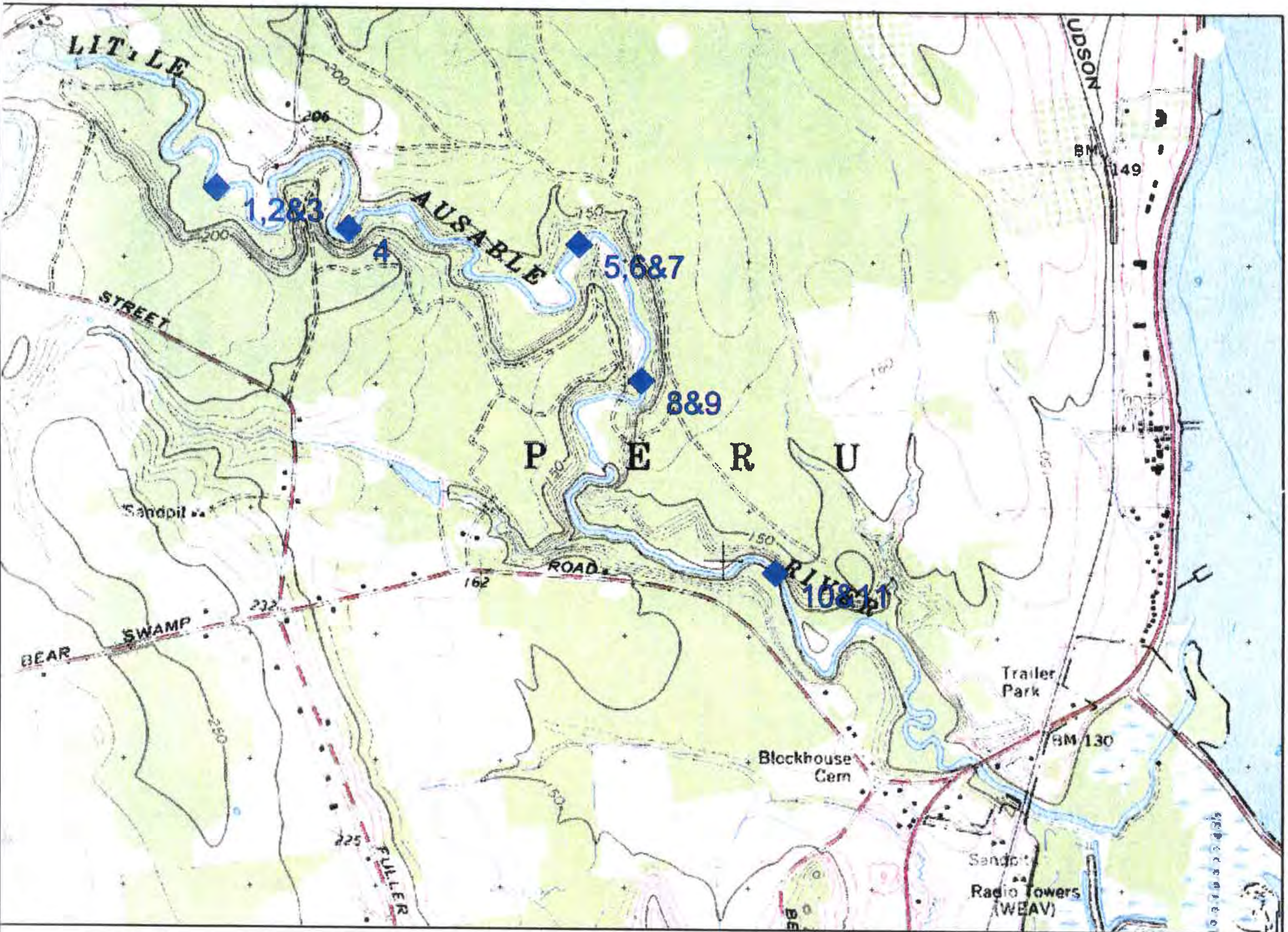
N : PLATTSBURGH
Da . 11/2/98
Scale: 1 inch equals 800 feet

Location: 044° 41' 55.9" N 073° 26' 56.6" W
Caption: Saranac River
electrofishing index stations



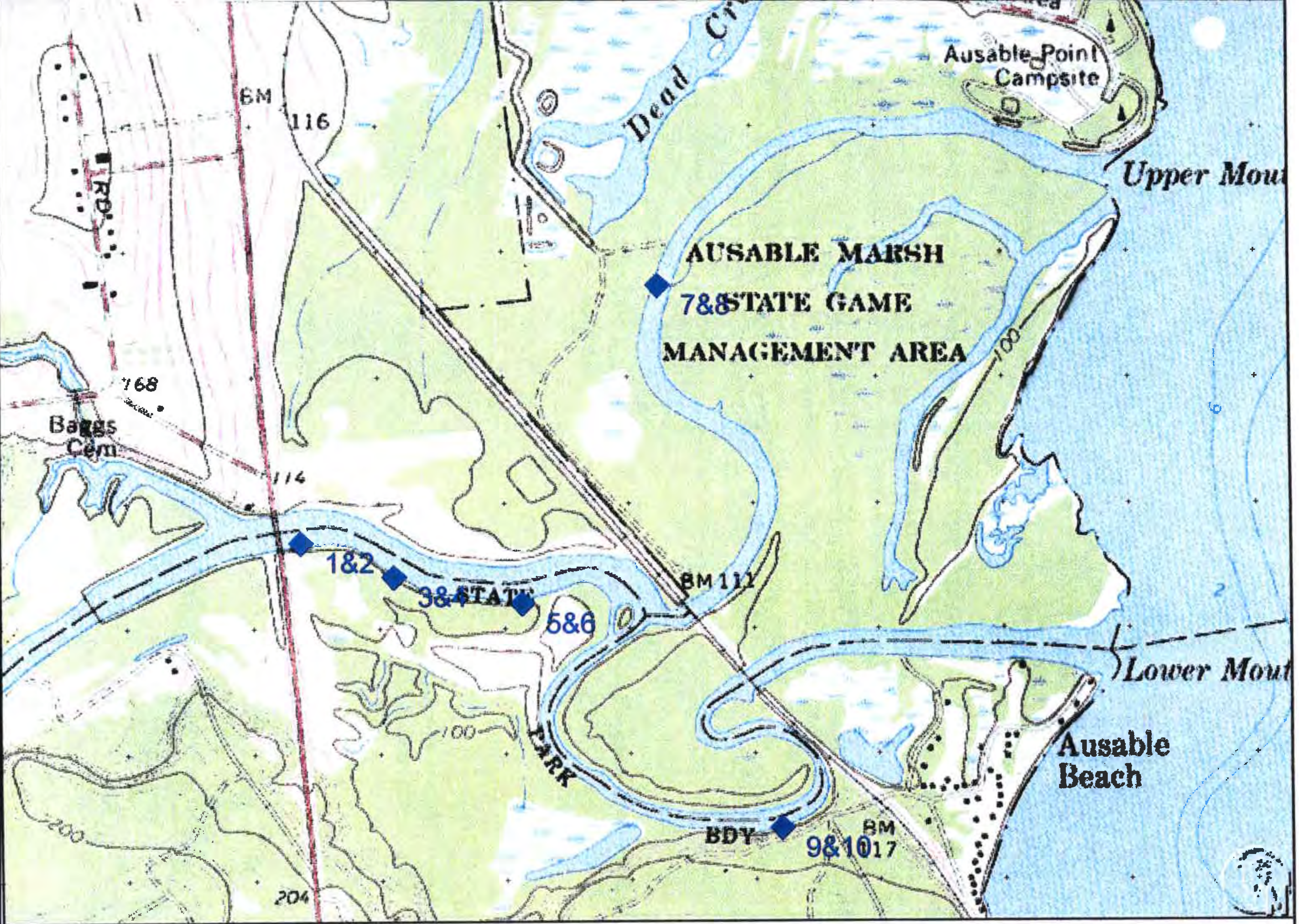
Name: PLATTSBURGH
Date: 11/2/98
Scale: 1 inch equals 1142 feet

Location: 044° 38' 16.2" N 073° 27' 47.1" W
Caption: Salmon River
electrofishing index stations



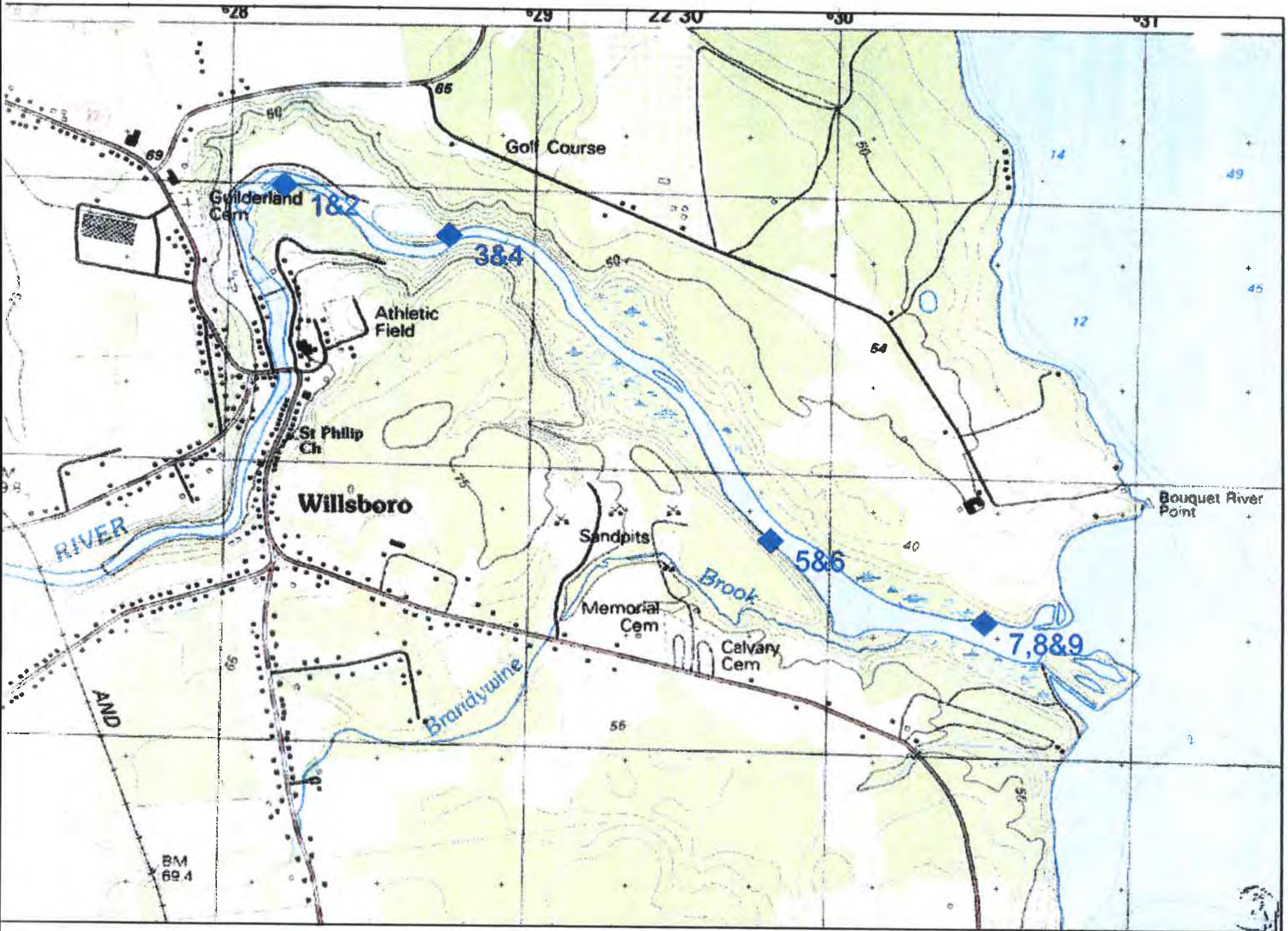
Name: KEESEVILLE
Date: 10/23/98
Scale: 1 inch equals 1333 feet

Location: 044° 35' 09.6" N 073° 27' 42.3" W
Caption: Little Ausable River
Index electrofishing stations



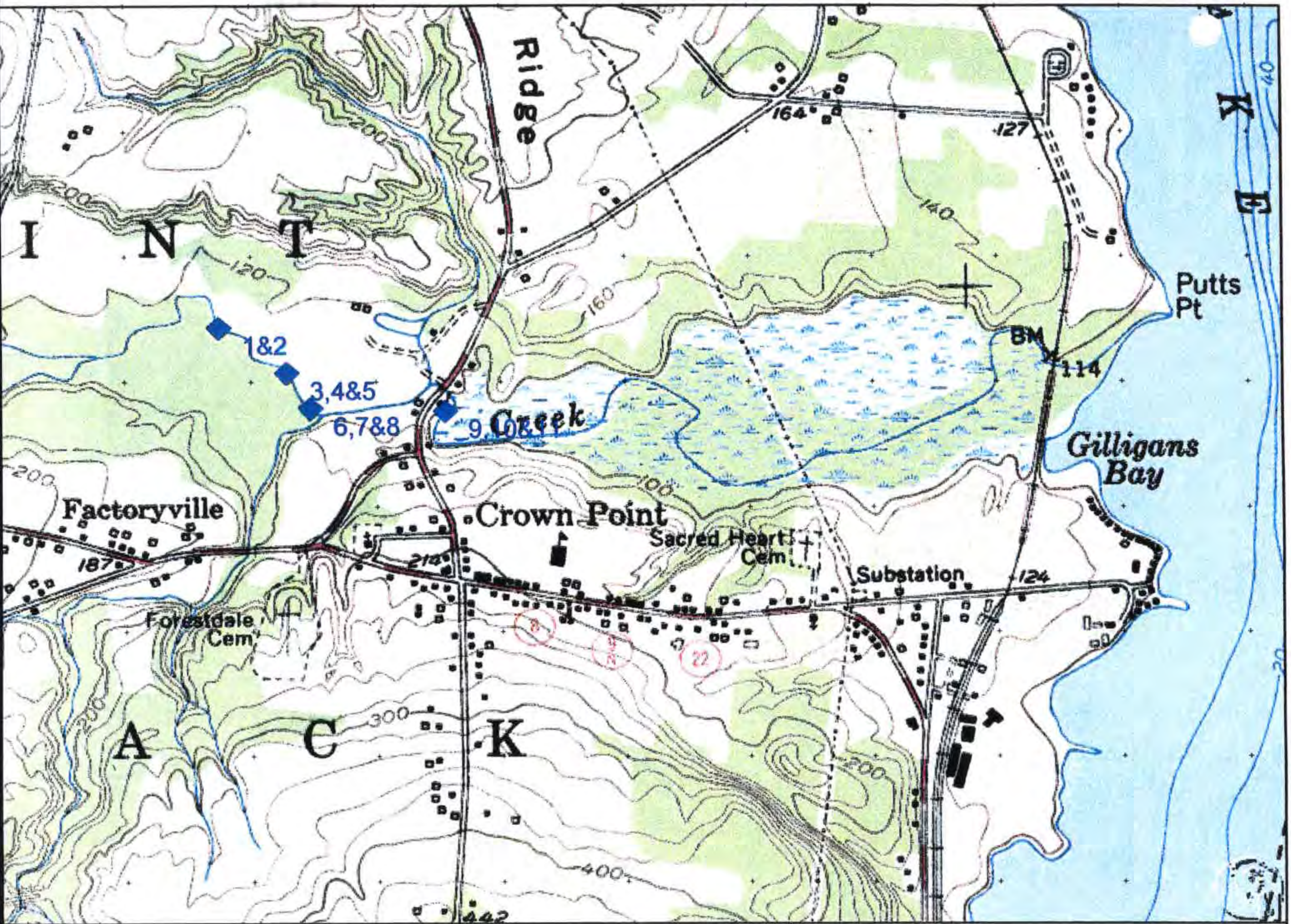
Name: KEESEVILLE
Date: 10/23/98
Scale: 1 inch equals 1000 feet

Location: 044° 33' 37.0" N 073° 26' 16.2" W
Caption: Ausable River
Index electrofishing stations



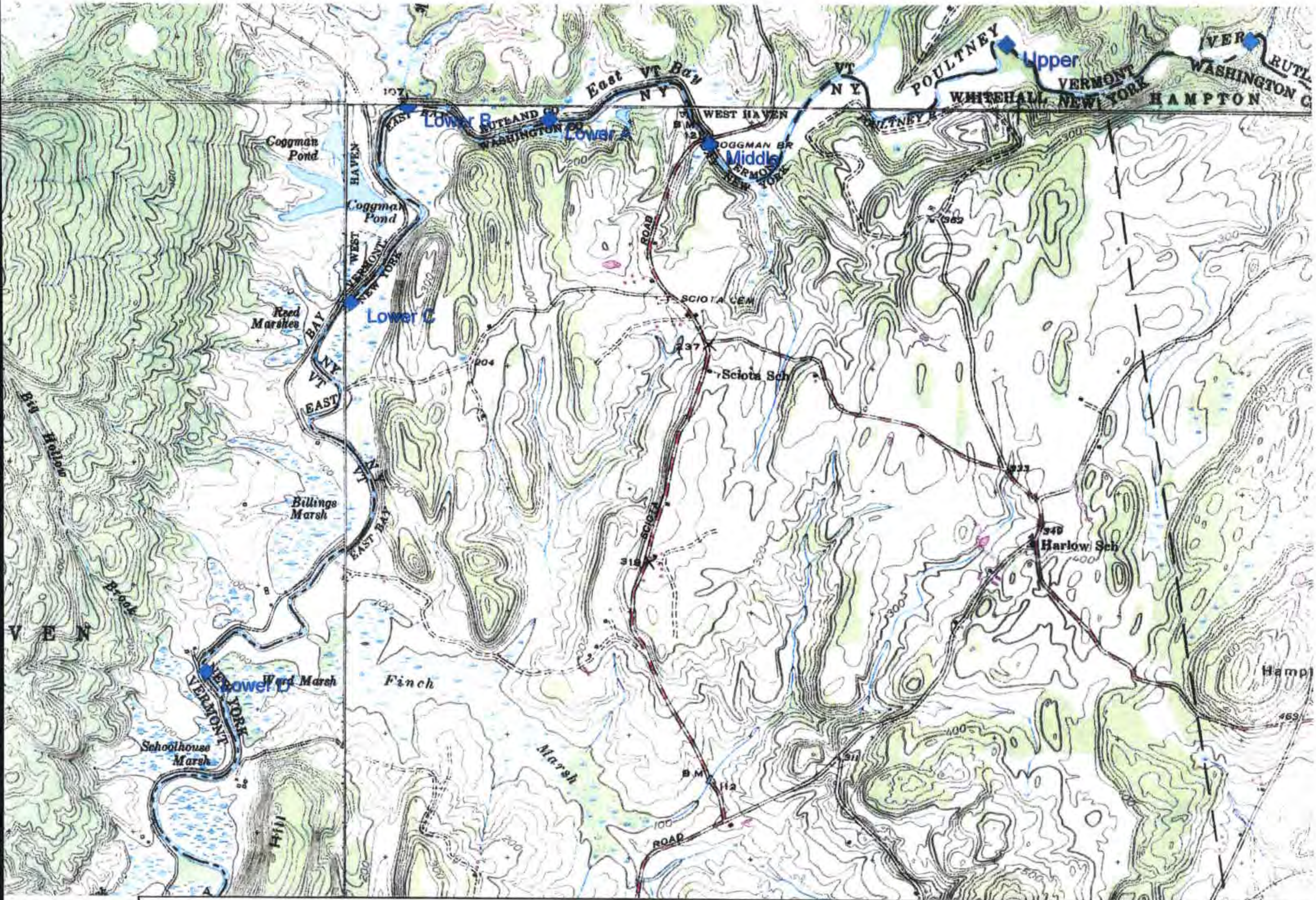
Name: WILLSBORO
Date: 10/23/98
Scale: 1 inch equals 1333 feet

Location: 044° 21' 38.3" N 073° 22' 35.6" W
Caption: Boquet River
Index electrofishing stations



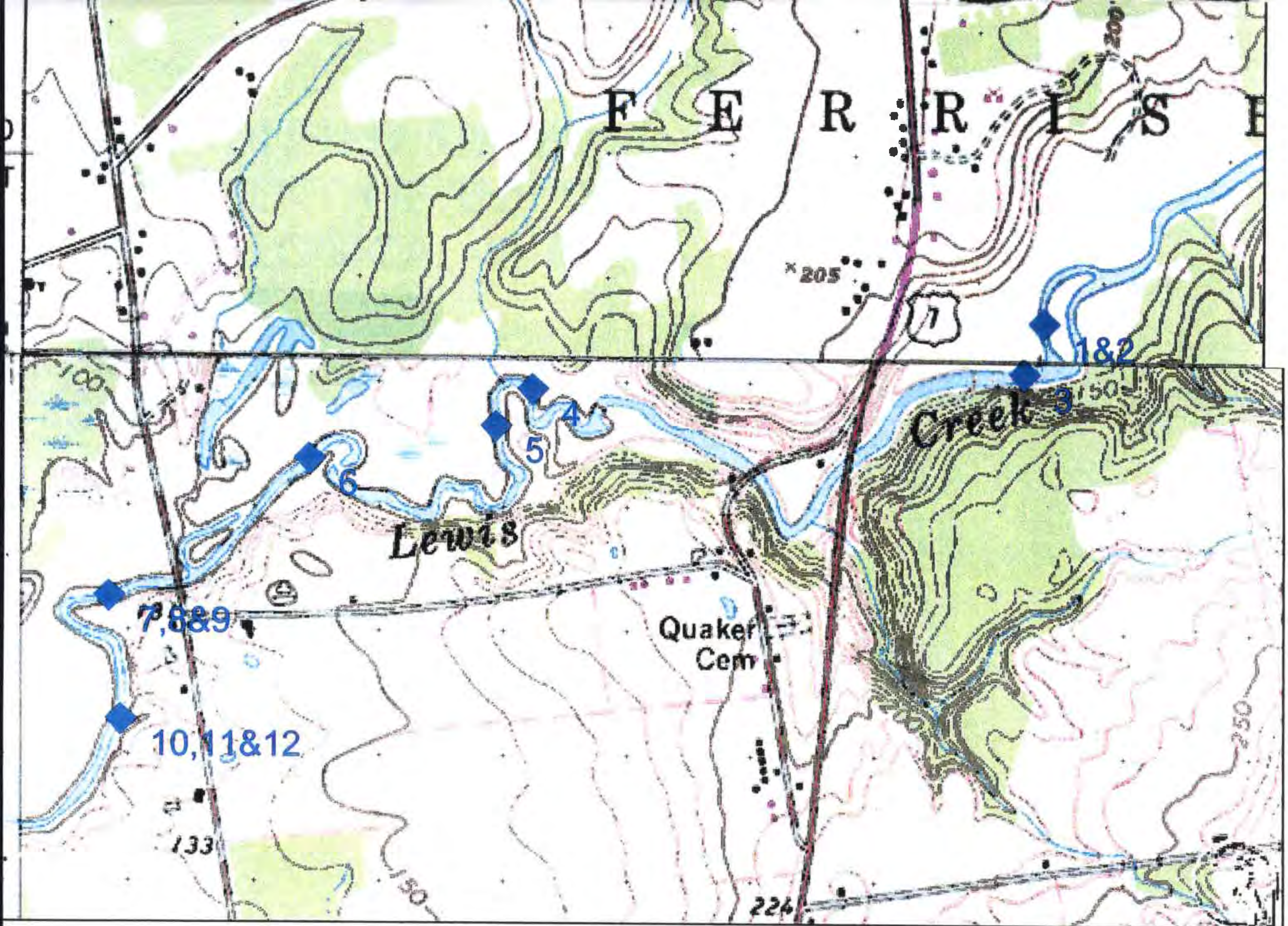
Name: CROWN POINT
Date: 10/26/98
Scale: 1 inch equals 1000 feet

Location: 043° 57' 14.4" N 073° 25' 35.8" W
Caption: Putnam Creek
electrofishing index stations



Name: THORN HILL
Date: 1/19/99
Scale: 1 inch equals 2000 feet

Location: 043° 36' 29.0" N 073° 20' 55.8" W
Caption: Poultney River
Index electrofishing sections



Name: MONKTON BORO
Date: 10/26/98
Scale: 1 inch equals 800 feet

Location: 044° 14' 53.1" N 073° 14' 05.2" W
Caption: Lewis Creek
electrofishing index stations

APPENDIX D

Comparisons of Sea Lamprey Catch Rates at Index Stations Within Streams

APPENDIX D

Catch per unit of effort of sea lamprey larvae at 8 index stations on the Great Chazy River, New York.

STATION	PRE-TREATMENT August 1992	POST-TREATMENT October 1992	PRE-TREATMENT August 1996	POST-TREATMENT September 1996
1	32	1	ns	0
2	83	2	33	0
3	153	2	57	0
4	32	2	117	0
5	123	0	124	0
6	100	0	77	0
7	39	0	38	0
8	ns	ns	115	0

Catch per unit of effort of sea lamprey larvae at 8 index stations on the Saranac River, New York.

STATION	PRE-TREATMENT August 1992	POST-TREATMENT October 1992
1	76	70
2	41	32
3	56	0
4	12	0
5	42	0
6	75	0
7	72	0
8	82	0

Catch per unit of effort of sea lamprey larvae at 12 index stations on the Salmon River, New York.

STATION	PRE-TREATMENT June 1990	POST-TREATMENT November 1990	PRE-TREATMENT July 1994	POST-TREATMENT May 1995
1	50	9	73	3
2	61	3	81	4
3	36	1	84	0
4	61	5	123	8
5	ns	ns	55	0
6	ns	ns	174	0
7	ns	ns	211	0
8	ns	ns	59	0
9	ns	ns	37	1
10	ns	ns	43	1
11	ns	ns	12 (11A only)	6 (11A&B)
12	ns	ns	98	2

Catch per unit of effort of sea lamprey larvae at 11 index stations on the Little Ausable River, New York.

STATION	PRE-TREATMENT August 1990	POST-TREATMENT November 1990	PRE-TREATMENT August 1994	POST-TREATMENT May & July 1995
1	82	0	111	ns
2	47	1	132	ns
3	94	3	184	ns
4	196	0	177	0
5	56	0	124	5
6	30	0	153	5
7	25	0	125	3
8	30	5	36	0
9	38	0	52	3
10	ns	ns	2	0
11	ns	ns	15	0

Catch per unit of effort of sea lamprey larvae at 10 index stations on the Ausable River, New York.

STATION	PRE-TREATMENT August 1986	POST-TREATMENT July 1991	PRE-TREATMENT July 1994	POST-TREATMENT July 1995
1	20	6	61	0
2	8	4	47	0
3	0	6	50	0
4	3	2	ns	0
5	ns	ns	131	2
6	ns	ns	89	0
7	ns	ns	47	0
8	ns	ns	44	0
9	ns	ns	ns	2
10	ns	ns	ns	0

Catch per unit of effort of sea lamprey larvae at 9 index stations on the Boquet River, New York.

STATION	POST-TREATMENT July 1991	PRE-TREATMENT September 1994	POST-TREATMENT July 1995
1	11	33	0
2	14	17	8
3	6	19	0
4	1	8	1
5	2	6	0
6	9	85	0
7	54	ns	8
8	2	ns	16
9	ns	2	16

Catch per unit of effort of sea lamprey larvae at 11 index stations on Putnam Creek, New York.

STATION	PRE-TREATMENT July 1990	POST-TREATMENT November 1990	PRE-TREATMENT July 1994	POST-TREATMENT May & June 1995
1	ns	ns	128	14
2	ns	ns	79	27
3	ns	ns	160	72
4	ns	ns	127	66
5	ns	ns	66	11
6	ns	ns	59	17
7	ns	ns	95	74
8	40	5	71	0
9	42	3	23	0
10	116	6	25	4
11	ns	ns	89	0

Catch per unit of effort of sea lamprey larvae at 12 index stations on Lewis Creek, Vermont.

STATION	PRE-TREATMENT September 1990	POST-TREATMENT July 1991	PRE-TREATMENT September 1994	POST-TREATMENT July 1995
1	ns	ns	16	3
2	ns	ns	36	12
3	ns	ns	61	0
4	ns	ns	103	5
5	ns	ns	124	0
6	ns	ns	108	0
7	ns	ns	20	0
8	ns	ns	28	0
9	ns	ns	5	ns
10	34	1	10	0
11	115	1	24	0
12	20	13	14	0

Catch per unit of effort of sea lamprey larvae in stream sections of the Poultney River.

Stream Section	Number of Stations	1995 Average CPUE	1996 Average CPUE
Upper	6	18.5	13.9
Middle	8	24.5	22.2
Lower A	6	29.7	15.9
Lower B	4	5.5	15.9
Lower C	1	4	5
Lower D	1	1	5

Stonebridge Brook

Prior to the 1991 TFM treatment of Stone Bridge Brook, electrofishing surveys were conducted. The highest density of sea lamprey larvae were found 1.7 miles upstream from the mouth. Electrofishing surveys conducted after the treatment showed no residual sea lamprey larvae. Annual surveys conducted in Stone Bridge Brook since, have shown no reestablishment of sea lamprey larvae.

Indian Brook

During 1988 extensive electro-fishing surveys were conducted throughout the 2.5 miles of Indian Brook, between the estuary and the barrier to fish passage, which is a set of falls in the town of Colchester, Vermont. The stream was divided into 6 sections longitudinally to compare the densities of sea lamprey and the native northern brook lamprey. Sea lamprey larvae were found to inhabit all of the 2.5 miles accessible to adult lamprey below the falls. Section A, which is the lower part of the stream including the estuary, was found to have the lowest density of larval sea lamprey. Sections B and C in the lower/middle portion of the accessible length of stream was found to have the highest density of sea lamprey larvae, while sections D, E, and F, near the falls showed a lower density.

Beaver Brook

Electro-fishing surveys were conducted during late July, 1993 on Beaver Brook. There were 10 index stations surveyed. Stations 1 -3 were located near the mouth of the river, 4 - 7 were __ miles upstream, and stations 8, 9, and 10 were approximately half way between the TFM application point and the mouth of the river. Actual catches ranged from 0 - 15, with the highest densities found in the upper portion of the brook.

Mount Hope Brook

Prior to the 1995 treatment of Mount Hope Brook, 7 stations were sampled, downstream from the fish hill road bridge in the town of South Bay, New York. The highest densities were found in the uppermost sections. A total of 216 sea lamprey were captured. Actual catches ranged from a high of 44 in the uppermost plot to 13 in the middle plot. Post-treatment surveys indicated a substantial reduction with a total catch of 8 sea lamprey. Reductions were 100 percent in 3 out of the 7 stations.

Trout Brook

Prior to the 1995 treatment of Trout Brook, Vermont, electrofishing surveys were conducted in the lower section of the brook. Eight stations were sampled, five in the estuarian habitat, and three upstream to the TFM application point at a steep gradient section. The highest densities of sea lamprey larvae were found in the lower three sections surveyed, where catches ranged from 11 to 25 per station. Catch rates in the other sections ranged from 0 to 8, sea lamprey per station. Following the treatment, surveys indicated that few residual sea lamprey larvae survived the treatment.

APPENDIX E

Routine Post-treatment Sea Lamprey and Nontarget Mortality Observations

Table 1. Boquet River TFM treatment - routine sea lamprey and nontarget mortality observations, September 12, 1990.

	Stream Section Number									
Species	1	2	3	4	5	6	7	8	9	Total
Sea lamprey ammo.[a]	1	184	315	505	375	957	1,138	1,607	46	5,128
Sea lamprey trans.[a]		22	64	81	140	180	398	290	22	1,197
Sea lamprey y-o-y [a]										0
Silver lamprey [a]					4	10		24		38
Common shiner								1		1
White sucker				1						1
Banded killifish								1		1
Pumpkinseed								1		1
Tessellated darter		2								2

[a] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable.

Assessment Crew: V. Gilligan, T. Gliddi, C. MacKenzie, G. Hovey, J. Gersmehl & USFWS Crew

Table 2. Little Ausable River TFM treatment - routine sea lamprey and nontarget mortality observations, September 14 - 16, 1990.

	Stream Section Number											
Species	1	2	3	4	5	6	7	8	9	10	11	Total
Sea lamprey ammo.[a]	0	0	3,564	443	1,550	1,142	291	13,036	47,536[b]	23,093[b]	390	91,045
Sea lamprey trans.[a]			231	53	51	97	344	683	4,439	24,997	516	31,411
Sea lamprey y-o-y [a]												0
Amer. brk. lamprey [a]								69			5	74
Bowfin								1			5	6
Northern pike											2	2
Common shiner								1				1
Bluntnose minnow			1									1
Fallfish								1	1			2
Brown bullhead											1	1
Stonecat				1	1	4		5	10			21
Tadpole madtom			6									6

[a] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable.

[b] Dead lamprey were too numerous to count in Sections 9 and 10 so kill figures were calculated based on sample counts in small quadrats, expanded over the entire stream section. Complete counts of all other observed, affected nontarget species were made.

Continued...

Table 2 (cont.).

	Stream Section Number											
Species	1	2	3	4	5	6	7	8	9	10	11	Total
Rock bass			3									3
Tessellated darter			1					4				5
Crayfish				1		2		1				4
Salamander								3				3
Mudpuppy								1	1		1	3
Mussel				1								1

Assessment Crew: V. Gilligan, T. Gliddi, C. MacKenzie, G. Hovey, W. Schoch, J. Gersmehl & USFWS Crew

Table 3. Ausable River TFM treatment - routine sea lamprey and nontarget mortality observations, September 16 -17, 1990.

Species	Stream Section Number														Total
	1	2	3	4	5	6	7	8A	8B	9	10	11A	11B	DryMill	
Sea lamprey ammo.[a]	0	0	22	50	57	218	1,200	1,570	1,451	5,366	3,138	5,091	3,493	540	22,196
Sea lamprey trans.[a]			2	0	3	6	104	94	288	775	255	364	352	67	2,310
Sea lamprey y-o-y[a]															0
Amer. brk. lamprey[a]	0	0	0	0	9	8	94	181	673	4,198	4,181	1,780	1,065	4	12,193
Northern pike													1		1
Bluntnose minnow						1	1		1	4				5	12
Blacknose dace			1												1
Longnose dace			1										1		2
Banded killifish							21								21
Brook stickleback							10								10
Tessellated darter				2			1		1	2			1		7
Log perch			4	3		2									9
Crayfish					2										2
Salamander			1				2							1	4
Mudpuppy			6		6	3		3	6	1	2	6	2		35
Frog tadpole							4								4

[a] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were

derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable.

Assessment Crew: V. Gilligan, T. Gliddi, W. Schoch, C. MacKenzie, B. Chipman, D. Callum, G. Hovey

Table 4. Salmon River TFM treatment - routine sea lamprey and nontarget mortality observations, September 18, 1990.

	Stream Section Number								
Species	1	2	3	4	5	6	7	8	Total
Sea lamprey ammo.[a]	0	8	8,682	19,358	17,859	3,358	1,207	1,380	51,852
Sea lamprey trans.[a]			1,848	8,027	2,006	798	107	190	12,976
Sea lamprey y-o-y [a]									0
Amer. brk. lamprey [a]				25					25
Blacknose dace							1		1
Longnose dace							3		3
Fallfish							1		1
White sucker					1	1			2
Brown bullhead			4	6	5			3	18
Stonecat		23			10	21	75	12	141
Tessellated darter					1				1
Salamander			1		1	4	3		9

[a] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific

samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable.

Assessment Crew: V. Gilligan, J. Sausville, C. MacKenzie, G. Hovey, J. Gersmehl & USFWS Crew

Table 5. Beaver Brook TFM treatment - routine sea lamprey and nontarget mortality observations, September 20, 1990.

	Stream Section Number						
Species	1	2	3	4	5	6	Total
Sea lamprey ammo.[a]	56	38	322	458	0	0	874
Sea lamprey trans.[a]	2		4	125			131
Sea lamprey y-o-y [a]							0
Silver lamprey [a]			4	15			19
Fathead minnow		1					1
White sucker		1					1
Tessellated darter	4	2					6
Salamander		1	1				2

[a] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable.

Assessment Crew: V. Gilligan, G. Hovey

Table 6. Putnam Creek TFM treatment - routine sea lamprey and nontarget mortality observations, September 21 - 22, 1990.

	Stream Section Number														
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Sea lamprey ammo.[a]	75	24	0	158	108	101	321	517	1,077	1,514	9,662	12,769	722	61	27,109
Sea lamprey trans.[a]		1		7	15	2	28	64	148	168	780	1,889	19		3,121
Sea lamprey y-o-y [a]															0
Silver lamprey [a]								4		8	60	982	148		1,202
Blacknose dace	8														8
Creek chub								1							1
White sucker								8							8
Tessellated darter								2							2
Log perch		2	1							1					4
Crayfish			1												1
Salamander	2	1													3
Mudpuppy														5	5

[a] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable.

Assessment Crew: V. Gilligan, W. Schoch, W. Masters, M. Abraham, K. Baginski, G. Hovey, J. Gersmehl & USFWS Crew

Table 7. Lewis Creek TFM treatment - routine sea lamprey and nontarget mortality observations, September 24 - 25, 1990.

	Stream Section Number														
Species	1A	1B	2A	2B	3	4	5	6	7	8	9	10	11A	11B	Total
Sea lamprey ammo.[a]	0	50	23	33	11	515	877	4,460	315	1,454	7,655	6,046	52	154	21,645
Sea lamprey trans.[a]		61	28	199	15	51	94	913	39	99	1,639	838	96	225	4,297
Sea lamprey y-o-y [a]															0
Silver lamprey [a]										8	36	473	16	10	543
Bowfin														6	6
Redfin pickerel														2	2
Northern pike														23	23
Chain pickerel														23	23
Golden shiner														1	1
Common shiner	10	2						1				1		12	26
Blacknose dace	64							2							66
Longnose dace	49			2	1	1									53

Creek chub	10												1	11

[a] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable.

Continued...

Table 7 (cont.).

	Stream Section Number													
Species	1A	1B	2A	2B	3	4	5	6	7	8	9	10	11A	11B	Total
Unidentified *Notropis* sp		1						1							2
White sucker	28													1	29
Brown bullhead												2		16	18
Trout-perch														20	20
Smallmouth bass								1							1
Tessellated darter	108							6							114
Yellow perch														1	1
Log perch										85	12	3	3	145	248
Crayfish				1		1			1						3
Salamander	13														13

Mudpuppy											3	2	1	11	17
Mussel	2							1		5					8

Assessment Crew: J. Anderson, B. Chipman, D. Callum, B. Horton, G. Hovey, T. Rickford, E. Leder, J. Gersmehl, M. Brewer

Table 8. Boquet Delta Bayluscide treatment - routine sea lamprey and nontarget mortality observations, September 9, 1991.

	Gull Plot				Sub	Shoreline Section				Sub
Species	1	2	3	4	Total	S1	S2[a]	S3	S4	Total
Sea lamprey ammo. [b]	1		1		2		1		10	11
Sea lamprey trans.[b]					0				4	4
Sea lamprey y-o-y[b]			2		2					0
Nontarget lamprey[b]					0					0
Emerald shiner					0		13[c]			13
Spottail shiner					0			52		52
Mimic shiner[d]					0		54[c]		2	56
Blacknose dace					0			1		1
Longnose dace					0				47[f]	47

[a] This is a sample drawn from an estimated 7,300 small fish other than lamprey affected in Section S2.

[b] The number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species affected, were determined by counts made of a collection of all observed dead lamprey in gull plots and a shoreline band within each shoreline section. Species verification was confirmed by USFWS staff, Essex Junction, VT. Data for young-of-year (often ignored in counts) are unreliable.
(The ammocoete in gull plot #1was apparently discarded and not in the identified collection.)

[c] These numbers result from an approximate 25% subsample of a group of 266 fish believed to be members of only these two species.

[d] *Notropis* sp. tentatively identified as mimic shiner.

[f] Based on an estimate that a collection of 9 represented 19% of those affected.

Continued...

Table 8 (cont.).

	Gull Plot				Sub	Shoreline Section				Sub
Species	1	2	3	4	Total	S1	S2[a]	S3	S4	Total
Brown bullhead					0		1	1		2
Banded killifish					0		39	5		44
Smallmouth bass					0				4	4
Largemouth bass					0		9			9
Tessellated darter[b]					0		5	1		6
Yellow perch					0			1		1
Slimy sculpin					0			1	17[c]	18
Unidentified fish					0	2,170				2,170
Crayfish					0				1	1

[a] This is a sample drawn from an estimated 7,300 small fish other than lamprey affected in Section S2.

[b] These may be johnny darters; they were originally identified as such.

[c] Based on an estimate that a collection of 15 represented 90% of those affected.

Assessment Crew: V. Gilligan, W. Masters, C. MacKenzie, R. Howey, T. Gliddi, M. Verna, J. Gersmehl & USFWS Crew*
* Original data forms for one of the gull plots contained no data collector names. However, it was likely collected by J. Gersmehl & USFWS Crew

Table 9. Little Ausable Delta Bayluscide treatment - routine sea lamprey and nontarget mortality observations, September 10, 1991.

	Gull Plot			Sub	Shore. Section		Sub
Species	1	2	3	Total	S1	S2[a]	Total
Sea lamprey [b]				0			0
Nontarget lamprey [b]				0			0
Brown bullhead		1	5	6			0
Pumpkinseed		2	13	15			0
Bluegill	1[c]			1			0
Yellow perch			3	3			0
Unidentified fish				0		7,500[d]	7,500
Crayfish				0	1		1

[a] Shoreline Section S2 was assessed by Endangered Species Unit (ESU) personnel as part of an increased effort required by permits to

locate affected amphibians. Amphibian results are reported separately.

[b] No sea lamprey or nontarget lamprey of any life stages were collected during or after this treatment.

[c] Four, additional, dead, young-of-year bluegill were observed just outside of gull plot #1.

[d] ESU personnel estimated 5,000 - 10,000 small fish (most <100 mm long) were affected along shore and offshore in this section.

Assessment Crew: V. Gilligan, W. Masters, C. MacKenzie*, T. Gliddi, M. Verna,
* Original data forms for one of the gull plots contained only C. MacKenzie's name, but someone probably assisted him.

Table 10. Saranac Delta Bayluscide treatment - routine sea lamprey and nontarget mortality observations, September 12, 1991.

	Gull Plot				Sub	Shore. Section		Sub
Species	1	2	3	4	Total	S1	S2	Total
Sea lamprey ammo.[a]	6	0	3	54	63	8	2	10
Sea lamprey trans.[a]				1	1		2	2
Sea lamprey y-o-y [a]	1	1	2	149	153			0
Nontarget lamprey [a]					0			0
Northern pike				1[b]	1			0
Golden shiner					0		2	2
Emerald shiner					0	1	2	3
Common shiner					0		4	4

Spottail shiner					0		1	1
Mimic shiner[c]				1	1	2		2
White sucker				1	1	1	58	59

[a] The number of sea lamprey ammocoetes, transformers and young-of-year, as well as other lamprey species affected, were determined by counts made of a collection of all observed dead lamprey in gull plots and a shoreline ‘band’ within each shoreline section. Species verification was confirmed by USFWS staff, Essex Junction, VT. Data for young-of-year (often ignored in counts) are unreliable.

[b] This fish too deep for collection; therefore species identification is tentative.

[c] *Notropis* sp. tentatively identified as mimic shiner.

Continued...

Table 10 (cont.).

	Gull Plot				Sub	Shore. Section		Sub
Species	1	2	3	4	Total	S1	S2	Total
Brown bullhead					0		2	2
Banded killifish					0	1		1
Rock bass				1	1			0
Pumpkinseed					0		2	2
Bluegill					0		4	4
Smallmouth bass					0		2	2
Largemouth bass					0		1	1
Tessellated darter[a]					0	1	4	5
Yellow perch				4	4	2	47	49

Log perch				1	1			0
Slimy sculpin					0	2		2

[a] These may be johnny darters; they were originally identified as such.

Assessment Crew: V. Gilligan, W. Masters, C. MacKenzie, T. Shanahan, T. Gliddi, M. Verna, J. Gersmehl & USFWS Crew*
* Original data forms for one gull plot contained no data collector names, but it was likely collected by J. Gersmehl & USFWS Crew.

Table 11. Salmon Delta Bayluscide treatment - routine sea lamprey and nontarget mortality observations, September 12, 1991.

	Gull Plot				Sub	Shoreline Section			Sub
Species	1	2	3	4	Total	S1	S2	S3	Total
Sea lamprey ammo.[a]		1		2	3	NA	NA	NA	137
Sea lamprey trans.[a]					0	NA	NA	NA	27
Sea lamprey y-o-y [a]					0	NA	NA	NA	1
Amer. brk. lamprey[a]					0	NA	NA	NA	13
Emerald shiner					0		2		2
Spottail shiner					0	5	1	2	8
Longnose dace					0	14	11		25
White sucker		3		1	4	77	13		90
Black bullhead				1	1				0

Brown bullhead					0	4			4
Banded killifish					0		1		1
Rock bass					0	5	1		6
Smallmouth bass					0	6	4		10
Yellow perch			1		1	11	5	1	17
Log perch					0			1	1
Mottled sculpin					0	13			13

[a] Crews collected available dead lamprey in gull plots and a shoreline ‘band’. Species verification was confirmed by USFWS staff, Essex Junction, VT. Shoreline lamprey observations were not segregated by section. A sample of 125 sea lamprey ammocoetes, 24 transformers and 1 young-of-year, and 12 American brook lamprey were collected representing 178 lamprey (combined species) reported. Shoreline numbers reported above have been extrapolated from the proportion of each species in the 162-lamprey sample.

Assessment Crew: L. Durfey, D. Callum, D. Gibson, B. Chipman, R. Preall, R. Brown

Table 12. Ausable Delta Bayluscide treatment - routine sea lamprey and nontarget mortality observations, September 12, 1991.

	Gull Plot				Sub	Shoreline Section				Sub
Species	1	2	3	4	Total	S1[a]	S2	S3[b]	S4[c]	Total
Sea lamprey ammo.[d]	3	13	14	5	35	38	6	11	7	62
Sea lamprey trans.[d]	1		1		2	10	7	13	10	40
Sea lamprey y-o-y[d]			1		1					0
Amer. brk. lamprey[d]	3	8	13		24	24	5	136	18	183
Emerald shiner	2				2	8	24	1	9	42

Spottail shiner		1			1	1		2	1	4
Sand shiner					0			1		1
Mimic shiner[f]				3	3	10	19	24	30	83

[a] Figures reported for species other than lamprey in this section are those found in a sample drawn from an estimated 4,000-5,000 small, silvery fishes and an estimated 230 banded killifish.

[b] Figures reported for Section S3 represent those in a sample from the northernmost 1/3 of this section (~1,000 lineal feet). Impending darkness precluded its completion. An estimated 1,500-1,800 small fish, mostly *Notropis* species, were observed in one ~150 square foot area. Numerous mortalities were also noted outside this section. All lamprey in this 1,000' subsection were collected.

[c] Figures other than lamprey reported for Section S4 represent those in a sample of an estimated 2,000 small fishes.

[d] The number of sea lamprey ammocoetes, transformers and young-of-year, as well as other lamprey species affected, were determined by counts made of a collection of all observed dead lamprey in gull plots and a shoreline 'band' within each shoreline section, except for portions of S3, as described above. Data for young-of-year (often ignored in counts and collections) are unreliable. Species verification was confirmed by USFWS staff, Essex Junction, VT.

[f] *Notropis* sp. tentatively identified as mimic shiner.

Continued...

Table 12 (cont.).

	Gull Plot				Sub	Shoreline Section				Sub
Species	1	2	3	4	Total	S1[a]	S2	S3[b]	S4[c]	Total
Unidentified *Notropis sp.*				1	1	16			3	19
Fallfish						2				2
Banded killifish				1	1	40	39	18	30	127
Smallmouth bass			5		5	1				1
Tessellated darter[d]					0	41	14	4	1	60

Yellow perch		13	118		131		1			1
Log perch					0		1			1

[a] Figures reported for species other than lamprey in this section are those found in a sample drawn from an estimated 4,000-5,000 small, silvery fishes and an estimated 230 banded killifish.

[b] Figures reported for Section S3 represent those in a sample from the northernmost 1/3 of this section (~1,000 lineal feet). Impending darkness precluded its completion. An estimated 1,500-1,800 small fish, mostly *Notropis* species, were observed in one ~150 square foot area. Numerous mortalities were also noted outside this section. All obvious lamprey in this 1,000' subsection were collected.

[c] Figures other than lamprey reported for Section S4 represent those in a sample of an estimated 2,000 small fishes.

[d] These may be johnny darters; they were originally identified as such.

Assessment Crew: V. Gilligan, W. Masters, C. MacKenzie, W. Miller, T. Gliddi, M. Verna, J. Gersmehl & USFWS Crew*,
L. Durfey, P. Moore, D. Osowsky, L. Nashett, D. Kosowski, W. Schoch, N. Staats

* Original data forms for one of the gull plots contained no data collector names.
However, it was likely collected by J. Gersmehl & USFWS Crew

Table 13. Stone Bridge Brook TFM treatment - routine sea lamprey and nontarget mortality observations, September 17, 1991.

Species	Stream Section Number								Total
	1	2A	2B	3	4	5	6	7	
Sea lamprey ammo.[a]	113	23	1	9	85	19	15	3	268
Sea lamprey trans.[a]	71	7	6	3	51	44	82	13	277
Sea lamprey y-o-y[a]									NA

Silver lamprey					201	1	20	2	224
Northern pike							5		5
Common shiner					1		1	3	5
Bluntnose minnow				2	4	6	711	2	725
Blacknose dace				2			4		6
White sucker		2				3	165		170
Brown bullhead							3		3
Tessellated darter		1				5	58		64
Log perch							7		7
Dusky salamander	5	2					7		14
Frog tadpole		1	4	1	3	97	247	11	364
Frog adult							1		1

[a] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section. No young-of-year estimates were provided.

Assessment Crew: B. Chipman, D. Gibson, R. Furbish, L. Garland, R. Shopland

Table 14. Mount Hope Brook TFM treatment - routine sea lamprey and nontarget mortality observations, September 21, 1991.

	Stream Section Number									
Species	1	2	3	4	4A	5	6	7	8	Total
Sea lamprey ammo.[a]	47	9,027	7,489	2,626	824	1,592	217	1		21,823

Sea lamprey trans.[a]		296	1,571	576	234	1,097	477	1		4,252
Sea lamprey y-o-y [a]				614		274	7			895
Silver lamprey [c]			52	27		82	14			175
Bowfin					2					2
Central mudminnow				1						1
Grass pickerel			2		2					4
Chain pickerel			5	21	4	34	14			78
Golden shiner							1			1
Blacknose shiner						1				1
Blacknose dace		1	1							2
White sucker		1			1					2

[a] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable.

Continued...

Table 14 (cont.).

	Stream Section Number									
Species	1	2[a]	3	4	4A[b]	5	6	7	8	Total

Yellow bullhead		3	2	2	1	1				9
Brown bullhead		12	1	1						14
Pumpkinseed						1				1
Tessellated darter[c]		3	5		6					14
Yellow perch						1				1
Log perch		5	3	2						10
Unidentified fish						1				1
Red-spotted newt		26	8	75	142	29	15			295
Two-line salamander	2	15	2	2						21
Rana sp. tadpole	4	1	1							6
Unidentified worm	1									1

[a] A total of 57 salamanders were reportedly affected in this section, however, only 41 (72%) were present in the sample sent for species identification.

[b] A total of 147 salamanders were reportedly affected in this section, however, 5 were observed in water too deep for collection and species identification.

[c] These may be johnny darters; they were originally identified as such.

Assessment Crew: V. Gilligan, T. Gliddi, L. Durfey, L. Demong, T. Shanahan, J. Gersmehl, G. Steinbach

Table 15. Saranac River TFM treatment - routine sea lamprey and nontarget mortality observations, September 16, 1992.

	Stream Section Number	

Species	1	2[a]	3[a]	4	5	Total
Sea lamprey ammo.[b]		31	91	162	54	338
Sea lamprey trans.[b]		3				3
Sea lamprey y-o-y[b]		6	47			53
Rainbow trout		2	1	2		5
Brook trout	1					1
Creek chub		2				2
Fallfish		1				1
Stonecat	107	189	29	6		331
Banded killifish				1		1
Log perch	24	4	4			32
Salamander	1		3			4
Unionid mollusk	1					1
Unidentified mollusk		1				1

[a] These totals include collections of target and nontarget organisms made the day of treatment, September 15, 1992.

[b] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable.

Assessment Crew: V. Gilligan, T. Gliddi, R. Brown, L. Saltsman

Table 16. Poultney River TFM treatment - routine sea lamprey and nontarget mortality observations, September 24 - 25, 1992.

Species	Stream Section Number								Total
	1[a]	2[a]	3[a]	4[a]	5	6	7	8	
Sea lamprey ammo.[b]	11	47	110	16	4	2	5		195
Sea lamprey trans.[b]									0
Sea lamprey y-o-y[b]		1	1						2
Silver lamprey[b]		32	67			2			101
Rosyface shiner			1						1
Fallfish	1								1
Unidentified cyprinid[c]							1		1
Bluegill		1							1

[a] These totals include collections of target and nontarget organisms made the day of treatment, September 24, 1992.

[b] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable.

[c] This fish was a probable *Notropis* species - the specimen was missing a major portion of its head and thus could not be keyed.

Assessment Crew: V. Gilligan, T. Gliddi, W. Schoch, B. Chipman

Table 17. Hubbardton River TFM treatment - routine sea lamprey and nontarget mortality observations, September 26, 1992.

Species	Stream Section Number 1	2	3	4	Total
Sea lamprey ammo.[a]	6	23	60	85	174
Sea lamprey trans.[a]		4		4	8
Sea lamprey y-o-y [a]					0
Silvery minnow	1				1
Unidentified minnow			1		1
Pumpkinseed	1				1
Tessellated darter	1				1

[a] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable.

Assessment Crew: D. Callum, C. MacKenzie

Table 18. Great Chazy River TFM treatment - routine sea lamprey and nontarget mortality observations, Sept. 30 - Oct. 13, 1992.

Species	Stream Section Number													Total
	1[a]	2[a]	3[a]	4[a]	5[a]	6	7	8	9[a,b]	10[a]	11[a]	12[c]	13[c]	
Sea lamprey ammo.[d]	3,541	1,625	13,093	16,417	14,154	110	640	2,154	24,655	3,594	6,881	115	1	86,980
Sea lamprey trans.[d]	1,255	434	1,704	5,441	8,257	38	517	1,042	11,834	1,846	9,338			41,706
Sea lamprey y-o-y[d]	1,569	136	697	477	786	3	47	0	395					4,110
North. brk. lamprey[d]					197									197
Northern pike										1				1
Muskellunge		2		3	14	1	1			2				23
Common shiner								1						1
Bluntnose minnow					8	1								9

[a] These sections were subsampled to estimate lamprey numbers; the totals here include expansion calculations from these subsamples. Other nontargets were counted over the entirety of each section, with the exception of Section 9.

[b] Approximately 19% of Section 9 was subsampled to estimate lamprey and nontarget organism numbers; the totals here include expansion calculations from this subsample.

[c] No samples collected in these sections; all observed dead lamprey assumed to be sea lamprey ammocoetes.

[d] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable. The numbers exclude lamprey collected by USFWS during initial phases of treatment before mortality assessment crews made their counts.

These USFWS collections contained several hundred sea lamprey ammocoetes in each of Sections 1, 3 and 5, and several thousand sea lamprey ammocoetes in Section 9. Also excluded were eight northern brook lamprey were present in the USFWS collections from Section 5.

Continued...

Table 18 (cont.).

Species	Stream Section Number													Total
	1	2	3	4	5	6	7	8	9[a]	10	11	12	13	
Fallfish	1					1				1				3
White sucker				6	9	5	2		1	1				24
Brown bullhead	7	7	9	2	15				1					41
Stonecat	6	33	62	39	211	389	1,383	345	383	2,915	2			5,768
Rock bass									1					1
Smallmouth bass							1			1				2
Fantail darter				3		14								17
Log perch		1	3	43	165	40	8	59	86	149	7			561
Salamander	40	64	130	75	426	84	184	64	105	31	6			1,209
Frog tadpoles	3	18	88	63	1,179	83	24			2				1,460
Adult frog			1		2					1				4
Leopard frog				1										1

[a] Approximately 19% of section 9 was subsampled to estimate nontarget organism numbers; the totals here include expansion calculations from this subsample.

Assessment Crew: V. Gilligan, T. Gliddi, B. Chipman, C. MacKenzie, L. Durfey, D. Gibson, W. Schoch, J. Sausville, K. Ransom

Table 19. Boquet River TFM treatment - routine sea lamprey and nontarget mortality observations, September 14, 1994.

	Stream Section Number									
Species	1	2	3	4	5	6	7	8	9	Total
Sea lamprey ammo.[a]	22	192	944	887	1,053	1,835	1,230	329		6,492
Sea lamprey trans.[a]			4	8	16	9	22	13		72
Sea lamprey y-o-y[a]										0
Silver lamprey[a]		2	7	16	11	46	44	10		136
Golden shiner								1	1	2
Common shiner			1							1
Rosyface shiner								1		1
Bluntnose minnow							1			1
Longnose dace	3									3
Fallfish						1				1
Smallmouth bass						1				1
Tessellated darter			1		3		1			5
Unidentified fish [b]			1							1

[a] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific

samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable.

[b] Decomposed specimen - unmeasurable and unidentifiable; probably not a result of treatment.

Continued...

Table 19 (cont.).

Species	Stream Section Number 1	2	3	4	5	6	7	8	9	Total
Crayfish	1									1
Frog tadpoles				2				1		3
Frog adults							2			2

Assessment Crew: V. Gilligan, T. Gliddi, C. MacKenzie, K. Ransom

Table 20. Little Ausable River TFM treatment - routine sea lamprey and nontarget mortality observations, September 16-17, 1994.

Species	Stream Section Number											Total
	1	2	3	4	5	6	7	8	9	10	11	
Sea lamprey ammo.[a]			9,421	189	601	1,229	12,182	3,129	10,093	594	205	37,643
Sea lamprey trans.[a]				1		17	189	199	220	5		631
Sea lamprey y-o-y[a]												0
Amer. brk. lamprey[a]								75	109			184
Bowfin											2	2
Northern pike									1	10	5	16
Golden shiner										1		1
Spottail shiner									1			1
Rosyface shiner										1		1
Bluntnose minnow				4								4
Creek chub	1											1
Fallfish						1	1		1			3
Longnose sucker	1											1

[a] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable.

Continued...

Table 20 (cont.).

Species	Stream Section Number											Total
	1	2	3	4	5	6	7	8	9	10	11	
White sucker				4					3	3		10
Brown bullhead										14	14	28
Stonecat			2	4	2	68	1		119			196
Pumpkinseed											1	1
Bluegill							8					8
Smallmouth bass		1										1
Tessellated darter	1			2		1			18		2	24
Log perch									23			23
Slimy sculpin										1		1
Crayfish	2		1		1	3					1	8
Unionid mollusk									1			1
Salamander	10		1						1			12

Frog tadpole	6											6
Frog adult							1			1	1	3

Assessment Crew: V. Gilligan, T. Gliddi, K. Ransom, A. Ellithorpe, J. Gersmehl & USFWS Crew

Table 21. Ausable River TFM treatment - routine sea lamprey and nontarget mortality observations, September 18-19, 1994.

	Stream Section Number													
Species	1	2	3	4	5	6	7[a]	8A	8B	9	10	11A	11B	Total
Sea lamprey ammo.[b]		24	55	53	153	655	4,421	6,963	5,821	18,742	4,209	15,826	11,240	68,162
Sea lamprey trans.[b]			1		2		24	144		726		105	79	1,081
Sea lamprey y-o-y[b]														0
Amer. brk. lamprey[b]					2		191	2,686	5,444	7,991	3,281	4,296	4,354	28,245
Common shiner										1				1
Bluntnose minnow											1			1
Fallfish													1	1
Longnose sucker				1										1
Banded killifish												1		1
Largemouth bass									1	1				2
Fantail darter			1			1								2

Tessellated darter									9				7	16
Log perch			5	6	47	19	3		2					82

[a] Includes Dry Mill Brook backwater area

[b] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable.

Continued...

Table 21 (cont.).

	Stream Section Number													
Species	1	2	3	4	5	6	7[a]	8A	8B	9	10	11A	11B	Total
Unidentified fish[b]													1	1
Crayfish		1	1			1	1	1	1					6
Mudpuppy												13	9	22
Salamander		3	4		7	3			10	1		2		30
Frog tadpole		1											1	2
Frog adult						1	3							4

[a] Includes Dry Mill Brook backwater area

[b] Partially decomposed specimen - unidentifiable.

Assessment Crew: V. Gilligan, T. Shanahan, E. Crawford, T. Gliddi, R. Huyck, C. MacKenzie, A. Ellithorpe, J. Gersmehl & USFWS Crew

Table 22. Salmon River TFM treatment - routine sea lamprey and nontarget mortality observations, September 20, 1994.

	Stream Section Number								
Species	1	2	3	4	5	6	7	8	Total
Sea lamprey ammo.[a]		2	23,200	27,000	12,006	554	581	234	63,577
Sea lamprey trans.[a]			60			10		1	71
Sea lamprey y-o-y[a]									0
Amer. brk. lamprey[a]								38	38
Common shiner			10						10
Rosyface shiner				1					1
Bluntnose minnow			1						1
Fallfish					1				1
White sucker						1			1

Stonecat		10	7	2	31	28	107		185
Tessellated darter							1		1
Crayfish			1				3		4
Salamander			4	1	1				6
Frog tadpole				1					1

[a] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable.

Assessment Crew: V. Gilligan, T. Gliddi, C. MacKenzie, K. Ransom

Table 23. Putnam Creek TFM treatment - routine sea lamprey and nontarget mortality observations, September 22-23, 1994.

	Stream Section Number														
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Sea lamprey ammo.[a]	1	7	52	551	123	71	202	481	2,773	2,955	8,181	4,089	32	27	19,545
Sea lamprey trans.[a]				23			18	10	146	192	421	272	10	22	1,114
Sea lamprey y-o-y[a]															0
Silver lamprey[a]									7			403			410
Bowfin												1			1
Rainbow trout		3	3	3											9
Brown trout			2												2
Brook trout		1	1	1	1			3							7

Central mudminnow												2			2
Northern pike											1				1
Mimic shiner								4							4
Blacknose dace			1	358	39	4	5	6	11						424
Longnose dace			1	1											2

[a] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable.

Continued...

Table 23 (cont.).

	Stream Section Number														
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
White sucker				2			2	2	2		1				9
Brown bullhead				1				1			1				3
Tessellated darter								1				2			3
Log perch			8	11	1			1		1					22
Slimy sculpin			1	3	6	3									13
Crayfish			1		2										3

Salamander	1	2	12	46	3	5				4?	1	2	3	11	90
Frog adult											1	1		1	3

Assessment Crew: V. Gilligan, T. Gliddi, C. MacKenzie, K. Ransom, C. Wray

Table 24. Lewis Creek TFM treatment - routine sea lamprey and nontarget mortality observations, October 6, 1994.

Species	Stream Section Number														Total
	1A[a]	1B[a]	2A[a]	2B[a]	3	4	5	6	7	8	9	10	11A	11B	
Sea lamprey ammo.[b]					63	883	1,787	1,912	150	12,038	21,934	1,764		6	40,537
Sea lamprey trans.[b]					5	9	23	37	8	195	456	138			871
Sea lamprey y-o-y[b]															0
Silver lamprey[b]										34	1,802	1,359	10	2	3,207

Chain pickerel													10	10
Golden shiner													1	1
Common shiner											1			1
Longnose dace					1					1				2
Brown bullhead										1	3	1	1		6
Smallmouth bass					1						1				2
Tessellated darter					1					1				2	4
Yellow perch														1	1

[a] The primary application point was moved downstream to the Section #2B / 3 boundary; therefore, no target or nontarget mortality was induced above Section 3.

[b] Estimates of the number of sea lamprey ammocoetes and transformers (no estimates of dead young-of-year were made), as well as silver lamprey, were derived by multiplying the proportions of these forms in section-specific samples as determined by USFWS staff (Essex Junction, VT) by the number of all lamprey mortalities observed in that section.

Continued...

Table 24 (cont.).

Species	Stream Section Number														Total
	1A[a]	1B[a]	2A[a]	2B[a]	3	4	5	6	7	8	9	10	11A	11B	
Log perch						6		1	3	9		1		6	26
Mudpuppy					2		2					4	1		9
Salamander							2			1					3

Frog adult						3	1					1			5

Assessment Crew: J. Anderson, B. Chipman, D. Gibson, N. Staats, A. Ellithorpe, G. Caldwell, M. Lyttle, R. Greenough, R. Howey, B. Carlisle

Table 25. Mount Hope Brook TFM treatment - routine sea lamprey and nontarget mortality observations, September 9, 1995.

	Stream Section Number									
Species	1[a]	2	3	4	4A	5	6	7	8	Total
Sea lamprey ammo.[b]		6,455	1,422	1,281	471	246				9,875
Sea lamprey trans.[b]		823	192	204	66	148				1,433

Sea lamprey y-o-y[b]										0
Silver lamprey[b]			15							15
Brook trout		1								1
Central mudminnow		3								3
Chain pickerel		4	6	3		6				19
Blacknose dace		8								8
Creek chub		4								4
Fallfish		6	1							7
Pearl dace		22								22
White sucker		72	3							75

[a] The primary application point was moved downstream of Section 1; no target or nontarget mortality occurred in this section.

[b] Estimates of the number of sea lamprey ammocoetes and transformers (no estimates were made for dead young-of-year), as well as the number of silver lamprey affected, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section.

Continued...

Table 25 (cont.).

Species	Stream Section Number									Total
	1[a]	2	3	4	4A	5	6	7	8	
Yellow bullhead		8	4							12

Brown bullhead		7		1						8
Tessellated darter		26	6	2	1					35
Slimy sculpin		1								1
Red-spotted newt		21	2	27	7	10				67
Two-line salamander		5	1							6
Rana sp. tadpole		1								1

[a] The primary application point was moved downstream of Section 1; no target or nontarget mortality occurred in this section.

Assessment Crew: V. Gilligan, T. Gliddi, J. LaPierre, T. Appleton

Table 26. Trout Brook TFM treatment - routine sea lamprey and nontarget mortality observations, September 12, 1995.

	Stream Section Number								
Species	1	2	3	4	5	6	7	8	Total

Sea lamprey ammo.[a]	4	16	31	7		2	17	5	82
Sea lamprey trans.[a]	2	6	34	21		8	2	2	75
Sea lamprey y-o-y[a]									0
Amer. brk. lamprey[a]		3	5	10		5	22	47	92
Silvery minnow	18[b]	16[b]	1						35
Blacknose dace							1		1
White sucker	2			1			1		4
Brown bullhead	6	5	2	1		2	1		17
Tessellated darter	1								1
Log perch							1		1

[a] The number of sea lamprey ammocoetes and transformers (no young-of-year were observed), as well as the number of American brook lamprey affected, were determined by counts made of each form in section-specific collections of <u>all</u> observed, dead lamprey (a departure from the usual proportion calculation method).

[b] Most silvery minnows observed affected in Sections 1 and 2 were thought to be killed the day before treatment by electrofishing.

Assessment Crew: B. Chipman, C. Remillard, F. Shroeder, M. Lyttle

Table 27. Salmon Delta Bayluscide treatment - routine sea lamprey and nontarget mortality observations, September 14, 1995.

	Shoreline Section[a]	Sub

Species	S1	S2	S3	Total
Sea lamprey ammo.[b]	15	13	22	50
Sea lamprey trans.[b]				0
Sea lamprey y-o-y[b]				0
Amer. brk. lamprey[b]	5	10	2	17
Emerald shiner		1		1
Spottail shiner			2	2
Rosyface shiner			6	6
Longnose dace			5	5
Unidentified cyprinid			8	8
Banded killifish			1,520[c]	1,520

[a] Observations were made along a 'band' of shoreline, approximately 20' wide from the water's edge toward the lake within the treatment zone. No gull feeding-activity counts were conducted in 1995. Two small, white suckers, adversely affected by the treatment, were collected in offshore areas but not assigned to any shoreline section.

[b] The number of sea lamprey ammocoetes (no transformers or young-of-year were observed), as well as the number of American brook lamprey affected, were determined by counts made of each form (as determined by USFWS staff, Essex Junction, VT) in section-specific collections of all observed, dead lamprey.

[c] The banded killifish mortality figure (1,520) is an estimate.

Continued...

Table 27 (cont).

Species	Shoreline Section[a] S1	 S2	 S3	Sub Total
Bluegill			8	8
Johnny darter			1	1
Mottled sculpin			1	1
Snails			2	2
Mussels (Pisidium)			10	10

[a] Observations were made along a 'band' of shoreline, approximately 20' wide from the water's edge toward the lake within the treatment zone. No gull feeding-activity counts were conducted in 1995. Two small, white suckers, adversely affected by the treatment, were collected in offshore areas but not assigned to any shoreline section.

Assessment Crew: V. Gilligan, T. Gliddi, T. Appleton, J. Drageland, D. Nettles, F. Schroeder

Table 28. Saranac Delta Bayluscide treatment - routine sea lamprey and nontarget mortality observations, September 15, 1995.

Species	Shore. Section[a] S1	S2[b]	Sub Total
Sea lamprey ammo. [c]	2		2
Mimic shiner	3		3
Tessellated darter	3		3

[a] Observations were made along a 'band' of shoreline, approximately 20' wide from the water's edge toward the lake within the treatment zone. No gull feeding-activity counts were conducted in 1995.

[b] Assessment crews interpreted a line of aircraft guidance bouys as the boundary of the treatment zone; however it was not. Consequently, a substantial length of shoreline within the treatment zone was left unsurveyed.

[c] The number of sea lamprey ammocoetes (no transformers or young-of-year were observed), as well as the number of any nontarget lamprey affected, were determined by counts made of each form (as determined by USFWS staff, Essex Junction, VT) in section-specific collections of all observed, dead lamprey.

Assessment Crew: V. Gilligan, T. Gliddi

Table 29. Ausable Delta Bayluscide treatment - routine sea lamprey and nontarget mortality observations, September 15, 1995.

	Shoreline Section[a]				Sub
Species	S1[b]	S2	S3[c]	S4	Total
Sea lamprey ammo.[d]	398	49	224	1,234	1,905
Sea lamprey trans.[d]					0
Sea lamprey y-o-y[d]					0
Amer. brk. lamprey[d]	295	1	141	593	1,030
Emerald shiner	100				100
Spottail shiner	2,100				2,100
Mimic shiner	9,200				9,200
Brown bullhead				5	5
Banded killifish	13,600		5,000		18,600
Lepomis spp.				7	7

[a] Observations were made along a ‘band’ of shoreline, approximately 20' wide from the water’s edge toward the lake within the treatment zone. No gull feeding-activity counts were conducted in 1995.

[b] Numbers of organisms other than lamprey and the single *Rana* sp. tadpole observed were estimated based on an overall estimate of fish affected multiplied by the proportion of each species represented in a 250 fish sample.

[c] Numbers of banded killifish in this section are based on visual estimates.

[d] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were

derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable.

Continued...

Table 29 (cont.).

Species	Shoreline Section[a]				Sub Total
	S1[b]	S2	S3	S4	
Smallmouth bass				2	2
Largemouth bass				8	8
Tessellated darter			4	4	8
Yellow perch				8	8
Log perch				2	2
Unidentified fish [c]		125,000	2,500	10,000	137,500
Mussels (Unionidae)		22			22
Rana sp. tadpole	1				1

[a] Observations were made along a 'band' of shoreline, approximately 20' wide from the water's edge toward the lake within the treatment zone. No gull feeding-activity counts were conducted in 1995.

[b] Numbers of organisms other than lamprey and the single *Rana* sp. tadpole observed were estimated based on an overall estimate of fish affected multiplied by the proportion of each species represented in a 250 fish sample.

[c] Numbers of unidentified fish (most ranging in size from 1 - 2") are based on visual estimates. No attempt was made to identify them to species, although most were probably cyprinids.

Assessment Crew: V. Gilligan, T. Gliddi, N. Staats, D. Gibson, J. Anderson, R. Brown, M. Brewer

Table 30. Boquet Delta Bayluscide treatment - routine sea lamprey and nontarget mortality observations, September 15, 1995.

Species	Shoreline Section[a]				Sub Total
	S1	S2	S3	S4	
Sea lamprey ammo.[b]		1			1
Emerald shiner		22			22
Mimic shiner		40			40
Longnose dace	1	3			4
Banded killifish		2			2

[a] Observations were made along a 'band' of shoreline, approximately 20' wide from the water's edge toward the lake within the treatment zone. No gull feeding-activity counts were conducted in 1995. Only ~300' of each shoreline section was surveyed due to darkness. However, on September 16, 1995 a USFWS crew conducted a partial shoreline walk in Section S1. They counted ~5,500 killifish, 3 emerald shiners and 1 sea lamprey.

[b] The single sea lamprey ammocoete collected from the partial surveys of all shoreline sections was identified to species by USFWS staff, Essex Junction, VT.

Assessment Crew: J. Sausville, T. Shanahan, T. Appleton, J. Drageland, D. Nettles, F. Schroeder, L. Durfey, L. Nashett

Table 31. Great Chazy River TFM treatment - routine sea lamprey and nontarget mortality observations, September 13-19, 1996.

Species	Stream Section Number													Total
	1	2	3[a]	4[a]	5[a]	6	7	8	9[a]	10[a]	11[b]	12[b]	13	
Sea lamprey ammo.[c]	226	389	3,413	6,341	1,105	8	14	320	6,510	1,053	2,785	153		22,317
Sea lamprey trans.[c]	8	28	23	187	20			3	54	72				395
Sea lamprey y-o-y[c]														0
North. brk. lamprey[c]					12									12
Bowfin												1		1
Central mudminnow				3										3
Muskellunge									1					1
Cutlips minnow				4			1							5
Common shiner												1		1
Bluntnose minnow										1				1
Longnose dace										1				1
Fallfish				2										2

[a] A USFWS crew separately collected target and nontarget lampreys in these stream sections. These collections are contained within this table and are illustrated separately in a separate sub-table below.

[b] No lamprey samples were collected here due to decomposition. All observed were assumed to be sea lamprey ammocoetes.

[c] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable.

Continued...

Table 31 (cont.).

	Stream Section Number													
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
White sucker					1									1
Brown bullhead						1			3		1			5
Channel catfish												1		1
Stonecat		2	2	45	13	3	4	1	3	13	1	1		88
Rock bass				9	1					1				11
Black crappie												1		1
Fantail darter[a]				48						1				49
Tessellated darter				3										3
Log perch				10		3		1		14				28
Leech	1													1
Crayfish	1	2			1									4
Mussel				13										13

Salamander[b]	22	28	85	44	182	16	26	5	28	1	4	1		442

[a] Two of these fantail darters were collected by USFWS staff, but are not shown in the sub-table below, which focuses only on lamprey.

[b] Representative salamanders were preserved and forwarded to NYSDEC endangered species unit for further identification. Field crews felt most were mudpuppies.

Continued...

Table 31 (cont.).

	Stream Section Number													
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Frog tadpole	3	13	178	28	2,956	229	119	20	41	24	3			3,614
Frog adult		1	3		2		2		3					11

Assessment Crew: V. Gilligan, J. LaPierre, C. MacKenzie, F. Aldinger, J. Oudman, R. VanValkenburgh, L. Durfey, B. Caldwell, R. Brown, L. Nashett, J. Gersmehl & USFWS Crew

Table 32. Poultney River TFM treatment - routine sea lamprey and nontarget mortality observations, October 31, 1996.

Species	Stream Section Number								Total
	1	2	3	4	5	6	7	8	
Sea lamprey[a]	261	987	2,137	875	954	243	273	40	5,770
Sea lamprey trans.[a]	6	25	101	81	348	220	157	51	989
Sea lamprey y-o-y[a]									0
Silver lamprey[a]	41	345	672	312	445	437	274	23	2,549
Bluntnose minnow	1								1
Fathead minnow	1								1
Fallfish	1								1
Brassy minnow	1								1
White sucker	3								3
Largemouth bass						1			1

Tessellated darter	5	2	2						9
Log perch					1	2		1	4
Salamander[b]			2						2

[a] Estimates of the number of sea lamprey ammocoetes, transformers, and young-of-year, as well as other lamprey species, were derived by multiplying the proportions of these forms (as determined by USFWS staff, Essex Junction, VT) in section-specific samples by the number of all lamprey mortalities observed in that section. Data for young-of-year (often ignored in counts) are unreliable.

[b] Salamanders from section 3 were placed in preservative and forwarded to the NYSDEC Endangered Species Unit for identification.

Assessment Crew: V. Gilligan, J. Oudman, L. Saltsman, N. Staats, R. Aldinger, B. Chipman, J. Gersmehl & USFWS Crew

Table 33. Hubbardton River TFM treatment - routine sea lamprey and nontarget mortality observations, October 31, 1996.

	Stream Section Number[a]				
Species	1	2	3	4	Total
Sea lamprey ammo.[b]				20	20
Sea lamprey trans.[b]					0
Sea lamprey y-o-y [b]					0
Tessellated darter			1		1

[a] The primary application point was moved substantially downstream in 1996. Its location was approximately 100 yards upstream of the Section 3 / Section 4 boundary. Therefore, only the lowermost 100 yards of Section 3 and all of Section 4 were assessed for target nontarget mortality.

[b] The number of sea lamprey ammocoetes (no transformers or young-of-year were observed), as well as the number of any nontarget lamprey affected, were determined by counts made of each form (as determined by USFWS staff, Essex Junction, VT) in

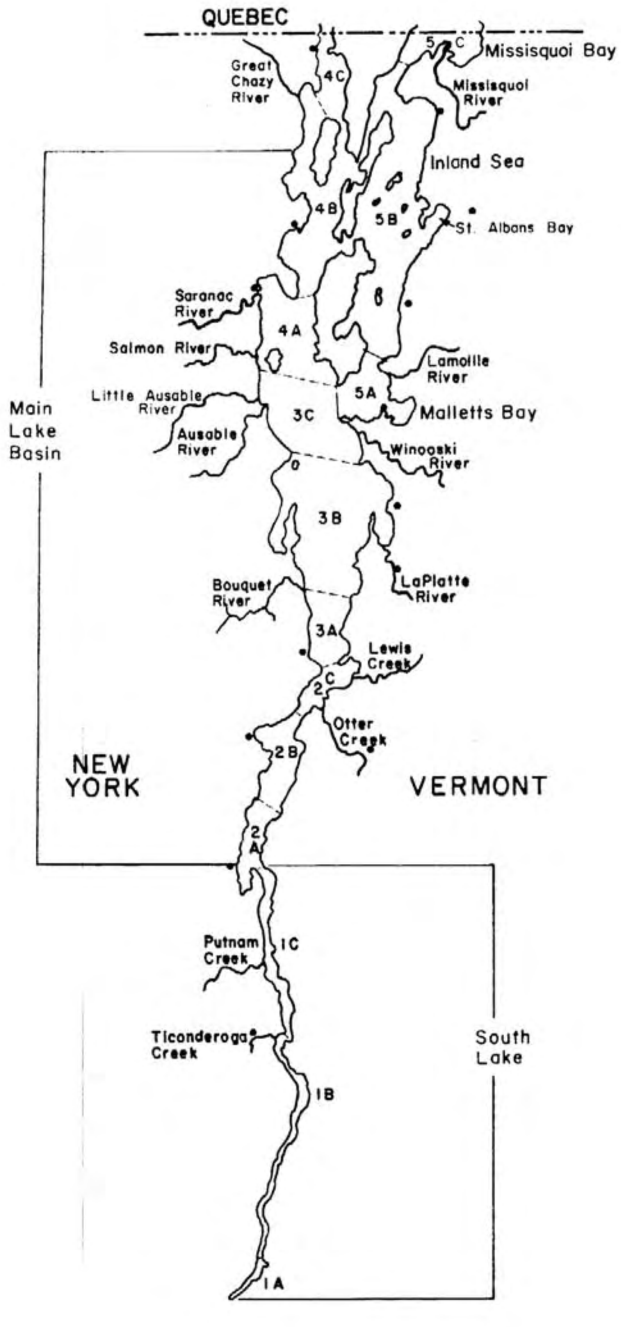
section-specific collections of <u>all</u> observed, dead lamprey.

Assessment Crew: D. Gibson, B. Caldwell

APPENDIX F

Lake Champlain Map
With Fishery Management Zones, Major Tributaries and Basins

Lake Champlain map showing fishery management zones, major tributaries, and primary basins.



APPENDIX G

Salmonid Stocking History for Lake Champlain

Salmonid Stocking History for Lake Champlain, **Lake Trout - 1972 to 1997**.

Yearlings

Main Lake

Stocking Year	Egg Source	Age	Average Size (Inches)	Mark	Stocking Location	Number Stocked	Number Equivalent
1973	Adirondack L	1+	3.2	None	Valcour Island	39,000	39,000
1974	Michigan	1+	4.5	None	Willsboro Pt. To Ausable Pt.	47,750	47,750
1974	Finger Lakes	1+	5.5	None	Westport	6,794	6,794
1974	Lake George	1+	4.8	None	Split Rock	5,796	5,796
1974	Finger Lakes	0++	3.2	None	Port Kent, Essex Ferries	72,588	14,518
1974	L. Michigan	0++	3.2	None	Cumberland Head	64,757	12,951
1974	Finger Lakes	0++	3.5	None	Split Rock, Willsboro Bay Schuyler Is.	112,389	22,478
1975	Finger Lakes	1+	5.0	AD	Westport to Cumberland Head	90,969	90,969
1975	Lake George	0++	3.0	LV	Essex, Westport	42,085	8,417
1975	Michigan	0++	4.0	LV	Cumberland Bay	45,626	9,125
1976	Michigan	1+	5.4	LV	Pt. AuRoche to Mullen Bay	78,600	78,600
1976	Michigan	1+	4.3	LV	Split Rock to Cumberland Head	64,600	64,600
1976	Finger Lakes	0++	3.5	RV	Essex, Schuyler Is.	74,103	14,820
1976	Michigan	0++	3.1	RV-AD	Willsboro Point	10,215	2,043
1977	Finger Lakes	1+	4.2	RV	Willsboro Bay & Pt.	27,250	27,250
1977	Finger Lakes	1+	5.6	RV	Pt. AuRoche to Mullen Bay	115,180	115,180
1978	Finger Lakes	1+	5.5	LP	Long Pt. to Cole Bay	138,521	138,521
1978	Finger Lakes	1+	4.7	LP	Ligonier Pt. to Schuyler Is.	52,188	52,188
1979	Finger Lakes	1+	5.6	RP	Westport to Willsboro	98,773	98,773
1979	Finger Lakes	1+	4.6	RP	Split Rock to Cannon Point	17,800	17,800
1979	Adirondack L	0++	2.6	LV	Willsboro Bay	1,262	252
1979	Adirondack L	0++	2.6	RV	Willsboro Bay	35,038	7,008
1979	Manitoba	0++	4.0	LP	Burlington Harbor	18,028	3,606
1980	Finger Lakes	1+	5.2	AD	Westport to Willsboro Bay	79,784	79,784
1980	Raquette Lake	1+	3.3	LV	Pumpkin Reef, Schuyler Is.	24,000	24,000
1980	L. Superior (Hatchery)	3+	16.9	LV-AD	Cumberland Head Ferry	725	725
1980	L. Superior (Hatchery)	3+	16.9	LV-Tag	Cumberland Head Ferry	1,450	1,450
1980	L. Superior	3+	16.9	LV-Tag	Willsboro Bay	3,197	3,197
1980	Allagash Lk. (Maine)	0++	4.6	LV	Essex Ferry	28,030	5,606
1980	Finger Lakes	0++	4.2	RP	Cumberland Head Ferry	9,200	1,840
1980	Manitoba	1+	6.1	LP	Burlington Harbor	4,210	4,210
1981	Manitoba	1+	6.0	RP	Burlington Harbor	13,000	13,000
1981	Jenny Lake	1+	6.0	RP	Burlington Harbor	37,748	37,748
1981	Finger Lakes	1+	5.5	LV	Westport to Schuyler Is.	151,459	151,459
1981	Finger Lakes	1+	6.0	LV	Willsboro Bay, Schuyler Is.	18,000	18,000
1981	Finger Lakes	1+	5.4	RP	Cumberland Head to Pt. AuRoche	40,000	40,000
1982	Jenny Lake	1+	5.3	RV	Westport	30,000	30,000
1982	Finger Lakes	1+	5.0	RV	Willsboro Bay	17,600	17,600
1982	Finger Lakes	1+	6.3	RV	Willsboro Pt. to Schuyler Is.	42,160	42,160
1982	Finger Lakes	1+	5.0	AD	Cumberland Head to Pt. AuRoche	25,200	25,200
1982	Jenny Lake	1+	5.7	RV	Essex, Charlotte	25,085	25,085
1982	Jenny Lake	1+	6.3	RV	Burlington to S. Hero	71,624	71,624
1982	Manitoba	1+	6.0	RV	Charlotte-South	38,300	38,300
1982	Jenny Lake	1+	6.2	RV	Essex	16,333	16,333
1983	Jenny Lake	1+	5.0	LP	Charlotte	22,002	22,002
1983	Finger Lakes	1+	6.6	LP	Essex to Schuyler Is.	69,239	69,239
1983	Finger Lakes	1+	6.6	LV	Cumberland Head to Pt. AuRoche	19,030	19,030
1983	Manitoba	1+	6.5	LP	Kingsland Bay, Panton	18,624	18,624
1983	Jenny Lake	1+	5.0	LP	S. Hero, Burlington	74,505	74,505
1983	Finger Lakes	0++	5.4	RP	Port Douglas	54,355	10,871
1983	Raquette Lake	0++	3.9	Dorsal	Port Douglas	44,200	8,840
1984	Manitoba	1+	6.0	RV	Burlington, Charlotte	22,500	22,500
1984	Finger Lakes	1+	7.8	RP	Westport to Cumberland Head	134,449	134,449
1984	Jenny Lake	0++	5.9	None	Cumberland Head Ferry	40,000	8,000
1984	Marquette	0++	5.7	None	Cumberland Head Ferry	94,513	18,903

1985	Finger Lakes	1+	7.0	AD	Essex Ferry Dock	36,500	36,500

Salmonid Stocking History for Lake Champlain, **Lake Trout - 1972 to 1997** (continued).

Stocking Year	Egg Source	Age	Average Size (Inches)	Mark	Stocking Location	Number Stocked	Number Equivalent
Yearlings							
1985	Finger Lakes	1+	7.0	AD	Cumberland Head Ferry	25,500	25,500
1985	Finger Lakes	1+	6.8	AD	Port Douglas Boat Launch	34,975	34,975
1985	Finger Lakes	1+	6.1	AD	Essex Ferry	13,100	13,100
1985	Finger Lakes	1+	7.0	AD	Westport	25,000	25,000
1985	Finger Lakes	1+	7.9	AD	Port Kent Ferry	41,000	41,000
1985	Finger Lakes	1+	7.9	AD	Essex Ferry	10,000	10,000
1986	Finger Lakes	1+	7.0	LV	Cumberland Head Ferry	35,000	35,000
1986	Finger Lakes	1+	8.0	LV	Port Kent Ferry	42,140	42,140
1986	Finger Lakes	1+	7.0	LV	Port Douglas Boat Launch	11,500	11,500
1986	Finger Lakes	1+	8.0	LV	Port Douglas Boat Launch	15,500	15,500
1986	Finger Lakes	1+	7.5	LV	Essex Ferry	35,000	35,500
1986	Finger Lakes	1+	8.0	LV	Westport/Panton	27,500	27,500
1987	Finger Lakes	1+	7.9	RV	Cumberland Head Ferry	34,100	34,100
1987	Finger Lakes	1+	6.3	RV	Port Kent Ferry	63,240	63,240
1987	Finger Lakes	1+	7.4	RV	Port Douglas Boat Launch	17,880	17,880
1987	Finger Lakes	1+	6.6	RV	Willsboro Point	20,380	20,380
1987	Finger Lakes	1+	8.1	RV	Essex Ferry	52,680	52,680
1987	Finger Lakes	1+	6.0	RV	Westport/Panton	24,000	24,000
1988	Jenny Lake	1+	5.9	None	Essex Ferry	21,300	21,300
1988	Jenny Lake	1+	5.9	None	Cumberland Head Ferry	30,000	30,000
1988	Finger Lakes	1+	8.1	LP	Essex Ferry	16,000	16,000
1988	Raquette Lake	1+	6.0	None	Westport/Panton	11,500	11,500
1988	Finger Lakes	1+	8.1	LP	Westport/Panton	12,500	12,500
1988	Finger Lakes	1+	8.4	LP	Port Douglas Boat Launch	18,410	18,410
1988	Finger Lakes	1+	8.4	LP	Willsboro Point, Schuyler Is.	8,560	8,560
1988	Raquette Lake	1+	6.5	None	Port Kent Ferry	41,500	41,500
1989	Finger Lakes	1+	8.4	RP	Cumberland Head Ferry	33,900	33,900
1989	Finger Lakes	1+	8.5	RP	Port Douglas Boat Launch	6,100	6,100
1989	Finger Lakes	1+	8.0	RP	Port Douglas Boat Launch	6,100	6,100
1989	Finger Lakes	1+	7.8	RP	Port Douglas Boat Launch	16,200	16,200
1989	Finger Lakes	1+	8.4	RP	Essex Ferry	17,400	17,400
1989	Finger Lakes	1+	8.0	RP	Essex Ferry	12,000	12,000
1989	Finger Lakes	1+	7.9	RP	Westport/Panton	16,300	16,300
1989	Finger Lakes	1+	8.8	RP	Port Kent Ferry	30,090	30,090
1989	Finger Lakes	1+	7.0	RP	Charlotte Ferry	9,600	9,600
1989	Finger Lakes	1+	7.0	RP	Arnold’s Bay	11,075	11,075
1990	Finger Lakes	1+	8.0	AD	Cumberland Head Ferry	22,670	22,670
1990	Finger Lakes	1+	8.0	AD	Port Douglas Boat Launch	5,230	5,230
1990	Finger Lakes	1+	7.4	AD	Port Douglas Boat Launch	5,230	5,230
1990	Finger Lakes	1+	8.5	AD,LVAD	Port Douglas Boat Launch	2,700	2,700
1990	Finger Lakes	1+	7.4	AD	Essex Ferry	22,670	22,670
1990	Finger Lakes	1+	8.2	AD,LVAD	Westport	18,000	18,000
1990	Finger Lakes	1+	8.5	AD,LVAD	Willsboro Point	18,000	18,000
1990	Finger Lakes	1+	8.5	AD,LVAD	Port Kent Ferry	17,800	17,800
1990	L. Champlain [1]	1+	6.0	AD	Arnold’s Bay	12,000	12,000
1991	Finger Lakes	1+	8.0	LV	Cumberland Head Ferry	23,000	23,000
1991	Finger Lakes	1+	8.0	LV	Port Douglas Boat Launch	13,800	13,800
1991	Finger Lakes	1+	8.0	LV	Essex Ferry	23,000	23,000
1991	Finger Lakes	1+	8.5	LV	Westport	18,400	18,400
1991	Finger Lakes	1+	8.5	LV	Willsboro Point	18,400	18,400
1991	Finger Lakes	1+	8.5	LV	Port Kent Ferry	28,400	28,400
1991	L. Champlain [1]	1+	6.0	LV	Arnold’s Bay-Button Bay	14,400	14,400
1991	L. Champlain	1+	6.0	LV	Burlington	5,000	5,000
1991	Lake Ontario-Wild [1]	1+	6.0	LV	Burlington	60,634	60,634
1991	L. Champlain [1]	1+	6.0	LV	Charlotte	20,000	20,000
1991	L. Champlain [1]	1+	6.0	LV	Grand Isle Ferry	15,000	15,000
1992	Finger Lakes	1+	7.4	RV	Cumberland Head Ferry	24,250	24,250
1992	Finger Lakes	1+	8.0	RV	Port Douglas Boat Launch	8,350	8,350

1992	Finger Lakes	1+	7.5	RV	Port Douglas Boat Launch	9,600	9,600
1992	Finger Lakes	1+	8.5	RV	Essex Ferry	24,250	24,250
1992	Finger Lakes	1+	8.0	RV	Westport	19,400	19,400
1992	Finger Lakes	1+	7.5	RV	Willsboro Point	19,400	19,400
1992	Finger Lakes	1+	6.0	RV	Button Bay	3,000	3,000

Salmonid Stocking History for Lake Champlain, **Lake Trout - 1972 to 1997** (continued).

Stocking Year	Egg Source	Age	Average Size (Inches)	Mark	Stocking Location	Number Stocked	Number Equivalent
Yearlings							
1992	Lake Ontario-Wild[1]	1+	6.0	RV	Arnold's Bay-Button Bay	11,688	11,688
1992	Lake Ontario-Wild[1]	1+	6.0	RV	Charlotte Ferry	12,040	12,040
1992	Finger Lakes	1+	7.0	RV	Burlington Ferry	38,400	38,400
1992	Finger Lakes	1+	8.0	RV	Grand Isle Ferry	15,000	15,000
1993	Finger Lakes	1+	7.0	LP	Cumberland Head Ferry	13,000	13,000
1993	Finger Lakes	1+	7.0	LP	Port Douglas Boat Launch	7,800	7,800
1993	Finger Lakes	1+	6.7	LP	Essex Ferry	13,000	13,000
1993	Finger Lakes	1+	7.0	LP	Westport	10,400	10,400
1993	Finger Lakes	1+	7.0	LP	Willsboro Point	10,400	10,400
1993	Finger Lakes	1+	6.7	LP	Port Kent Ferry	10,400	10,400
1993	Finger Lakes	1+	8.0	LP	Button Bay	5,000	5,000
1993	Lake Ontario-Wild[1]	1+	5.9	LP	Arnold Bay	5,004	5,004
1993	Finger Lakes	1+	6.1	LP	Charlotte Ferry	6,284	6,284
1993	Lake Ontario-Wild[1]	1+	5.9	LP	Charlotte Ferry	6,816	6,816
1993	Finger Lakes	1+	7.5	LP	Burlington Ferry	26,884	26,884
1993	Finger Lakes	1+	7.5	LP	Burlington Harbor	30,700	30,700
1993	Finger Lakes	1+	7.5	None	Grand Isle Ferry	8,000	8,000
1993	Finger Lakes	1+	6.0	LP	Grand Isle Ferry	17,034	17,034
1994	L. Champlain[1]	1+	7.5	RP	Cumberland Head Ferry	18,500	18,500
1994	L. Champlain[1]	1+	7.9	RP	Grand Isle Ferry	20,967	20,967
1994	L. Champlain[1]	1+	8.4	RP	Grand Isle Ferry	4,100	4,100
1994	L. Champlain[1]	1+	8.1	RP	Rouses Point	3,600	3,600
1994	Finger Lakes	1+	7.5	RP	Pt. Douglas Boat Launch	4,200	4,200
1994	Finger Lakes	1+	9.0	RP	Pt. Douglas Boat Launch	6,900	6,900
1994	Finger Lakes	1+	7.5	RP	Essex Ferry	18,600	18,600
1994	Finger Lakes	1+	7.5	RP	Willsboro Point	15,000	15,000
1994	Finger Lakes	1+	9.0	RP	Port Kent Ferry	15,000	15,000
1994	Lake Ontario-Wild[1]	1+	6.4	RP	Charlotte Ferry	29,994	29,994
1994	L. Champlain[1]	1+	7.8	RP	Burlington Harbor	15,400	15,400
1994	Lake Ontario-Wild[1]	1+	6.3	RP	Burlington Harbor	19,986	19,986
1994	L. Champlain[1]	1+	7.0	RP	Westport	14,800	14,800
1994	L. Champlain[1]	1+	8.1	RP	Button Bay	5,085	5,085
1994	L. Champlain[1]	1+	8.1	RP	Arnold Bay	5,060	5,060
1995	Finger Lakes	1+	7.7	AD	Cumberland Head Ferry	17,000	17,000
1995	L. Champlain[1]	1+	7.9	AD	Grand Isle Ferry	11,520	11,520
1995	Finger Lakes	1+	9.0	AD	Port Kent Ferry	21,000	21,000
1995	L. Champlain[1]	1+	7.9	AD	Burlington Harbor	16,960	16,960
1995	Finger Lakes	1+	8.5	AD	Essex Ferry	22,000	22,000
1995	L. Champlain[1]	1+	7.7	AD	Charlotte Ferry	16,675	16,675
1996	L. Champlain[1]	1+	7.8	LV	Grand Isle Ferry	13,796	13,796
1996	Finger Lakes	1+	9.8	LV	Burlington Harbor	10,145	10,145
1996	Finger Lakes	1+	8.4	LV	Essex Ferry	25,000	25,000
1996	L. Champlain[1]	1+	7.8	LV	Charlotte Ferry	19,600	19,600
1997	L. Champlain[1]	1+	7.3	RV	Hatchery Cove	14,780	14,780
1997	Finger Lakes	1+	8.3	RV	Port Kent Ferry	12,500	12,500
1997	L. Champlain[1]	1+	7.1	RV	Burlington Harbor	25,134	25,134
1997	Finger Lakes	1+	8.0	RV	Essex Ferry	12,500	12,500
1997	L. Champlain[1]	1+	7.1	RV	Charlotte Ferry	22,170	22,170

Malletts Bay

1972	Manitoba	2+	8.3	None	Lamoille R. Access	1,000	1,000
1972	Manitoba	2+	8.3	AD	Lamoille R. Access	360	360
					Inland Sea		
1972	Manitoba	2+	6.0	None	VanEverest Access	3,000	3,000
1972	Michigan	1+	5.0	LV	N. Hero, VanEverest Access	8,800	8,800
1975	Manitoba	1+	6.0	RV	Inland Sea	55,000	55,000
1976	Manitoba	1+	5.8	LP	Inland Sea	98,000	98,000
1977	Manitoba	1+	5.8	RP	Inland Sea	118,000	118,000

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[1] These strains are naturalized in their respective waters but are comprised primarily of Finger Lakes strain stockings or their descendants, and are thus considered the equivalent of Finger Lakes strain.

Salmonid Stocking History for Lake Champlain, **Landlocked Atlantic Salmon - 1973 to 1997**.

Stocking Year	Egg Source	Age	Average Size (Inches)	Mark	Stocking Location	Number Stocked	Number Equivalent
Yearlings							
					Main Lake		
1973	Craig Brook	0+	1.0	None	Saranac River	20,000	1,000
1973	Craig Brook	0+	1.0	None	Boquet River	17,210	860
1973	Craig Brook	0++	4.3	AD	Boquet River	5,660	2,689
1973	W. Grand Lake	0++	4.0	None	Boquet River	5,975	2,569
1974	Little Clear	0+	—	None	Boquet River	201,550	10,078
1974	Little Clear	0++	3.4	None	Ausable River	65,256	23,058
1974	Little Clear	0++	3.5	AD	Boquet River	5,640	2,002
1975	Little Clear	1+	4.3	None	Saranac River	7,261	3,848
1975	Little Clear	1+	4.3	AD	Boquet River	1,709	888
1975	Little Clear	0+	1.0	None	Boquet River	144,926	7,246
1976	Little Clear	0+	1.0	None	Boquet River	152,200	7,610
1976	Little Clear	0++	2.5	None	Boquet River	8,000	2,667
1976	Little Clear	0++	2.8	RV	Boquet River	8,000	2,667
1977	Little Clear	1+	3.3	RV	Saranac River	12,700	7,500
1977	Little Clear	0+	1.0	None	Boquet River	150,000	7,500
1978	Little Clear	1+	3.9	AD	Boquet River	12,250	6,186
1978	Lake George	1+	5.2	AD	Saranac River	19,100	17,285
1978	Little Clear	0+	1.0	None	Boquet River	200,000	10,000
1978	Memphremagog	0+	1.0	None	Lewis Creek	4,356	218
1979	Little Clear	1+	3.4	None	Saranac River	20,845	10,422
1979	Little Clear	1+	3.4	LV	Boquet River	29,795	14,898
1979	Little Clear	0+	1.0	None	Boquet River	245,000	12,250
1979	Memphremagog	0+	1.0	None	Lewis Creek	10,000	500
1980	Little Clear	1+	3.3	None	Saranac River	3,825	1,912
1980	Little Clear	1+	3.3	AD	Boquet River	10,000	5,000
1980	Little Clear	0+	1.0	None	Boquet River	190,000	9,500
1980	W. Grand Lake	0+	5.5	None	Westport, Essex	30,000	27,800
1980	W. Grand Lake	0+	5.4	None	Willsboro Bay	14,960	13,689
1980	W. Grand Lake	0+	5.4	None	Ausable River	8,800	4,400
1980	W. Grand Lake	0++	5.8	None	Ausable River	3,125	1,562
1980	Memphremagog	0+	1.5	None	Winooski River	52,500	2,625
1980	Maine	0+	1.5	None	Winooski River	25,000	1,250
1981	Little Clear	1+	4.9	None	Ausable River	6,070	4,795
1981	Little Clear	1+	4.9	LV	Boquet River	25,000	18,750
1981	Little Clear	1+	5.0	None	Saranac River	23,650	17,738
1981	Little Clear	1+	5.0	LV-AD	Willsboro Bay	10,140	9,182
1981	Little Clear	0+	1.5	None	Boquet River	17,820	891
1982	Maine	1+	4.9	None	Ausable River	20,000	15,580
1982	Maine	1+	4.4	None	Saranac River	24,300	14,559
1982	Little Clear	1+	4.3	RV-AD	Willsboro Bay, Cumberland Bay	16,200	8,019
1982	Little Clear	1+	4.6	RV	Boquet River	26,761	18,532
1982	Little Clear	0+	1.2	None	Boquet River	71,000	3,550
1982	Maine	1+	5.2	None	Lower Winooski River	13,385	10,273
1982	New Hampshire	1+	5.6	None	Lewis Creek	3,900	3,375
1983	Little Clear	1+	5.6	None	Saranac River	28,200	26,508
1983	Little Clear	1+	5.9	LV	Boquet River	15,000	14,625
1983	Little Clear	1+	5.6	RV	Boquet River	15,000	14,175
1983	Maine	1+	4.7	None	Willsboro Bay, Cumberland Bay	78,003	54,603
1983	Little Clear	1+	5.5	LV-AD	Cumberland Bay	10,000	8,867
1983	Little Clear	2+	8.8	AD	Boquet River	10,018	10,018
1983	Little Clear	2+	8.8	None	Boquet River	1,000	1,000
1983	Little Clear	2+	8.7	None	Saranac River	11,286	11,286
1983	Maine	1+	5.0	None	Saranac River	18,002	14,401
1983	Maine	1+	5.1	None	Ausable River	37,720	31,119
1983	Maine	1+	4.8	None	Winooski River	40,091	30,670
1983	Memphremagog	1+	6.0	None	Lewis Creek	6,000	5,250
1983	Maine	1+	4.8	None	Burlington	5,900	4,514
1983	Memphremagog	1+	7.0	None	Otter Creek	15,820	15,820
1983	Maine	1+	5.0	None	Grand Isle	3,700	2,775

Salmonid Stocking History for Lake Champlain, **Landlocked Atlantic Salmon - 1973 to 1997** (Cont.).

Stocking Year	Egg Source	Age	Average Size (Inches)	Mark	Stocking Location	Number Stocked	Number Equivalent
Yearlings							
1984	Maine	0+	1.0	None	Boquet River	169,500	8,475
1984	Little Clear	1+	6.1	RV	Boquet River	14,752	14,531
1984	Little Clear	1+	6.1	LV	Boquet River	14,452	14,307
1984	Little Clear	0++	5.1	None	Boquet River	75,000	37,500
1984	Little Clear	0++	4.9	None	Ausable River	30,000	14,950
1984	Little Clear	0++	5.1	None	Saranac River	21,000	10,500
1984	New Hampshire	1+	6.7	None	Winooski River	17,500	17,500
1984	New Hampshire	1+	6.7	None	Lewis Creek	2,500	2,500
1985	Maine	1+	6.0	None	Lewis Creek	3,000	2,655
1985	Maine	1+	6.1	None	Winooski River	17,910	16,841
1985	Little Clear	1+	6.7	LV	Boquet River	20,100	20,000
1985	Little Clear	1+	6.2	RV	Boquet River	20,100	19,799
1985	Little Clear	1+	5.5	AD	Boquet River	30,533	26,868
1985	Little Clear	1+	5.5	None	Boquet River	30,533	26,868
1985	Little Clear	0++	4.5	None	Boquet River	25,965	12,478
1985	Grand Lakes	0++	3.8	None	Boquet River	20,000	8,067
1985	Grand Lakes	0++	3.8	None	Saranac River	39,997	16,121
1985	Little Clear	1+	5.1	None	Saranac River	30,012	22,959
1985	Maine	1+	5.1	None	Ausable River	5,100	3,902
1985	Little Clear	1+	5.1	None	Ausable River	15,060	11,521
1985	Little Clear	1+	7.6	None	Peru Boat Launch	26,000	26,000
1986	Maine	1+	6.4	None	Winooski River	22,007	21,677
1986	New Hampshire	1+	6.2	None	Winooski River	14,006	13,726
1986	New Hampshire	1+	6.6	None	Otter Creek	5,200	5,148
1986	Champlain	1+	6.0	None	Otter Creek	2,754	2,603
1986	Maine	1+	6.0	None	Otter Creek	5,436	5,273
1986	Little Clear	1+	6.0	LV	Boquet River	20,100	20,100
1986	Little Clear	1+	5.6	RV	Boquet River	20,100	19,481
1986	Maine	1+	4.9	None	Ausable River	20,267	16,113
1986	Maine	1+	5.0	None	Saranac River	15,000	11,925
1986	Maine	1+	4.5	None	Essex Ferry	30,000	18,000
1986	Maine	1+	5.5	None	Plattsburgh	30,000	26,400
1986	Maine	1+	5.5	None	Port Kent Ferry	25,000	22,000
1986	Little Clear	1+	7.5	None	Port Douglas	17,500	17,500
1986	Little Clear	0++	5.1	None	Boquet River	14,000	7,000
1986	Maine	0++	4.2	None	Saranac River	147,715	67,703
1987	Maine	1+	6.0	None	Winooski River	14,414	13,332
1987	New Hampshire	1+	6.0	None	Winooski River	21,400	19,795
1987	New Hampshire	1+	6.0	None	Otter Creek	15,580	13,710
1987	Little Clear	1+	6.1	AD	Boquet River	27,800	27,800
1987	Little Clear	1+	6.4	AD	Boquet River	17,200	17,200
1987	Little Clear	1+	5.6	None	Ausable River	20,200	19,510
1987	Little Clear	1+	5.5	RV	Saranac River	15,900	15,025
1987	Maine	1+	6.0	None	Essex Ferry	30,340	27,913
1987	Maine	1+	5.0	LV	Port Kent Ferry Dock	23,940	16,758
1987	Maine	1+	6.5	None	Cumberland Bay	30,060	29,759
1987	Maine	0+	1.0	None	Boquet River	141,000	7,050
1988	Maine	1+	6.4	None	Winooski River	21,378	21,378
1988	Maine + New Hampshire	1+	6.1	None	Otter Creek	14,002	13,652
1988	Maine	0+	1.0	None	Boquet River	200,000	10,000
1988	Little Clear	1+	6.5	AD	N. Br. Boquet River	20,100	20,000
1988	Little Clear	1+	6.5	AD	Boquet River	24,900	24,776
1988	Maine	1+	6.5	None	Ausable River	20,000	19,900
1988	Maine	1+	6.1	RV	Saranac River	15,000	19,925
1988	Maine	1+	6.0	None	Essex Ferry	30,700	30,547
1988	Maine	1+	6.0	None	Port Douglas boat Launch	30,000	29,850
1988	Maine	1+	6.5	LV	Port Kent Ferry	25,300	25,174
1989	Maine	1+	5.0-6.0	None	Winooski River	47,314	45,707

1989	Maine	1+	5.0-6.0	None	Otter Creek	36,221	35,312
1989	New Hampshire	1+	5.0	None	Otter Creek	12,620	12,326
1989	Maine + Little Clear	0+	1.0	None	Boquet River	229,500	11,475

Salmonid Stocking History for Lake Champlain, **Landlocked Atlantic Salmon - 1973 to 1997** (Cont.).

Stocking Year	Egg Source	Age	Average Size (Inches)	Mark	Stocking Location	Number Stocked	Number Equivalent
Yearlings							
1989	Maine	0+	1.0	None	E. Br. Ausable River	49,500	2,475
1989	Little Clear	1+	4.9	AD	N. Br. Boquet River	21,450	15,895
1989	Little Clear	1+	4.9	AD	Boquet River	15,470	11,464
1989	Little Clear	1+	4.5	None	Boquet River	6,000	4,113
1989	Maine	1+	5.5	None	Ausable River	20,000	18,950
1989	Maine	1+	5.6	RV	Saranac River	5,000	4,728
1989	Little Clear	1+	5.6	RV	Saranac River	10,000	9,455
1989	Maine	1+	6.0	LV	Port Kent Ferry	26,170	25,777
1989	Maine	1+	5.5	None	Cumberland Bay	20,000	18,900
1990	Maine	1+	6.1	None	Winooski River	36,512	36,373
1990	Maine	1+	6.1	None	Otter Creek	35,522	35,344
1990	Little Clear	0+	1.6	None	Boquet River	145,200	7,260
1990	Little Clear	1+	6.9	AD	N. Br. Boquet River	3,200	3,176
1990	Little Clear	1+	6.7	AD	N. Br. Boquet River	15,500	15,500
1990	Little Clear	1+	6.9	AD	Boquet River	24,200	24,019
1990	Maine	1+	5.5	None	Ausable River	20,140	19,032
1990	Maine	1+	6.0	RV	Saranac River	17,370	17,283
1990	Maine	1+	6.3	LV	Port Kent Ferry	26,400	25,317
1990	Maine	1+	6.0	None	Cumberland Bay	20,040	19,218
1990	Maine	1+	5.8	None	Grande Isle Ferry	4,009	3,974
1991	Maine	1+	6.0	None	Winooski River	40,011	40,011
1991	Maine	1+	6.0	None	Otter Creek	30,051	30,051
1991	Memphremagog	1+	7.0	None	Lewis Creek	2,000	2,000
1991	Little Clear	1+	6.5	AD	Boquet River	25,000	24,962
1991	Little Clear	1+	6.5	AD	N. Branch Boquet River	20,000	19,970
1991	Maine	1+	5.1	None	Ausable River	20,011	16,135
1991	Maine	1+	5.5	RV	Saranac River	15,000	14,009
1991	Maine	1+	5.5	None	Saranac River	20,000	18,679
1991	Maine	1+	6.5	LV	Port Kent Ferry	26,500	25,414
1991	Maine	1+	6.5	None	Essex Ferry	22,600	21,673
1992	Maine	1+	6.0	None	Winooski River	30,100	30,100
1992	Maine	1+	6.0	None	Otter Creek	25,018	25,018
1992	Maine	1+	6.0	None	Grand Isle Ferry	5,010	5,010
1992	Little Clear	0+	1.0	None	Boquet River	96,850	4,843
1992	Little Clear	1+	6.7	AD	Boquet River	25,000	25,000
1992	Little Clear	1+	6.7	AD	N. Br. Boquet River	20,000	20,000
1992	Maine	1+	6.4	None	Ausable River	19,990	19,707
1992	Maine	1+	6.4	RV	Saranac River	14,740	14,532
1992	Maine	1+	6.4	None	Saranac River	20,000	19,717
1992	Maine	1+	6.4	LV	Port Kent Ferry	23,690	23,355
1992	Maine	1+	6.4	None	Essex Ferry	24,900	24,548
1992	Maine	1+	6.0	None	Cumberland Bay	30,000	28,020
1992	Maine	0++	3.6	None	Saranac River	61,235	22,822
1993	Maine	1+	6.0	None	Winooski River	53,513	53,513
1993	Maine	1+	6.0	None	Otter Creek	22,801	22,801
1993	Memphremagog	1+	6.0	None	Otter Creek	2,200	2,200
1993	Maine	1+	5.9	None	Kingsland Bay	5,004	5,004
1993	Maine	1+	6.0	None	Grand Isle Ferry	15,000	15,000
1993	Little Clear	1+	6.5	AD	Boquet River	25,000	25,000
1993	Little Clear	1+	6.5	AD	North Branch Boquet River	20,000	20,000
1993	Maine	1+	5.9	None	Ausable River	20,020	19,019
1993	Maine	1+	5.9	RV	Saranac River	13,410	12,740
1993	Maine	1+	5.9	None	Saranac River	13,050	12,398
1993	Maine	1+	5.9	LV	Port Kent Ferry	26,610	25,280

1993	Maine	1+	5.9	None	Cumberland Bay	13,000	12,350
1994	Maine	1+	6.5	None	Vantine Access	5,008	5,008
1994	Maine	1+	5.5	RV	Saranac River	14,120	13,704
1994	L. Champlain	1+	5.1	None	Winooski River	2,300	2,300
1994	Maine	1+	4.6	None	Winooski River	12,800	12,800
1994	Memphremagog	1+	7.3	None	Winooski River	12,130	10,130
1994	Little Clear	0+	1.0	None	Boquet River	210,000	10,500
1994	Little Clear	0+	1.0	None	E. Branch Ausable River	14,000	700
1994	Little Clear	1+	6.3	AD	Boquet River	25,000	24,885

Salmonid Stocking History for Lake Champlain, **Landlocked Atlantic Salmon - 1973 to 1997** (Cont.).

Stocking Year	Egg Source	Age	Average Size (Inches)	Mark	Stocking Location	Number Stocked	Number Equivalent
Yearlings							
1994	Little Clear	1+	6.3	AD	N. Branch Boquet River	20,000	19,908
1994	Maine	1+	5.5	None	Ausable River	11,000	10,677
1994	Maine	1+	7.0	LV	Port Kent Ferry	21,530	21,508
1994	Maine	1+	6.1	None	Otter Creek	19,008	19,008
1994	Maine	1+	6.7	None	Kingsland Bay	5,005	5,005
1995	Memphremagog	1+	7.0	None	Vantine Access	5,000	5,000
1995	Little Clear	0+	1.1	None	Saranac River	30,000	1,500
1995	Maine	1+	6.2	RV	Saranac River	15,500	14,588
1995	Little Clear	0+	1.1	None	Ausable River	20,000	1,000
1995	Maine	1+	5.8	None	Ausable River	3,500	3,122
1995	Little Clear	1+	7.0	None	Ausable River	2,870	2,850
1995	Maine	1+	6.0	LV	Port Kent Ferry	24,800	24,676
1995	Maine	1+	5.9	None	Winooski River	25,532	24,382
1995	Little Clear	0+	1.0	None	Boquet River	200,000	10,000
1995	Little Clear	1+	6.4	AD	Boquet River	27,500	27,107
1995	Little Clear	1+	6.4	AD	No. Branch Boquet R.	17,500	17,250
1995	Maine	1+	6.0	None	Otter Creek	20,008	19,110
1996	Little Clear	1+	4.3	None	Vantine Access	1,305	1,273
1996	Memphremagog	1+	5.5	None	Hatchery Cove	11,016	10,793
1996	Little Clear	0+	1.0	None	Saranac River	95,000	4,750
1996	Maine	1+	6.2	RV	Saranac River	16,850	16,350
1996	Maine	1+	6.2	None	Saranac River	17,400	16,884
1996	Maine	0++	5.0	None	Saranac River	5,000	2,500
1996	Little Clear	0++	5.0	None	Saranac River	9,000	4,500
1996	Little Clear	0+	1.0	None	Ausable River	52,000	2,600
1996	Maine	1+	6.2	None	Ausable River	15,600	15,133
1996	Maine	1+	6.2	LV	Port Kent Ferry	25,350	24,590
1996	Maine	1+	6.3	None	Winooski River (at mouth)	33,821	32,903
1996	Memphremagog	1+	7.1	None	Winooski River (at mouth)	100	100
1996	Little Clear	1+	5.1	None	Winooski River (at dam)	5,010	4,885
1996	Little Clear	0+	1.0	None	Boquet River	189,400	9,470
1996	Little Clear	1+	6.4	AD	Boquet River	25,000	24,975
1996	Little Clear	1+	6.4	AD	No. Branch Boquet R.	20,000	19,980
1996	Little Clear	1+	4.3	None	Kingsland Bay	4,100	3,950
1996	Little Clear	1+	4.3	None	Otter Creek	5,000	4,950
1996	Maine	1+	6.2	None	Otter Creek	22,666	22,502
1997	Memphremagog	1+	6.5	None	Hatchery Cove	28,582	28,553
1997	Little Clear	0+	1.0	None	Saranac River	70,000	3,500
1997	Little Clear	1+	6.3	RV	Saranac River	15,790	15,790
1997	Little Clear	1+	5.5	None	Saranac River	18,000	16,110
1997	Little Clear	0++	3.0	None	Saranac River	15,000	1,364
1997	Little Clear	0++	5.8	None	Saranac River	8,500	4,250
1997	Little Clear	0+	1.0	None	Ausable River	40,000	2,000
1997	Little Clear	1+	5.5	None	Ausable River	16,500	14,768
1997	Little Clear	1+	5.5	LV	Port Kent Ferry	30,870	27,628
1997	Memphremagog	0+	1.2	None	Winooski River	10,000	500
1997	Memphremagog	1+	7.0	None	Winooski River	100	99
1997	Little Clear	1+	4.9	None	Winooski River	13,475	9,985
1997	Maine	1+	5.1	None	Winooski River	14,528	11,114
1997	Little Clear	0+	1.0	None	Boquet River	200,000	10,000
1997	Little Clear	1+	5.8	AD	Boquet River	25,000	24,375

1997	Little Clear	1+	6.7	AD	No. Branch Boquet R.	20,000	19,661
1997	Little Clear	1+	7.0	None	Kingsland Bay	4,007	3,979
1997	Little Clear	1+	5.2	None	Otter Creek	20,038	15,329

Salmonid Stocking History for Lake Champlain, **Landlocked Atlantic Salmon - 1973 to 1997** (Cont.).

Stocking Year	Egg Source	Age	Average Size (Inches)	Mark	Stocking Location	Number Stocked	Number Equivalent
Yearlings							
					Malletts Bay		
1974	Memphremagog	0+	1.0	None	Lamoille River	39,500	1,975
1974	Memphremagog	0++	3.5	None	Lamoille River	10,500	525
1975	Memphremagog	1+	4.0	None	Lamoille River	30,500	12,500
1976	New Hampshire	1+	3.8	RV	Lamoille River	25,000	12,285
1977	Memphremagog	1+	5.6	AD	Malletts Bay	13,300	11,669
1978	Memphremagog	1+	5.0	None	Malletts Bay	26,702	20,027
1978	Memphremagog	1+	3.0	None	Lamoille River	11,440	4,767
1979	New Hampshire	1+	5.0	RV	Lamoille River	11,000	8,250
1979	Memphremagog	1+	4.8	RV-AD	Malletts Bay	12,000	6,000
1980	Memphremagog	1+	5.2	None	Malletts Bay	13,600	9,683
1980	New Hampshire	2+	5.2	RP	Malletts Bay	6,322	4,968
1980	Sea Run	2+	15.	None	Malletts Bay	150	150
1980	Sea Run	- -	24.	None	Malletts Bay	7	7
1981	Little Clear	1+	5.1	None	Malletts Bay	24,000	20,211
1981	Memphremagog	1+	7.0	None	Malletts Bay	6,052	6,052
1982	New Hampshire	1+	5.6	RV	Malletts Bay	30,000	25,965
1983	Maine	1+	4.8	None	Malletts Bay	15,022	11,492
1983	Maine	1+	4.8	LV	Lamoille River	14,500	10,593
1984	New Hampshire	1+	5.0	AD	Lamoille River	10,000	7,500
1984	Maine	0+	1.0	None	Lamoille River	36,000	1,800
1985	Maine	1+	6.1	AD	Below Peterson Dam	10,000	9,500
1986	L. Champlain	1+	6.0	AD	Lamoille River	1,800	1,701
1987	New Hampshire	1+	5.3	AD	Lamoille River	10,000	9,750
1988	Maine	1+	6.2	None	Lamoille River	10,000	9,523
1989	Memphremagog	1+	6.0	None	Lamoille River	11,000	11,000 *
1990	L. Champlain	1+	6.0	AD	Lamoille River	2,350	2,350
1990	Maine	1+	6.0	AD	Lamoille River	7,399	7,362
1991	New Hampshire	1+	7.0	AD	Lamoille River	9,760	9,760
1991	Memphremagog	1+	7.0	AD	Lamoille River	5,800	5,800
1991	L. Champlain	1+	7.0	AD	Lamoille River	4,500	4,500
1992	Memphremagog	1+	7.0	None	Lamoille River	12,100	12,100
1993	Maine	1+	5.7	None	Lamoille River	14,024	14,024
1994	Memphremagog	1+	7.3	None	Lamoille River	8,020	8,020
1995	Memphremagog	1+	6.6	None	Lamoille River	15,005	14,330
1996	Memphremagog	1+	5.2	None	Lamoille River	20,000	19,500
1997	Little Clear & Maine	1+	5.0	None	Lamoille River	6,825	5,317
					Inland Sea:		
1978	Memphremagog	0+	2.0	None	Inland Sea	35,000	1,750

1979	Memphremagog	0+	4.5	None	Inland Sea	25,000	1,250
1980	Memphremagog	1+	7.0	None	Inland Sea	5,000	3,560
1980	Memphremagog	1+	5.0	None	Missisquoi River	5,000	3,560

Salmonid Stocking History for Lake Champlain, **Landlocked Atlantic Salmon - 1973 to 1997** (Cont.).

Stocking Year	Egg Source	Age	Average Size (Inches)	Mark	Stocking Location	Number Stocked	Number Equivalent
Yearlings							
1981	Little Clear	1+	5.1	None	Inland Sea	24,377	16,679
1981	Maine	1+	5.1	None	Inland Sea	8,640	7,276
1981	Memphremagog	1+	7.0	None	Inland Sea	5,067	5,067
1982	Maine	1+	5.2	None	Inland Sea	60,894	46,736
1983	New Hampshire	1+	5.4	RV-AD	Inland Sea	28,700	27,481
1983	Maine	1+	4.8	LV-AD	Inland Sea	27,968	21,397
1984	New Hampshire	1+	6.1	None	Inland Sea	27,203	25,843
1985	New Hampshire	1+	6.1	None	Kile Kare	15,000	14,700
1985	New Hampshire	1+	6.0	None	Grand Isle St. Pk.	10,000	9,425
1985	New Hampshire	1+	5.9	None	Tabor’s Point	10,000	9,450
1985	New Hampshire	1+	6.0	None	Sandbar	10,000	9,725
1985	New Hampshire	1+	6.5	None	VanEverest	5,000	4,975
1986	Champlain	1+	5.8	AD	Kile Kare	9,354	8,889
1986	Maine	1+	5.9	None	Grand Isle	7,218	7,074
1986	Maine	1+	5.8	None	Tabors	7,208	6,884
1986	Maine	1+	6.0	None	Appletree	7,215	7,071
1986	Maine	1+	6.1	None	Knights	7,006	6,971
1986	Maine	1+	6.0	None	Steven’s Point	7,020	6,880
1986	Maine	1+	6.0	None	Kile Kare	6,808	6,604
1986	Maine	1+	6.2	None	VanEverest	7,204	7,060
1987	Maine	1+	6.0	None	Inland Sea	50,041	42,888
1988	Maine & New Hampshire	1+	6.1	None	Inland Sea	52,278	50,099
1989	Maine	1+	5.0-6.0	None	Inland Sea	24,068	22,420
1989	New Hampshire	1+	6.0	None	Inland Sea	14,497	13,504
1989	Memphremagog	1+	5.0	None	Inland Sea	10,250	9,548
1990	Maine	1+	5.9	None	Inland Sea	18,012	17,877
1990	Maine	1+	5.8	None	Inland Sea	18,634	18,507
1990	Memphremagog	1+	5.9	None	Inland Sea	8,650	8,564
1991	Maine	1+	6.0	None	Inland Sea	30,029	29,829
1991	Memphremagog	1+	7.0	None	Inland Sea	16,000	16,000
1992	Memphremagog	1+	7.0	None	Inland Sea	18,200	18,200
1992	Maine	1+	5.6-6.0	None	Inland Sea	40,035	40,035
1993	Maine	1+	6.0	None	Inland Sea	52,689	52,689
1994	Maine	1+	6.3	None	Appletree	8,002	8,002
1994	Maine	1+	6.1	None	Grand Isle Park	8,011	8,011
1994	Maine	1+	6.7	None	Kill Kare	6,004	6,004
1994	Memphremagog	1+	7.0	None	Kill Kare	2,000	2,000
1994	Maine	1+	6.1	None	Steven’s Point	8,009	8,009
1994	Memphremagog	1+	7.8	None	Van Everest	7,180	7,180
1995	Memphremagog	1+	5.8	None	Appletree	2,000	1,620
1995	Memphremagog	1+	7.0	None	Sandbar	11,138	10,638
1995	Memphremagog	1+	6.9	None	Grand Isle Park	10,004	9,550
1995	Memphremagog	1+	6.6	None	Kill Kare	10,000	9,550
1995	Memphremagog	1+	7.5	None	Van Everest	10,080	10,080

1995	Memphremagog	1+	6.1	None	Steven’s Point	10,008	9,758
1996	Little Clear	1+	4.7	None	Appletree	19,070	18,543
1996	Maine	1+	6.2	None	Grand Isle Park	9,052	9,007
1996	Memphremagog	1+	5.9	None	Grand Isle Park	5,000	4,975
1996	Memphremagog	1+	5.2	None	Kill Kare	5,000	4,875
1996	Maine	1+	6.0	None	Kill Kare	6,402	6,242
1996	Memphremagog	1+	5.4	None	Van Everest	9,470	9,233
1996	Maine	1+	6.2	None	Steven’s Point	9,069	8,979
1997	Memphremagog	1+	6.6	None	Appletree	10,010	9,960
1997	Maine	1+	5.3	None	Kill Kare	10,011	7,658
1997	Maine	1+	5.1	None	Van Everest	19,082	14,598
1997	Maine	1+	5.2	None	Steven’s Point	10,005	7,654

* Exact length data unavailable. 1:1 Conversion rate assumed.

Salmonid Stocking History for Lake Champlain, **Brown Trout - 1973 to 1997**.

Stocking Year	Egg Source	Age	Average Size (Inches)	Mark	Stocking Location	Number Stocked	Number Equivalent
Yearlings							
					Main Lake		
1977	Domestic	0++	5.0	None	Burlington Harbor	12,000	2,400
1978	Randolph	1+	6.9	AD	Cumberland Bay	5,000	5,000
1979	Domestic	1+	6.0	RV	Burlington Harbor	15,000	15,000
1979	Domestic	2+	10.	RV	Burlington Harbor	15,000	15,000
1979	Domestic	1+	7.5	LV	Cumberland Bay	10,000	10,000
1979	Domestic	1+	6.2	LV-AD	Cumberland Bay	4,978	4,978
1979	Bennington	1+	9.0	None	Burlington Harbor	25,000	25,000
1980	Catskill	1+	8.2	LP	Cumberland Bay	16,180	16,180
1980	Rome Lab	1+	6.6	RP	Westport	5,000	5,000
1981	Domestic	1+	8.0	None	Burlington Harbor	15,852	15,852
1981	Catskill	1+	7.4	AD	Cumberland Bay	20,000	20,000
1981	Domestic	0++	8.0	None	Burlington to Button Bay	17,000	3,400
1982	Randolph	1+	7.9	LP	Westport, Essex	10,000	10,000
1982	Domestic	1+	8.0	None	Burlington Harbor	4,500	4,500
1982	Randolph	1+	8.0	LP	Cumberland Bay	10,200	10,200
1982	Crawford	1+	6.8	None	Cumberland Bay	10,400	10,400
1983	Domestic	1+	9.0	None	Burlington to Button Bay	9,500	9,500
1983	Domestic	1+	8.9	None	Cumberland Bay	20,000	20,000
1983	Domestic	1+	8.0	None	Westport	8,000	8,000
1983	Rome Lab	0++	4.0	None	Westport	9,000	1,800
1983	Randolph	0++	6.2	None	Willsboro Bay	21,700	4,340
1983	Domestic	1++	9.0	None	Burlington, Kingsland Bay	6,000	6,000
1983	Randolph	0++	7.3	None	Willsboro Bay	16,500	3,300
1983	Catskill	0++	6.9	None	Willsboro	70,000	14,000
1984	Randolph	1+	10.	None	Cumberland Bay	20,000	20,000
1984	Domestic	1+	8.0	None	Burlington, Kingsland Bay	8,000	8,000
1984	Rome Lab	1+	6.5	None	Essex, Port Henry	6,980	6,980
1985	Rome Lab	0+	5.0	None	Westport	5,481	1,098
1985	Rome Lab	1+	8.8	None	Plattsburgh	20,000	20,000
1985	Domestic	1+	6.0	None	Winooski River	3,000	3,000
1985	Domestic	1+	9.0	None	Lewis Creek	900	900
1985	Domestic	1+	12.	None	Kingsland Bay	200	200
1986	Bennington	1+	7.0	None	Kingsland Bay	30,000	30,000
1986	Rome	1+	8.0	None	Kingsland Bay	11,000	11,000
1986	Rome	1+	8.0	None	Button Bay	4,000	4,000
1986	Rome	1+	8.0	None	Burlington, Potash	5,000	5,000
1986	Bennington	1+	8.0	None	Burlington Harbor	10,000	10,000
1986	Domestic	1+	9.3	None	Plattsburgh	20,000	20,000
1987	Bennington	1+	7.0	None	Kingsland Bay	5,000	5,000
1987	Bennington	1+	7.0	None	Burlington Harbor	5,000	5,000
1987	Bennington	1+	8.5	None	Plattsburgh	16,600	16,600
1988	Rome	1+	8.0	None	Plattsburgh	20,000	20,000
1988	Raymond X Crystal	1+	7.0	None	Burlington Harbor	10,000	10,000
1988	Rome	1+	7.0	None	Kingsland Bay	5,000	5,000
1989	Randolph	1+	11.0	None	Plattsburgh	20,000	20,000
1990	Randolph	1+	10.	None	Plattsburgh	20,000	20,000
1991	Randolph	1+	9.5	None	Plattsburgh	13,035	13,035
1991	Randolph	1+	10.	None	Plattsburgh	7,000	7,000
1991	Rome	1+	7.0-8.0	None	Button Bay - Kingsland Bay	11,375	11,375
1991	Rome	1+	8.0	None	Burlington	5,000	5,000
1992	Rome Lab	1+	9.5	None	Plattsburgh	20,000	20,000
1992	Rome	1+	8.0	None	Button Bay- Kingsland Bay	12,000	12,000
1992	Rome	1+	8.0	None	Burlington	6,000	6,000
1993	Seeforellen	1+	6.9	AD	Plattsburgh	10,000	10,000
1993	Rome Lab	1+	9.0	None	Plattsburgh	5,000	5,000
1993	Rome Lab	1+	8.5	None	Plattsburgh	5,000	5,000
1993	Rome	1+	7.3	None	Button Bay - Kingsland Bay	10,000	10,000
1993	Rome	1+	8.8	None	Burlington Harbor	5,000	5,000
1993	Rome	1+	9.0	None	Grand Isle Hatchery Discharge	5,000	5,000

Salmonid Stocking History for Lake Champlain, **Brown Trout - 1973 to 1997** (continued).

Stocking Year	Egg Source	Age	Average Size (Inches)	Mark	Stocking Location	Number Stocked	Number Equivalent
Yearlings							
1994	Rome Lab	1+	9.5	None	Plattsburgh	20,000	20,000
1994	Rome	1+	8.2	None	Grand Isle Hatchery Discharge	3,500	3,500
1994	Rome	1+	6.0	None	Burlington Harbor	5,000	5,000
1994	Rome	1+	6.0	None	Button Bay - Kingsland Bay	10,000	10,000
1995	Rome Lab	1+	9.0	None	Plattsburgh	10,000	10,000
1995	Rome Lab	1+	11.0	None	Plattsburgh	4,700	4,700
1995	Rome Lab	1+	9.5	None	Plattsburgh	3,000	3,000
1995	Rome	1+	8.9	None	Vantine Access	3,100	3,100
1995	Rome	1+	8.5	None	Burlington Harbor	3,000	3,000
1995	Rome	1+	8.9	None	Kingsland Bay	5,000	5,000
1995	Rome	1+	8.9	None	Button Bay	5,000	5,000
1996	Rome	1+	7.2	None	Hatchery Cove	4,000	4,000
1996	Rome Lab	1+	9.3	None	Plattsburgh	17,490	17,490
1996	Rome	1+	8.8	None	Burlington Harbor	5,000	5,000
1996	Rome	1+	8.8	None	Kingsland Bay	5,000	5,000
1996	Rome	1+	9.0	None	Button Bay	5,000	5,000
1997	Rome	1+	8.5	None	Grand Isle Ferry	4,000	4,000
1997	Rome Lab	1+	8.5	None	Plattsburgh	19,000	19,000
1997	Rome	1+	6.3	None	Kingsland Bay	4,000	4,000
1997	Rome	1+	6.3	None	Button Bay	3,400	3,400
					Malletts Bay		
1984	Domestic	1+	9.0	AD	Lamoille River	10,000	10,000
1985	Domestic	1+	6.0	None	Lamoille River	2,000	2,000
1985	Domestic	1+	11.3	AD	Malletts Bay	7,242	7,242
1985	Domestic	1+	11.0	None	Malletts Bay	2,772	2,772
1986	Bennington	1+	8.0	AD	Lamoille River	10,000	10,000
1987	Bennington	1+	7.0	None	Lamoille River	10,000	10,000
1988	Raymond X Crystal	1+	7.0	None	Lamoille River	10,000	10,000
1991	Rome	1+	7.0	None	Lamoille River	5,000	5,000
1992	Rome	1+	8.0	None	Lamoille River	6,000	6,000
1993	Rome	1+	8.4	None	Lamoille River	5,000	5,000
1994	Seeforellen	1+	6.0	None	Lamoille River	3,900	3,900
1995	Rome	1+	8.1	None	Lamoille River	1,100	1,100
1995	Rome	1+	8.9	None	Lamoille River	5,115	5,115
1996	Rome	1+	7.2	None	Lamoille River	5,000	5,000
					Inland Sea		
1980	Bennington	1+	10.	None	St. Albans Point	2,000	2,000
1981	Domestic	0++	8.0	None	Grand Isle, St. Albans Pt.	6,500	1,300
1982	Domestic	1+	8.0	None	St. Albans Point	4,250	4,250
1983	Domestic	1+	9.0	None	St. Albans Point to Sandbar	16,000	16,000
1984	Domestic	1+	12.0	None	St. Albans Point	3,500	3,500
1984	Domestic	1+	8.0	None	Grand Isle, Sandbar	8,000	8,000
1985	Domestic	1+	9.0	None	Kill Kare	7,000	7,000
1985	Domestic	1+	8.0	None	Sandbar	3,000	3,000
1985	Domestic	1+	12	None	Missisquoi River	1,700	1,700

1986	Rome	1+	7.0	None	Sandbar	10,000	10,000
1986	Bennington	1+	8.0	None	St. Albans	5,000	5,000
1986	Bennington	1+	8.0	None	Kill Kare	10,000	10,000

Salmonid Stocking History for Lake Champlain, **Brown Trout - 1973 to 1997** (continued).

Stocking Year	Egg Source	Age	Average Size (Inches)	Mark	Stocking Location	Number Stocked	Number Equivalent
Yearlings							
1987	Bennington	1+	7.0	None	Inland Sea	10,000	10,000
1988	Rome	1+	7.5	None	Inland Sea	17,000	17,000
1991	Rome	1+	8.0	None	Sandbar	4,300	4,300
1992	Rome	1+	8.0	None	Sandbar	10,800	10,800
1993	Rome	1+	9.5	None	Sandbar	5,000	5,000
1994	Rome	1+	8.1	None	Kill Kare	4,020	4,020
1994	Rome	1+	8.1	None	Sandbar	2,580	2,580
1995	Rome	1+	8.9	None	North Hero Bridge	2,000	2,000
1995	Rome	1+	8.9	None	Kill Kare	2,000	2,000
1995	Rome	1+	8.9	None	Sandbar	3,410	3,140
1996	Rome	1+	7.2	None	North Hero Bridge	2,000	2,000
1996	Rome	1+	7.3	None	Kill Kare	2,000	2,000
1996	Rome	1+	7.8	None	Appletree Cove	2,000	2,000
1997	Rome	1+	6.2	None	Kill Kare	4,100	4,100
1997	Rome	1+	8.5	None	Appletree Cove	5,700	15,700

Salmonid Stocking History for Lake Champlain, **Steelhead Trout - 1972-1997**.

Yearlings

Main Lake

Stocking Year	Egg Source	Age	Average Size (Inches)	Mark	Stocking Location	Number Stocked	Number Equivalent
1972	Washington	0++	2.3	LV	Ausable River	11,000	3,667
1972	Washington	0++	2.3	None	Ausable River	25,000	8,333
1974	Washington	1+	5.3	RP	Salmon River	14,850	12,252
1974	Michigan	1+	3.1	LP	Salmon River	13,845	6,922
1974	Michigan	2+	8.0	RV	Winooski River	6,000	6,000
1974	Michigan	2+	10.	LV	Winooski River	4,000	4,000
1974	Michigan	0+	1.0	None	Lewis Creek	5,000	250
1975	Washington	1+	5.0	AD	Salmon River	27,649	21,290
1975	Michigan	2+	10.	None	Winooski River	8,000	8,000
1975	Oregon	0+	1.5	None	Winooski River	10,000	500
1975	Oregon	0+	1.5	None	Winooski River	70,000	3,500
1975	Oregon	0+	1.5	None	Lewis Creek	20,000	1,000
1975	Oregon	0+	1.5	None	Winooski River	50,000	2,500
1976	Washington	1+	4.7	LV	Salmon River	13,100	9,105
1976	Washington	1+	4.7	None	Saranac River	9,983	6,932
1976	Michigan	1+	4.2	LV (8%)	Winooski River	37,000	23,495
1976	Oregon	1+	5.3	LP(20%)	Winooski River	20,400	11,254
1976	Michigan	2+	4.6	RV(45%)	Winooski River	11,000	11,000
1976	Oregon	0+	1.6	None	Lewis Creek	25,000	1,250
1976	Oregon	0+	1.6	None	Winooski River	20,000	1,000
1977	Washington	1+	5.0	RV	Saranac River	6,369	4,968
1977	Oregon	1+	6.1	LP(17%)	Winooski River	61,400	59,098
1977	Washington	0+	- -	None	Lewis Creek	15,500	775
1978	Washington	1+	6.4	AD	Saranac River	12,300	11,808
1978	Washington	1+	6.0	AD	Winooski River	38,122	38,122
1978	Washington	0+	1.0	None	Lewis Creek	15,050	752
1979	Washington	1+	6.0	RV	Lewis Creek	2,340	2,340
1979	Washington	0+	1.0	None	Winnoski River	20,000	1,000
1979	Washington	0+	1.0	None	Winooski River	20,000	1,000
1979	Washington	0+	1.0	None	Winooski River	20,000	1,000
1979	Washington	0+	4.0	AD	Winooski River	47,450	2,372
1980	Washington	1+	5.9	LV	Saranac River	15,000	14,400
1980	Washington	1+	5.9	LV-AD	Saranac River	15,000	14,400
1980	Washington	0+	1.5	None	Lewis Creek	40,000	2,000
1980	Washington	0+	1.5	None	LaPlatte River	25,000	1,250
1980	Washington	0+	4.5	None	Winooski River	22,000	1,100
1981	Washington	1+	6.1	RV	Saranac River	30,000	29,250
1981	Washington	1+	6.1	RV-AD	Saranac River	15,000	14,625
1981	Washington	1+	6.1	None	Boquet River	14,960	14,586
1981	Washington	0+	1.0	None	Otter Creek	32,000	1,600
1981	Washington	0+	1.0	None	Lewis Creek	36,864	1,843
1981	Washington	1+	6.0	None	Lewis Creek	21,745	21,745
1981	Washington	1+	6.0	None	LaPlatte River	11,560	11,560
1982	Cayuga L./ Nashua	1+	5.3	LV	Saranac River	7,500	6,187
1982	Cayuga L./ Nashua	1+	5.3	LV-AD	Saranac River	2,500	2,063
1982	Cauuga L.	1+	3.8	None	Saranac River	10,000	9,500
1982	Washington	1+	6.0	None	Lewis Creek	17,903	17,903
1982	Memphremagog	1+	6.0	RV	Lewis Creek	2,100	2,100
1982	Washington	1+	6.0	None	LaPlatte River	3,000	3,000
1982	Washington	1+	6.0	None	Potash Brook	2,000	2,000

1982	Washington	1+	6.5	None	Winooski River	9,805	9,805
1983	Michigan	1+	4.0	None	Lewis Creek	13,900	5,792
1983	Michigan	1+	6.0	None	Lewis Creek	5,000	5,000
1983	Michigan	1+	5.0	None	Winooski River	26,300	19,725
1984	Lake Ontario (Wash.)	1+	5.2	None	Saranac River	17,470	15,111
1984	FL/Nashua	1+	6.9	RV	Saranac River	12,000	11,760
1984	FL/Nashua	1+	6.9	RV	Ausable River	7,000	6,860
1984	Finger Lakes	1+	4.6	AD	Ausable River	5,000	3,125
1984	Michigan	1+	3.0	None	Lewis Creek	15,000	5,000
1984	Michigan	1+	2.0	None	Winooski River	18,000	6,000
1985	Memphremagog	1+	3.0	None	Winooski River	19,000	9,500

Salmonid Stocking History for Lake Champlain, **Steelhead Trout - 1972-1997** (continued).

Stocking Year	Egg Source	Age	Average Size (Inches)	Mark	Stocking Location	Number Stocked	Number Equivalent
Yearlings							
1985	Lake Ontario (Wash.)	1+	9.0	None	Winooski River	200	200
1985	Lake Ontario (Wash.)	1+	5.4	None	Boquet River	20,000	16,900
1985	Lake Ontario (Wash.)	1+	5.4	None	Saranac River	30,000	25,350
1985	Lake Ontario	1+	5.4	None	Ausable River	15,000	12,675
1985	Finger Lakes X Domestic	0++	3.3	None	Ausable River	12,626	4,293
1985	Finger Lakes	0++	2.5	None	Ausable River	39,146	13,049
1986	Lake Ontario	0+	1.0	None	Ausable River	181,000	9,050
1986	Lake Ontario	1+	5.8	None	Ausable River	25,000	23,750
1986	Lake Ontario	1+	5.8	None	Saranac River	40,000	38,000
1987	Memphremagog	1+	9.0	None	Lewis Creek	14,800	14,800
1987	Lake Ontario	1+	5.4	None	Ausable River	16,500	13,860
1987	Lake Ontario	1+	5.4	None	Salmon River	5,500	4,620
1987	Lake Ontario	1+	5.2	None	Saranac River	25,000	20,375
1987	Lake Ontario	1+	5.6	None	Saranac River	24,500	21,683
1988	Memphremagog	1+	6.0	None	Lewis Creek	13,000	13,000[1]
1988	Memphremagog	1+	6.0	None	Winooski River	11,056	11,056[1]
1988	lake Ontario	1+	5.4	None	Ausable River	27,500	23,788
1988	Lake Ontario	1+	5.4	None	Salmon River	5,000	4,325
1988	Lake Ontario	1+	5.4	None	Saranac River	57,500	49,738
1989	Memphremagog	1+	6.0	None	Lewis Creek	8,000	8,000[1]
1989	Memphremagog	1+	6.0	None	Winooski River	5,000	5,000[1]
1989	Finger LakesHybrid	1+	7.4	None	Saranac River	10,000	9,950
1990	Memphremagog	1+	4.9	None	Lewis Creek	11,372	8,168
1990	Memphremagog	1+	4.9	None	Winooski River	7,000	6,930
1990	Finger Lake Wild	1+	4.5	None	Ausable River	15,000	9,375
1990	Finger Lake Hybrid	1+	7.0	None	Salmon River	6,000	5,970
1990	Finger Lake Wild	1+	4.5	None	Saranac River	45,000	28,125
1991	Memphremagog	1+	4.0	None	Lewis Creek	7,600	3,935
1991	Finger Lake Wild	1+	4.0	None	Ausable River	14,300	8,938
1991	Lake Ontario	0+	2.0	None	Ausable River	25,000	8,333
1991	Finger Lake Hybrid	1+	7.0	None	Salmon River	5,000	4,975
1991	Finger Lake Wild	1+	4.0	None	Saranac River	42,700	16,688
1991	Finger Lakes	1+	7.0	None	Saranac River	5,400	5,373
1992	Memphremagog	1+	5.0-7.0	None	Lewis Creek	32,693	32,693
1992	Memphremagog	2+[2]	18-30	Ad-Floy	Winooski River	1,538	1,538
1992	Lake Ontario	1+	6.3	None	Ausable River	15,000	14,863
1992	Lake Ontario	1+	6.3	None	Salmon River	5,000	4,954
1992	Lake Ontario	1+	6.3	None	Saranac River	45,000	44,591
1993	Lake Ontario	1+	7.0	None	Ausable River	14,700	14,700
1993	Lake Ontario	1+	7.0	None	Salmon River	4,900	4,900
1993	Lake Ontario	1+	70	None	Saranac River	44,100	44,100
1993	Memphremagog	1+	7.7	None	Otter Creek	3,000	3,000
1993	Memphremagog	1+	9.0	None	Lewis Creek	15,000	15,000
1993	Memphremagog	1+	9.0	None	LaPlatte River	5,000	5,000

1993	Memphremagog	1+	9.0	None	Winooski River	32,850	32,850
1993	Memphremagog	1+	9.0	None	Grand Isle Hatchery Discharge	5,000	5,000
1994	Lake Ontario	1+	6.0	None	Saranac River	40,500	37,397
1994	Lake Ontario	1+	6.0	None	Salmon River	4,500	4,155
1994	Memphremagog	1+	9.2	None	Valntine Access	5,000	5,000
1994	Lake Ontario	1+	6.0	None	Ausable River	13,500	12,465
1994	Memphremagog	1+	9.2	None	LaPlatte River	5,020	5,020
1994	Memphremagog	1+	8.9	None	Winooski River	25,940	25,940
1994	Memphremagog	1+	9.2	None	Little Otter Creek	3,010	3,010
1994	Memphremagog	1+	10.4	None	Lewis Creek	8,900	8,900
1994	Memphremagog	1+	9.2	None	Lewis Creek	6,300	6,300
1995	Lake Ontario	1+	6.0	None	Saranac River	30,600	28,669
1995	Lake Ontario	1+	6.0	None	Salmon River	3,400	3,186
1995	Memphremagog	1+	8.5	None	Vantine Access	2,000	2,000
1995	Lake Ontraio	1+	6.0	None	Ausable River	7,000	6,559
1995	Memphremagog	1+	8.4	None	Winooski River	25,385	25,385
1995	Memphremagog	1+	8.5	None	LaPlatte River	2,000	2,000
1995	Memphremagog	1+	9.0	None	Lewis Creek	13,120	13,120

Salmonid Stocking History for Lake Champlain, **Steelhead Trout - 1972-1997** (continued).

Stocking Year	Egg Source	Age	Average Size (Inches)	Mark	Stocking Location	Number Stocked	Number Equivalent
Yearlings							
1995	Memphremagog	1+	9.0	None	Little Otter Creek	2,000	2,000
1996	Memphremagog	1+	7.7	None	Hatchery Cove	4,002	4,002
1996	Skamania	1+	5.9	None	SaranacRiver	15,000	13,950
1996	Skamania	1+	5.9	None	Salmon River	1,000	930
1996	Skamania	1+	5.9	None	Ausable River	4,000	3,720
1996	Memphremagog	1+	8.8	None	Winooski River	4,832	4,832
1996	Memphremagog	1+	7.7	None	Winooski River	6,032	6,032
1996	Memphremagog	1+	8.9	AD	LaPlatte River	1,000	1,000
1996	Memphremagog	1+	8.9	None	Lewis Creek	6,050	6,050
1996	Memphremagog	1+	9.1	AD	Little Otter Creek	1,000	1,000
1997	Memphremagog	1+	9.3	None	Hatchery Cove	1,616	1,616
1997	Memphremagog	1	7.9	None	Hatchery Cove	3,385	3,385
1997	Wytheville[3]	1+	9.9	None	Hatchery Cove	270	270
1997	Skamania	1+	5.6	None	Saranac River	15,000	13,040
1997	Skamania	1+	5.6	None	Salmon River	1,000	870
1997	Skamania	1+	5.6	None	Ausable River	4,000	3,478
1997	Memphremagog	1+	7.9	None	Winooski River	22,080	22,080
1997	Memphremagog	1+	9.5	None	Winooski River	4,620	4,620
1997	Memphremagog	1+	9.5	None	LaPlatte River	2,000	2,000
1997	Memphremagog	1+	9.3	None	Lewis Creek	21,640	21,640
					Malletts Bay		
1984	Michigan	1+	4.0	AD	LaMoille River	11,440	4,760
1985	Memphremagog	1+	4.0	AD	LaMoille River	10,000	7,500
1986	Memphremagog	1+	5.5	AD	LaMoille River	2,400	2,400
1986	Lake Ontario	1+	6.0	None	LaMoille River	3,051	3,051
1987	Lake Ontario	1+	7.9	AD	LaMoille River	10,500	10,500
1988	Memphremagog	1+	6.0	None	LaMoille River	11,220	11,220[1]
1990	Memphremagog	1+	5.1	None	LaMoille River	5,000	4,950
1993	Memphremagog	1+	8.8	None	LaMoille River	5,000	5,000
1994	Memphremagog	1+	9.0	None	LaMoille River	8,118	8,118
1995	Memphremagog	1+	8.5	None	LaMoille River	9,520	9,520
1996	Memphremagog	1	7.7	None	LaMoille River	5,000	5,000
1997	Memphremagog	1+	9.4	None	LaMoille River	3,375	3,375
					Inland Sea		
1982	Washington	1+	6.0	None	Mill River	2,000	2,000
1982	Washington	1+	6.0	None	Stone Bridge Brook	2,000	2,000
1983	Michigan	1+	5.0	None	Mill River	3,700	2,775
1984	Michigan	1+	2.0	None	Mill River	3,000	1,000
1985	Memphremagog	1+	5.0	AD	Mill River	3,000	2,250
1985	Lake Ontario	1+	9.0	None	Stone Bridge Brook	600	600
1987	Memphremagog	1+	9.0	None	Mill River	2,000	2,000

1993	Memphremagog	1+	7.7+	None	Mill River	2,000	2,000
1994	Memphremagog	1+	10.4	None	Mill River	2,070	2,070
1995	Memphremagog	1+	9.0	None	Mill River	2,000	2,000
1996	Memphremagog	1+	7.7	None	Mill River	1,000	1,000
1997	Memphremagog	1+	9.4	None	Mill River	5,030	5,030
1997	Memphremagog	1+	9.3	None	Van Everest	1,700	1,700
					South Lake		
1977	Washinhton	1+	4.7	RV	Ticonderoga Creek	6,369	4,204
1978	Washimgton	1+	6.4	AD	Ticonderoga Creek	12,300	11,808
1980	Washington	1+	5.9	LV	Putnam Creek	10,000	9,600
1981	Washington	1+	6.1	RV	Putnam Creek	3,440	3,440
1985	Rainey B.	1+	4.2	None	Rainey Brook	1,720	860

[1] Exact length data unavailable; 1:1 conversion rate assumed

[2] Mainly 2 year old steelhead averaging 18.0 inches. Also a few older surplus broodstock up to 30.0 inches were stocked.

[3] Surplus stocking of domestic rainbow trout, leftover after annual sportmens show. These are not added in to the annual steelhead totals.

APPENDIX H

Standard Criteria for Classifying Sea Lamprey Marks on Lake Champlain Salmonids

APPENDIX H

Standard Criteria for Classifying Lamprey Marks on Lake Champlain Salmonids

Stages of healing based upon criteria developed by the U.S. Fish and Wildlife Service personnel at the Hammond Bay Biological Station (King and Edsall 1979). Attack terminology after Gersmehl and Chiotti (1983).

Type "A" Attack

Stages of Healing	Classification of Mark	Definition
I	Fresh Wound	A mark where the integument has been perforated; musculature visible; the wound site has a pit or depression, and is rough to touch.
II	Healing Wound	A mark still in early stages of healing which has been glazed over with transparent tissue and is smooth to the touch.
III	Healing Wound	A mark in later stages of healing in which repigmentation is beginning but the underlying musculature is still visible.
IV	Scar	A mark in final stages of healing with the musculature no longer visible; repigmentation is almost complete. In the most advanced phase, regenerated scales having a distorted pattern, cover the affected area.

Type "B" Attack

Stages of Healing	Classification of Mark	Definition
I	Hit	A mark where the integument is abraided but not perforated; scales missing, wound site rough to the touch.
II	Hit	Similar to Stage I, but the wound is smooth

APPENDIX I

Salmonid Wounding Summary, 1982 - 1997

Appendix I

Lake Trout, Landlocked Atlantic Salmon, Brown Trout and Rainbow Trout Sea Lamprey Wounding Rates from 1982 - 1997

Glossary for sea lamprey wounding tables:

Zone:	Location where sample occurred
Size Class:	Size increments of fish in millimeters (represents 4 inch intervals)
No. Fish:	Number of fish in a size class or zone
No. Fish w/FW:	Number of fish with fresh wounds
No. Fish w/HW:	Number of fish with healing wounds
No. Fish w/W:	Number of fish with fresh wounds and healing wounds
No. Fish w/Scars:	Number of fish with scars
No. Fish w/Attacks:	Number of fish with fresh wounds, healing wounds and scars
No. Fish w/Hits:	Number of fish with hits
Wounds/100 Fish:	Number of fresh wounds and healing wounds per 100 fish
Attacks/100 Fish:	Number of fresh wounds, healing wounds, and scars per 100 fish
% Fish w/W:	Number of fish with fresh wounds and healing wounds expressed as a percent
% Fish w/Attacks:	Number of fish with fresh wounds, healing wounds, and scars expressed as a percent

Lake Trout

Summer Gillnetting

1982

New York

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	16	2	2	4	0	4	0	25	25	25	25
432-533	4	0	2	2	0	2	0	50	50	50	50
534-634	7	2	5	5	4	7	1	171	286	71	100
635-735	2	0	2	2	2	2	1	200	550	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	29	4	11	13	6	15	2	76	128	45	52

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	25	0	1	1	0	1	1	4	4	4	4
432-533	11	7	1	8	5	8	0	91	145	73	73
534-634	30	12	8	16	16	26	4	73	180	53	87
635-735	18	7	5	10	18	18	2	100	522	56	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	84	26	15	35	39	53	7	61	196	42	63

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	14	1	0	1	0	1	0	7	7	7	7
432-533	15	3	3	6	7	9	1	40	87	40	60
534-634	41	15	15	24	24	34	2	83	180	59	83
635-735	30	6	10	13	24	26	4	70	297	43	87
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	100	25	28	44	55	70	7	62	177	44	70

Vermont

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	55	7	3	8	0	8	0	20	20	15	15
432-533	28	6	1	7	13	17	2	25	75	25	61
534-634	53	8	12	19	38	46	5	40	157	36	87
635-735	25	3	11	14	24	25	3	64	300	56	100
736-836	1	1	0	1	1	1	0	200	400	100	100
Total	162	25	27	49	76	97	10	35	120	30	60

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	13	1	0	1	0	1	0	8	8	8	8
432-533	16	4	3	5	6	10	0	44	81	31	63
534-634	44	15	7	21	34	37	2	52	186	48	84
635-735	12	4	1	5	12	12	1	42	300	42	100
736-836	2	0	0	0	2	2	0	0	550	0	100
Total	87	24	11	22	44	62	3	41	164	25	71

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	1	0	1	0	1	0	100	100	100	100
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	1	0	1	0	1	0	50	50	50	50

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	12	2	0	2	0	2	0	17	17	17	17
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	12	2	0	2	0	2	0	17	17	17	17

1983

New York

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	92	20	13	26	8	28	1	50	60	28	30
432-533	19	3	6	9	5	10	5	53	95	47	53
534-634	23	5	14	16	18	21	6	91	257	70	91
635-735	17	1	12	12	15	17	6	82	294	71	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	151	29	45	63	46	76	18	60	121	42	50

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	38	2	2	4	0	4	0	13	13	11	11
432-533	29	2	5	7	4	7	3	31	72	24	24
534-634	38	6	13	16	25	31	8	58	166	42	82
635-735	53	12	31	37	46	53	18	117	404	70	100
736-836	1	0	1	1	1	1	0	100	700	100	100
Total	159	22	52	65	76	96	29	62	195	41	60

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	44	8	4	10	2	12	1	30	34	23	27
432-533	19	3	3	6	2	8	0	32	42	32	42
534-634	46	13	9	20	28	38	3	54	159	44	83
635-735	45	8	14	22	35	41	4	62	207	49	91
736-836	1	0	0	0	1	1	0	0	300	0	100
Total	155	32	30	58	68	100	8	46	124	37	65

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	109	14	7	21	3	24	3	22	25	19	22
432-533	33	9	1	9	5	12	2	42	64	27	36
534-634	30	8	9	16	16	23	5	57	140	53	77
635-735	36	8	14	21	27	33	4	67	239	58	92
736-836	3	1	1	2	3	3	0	67	333	67	100

Total	211	40	32	69	54	95	14	38	88	33	45

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	3	1	0	1	0	1	0	33	33	33	33
432-533	1	1	0	1	0	1	1	100	100	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	4	2	0	2	0	2	1	50	50	50	50

1984

New York

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	76	6	11	16	10	22	3	30	47	21	29
432-533	30	2	5	7	15	18	3	27	87	23	60
534-634	21	4	7	9	16	19	6	62	186	43	90
635-735	32	3	14	17	30	31	11	72	416	53	97
736-836	1	0	0	0	1	1	1	0	400	0	100
Total	160	15	37	49	72	91	24	42	149	31	57

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	56	2	6	8	8	14	2	14	32	14	25
432-533	47	8	7	15	16	27	7	44	83	32	57
534-634	44	6	15	18	35	43	9	57	211	41	98
635-735	48	5	22	24	43	46	12	73	356	50	96
736-836	6	2	4	5	6	6	2	133	583	83	100
>836	1	0	1	1	1	1	0	300	600	100	100
Total	202	23	55	71	109	137	32	49	178	35	68

Vermont

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	12	2	2	2	0	2	0	67	67	17	17
432-533	0	0	0	0	0	0	0	0	0	0	0

534-634	1	1	0	1	0	1	0	100	100	100	100
635-735	1	0	1	1	0	1	0	100	100	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	14	3	3	4	0	4	0	71	71	29	29

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	4	1	3	3	0	3	0	175	175	75	75
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	1	0	1	1	0	1	1	100	100	100	100
635-735	1	0	1	1	1	1	0	300	400	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	7	1	5	5	1	5	1	143	157	71	71

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	99	12	15	23	2	25	1	29	31	23	25
432-533	59	10	10	19	12	29	1	36	58	32	49
534-634	69	11	20	26	41	50	5	46	145	38	72
635-735	97	8	38	42	76	83	8	58	228	43	86
736-836	8	0	2	2	6	7	0	38	238	25	88
Total	332	41	85	112	137	194	15	42	122	34	58

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	250	18	23	38	18	53	3	19	30	15	21
432-533	130	13	6	18	29	42	2	15	46	14	32
534-634	72	13	17	27	41	53	2	44	140	38	74
635-735	87	6	32	36	74	75	5	55	243	41	86
736-836	6	1	4	4	6	6	1	100	533	67	100
Total	545	51	82	123	168	229	13	28	88	23	42

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	4	0	0	0	0	0	0	0	0	0	0

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	11	0	0	0	0	0	0	0	0	0	0
432-533	3	0	0	0	0	0	0	0	0	0	0
534-634	1	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	15	0	0	0	0	0	0	0	0	0	0

1985

New York

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	56	5	3	7	0	7	4	27	27	13	13
432-533	10	3	1	3	4	5	3	40	80	30	50
534-634	9	1	5	5	6	8	2	78	178	56	89
635-735	10	4	8	9	9	10	1	200	500	90	100
736-836	1	0	1	1	1	1	1	200	600	100	100
Total	86	13	18	25	20	31	11	56	110	29	36

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	32	2	1	3	2	5	0	19	28	9	16
432-533	19	3	1	4	10	11	4	26	105	21	58
534-634	27	3	6	8	22	24	3	48	252	30	89
635-735	30	6	11	13	29	30	8	70	493	43	100
736-836	4	1	3	4	4	4	3	100	525	100	100
>836	0	0	0	0	0	0	0	0	0	0	0
Total	112	15	22	32	67	74	18	44	238	29	66

Vermont

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	6	0	1	1	0	1	0	17	17	17	17

432-533	4	1	1	2	2	2	0	50	100	50	50
534-634	5	0	1	1	3	4	0	40	100	20	80
635-735	3	2	2	3	3	3	0	133	400	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	15	3	5	7	8	10	0	60	147	47	67

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	5	1	2	2	0	2	0	60	60	40	40
534-634	3	0	1	1	1	2	0	33	66	33	67
635-735	3	0	2	2	2	2	0	133	267	67	67
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	12	1	5	5	3	6	0	67	108	42	50

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	26	9	7	14	0	14	0	81	81	54	54
432-533	25	7	3	9	9	15	0	40	92	36	60
534-634	58	10	14	23	30	42	3	43	117	40	72
635-735	35	6	14	17	30	30	5	74	234	49	86
736-836	3	0	1	1	3	3	0	67	267	33	100
Total	147	32	39	64	72	104	8	57	137	44	71

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	75	18	13	25	3	26	0	49	53	33	35
432-533	46	13	5	16	20	27	3	39	100	35	59
534-634	51	13	20	28	36	46	4	80	190	55	90
635-735	20	5	12	14	15	17	1	115	310	70	85
736-836	5	3	2	3	5	5	0	120	440	60	100
Total	197	52	52	86	79	121	8	63	136	44	61

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	4	1	1	1	0	1	0	50	50	25	25
432-533	0	0	0	1	0	0	0	0	0	0	0
534-634	5	0	3	3	3	4	1	67	133	60	80
635-735	1	0	1	1	1	1	0	100	200	100	100

736-836	0	0	0	0	0	0	0	0	0	0	0
Total	10	1	5	5	4	6	1	70	110	50	60

1986

New York

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	73	11	4	13	3	14	2	26	30	18	19
432-533	14	4	4	6	8	9	1	71	150	43	64
534-634	15	6	2	7	13	13	3	53	260	47	87
635-735	7	3	4	5	7	7	1	100	443	71	100
736-836	1	0	1	1	1	1	0	100	800	100	100
Total	110	24	15	32	32	44	7	41	110	29	40

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	60	7	3	9	9	18	2	22	38	15	30
432-533	21	6	4	8	6	10	6	52	90	38	48
534-634	37	9	6	15	30	31	11	43	251	41	84
635-735	27	8	10	14	27	27	6	89	504	52	100
736-836	5	1	4	4	5	5	3	140	1040	80	100
Total	150	31	27	50	77	91	28	47	215	33	61

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	25	4	8	11	5	14	0	60	80	44	56
432-533	41	10	10	17	17	29	2	54	98	42	71
534-634	35	6	16	21	20	31	3	80	163	60	89
635-735	13	4	10	10	12	12	0	131	292	77	92
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	114	24	44	59	54	86	5	72	136	52	75

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	59	10	7	16	7	20	2	29	44	27	34
432-533	62	10	13	21	29	41	1	42	103	34	66
534-634	30	6	12	15	23	27	2	70	183	50	90
635-735	23	3	14	14	21	22	3	96	357	61	96
736-836	3	0	1	1	3	3	1	33	567	33	100
Total	177	29	47	67	83	113	9	49	138	38	64

1987

New York

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	87	8	1	9	2	10	4	10	13	10	12
432-533	22	6	0	6	6	11	5	27	73	27	50
534-634	13	1	1	2	10	10	4	15	185	15	77
635-735	11	0	1	1	9	10	5	9	182	9	91
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	133	15	3	18	27	41	16	14	53	14	31

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	36	5	2	7	4	9	2	25	39	19	25
432-533	21	4	1	5	12	14	4	29	129	24	67
534-634	26	5	2	7	16	18	2	27	158	27	69
635-735	18	1	6	7	17	17	6	61	467	39	94
736-836	2	0	0	0	2	2	1	0	400	0	100
Total	103	15	11	26	35	60	15	32	169	25	58

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	37	5	1	6	8	14	2	16	41	16	38
432-533	61	20	4	24	27	41	4	43	113	39	67
534-634	50	13	12	22	41	45	13	60	224	44	90
635-735	48	8	22	26	43	46	11	83	363	54	96
736-836	1	0	1	1	4	1	1	100	500	100	100
Total	197	46	40	79	123	147	31	52	190	40	75

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	61	14	3	17	13	26	4	33	56	28	43
432-533	82	19	8	24	34	49	8	35	106	29	60
534-634	45	9	10	17	33	38	9	49	207	38	84
635-735	30	3	17	19	29	30	7	123	433	63	100
736-836	5	1	4	4	5	5	1	100	580	80	100
Total	223	46	42	81	114	148	29	51	167	36	66

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	8	2	2	3	0	3	0	50	50	38	38
432-533	4	1	1	2	0	2	0	50	50	50	50
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	12	3	3	5	0	5	0	50	50	42	42

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	14	4	3	6	0	6	0	57	57	43	43
432-533	3	1	0	1	0	1	1	33	33	33	33
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	17	5	3	7	0	7	1	53	53	41	41

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	0	0	0	0	0	0	0

1988

New York

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	66	2	7	9	3	11	2	18	24	14	17
432-533	47	8	8	15	20	31	5	36	94	32	66
534-634	35	6	8	13	27	30	8	40	203	37	86
635-735	7	1	1	2	7	7	2	29	371	29	100
736-836	1	0	0	0	1	1	0	0	800	0	100
Total	156	17	24	39	58	80	17	29	106	25	51

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	30	0	2	2	5	6	2	7	23	7	20
432-533	50	0	6	6	20	22	9	12	84	12	44
534-634	38	1	11	12	31	35	6	39	245	32	92
635-735	38	0	22	22	38	38	9	87	511	58	100
736-836	9	0	4	4	9	9	4	56	889	44	100
Total	245	1	45	46	103	110	30	25	170	19	45

Vermont

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	5	0	1	1	1	1	0	20	60	20	20
432-533	4	0	1	1	2	3	0	25	125	25	75
534-634	10	2	5	7	7	9	0	80	240	70	90
635-735	2	0	2	2	2	2	1	300	700	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	21	2	9	11	12	15	1	76	219	52	71

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	32	4	3	7	7	12	2	22	44	22	38
432-533	81	19	11	28	40	51	3	42	126	35	63
534-634	76	16	13	26	57	64	4	43	201	34	84
635-735	40	4	15	15	38	38	6	55	308	38	95
736-836	6	0	4	4	6	6	0	183	650	67	100
Total	235	43	46	80	148	171	154	46	183	34	73

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	32	5	4	8	2	9	0	31	38	25	28
432-533	65	10	13	22	26	40	1	35	94	34	62
534-634	61	8	21	26	46	52	4	54	118	43	85
635-735	43	6	28	30	41	42	2	109	351	70	98
736-836	6	1	5	5	6	6	1	166	567	83	100
Total	207	30	71	91	121	149	8	59	182	44	72

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	3	2	1	2	0	2	0	100	100	67	67
432-533	4	0	0	0	2	2	0	0	50	0	50
534-634	1	0	0	0	1	1	0	0	100	0	100
635-735	2	0	0	0	2	2	1	0	200	0	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	10	2	1	2	5	7	1	30	90	20	70

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	5	1	0	1	0	1	1	20	20	20	20
432-533	8	2	0	2	4	5	1	25	75	25	63
534-634	1	1	0	1	0	1	0	100	100	100	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	14	4	0	4	4	7	2	29	57	29	50

1989

New York

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	130	3	11	13	11	20	7	14	23	10	15
432-533	23	0	8	8	10	13	1	48	148	35	57
534-634	29	2	9	11	25	26	7	41	290	38	90
635-735	11	0	4	4	11	11	5	45	745	36	100

736-836	3	0	1	1	3	3	1	33	800	33	100
Total	196	5	33	37	60	73	21	24	130	19	37

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	38	1	2	3	5	7	2	16	32	8	18
432-533	31	4	6	9	12	15	4	39	123	29	48
534-634	48	5	14	19	41	43	10	48	258	40	90
635-735	45	2	12	14	44	44	17	51	502	31	98
736-836	6	0	3	3	6	6	5	83	817	50	100
Total	168	12	37	48	108	115	38	41	267	29	68

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	24	1	2	3	1	3	0	13	17	13	13
432-533	34	10	3	13	9	16	0	38	82	38	47
534-634	83	14	23	35	63	71	6	49	222	42	86
635-735	41	3	11	13	40	40	7	44	344	32	98
736-836	5	0	2	2	5	5	0	60	420	40	100
Total	187	28	41	66	118	135	13	42	202	35	72

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	18	2	0	2	0	2	0	28	28	11	11
432-533	31	6	0	6	11	16	1	23	71	19	52
534-634	51	5	21	24	31	44	8	67	198	47	86
635-735	37	6	17	22	35	35	5	95	432	59	95
736-836	5	0	4	4	4	5	1	140	540	80	100
Total	142	19	42	58	81	102	15	62	222	41	72

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	3	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	0	0	0	0	0	0	0
534-634	1	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0

736-836	0	0	0	0	0	0	0	0	0	0	0
Total	6	0	0	0	0	0	0	0	0	0	0

1990

New York

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	56	9	3	11	1	11	3	29	32	20	20
432-533	36	13	4	16	17	24	5	61	122	44	67
534-634	39	10	9	18	31	35	6	62	262	46	90
635-735	33	6	15	18	31	33	5	79	352	55	100
736-836	2	0	1	1	2	2	1	50	550	50	100
Total	166	38	32	64	82	105	20	54	175	39	63

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	38	3	1	4	1	4	0	11	13	11	11
432-533	26	3	4	7	13	16	3	27	115	27	62
534-634	85	22	30	46	67	78	17	76	244	54	92
635-735	57	13	25	32	54	56	17	79	400	56	98
736-836	7	3	5	7	7	7	2	143	514	100	100
Total	213	44	65	96	142	161	39	62	238	45	76

Vermont

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	10	0	0	0	0	0	0	0	0	0	0
432-533	4	0	1	1	1	2	1	25	50	25	50
534-634	8	0	4	4	6	7	1	50	200	50	88
635-735	2	0	2	2	2	2	1	200	450	100	100
736-836	2	0	1	1	2	2	0	50	700	50	100
Total	26	0	8	8	11	13	3	38	158	31	50

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	9	0	0	0	1	1	0	0	11	0	11
432-533	7	0	0	0	3	3	0	0	71	0	43

534-634	24	2	6	7	18	20	1	42	242	29	83
635-735	20	3	10	12	18	19	2	90	345	60	95
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	60	5	16	19	40	43	3	47	222	32	72

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	26	3	4	6	5	10	0	35	58	23	39
432-533	47	12	6	14	26	34	1	43	140	30	72
534-634	128	29	44	65	109	117	7	65	263	51	91
635-735	85	16	34	41	78	81	10	80	371	48	95
736-836	2	0	2	2	2	2	0	300	1100	100	100
Total	288	60	90	128	220	244	18	65	262	44	85

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	53	7	1	7	2	9	0	15	19	13	17
432-533	75	12	14	22	29	42	4	36	97	29	56
534-634	138	22	60	75	114	123	17	77	249	54	89
635-735	94	11	49	52	92	93	20	84	396	55	99
736-836	7	2	5	6	7	7	1	129	657	86	100
Total	367	54	129	162	244	274	42	62	241	44	75

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	21	2	1	2	3	5	1	14	38	10	24
432-533	20	3	4	5	10	14	3	45	135	25	70
534-634	19	3	12	14	16	19	1	105	305	74	100
635-735	12	4	7	8	10	11	1	108	408	67	92
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	72	12	24	29	39	49	6	63	197	40	68

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	7	0	1	1	0	1	0	14	14	14	14
432-533	5	1	1	2	5	5	0	40	240	40	100
534-634	3	1	2	3	2	3	1	100	300	100	100

635-735	3	0	2	2	3	3	1	100	400	67	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	18	2	6	8	10	12	2	50	189	44	67

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	8	1	2	3	0	3	1	38	38	38	38
432-533	1	1	0	1	1	1	0	100	300	100	100
534-634	2	2	0	2	2	2	0	100	250	100	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	11	4	2	6	3	6	1	55	100	55	55

1991

New York

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	22	1	0	1	1	2	0	5	9	5	9
432-533	15	3	3	6	5	9	5	47	87	40	60
534-634	30	8	7	12	20	24	15	57	167	40	80
635-735	18	5	5	8	15	16	12	67	233	44	89
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	85	17	15	27	41	51	32	44	126	32	60

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	9	2	0	2	0	2	0	22	22	22	22
432-533	8	0	1	1	2	3	3	13	50	13	38
534-634	32	7	15	18	30	31	11	78	250	56	97
635-735	50	10	20	28	38	47	19	78	276	56	94
736-836	4	1	3	3	3	4	3	100	214	75	100
Total	106	20	39	52	73	87	36	70	225	49	82

Vermont

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	17	0	2	2	2	3	0	12	29	12	18
432-533	3	1	1	1	2	3	0	67	133	33	100
534-634	22	4	3	7	14	15	2	50	195	32	68
635-735	15	6	6	10	12	14	0	120	340	67	93
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	57	11	12	20	30	35	2	58	181	35	61

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	5	0	1	1	4	2	0	20	100	20	40
432-533	4	0	1	1	2	2	0	25	100	25	50
534-634	10	4	3	5	9	9	1	70	270	50	90
635-735	20	5	7	10	17	18	2	70	335	50	90
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	39	9	12	17	32	31	3	59	264	44	80

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	15	1	1	2	1	3	1	13	20	13	20
432-533	12	1	1	2	5	7	2	17	92	17	58
534-634	77	9	28	35	54	63	24	61	192	46	82
635-735	83	14	44	51	66	77	36	106	299	61	93
736-836	3	2	1	2	3	3	1	200	700	67	100
Total	190	27	75	92	129	153	64	76	227	48	81

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	25	3	1	4	2	6	1	28	36	16	24
432-533	24	5	0	5	9	12	4	25	75	21	50
534-634	70	17	25	39	49	62	30	67	181	56	89
635-735	65	19	18	33	53	58	26	78	246	51	89
736-836	9	3	6	8	9	9	3	200	567	89	100
Total	193	47	50	89	122	147	64	67	189	46	76

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	13	0	0	0	0	0	4	0	0	0	0
432-533	3	1	1	2	1	2	1	67	100	67	67

534-634	8	1	4	4	5	6	5	63	200	50	75
635-735	6	2	2	3	6	6	3	67	317	50	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	30	4	7	9	12	14	13	37	127	30	47

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	10	1	0	1	0	1	2	10	10	10	10
432-533	6	2	1	3	2	5	2	50	83	50	83
534-634	4	2	2	3	3	4	3	100	200	75	100
635-735	4	2	2	3	2	3	4	100	150	75	75
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	24	7	5	10	7	13	11	50	83	42	54

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	11	4	0	4	0	4	1	36	36	36	36
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	2	0	1	1	1	2	2	50	100	50	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	13	4	1	5	1	6	3	38	46	39	46

1992

New York

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	52	1	2	2	4	5	2	6	17	4	10
432-533	36	4	1	5	14	16	2	14	72	14	44
534-634	38	1	4	5	32	35	5	13	226	13	92
635-735	67	4	16	18	66	66	7	43	427	27	99
736-836	6	0	3	3	6	6	1	50	500	50	100

>836	1	0	1	1	1	1	1	100	600	100	100
Total	200	10	27	34	123	129	18	23	222	17	65

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	50	1	2	3	3	6	0	6	22	6	12
432-533	39	2	0	2	14	15	2	5	6	5	39
534-634	40	7	7	14	38	38	3	38	308	35	95
635-735	123	6	30	35	121	123	14	33	520	29	100
736-836	18	1	7	8	18	18	2	67	978	44	100
Total	270	17	46	62	194	200	21	27	360	23	74

Vermont

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	19	0	3	3	0	3	1	16	16	16	16
432-533	20	0	2	2	4	6	4	15	35	10	30
534-634	24	0	6	6	11	14	17	33	96	25	58
635-735	30	0	5	5	20	21	26	37	143	17	70
736-836	1	0	1	1	1	1	1	300	500	100	100
Total	94	0	17	17	36	45	49	30	86	18	48

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	3	0	0	0	0	0	1	0	0	0	0
432-533	8	0	0	0	2	2	3	0	25	0	25
534-634	25	0	3	3	18	15	9	12	84	12	60
635-735	35	1	4	5	27	27	21	17	143	14	77
736-836	1	0	1	1	1	1	0	100	300	100	100
Total	72	1	8	9	48	45	34	14	106	13	63

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	27	2	1	3	4	6	1	11	33	11	22
432-533	25	0	1	1	8	8	4	4	44	4	32
534-634	61	3	5	8	37	39	19	15	133	13	64
635-735	105	5	25	30	89	90	39	33	248	29	86
736-836	8	0	2	2	5	6	4	25	275	25	75

Total	226	10	34	44	143	149	67	22	169	20	66

Zone 3B		No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	Wounds/	Attacks/	% Fish	% Fish w/
Size Class	No. Fish	w/FW	w/HW	w/W	w/Scars	w/Attacks	w/Hits	100 Fish	100 Fish	w/W	Attacks
0-431	28	2	0	2	3	4	0	7	18	7	14
432-533	44	0	1	1	13	13	3	2	41	2	30
534-634	47	2	9	10	30	33	7	26	138	21	70
635-735	99	3	23	24	86	89	34	29	263	24	90
736-836	5	0	1	1	4	4	2	20	180	20	80
Total	223	7	34	38	136	143	46	20	160	17	64

Zone 3C		No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	Wounds/	Attacks/	% Fish	% Fish w/
Size Class	No. Fish	w/FW	w/HW	w/W	w/Scars	w/Attacks	w/Hits	100 Fish	100 Fish	w/W	Attacks
0-431	8	0	1	1	2	2	0	25	88	13	25
432-533	5	1	2	3	1	3	0	60	80	60	60
534-634	6	2	0	2	6	6	0	33	283	33	100
635-735	4	0	0	0	4	4	1	0	150	0	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	23	3	3	6	13	15	1	30	148	26	65

Zone 4A		No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	Wounds/	Attacks/	% Fish	% Fish w/
Size Class	No. Fish	w/FW	w/HW	w/W	w/Scars	w/Attacks	w/Hits	100 Fish	100 Fish	w/W	Attacks
0-431	6	1	0	1	0	1	0	17	17	17	17
432-533	4	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	1	0	0	0	1	1	0	0	100	0	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	11	1	0	1	1	2	0	9	18	9	18

Zone 4B		No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	Wounds/	Attacks/	% Fish	% Fish w/
Size Class	No. Fish	w/FW	w/HW	w/W	w/Scars	w/Attacks	w/Hits	100 Fish	100 Fish	w/W	Attacks
0-431	4	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	4	0	0	0	0	0	0	0	0	0	0

1993

New York

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	100	3	0	3	1	4	0	3	6	3	4
432-533	18	0	2	2	6	8	0	11	61	11	44
534-634	29	5	6	10	19	22	1	55	217	34	76
635-735	37	5	17	18	36	37	3	97	546	49	100
736-836	3	0	2	2	3	3	1	100	600	67	100
Total	187	13	27	35	65	74	5	32	160	19	40

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	71	2	5	7	2	8	2	11	16	10	11
432-533	43	2	5	6	13	18	3	16	58	14	42
534-634	35	5	6	9	24	28	4	31	149	26	80
635-735	94	11	46	52	86	92	17	81	387	55	98
736-836	8	0	5	5	8	8	2	63	588	63	100
Total	251	20	67	79	133	154	28	43	199	31	61

Vermont

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	12	0	2	0	2	2	2	0	0	0	17
432-533	9	0	3	1	2	2	3	11	11	11	22
534-634	9	0	4	2	2	2	4	89	133	22	22
635-735	26	6	13	11	10	10	13	92	196	42	38
736-836	1	0	0	0	0	0	0	0	0	0	0
Total	57	6	22	14	16	16	22	58	112	25	28

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	4	0	0	0	0	0	0	0	0	0	0
432-533	6	0	0	0	1	1	0	0	67	0	17
534-634	5	0	2	2	4	5	0	40	140	40	100
635-735	33	0	18	18	23	28	6	79	197	55	85

736-836	1	0	1	1	1	1	0	100	300	100	100
Total	49	0	21	21	29	35	6	59	161	43	71

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	25	0	1	1	0	1	1	4	4	4	4
432-533	48	2	4	5	11	14	4	13	38	10	29
534-634	46	0	13	13	26	32	7	35	126	28	70
635-735	159	8	61	67	118	130	18	54	203	42	82
736-836	5	0	3	3	4	5	1	100	300	60	100
Total	283	10	82	89	159	182	31	40	147	61	64

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	111	3	4	7	3	9	2	6	9	6	8
432-533	55	3	3	6	16	21	7	11	45	11	38
534-634	65	1	12	13	35	38	8	25	108	20	58
635-735	142	7	44	47	116	121	21	47	251	33	85
736-836	11	1	6	6	10	11	2	82	418	55	100
Total	384	15	69	79	180	200	40	27	132	21	52

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	21	0	0	0	1	1	0	0	5	0	5
432-533	23	0	0	0	7	7	0	0	35	0	30
534-634	15	3	4	6	8	11	0	60	120	40	73
635-735	12	2	4	4	11	11	5	92	317	33	92
736-836	3	0	1	1	3	3	1	33	300	33	100
Total	74	5	9	11	30	33	6	28	100	15	45

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	10	1	0	1	0	1	1	10	10	10	10
432-533	10	0	0	0	1	1	1	0	20	0	10
534-634	7	0	3	3	3	6	1	57	143	43	86
635-735	4	0	3	3	2	3	0	125	350	75	75

736-836	0	0	0	0	0	0	0	0	0	0	0
Total	31	1	6	7	6	11	3	32	87	23	35

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	0	0	0	0	0	0	0	0	0	0
432-533	6	0	0	0	1	1	0	0	17	0	17
534-634	1	0	0	0	1	1	0	0	200	0	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	9	0	0	0	2	2	0	0	33	0	22

1994

New York

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	119	1	4	5	1	6	1	6	7	4	5
432-533	43	4	5	8	9	16	3	23	49	19	37
534-634	39	5	12	16	13	24	2	46	103	41	62
635-735	23	3	11	14	22	23	4	83	378	61	100
736-836	6	1	3	4	6	6	0	67	450	67	100
Total	230	14	35	47	51	75	10	25	80	20	33

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	77	0	0	0	3	3	0	0	4	0	4
432-533	68	5	3	8	17	21	3	12	44	12	31
534-634	75	10	18	27	56	60	12	47	185	36	80
635-735	80	7	34	40	78	79	12	69	491	50	99
736-836	19	2	10	11	19	19	4	111	647	58	100
Total	319	24	65	86	173	182	31	37	216	27	57

Vermont

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	19	1	0	1	0	1	0	5	5	5	5
432-533	5	1	0	1	3	3	0	20	100	20	60

534-634	5	0	0	0	1	1	0	0	20	0	20
635-735	13	0	0	2	9	9	1	15	154	15	69
736-836	1	0	0	0	1	1	1	0	100	0	100
Total	43	2	0	4	14	15	2	9	65	9	35

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	7	0	0	0	0	0	0	0	0	0	0
432-533	3	0	0	0	1	1	0	0	33	0	33
534-634	8	1	1	2	3	4	1	25	150	25	50
635-735	20	0	4	4	13	15	4	20	125	20	75
736-836	2	0	0	0	2	2	1	0	250	0	100
Total	40	1	5	6	19	22	6	15	108	15	55

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	53	2	1	3	2	5	2	8	13	6	9
432-533	48	1	1	2	10	10	2	4	35	4	21
534-634	62	7	17	23	28	35	10	47	124	37	57
635-735	107	6	32	35	91	95	19	57	267	33	89
736-836	11	0	4	4	9	9	4	36	345	36	82
Total	281	16	55	67	140	154	37	36	151	24	55

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	95	2	5	6	6	10	3	7	16	6	11
432-533	120	6	11	17	24	38	9	17	47	14	32
534-634	97	8	18	26	48	58	12	31	118	27	60
635-735	109	6	45	46	90	92	21	64	279	42	84
736-836	17	1	10	11	17	17	6	118	482	65	100
Total	438	23	89	106	185	215	51	34	130	24	49

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	24	1	1	2	0	2	1	13	13	8	8
432-533	23	3	5	8	2	10	2	39	52	35	44
534-634	16	1	5	6	9	12	1	56	175	38	75

635-735	13	2	6	7	11	13	3	115	362	54	100
736-836	1	0	0	0	1	1	0	0	500	0	100
Total	77	7	17	23	23	38	7	47	123	30	49

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	13	2	0	2	0	2	1	15	15	15	15
432-533	8	2	1	2	0	2	0	38	38	25	25
534-634	8	0	2	2	5	5	1	25	163	25	63
635-735	5	0	2	2	3	4	1	60	160	40	80
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	34	4	5	8	8	13	3	29	76	24	38

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	7	1	0	1	0	1	0	14	14	14	14
432-533	4	0	0	0	0	0	0	0	0	0	0
534-634	4	1	1	2	2	2	1	50	100	50	50
635-735	1	0	1	1	1	1	1	100	400	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	16	2	2	4	3	4	2	25	56	25	25

1995

New York

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	127	2	2	4	2	6	0	3	6	3	5
432-533	52	5	2	7	13	18	3	13	42	14	35
534-634	73	8	12	19	47	56	3	30	151	26	77
635-735	53	3	20	23	51	51	4	55	383	43	96
736-836	3	1	1	2	3	3	0	66	700	67	100
Total	308	19	37	55	116	134	10	21	118	18	44

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	58	0	2	2	1	3	0	3	5	3	5
432-533	48	4	8	11	9	17	0	25	50	23	35
534-634	92	13	25	36	60	71	3	49	166	39	77
635-735	79	10	32	37	72	75	12	75	377	47	95
736-836	10	2	4	6	10	10	2	100	730	60	100
Total	287	29	71	92	152	176	17	45	192	32	61

Vermont

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	14	0	1	1	0	1	0	7	7	7	7
432-533	7	0	1	1	0	1	0	29	29	14	14
534-634	16	0	5	5	5	10	0	31	69	31	63
635-735	10	0	5	5	7	9	0	100	190	50	90
736-836	2	0	1	1	2	2	0	100	400	50	100
Total	49	0	13	13	14	23	0	41	84	27	47

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	5	0	0	0	0	0	0	0	0	0	0
432-533	4	0	0	0	0	0	0	0	0	0	0
534-634	10	0	1	1	4	5	0	40	120	10	50
635-735	14	1	5	6	9	13	0	71	200	43	93
736-836	3	0	0	0	3	3	1	0	433	0	100
Total	36	1	6	7	16	21	1	39	147	19	58

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	15	1	0	1	1	2	0	7	13	7	13
432-533	44	2	3	5	8	12	4	14	39	11	27
534-634	73	5	10	14	29	39	7	26	93	19	53
635-735	78	8	25	33	57	66	8	50	203	42	85
736-836	12	0	5	5	9	12	2	42	283	42	100
Total	222	16	43	58	104	131	21	32	126	26	59

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks

0-431	51	1	1	2	1	2	1	4	6	4	4
432-533	68	0	7	7	12	15	2	12	32	10	22
534-634	131	7	15	22	70	81	15	18	104	17	62
635-735	78	2	20	22	60	67	11	40	240	28	86
736-836	13	0	3	3	8	10	2	31	192	23	77
Total	341	10	46	56	151	175	31	20	109	16	51

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	22	0	0	0	1	1	1	0	5	0	5
432-533	13	0	1	1	3	3	1	8	54	8	23
534-634	12	0	1	1	6	7	2	17	100	8	58
635-735	6	0	0	0	5	5	1	0	200	0	83
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	53	0	2	2	15	16	5	6	58	4	30

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	9	0	0	0	0	0	0	0	0	0	0
432-533	5	0	0	0	2	2	0	0	40	0	40
534-634	9	0	3	3	3	5	1	44	89	33	56
635-735	3	0	1	1	2	2	0	33	167	33	67
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	26	0	4	4	7	9	1	19	58	15	35

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	10	1	0	1	0	1	0	10	10	10	10
432-533	5	1	0	1	0	1	0	40	40	20	20
534-634	8	0	0	0	4	4	0	0	75	0	50
635-735	3	0	0	0	1	1	1	0	133	0	33
736-836	1	0	0	0	0	0	0	0	0	0	0
Total	27	2	0	2	5	7	1	11	48	7	26

1996

New York

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	158	11	1	12	3	14	0	9	11	8	9
432-533	122	17	15	30	21	47	3	30	50	25	39
534-634	178	20	43	58	99	123	22	43	147	33	69
635-735	111	10	43	48	94	103	14	73	319	43	93
736-836	13	0	5	5	12	13	3	69	569	39	100
Total	582	58	107	153	229	300	42	37	132	26	52

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	99	1	3	4	5	9	4	4	9	4	9
432-533	142	10	7	15	13	24	6	14	28	11	17
534-634	194	29	48	64	100	125	32	50	141	33	64
635-735	164	20	71	79	135	151	18	73	283	48	92
736-836	25	3	16	16	24	25	2	108	676	64	100
Total	624	63	145	178	277	334	62	43	153	29	54

Vermont

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	18	0	1	1	2	3	0	6	25	6	17
432-533	25	1	1	2	7	9	1	8	40	8	36
534-634	19	0	1	1	11	11	2	5	126	5	58
635-735	10	0	2	2	10	10	1	20	270	20	100
736-836	6	0	2	5	0	5	2	33	450	83	83
Total	78	1	7	11	30	38	6	10	118	14	49

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	12	0	0	0	1	1	0	0	8	0	8
432-533	9	0	2	2	1	2	0	22	33	22	22
534-634	37	1	6	7	17	21	3	22	100	19	57
635-735	32	3	2	5	20	23	3	25	153	16	72
736-836	6	0	2	2	5	6	0	50	233	33	100
Total	96	4	12	16	44	53	6	22	108	17	55

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	40	0	0	0	1	1	2	0	3	0	3
432-533	52	1	6	6	18	20	0	14	52	12	39
534-634	136	4	19	23	65	77	9	18	94	17	57
635-735	142	11	23	34	105	115	9	31	207	24	81
736-836	21	2	3	5	19	19	0	24	348	24	91
Total	391	18	51	68	208	232	20	21	134	17	59

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	127	5	1	6	3	9	1	5	7	5	7
432-533	83	4	2	6	18	22	0	7	37	7	27
534-634	145	9	15	22	80	90	16	17	106	15	62
635-735	177	4	37	41	140	147	17	32	210	23	83
736-836	22	0	4	27	20	21	4	27	305	123	96
Total	554	22	59	102	261	289	38	18	114	18	52

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	27	1	1	2	1	3	0	7	15	7	11
432-533	14	1	0	1	1	1	1	7	14	7	7
534-634	23	3	2	5	14	16	3	30	113	22	70
635-735	35	4	6	10	32	34	3	31	240	29	97
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	99	9	9	18	48	54	7	21	117	18	55

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	12	0	0	0	0	0	0	0	0	0	0
432-533	7	0	0	0	0	0	1	0	0	0	0
534-634	11	4	1	5	2	8	2	45	118	46	73
635-735	10	0	4	4	10	10	0	60	390	40	100
736-836	1	0	0	0	1	1	0	0	100	0	100
Total	41	4	5	9	13	19	3	27	129	22	46

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	12	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	1	1	0	0	50	0	50
534-634	3	0	0	0	1	1	0	0	33	0	33
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	17	0	0	0	2	2	0	0	12	0	12

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	1	0	1	1	1	0	100	200	100	100
635-735	1	0	0	0	1	1	0	0	100	0	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	1	0	1	2	2	0	50	150	50	100

1997

New York

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	91	8	2	9	1	10	2	11	12	10	11
432-533	63	12	11	21	13	29	5	38	64	33	46
534-634	80	13	27	36	35	54	6	65	134	45	68
635-735	74	5	41	44	59	70	14	84	264	59	95
736-836	12	1	4	4	12	12	3	75	450	33	100
Total	320	39	85	114	120	175	30	49	127	36	55

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	69	3	2	5	1	6	2	7	9	7	9
432-533	64	5	8	13	15	23	4	20	48	20	36
534-634	102	11	40	48	65	84	12	61	168	47	82
635-735	119	17	60	68	97	109	17	91	293	57	92
736-836	20	1	12	12	19	19	6	105	500	60	95
Total	374	37	122	146	197	241	41	56	176	39	64

Vermont

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	9	0	0	0	0	0	0	0	0	0	0
432-533	4	1	0	1	1	1	1	25	50	25	25
534-634	11	0	2	2	7	8	0	55	155	18	73
635-735	14	1	6	6	11	11	1	71	236	43	79
736-836	4	2	2	3	4	4	1	125	450	75	100
Total	42	4	10	12	23	24	3	52	167	29	57

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	8	1	0	1	1	2	0	13	25	13	25
432-533	5	0	5	5	2	5	0	100	140	100	100
534-634	13	1	6	7	9	10	0	69	208	54	77
635-735	16	3	12	12	12	15	4	169	375	75	94
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	42	5	23	25	24	32	4	100	229	60	76

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	32	0	1	1	1	2	2	3	6	3	6
432-533	25	0	2	2	5	6	3	8	32	8	24
534-634	50	0	19	19	22	35	2	62	128	38	70
635-735	73	7	36	40	55	68	9	82	244	55	93
736-836	11	2	5	7	10	10	0	91	318	64	91
Total	191	9	63	69	93	121	16	54	150	36	63

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	84	1	3	4	2	6	5	5	7	5	7
432-533	89	1	7	8	20	25	2	9	37	9	28
534-634	91	6	22	25	44	55	5	44	120	27	60
635-735	118	7	61	64	82	104	13	90	213	54	88
736-836	11	1	9	9	10	11	0	145	364	82	100

Total	393	16	102	110	158	201	25	44	112	28	51

Zone 3C		No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	Wounds/	Attacks/	% Fish	% Fish w/
Size Class	No. Fish	w/FW	w/HW	w/W	w/Scars	w/Attacks	w/Hits	100 Fish	100 Fish	w/W	Attacks
0-431	21	2	2	3	0	3	0	24	24	14	14
432-533	18	1	1	2	4	6	1	11	33	11	33
534-634	23	2	3	4	10	13	2	22	74	17	57
635-735	21	3	9	11	20	21	1	71	271	52	100
736-836	3	0	0	0	3	3	0	0	233	0	100
Total	86	8	15	20	37	46	4	31	107	23	53

Zone 4A		No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	Wounds/	Attacks/	% Fish	% Fish w/
Size Class	No. Fish	w/FW	w/HW	w/W	w/Scars	w/Attacks	w/Hits	100 Fish	100 Fish	w/W	Attacks
0-431	25	0	0	0	1	1	1	0	8	4	0
432-533	18	0	3	3	6	7	1	17	56	17	39
534-634	17	2	3	4	9	11	0	29	88	24	65
635-735	17	1	6	7	12	13	0	41	159	41	76
736-836	2	0	0	0	1	1	0	0	100	0	50
Total	79	3	12	14	29	33	2	19	71	18	42

Zone 4B		No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	Wounds/	Attacks/	% Fish	% Fish w/
Size Class	No. Fish	w/FW	w/HW	w/W	w/Scars	w/Attacks	w/Hits	100 Fish	100 Fish	w/W	Attacks
0-431	16	1	2	3	0	3	1	19	19	19	19
432-533	16	1	1	2	5	6	0	19	69	13	38
534-634	10	0	2	2	8	9	1	20	140	20	90
635-735	9	0	2	2	8	8	2	44	233	22	89
736-836	2	0	0	0	2	2	0	0	650	0	100
Total	53	2	7	9	23	28	4	23	117	17	53

Summer Creel Survey

1990

Vermont

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	3	0	0	0	0	0	0	33	133	0	0
534-634	7	3	5	6	6	7	0	129	300	86	100
635-735	4	1	4	4	4	4	0	225	375	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	14	4	9	10	10	11	0	136	286	71	79

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	3	0	2	2	3	3	0	67	267	67	100
635-735	1	0	1	1	1	1	0	100	500	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	4	0	3	3	4	4	0	75	325	75	100

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	5	0	1	1	2	3	0	20	60	20	60
534-634	10	0	3	3	7	7	3	40	190	30	70
635-735	4	1	1	1	3	3	0	75	200	25	75
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	19	1	5	5	12	13	3	42	158	26	68

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	5	2	0	2	1	3	0	40	60	40	60
432-533	67	12	17	23	25	41	5	55	112	34	61
534-634	96	23	41	58	71	86	12	82	218	60	90
635-735	46	10	24	30	42	46	6	104	354	65	100
736-836	2	2	2	2	2	2	0	200	550	100	100
Total	216	49	84	115	141	178	23	79	213	53	82

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	1	1	0	0	100	0	100

534-634	1	0	0	0	1	1	0	0	100	0	100
635-735	1	0	1	1	1	1	0	400	1000	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	0	1	1	3	3	0	133	400	33	100

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	1	0	1	1	1	1	0	300	400	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	1	1	1	1	0	300	400	100	100

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	4	0	0	0	3	3	1	0	150	0	75
534-634	12	0	3	3	10	10	0	33	258	25	83
635-735	8	1	4	4	8	8	2	138	413	50	1
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	24	1	7	7	21	21	3	63	292	29	88

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	3	1	0	1	1	1	0	33	67	33	33
432-533	38	5	8	12	15	21	1	40	118	32	55
534-634	74	11	36	42	53	65	4	87	238	57	88
635-735	27	9	20	24	25	27	2	137	389	89	1
736-836	1	0	0	0	1	1	0	0	300	0	1
Total	143	26	64	79	95	115	7	81	232	55	80

1991

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	14	0	2	2	12	12	3	14	179	14	86
534-634	36	2	10	12	35	35	9	39	278	33	97
635-735	23	6	4	9	23	23	5	48	452	39	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	73	8	16	23	70	70	17	37	314	32	96

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	1	0	0	0	0
432-533	24	4	0	4	15	15	3	17	121	17	63
534-634	56	4	23	28	46	52	5	57	225	50	93
635-735	31	0	14	14	26	28	4	61	365	45	90
736-836	2	0	1	1	2	2	0	50	600	50	100
Total	114	8	38	47	89	97	12	49	246	41	85

1992

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	1	1	0	0	200	0	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	1	1	0	0	200	0	100

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	1	1	1	1	0	100	500	100	100
432-533	1	0	0	0	1	1	0	0	200	0	100
534-634	1	0	1	1	1	1	0	100	500	100	100
635-735	1	0	1	1	1	1	0	100	200	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	4	0	3	3	4	4	0	75	350	75	100

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	8	0	0	0	2	2	1	0	2	0	25
534-634	11	0	3	3	6	7	1	3	20	27	64
635-735	3	0	2	2	3	3	1	2	15	67	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	22	0	5	5	11	12	3	5	37	50	55

1993

Vermont

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

1994

Vermont

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	4	0	0	0	1	1	0	0	1	0	25
534-634	3	0	1	1	1	1	0	2	5	33	33
635-735	5	0	0	0	4	4	0	0	8	0	80
736-836	1	0	0	0	1	1	0	0	2	0	100
Total	13	0	1	1	4	4	0	2	16	8	31

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	6	0	1	1	4	5	0	17	83	17	83
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	7	0	1	1	4	5	0	14	71	14	71

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	4	1	1	2	3	4	0	75	375	50	100
635-735	4	0	0	0	4	4	1	0	275	0	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	8	1	1	2	7	8	1	38	325	25	100

1995

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	5	1	0	1	1	2	0	20	40	20	40
534-634	23	0	2	2	11	11	1	13	78	9	48
635-735	4	0	3	3	2	3	1	75	225	75	75
736-836	1	0	0	0	1	1	0	0	200	0	100
Total	33	1	5	6	15	17	2	21	94	18	52

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	3	0	0	0	0	0	0	0	0	0	0
534-634	17	0	1	1	7	7	2	6	71	6	41
635-735	7	0	1	1	6	6	2	14	186	14	86
736-836	6	0	0	0	2	2	2	0	50	0	33

Total	33	0	2	2	15	15	6	6	85	6	45

1996

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	2	0	1	1	1	1	0	100	200	50	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	0	1	1	1	1	0	67	133	33	67

1997

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	3	1	0	1	0	1	0	33	33	33	33
534-634	7	0	2	2	3	4	1	29	71	29	57
635-735	9	1	3	4	6	8	3	56	178	44	89
736-836	2	0	1	1	2	2	1	100	350	50	100
Total	21	2	6	8	11	15	5	48	138	38	71

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	3	0	0	0	0	0	0	0	0	0	0
432-533	15	1	3	4	4	6	3	27	67	27	40
534-634	29	2	11	12	11	19	7	52	100	41	66
635-735	19	4	11	12	11	19	0	100	205	63	100
736-836	5	0	1	1	1	2	0	120	320	20	40
Total	71	7	26	29	27	46	10	62	132	41	65

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	4	0	0	0	1	1	0	0	25	0	25

432-533	31	6	4	9	11	17	2	35	84	29	55
534-634	25	3	8	9	11	15	8	52	104	36	60
635-735	15	3	8	8	6	13	3	73	153	53	87
736-836	1	0	0	0	1	1	0	0	400	0	100
Total	76	12	20	26	30	47	13	46	105	34	62

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	37	2	11	13	16	19	2	38	97	35	51
534-634	98	5	17	22	71	77	8	26	141	22	79
635-735	30	0	8	8	26	27	4	33	323	27	90
736-836	3	0	2	2	3	3	1	100	800	67	100
Total	168	7	38	45	116	126	15	31	176	27	75

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	3	0	0	0	0	0	0	0	0	0	0
432-533	52	2	3	5	21	24	2	10	75	10	46
534-634	89	6	28	32	64	78	12	45	171	36	88
635-735	68	6	24	28	57	60	7	49	276	41	88
736-836	3	0	1	1	3	3	0	33	600	33	100
Total	215	14	56	66	145	165	21	37	185	31	77

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	1	0	1	1	2	0	100	350	20	100
432-533	36	5	1	6	7	11	3	17	39	17	31
534-634	93	7	8	14	46	54	4	17	90	15	58
635-735	49	7	15	21	30	38	4	55	178	46	78
736-836	6	0	3	3	5	6	0	67	417	50	100
>836	1	0	0	0	1	1	0	0	100	0	100
Total	186	20	27	45	89	111	11	30	117	24	60

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	1	1	0	1	0	100	100	100	1
432-533	7	1	0	1	1	3	0	14	43	14	43
534-634	12	0	0	0	8	8	2	0	75	0	67

635-735	3	2	0	2	3	3	0	67	267	67	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	23	3	1	4	12	15	2	17	91	17	65

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	7	1	0	1	2	2	0	14	86	14	29
534-634	7	1	0	1	5	5	0	14	86	14	71
635-735	1	0	0	0	1	1	0	0	100	0	100
736-836	1	0	0	0	1	1	0	0	100	0	100
Total	16	2	0	2	9	9	0	13	88	13	56

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	1	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Winter Creel Surveys

1991

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	12	0	2	2	5	6	3	25	100	17	50
534-634	24	0	11	11	12	19	6	58	135	46	79
635-735	17	1	7	8	15	15	7	53	218	47	88
736-836	1	0	0	0	1	1	0	0	500	0	100
Total	55	1	20	21	33	41	16	47	158	38	75

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	1	1	0	1	1	1	1	100	400	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	1	0	1	1	1	1	100	400	100	100

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	1	1	1	1	0	100	200	100	100
432-533	4	1	3	4	4	4	0	125	325	100	100
534-634	5	2	2	2	2	2	0	80	200	40	40
635-735	3	0	0	0	1	1	0	0	100	0	33
736-836	2	0	1	1	1	1	0	50	200	50	50
Total	15	3	7	8	9	9	0	73	213	53	60

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	4	1	1	2	2	3	0	125	175	50	75
534-634	3	1	0	1	2	3	0	33	100	33	100
635-735	4	3	1	4	3	4	0	200	400	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	11	5	2	7	7	10	0	127	236	64	91

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	2	1	1	1	1	1	0	150	250	100	100
534-634	1	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	1	1	1	1	1	0	100	167	33	33

1992

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	6	0	0	0	1	1	0	0	33	0	17
432-533	40	0	2	2	16	17	7	8	63	5	43
534-634	60	4	12	16	39	43	16	30	153	27	72
635-735	46	3	8	10	35	37	10	28	172	22	80
736-836	4	0	1	1	4	4	2	25	225	25	100
Total	156	7	23	29	95	102	35	22	13	19	65

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	10	1	2	2	3	5	1	40	100	20	50
534-634	42	2	11	11	24	29	8	45	143	26	69
635-735	53	5	18	23	39	45	18	55	221	43	85
736-836	6	2	3	4	6	6	1	117	450	67	100
Total	111	10	34	40	72	85	28	53	193	36	77

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	2	1	1	1	1	1	0	150	300	100	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	1	1	1	1	1	0	150	300	100	100

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	3	1	0	1	2	2	0	33	133	33	67
534-634	6	0	1	1	6	6	2	17	183	17	100
635-735	8	4	2	5	7	8	1	75	288	63	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	17	5	3	7	15	16	3	47	224	41	94

1993

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	3	0	0	0	0	0	0	0	0	0	0
432-533	18	0	1	1	9	10	0	6	67	6	56
534-634	45	3	5	8	25	28	5	20	113	18	62
635-735	31	2	7	8	26	30	1	39	294	26	97
736-836	7	0	2	2	5	5	2	57	271	29	71
Total	104	5	15	19	65	73	8	25	166	18	70

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	24	2	2	4	18	21	4	17	142	17	88
635-735	12	1	2	3	8	10	1	33	175	25	83
736-836	1	1	0	1	1	1	1	100	200	100	100
>840	1	1	1	1	1	1	0	200	300	100	100
Total	39	5	5	9	28	33	6	28	154	23	85

1994

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	6	0	2	2	1	2	0	33	50	33	33
534-634	11	1	4	4	7	8	1	55	191	36	73
635-735	10	1	1	2	9	9	1	20	210	20	90
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	28	2	7	8	17	19	2	36	161	29	68

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	1	1	0	0	50	0	50
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	1	0	0	0	1	1	0	0	200	0	50

736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	0	0	0	2	2	0	0	100	0	67

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	9	0	0	0	3	3	0	0	56	0	33
534-634	10	1	2	3	3	5	0	30	70	30	50
635-735	13	1	2	3	5	7	3	85	146	23	54
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	32	2	4	6	11	15	3	44	97	19	47

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	5	0	1	1	2	3	0	20	80	20	60
534-634	34	2	11	12	18	20	3	53	121	35	59
635-735	16	3	6	8	11	14	2	75	194	50	88
736-836	4	0	2	2	4	4	0	125	275	50	100
Total	59	5	20	23	35	41	5	61	147	39	70

1995

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	0	0	0	0	0	0	0	0	0	0
432-533	14	0	1	1	6	6	1	14	57	7	43
534-634	32	0	3	3	17	17	2	9	88	9	53
635-735	16	1	2	3	15	15	3	25	313	19	94
736-836	1	0	0	0	1	1	1	0	900	0	100
Total	65	1	6	7	39	39	7	14	146	0	0

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	1	1	0	0	0	0	1
534-634	11	0	1	1	7	7	1	9	109	9	64
635-735	11	0	4	4	8	9	2	55	236	36	82
736-836	0	0	0	0	0	0	0	0	0	0	0

Total	23	0	5	5	16	17	3	30	170	22	74

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	2	0	1	1	2	2	0	50	200	50	100
635-735	1	0	0	0	1	1	0	0	200	0	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	0	1	1	3	3	0	33	200	33	33

1996

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	6	0	0	0	0	0	0	0	0	0	0
534-634	11	1	0	1	4	5	0	9	45	9	45
635-735	7	1	0	1	5	5	0	29	186	14	71
736-836	2	0	0	0	2	2	0	0	150	0	100
Total	26	2	0	2	11	12	0	12	81	8	46

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	3	0	0	0	0	0	0	0	0	0	0
432-533	26	3	0	3	3	4	0	12	27	12	15
534-634	39	2	0	2	9	10	0	5	67	5	26
635-735	22	2	1	3	14	16	1	14	159	14	73
736-836	2	0	0	0	2	2	0	0	300	0	100
Total	92	7	1	8	28	32	1	9	80	9	35

1997

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	0	0	0	0	0	0	0	0	0	0
432-533	10	1	1	2	3	5	0	20	60	20	50

534-634	17	0	3	3	9	9	0	18	71	18	53
635-735	12	0	2	2	8	9	2	25	175	17	75
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	41	1	6	7	20	23	2	12	60	17	56

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	4	0	1	1	3	3	0	50	125	25	75
635-735	14	1	2	3	13	13	2	21	193	21	93
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	20	1	3	4	16	16	2	25	160	20	80

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	7	2	1	3	4	5	0	57	114	43	71
635-735	4	2	1	3	3	4	0	75	275	75	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	11	4	2	6	7	9	0	64	173	55	82

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	1	1	1	1	0	100	300	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	1	1	1	1	0	100	300	100	100

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	20	0	0	0	6	6	1	0	35	0	30
534-634	67	7	14	20	41	48	1	34	136	30	72
635-735	28	3	9	10	26	27	2	54	343	36	96
736-836	1	0	1	1	1	1	0	100	800	100	100

Total	116	10	24	31	74	82	4	34	174	27	71

Tributary Creel Surveys

1991

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	3	0	0	0	1	1	1	0	67	0	33
534-634	6	1	3	4	4	6	0	183	300	67	100
635-735	7	1	2	3	4	5	0	43	143	43	71
736-836	1	0	0	0	1	1	0	0	100	0	100
Total	17	2	5	7	10	13	1	82	182	41	77

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	1	1	0	0	100	0	100
534-634	1	1	1	1	1	1	0	200	500	100	100
635-735	2	1	0	1	1	1	0	50	200	50	50
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	5	2	1	2	3	3	0	60	200	40	60

Zone 5A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	1	1	0	0	200	0	100
534-634	1	0	1	1	1	1	0	100	300	100	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	1	1	2	2	0	500	250	50	100

1996

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	1	1	0	0	200	0	100
534-634	3	1	0	1	1	1	0	33	67	33	33
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	4	1	0	1	2	2	0	25	100	25	50

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	8	0	1	1	2	3	0	13	38	13	38
534-634	19	0	1	1	9	10	2	5	116	5	53
635-735	7	0	4	4	7	7	1	71	300	57	100
736-836	3	0	1	1	3	3	0	33	633	33	100
Total	37	0	7	7	21	23	3	22	176	19	62

Zone 5A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	9	0	2	2	5	7	0	22	133	22	78
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	9	0	2	2	5	7	0	22	133	22	78

1997

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	5	0	1	1	1	2	0	80	120	20	40
534-634	3	1	2	2	1	2	0	100	200	68	68
635-735	3	2	3	3	1	3	0	233	267	100	100
736-836	1	1	1	1	1	1	0	200	300	100	100
Total	12	4	7	7	4	8	0	133	192	58	68

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	1	1	0	1	0	100	100	100	100
432-533	8	0	2	2	1	3	0	38	50	25	38
534-634	18	2	6	7	7	10	1	61	111	39	56
635-735	18	2	11	12	12	16	2	122	250	68	89
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	45	4	20	22	20	30	3	82	156	49	68

Fall Electrofishing

1991

Vermont

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	1	1	0	0	500	0	100
534-634	13	0	2	2	11	12	0	15	269	15	92
635-735	30	4	6	8	29	29	0	37	430	27	97
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	44	4	8	10	41	42	0	30	384	23	96

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	3	0	0	0	3	3	0	0	433	0	100

736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	0	0	0	3	3	0	0	433	0	100

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	117	18	30	44	90	102	13	44	200	38	87
635-735	264	36	81	108	227	247	52	57	269	41	94
736-836	12	3	2	4	12	12	1	58	525	33	100
Total	393	57	113	156	329	361	66	53	256	40	92

1992

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	2	0	0	0	1	1	0	0	100	0	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	1	1	0	0	100	0	100

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	1	1	0	0	100	0	100
432-533	8	1	0	1	3	4	0	13	50	13	50
534-634	152	4	40	42	115	129	0	30	168	28	85
635-735	659	25	153	175	586	618	1	30	222	27	94
736-836	37	3	9	12	37	37	1	32	319	32	100
Total	857	33	202	230	742	789	2	30	215	27	92

1993

Vermont

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	9	0	2	2	9	9	0	22	189	22	100
736-836	1	0	1	1	0	1	0	100	100	100	100
Total	10	0	3	3	9	10	0	0	180	30	100

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	1	1	2	1	2	0	200	300	200	200
534-634	12	4	2	5	8	10	0	50	200	42	83
635-735	29	4	6	9	27	27	0	48	300	31	93
736-836	5	1	2	3	4	5	0	80	300	60	100
Total	47	10	11	19	40	44	0	55	274	40	94

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	0	0	0	0	0	0	0
534-634	118	10	41	47	85	106	7	47	153	40	90
635-735	410	46	111	143	354	378	51	42	220	35	92
736-836	38	7	12	18	35	37	7	53	258	47	97
>836	1	0	1	1	1	1	1	100	300	100	100
Total	570	63	165	209	475	522	66	44	208	37	92

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	3	0	0	0	2	2	0	0	67	0	67
534-634	37	2	8	10	28	32	1	38	230	27	86
635-735	123	22	43	57	114	117	6	68	401	46	95
736-836	14	2	5	7	14	14	1	71	521	50	100
Total	177	26	56	74	158	165	8	61	370	42	93

1995

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	2	0	0	0	0	0	1	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	0	0	1	0	0	0	0

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	2	0	0	0	2	2	0	0	100	0	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	2	2	0	0	100	0	100

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	17	2	7	8	3	10	0	53	71	47	58
534-634	169	8	41	49	110	130	0	33	133	29	77
635-735	217	7	64	70	171	192	4	41	181	32	89
736-836	16	2	2	4	15	15	1	25	281	25	94
Total	419	19	114	131	299	347	5	38	161	31	83

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	3	0	1	1	3	3	0	33	133	33	100
534-634	113	3	29	30	72	87	1	33	124	27	77
635-735	233	23	74	92	204	219	4	45	196	40	94
736-836	22	1	4	5	20	20	1	27	236	23	91
Total	371	27	108	128	299	329	6	40	176	35	89

Zone 5A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	1	1	0	1	0	100	100	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	1	1	0	1	0	100	100	0	0

1996

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	1	0	1	0	1	0	100	100	100	100
635-735	1	0	0	0	1	1	0	0	300	0	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	1	0	1	1	2	0	50	200	50	100

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	2	0	1	1	0	1	0	50	50	50	50
534-634	120	8	40	46	70	93	0	44	124	38	78
635-735	165	5	59	64	133	150	0	48	192	39	91
736-836	11	3	6	6	9	10	0	109	245	55	91
Total	298	16	106	117	212	254	0	49	165	39	85

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	1	1	1	0	1	0	200	200	100	100
432-533	3	0	1	1	1	2	0	33	100	33	67
534-634	16	0	4	4	7	10	1	25	94	25	63
635-735	16	4	5	8	13	15	2	69	200	50	94
736-836	4	1	1	2	4	4	1	50	350	50	100
Total	40	6	12	16	25	32	4	50	165	40	80

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	2	0	0	0	1	1	1	0	100	0	50
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	1	1	1	0	100	0	50

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	13	0	1	1	1	2	0	8	15	8	15
534-634	159	12	46	55	121	141	1	40	160	35	89
635-735	350	27	129	145	324	332	1	53	229	41	95
736-836	33	3	17	18	33	33	0	76	348	55	100
>836	1	0	1	1	1	1	0	200	600	100	100
Total	556	42	194	220	480	509	2	50	212	40	92

1997

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	1	1	0	0	100	0	100
432-533	6	0	3	3	3	5	0	50	100	50	83
534-634	196	14	63	71	131	161	3	43	136	36	82
635-735	252	16	63	75	212	226	4	34	175	30	90
736-836	21	3	7	8	19	20	0	57	281	38	95
Total	476	33	136	157	366	413	7	39	162	33	87

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	0	0	0	1	1	0	0	50	0	50

432-533	13	0	1	1	4	5	1	8	38	8	39
534-634	183	2	34	35	109	125	2	21	98	19	68
635-735	212	6	65	71	166	184	1	37	165	33	87
736-836	3	0	0	0	3	3	0	0	333	0	100
Total	413	8	100	107	283	318	4	29	132	26	77

Spring Electrofishing

1994

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	1	0	0	0	1	1	0	0	200	0	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	1	1	0	0	200	0	100

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	0	0	0	2	2	0	0	200	0	2
635-735	15	0	1	1	15	15	0	7	240	1	36
736-836	1	0	1	1	2	3	0	100	300	1	3
Total	17	0	2	2	19	20	0	12	241	2	41

Fall Fishlift

1994

Vermont

Fishlift	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	0	0	0	1	1	0	0	300	0	100
635-735	8	0	1	1	8	8	1	25	250	13	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	9	0	1	1	9	9	1	22	256	11	100

1996

Vermont

Fishlift	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	45	2	12	14	19	27	4	38	104	31	60
635-735	44	2	5	6	22	25	5	20	134	14	57
736-836	1	0	0	0	1	1	0	0	500	0	100
Total	90	4	17	20	42	53	9	29	123	22	59

1997

Vermont

Fishlift	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	37	1	12	13	23	29	0	46	146	35	78
635-735	54	2	16	17	41	44	2	39	172	31	81
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	91	3	28	30	64	73	2	42	162	33	80

Gillnetting

1992

New York

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	1	1	1	0	1	1	300	300	100	100
635-735	1	1	0	1	0	1	0	500	500	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	2	1	2	0	2	1	400	400	100	100

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	0	1	1	1	1	0	100	200	100	100
635-735	1	1	0	1	1	1	1	100	400	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	1	1	2	2	2	1	100	300	100	100

Vermont

Zone 5A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	6	0	0	0	1	1	0	0	17	0	17
534-634	1	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	7	0	0	0	1	1	0	0	14	0	14

1983

New York

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	2	2	2	2	2	2	1	300	500	100	100
635-735	1	1	1	1	1	1	1	400	500	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	3	3	3	3	3	2	367	500	100	100

1984

Vermont

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

1986

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0

Total	3	0	0	0	0	0	0	0	0	0	0

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	3	1	1	1	1	2	1	100	133	33	67
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	1	1	1	1	2	1	100	133	33	67

1987

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	1	1	1	1	1	1	0	200	600	100	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	1	1	1	1	1	0	100	300	50	50

1988

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	3	0	0	0	0	0	0	0	0	0	0
432-533	11	2	2	3	1	3	0	55	64	27	27
534-634	2	2	1	2	1	2	0	250	300	100	100

635-735	1	1	0	1	1	1	0	300	400	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	17	5	3	6	3	6	0	82	100	35	35

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	1	1	0	1	0	100	100	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	1	1	0	1	0	100	100	100	100

1989

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	1	1	0	1	0	300	300	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	1	1	0	1	0	300	300	100	100

1990

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0

432-533	1	1	0	1	0	1	0	100	100	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	1	0	1	0	1	0	100	100	100	100

Zone 3C		No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	Wounds/	Attacks/	% Fish	% Fish w/
Size Class	No. Fish	w/FW	w/HW	w/W	w/Scars	w/Attacks	w/Hits	100 Fish	100 Fish	w/W	Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	2	0	2	2	1	2	0	150	200	100	100
534-634	1	1	0	1	1	1	1	100	200	100	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	1	2	3	2	3	1	133	200	100	100

1992

Vermont

Zone 4B		No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	Wounds/	Attacks/	% Fish	% Fish w/
Size Class	No. Fish	w/FW	w/HW	w/W	w/Scars	w/Attacks	w/Hits	100 Fish	100 Fish	w/W	Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	1	1	0	1	1	1	0	100	300	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	1	0	1	1	1	0	100	300	100	100

Zone 4A		No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	Wounds/	Attacks/	% Fish	% Fish w/
Size Class	No. Fish	w/FW	w/HW	w/W	w/Scars	w/Attacks	w/Hits	100 Fish	100 Fish	w/W	Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	1	0	1	0	1	0	100	100	100	100
635-735	0	0	0	0	0	0	0	0	0	0	0

736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	1	0	1	0	1	0	100	100	100	100

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	0	0	0	0	0	0	0

1994

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	0	0	0	1	1	0	0	100	0	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	1	1	0	0	100	0	100

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	8	1	1	2	1	2	1	25	38	25	25
534-634	3	0	1	1	0	1	0	33	33	33	33
635-735	1	0	1	1	1	1	0	200	300	100	100

736-836	0	0	0	0	0	0	0	0	0	0	0
Total	12	1	3	4	2	4	1	42	58	33	33

Zone 5C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	2	0	1	1	0	1	1	50	50	50	50
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	1	0	1	1	1	1	0	300	400	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	0	2	2	1	2	1	133	167	67	67

1995

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	0	0	0	0	0	0	0

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	0	0	0	0	0	0	0

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0

Total	1	0	0	0	0	0	0	0	0	0	0

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	0	0	0	0	0	0	0	0	0	0
432-533	8	1	0	1	2	2	0	13	38	13	25
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	10	1	0	1	2	2	0	10	30	10	20

Zone 5C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	1	0	0	0	1	0	100	100	0	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	1	0	100	100	0	100

1996

New York

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	3	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0

635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	0	0	0	0	0	0	0

Zone 5C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	3	1	0	1	0	1	0	33	33	33	33
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	1	0	1	0	1	0	33	33	33	33

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	3	2	0	2	2	2	0	66	133	67	67
534-634	1	1	0	1	0	1	0	100	100	100	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	5	3	0	3	2	3	0	60	100	60	60

1997

New York

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Summer Creel Surveys

1990

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	21	0	1	1	2	3	5	10	24	5	14
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	22	0	1	1	2	3	5	8	23	5	14

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks

0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	0	0	0	0	0	0	0	0	0	0

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	7	2	1	3	0	3	0	43	43	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	8	2	1	3	0	3	0	43	43	100	100

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	0	1	1	0	1	0	50	50	50	50
432-533	7	3	0	3	1	3	0	43	57	43	43
534-634	2	0	2	2	1	2	0	150	300	1	1
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	11	3	3	6	2	6	0	64	100	55	55

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	3	1	1	1	0	1	0	67	67	33	33
534-634	1	0	1	1	1	1	0	200	400	1	1
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	5	1	2	2	1	2	0	80	120	40	40

Zone 5A		No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	Wounds/	Attacks/	% Fish	% Fish w/

Size Class	No. Fish	w/FW	w/HW	w/W	w/Scars	w/Attacks	w/Hits	100 Fish	100 Fish	w/W	Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	4	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	4	0	0	0	0	0	0	0	0	0	0

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	6	0	1	1	0	1	0	17	17	17	17
432-533	31	5	1	6	2	7	1	32	48	19	23
534-634	4	1	1	2	1	2	0	100	150	50	5
635-735	1	1	1	1	0	1	0	300	300	1	1
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	42	7	4	10	3	11	1	43	60	24	26

1991

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	1	0	1	1	1	0	50	150	50	50
432-533	2	0	0	0	0	0	0	0	0	0	0
534-634	1	0	0	0	1	1	0	0	400	0	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	5	1	0	1	2	2	0	25	140	20	40

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	7	1	1	2	2	2	2	29	71	29	29
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	8	1	1	2	2	2	2	25	63	25	25

Zone 5A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	4	0	0	0	0	0	0	0	0	0	0
432-533	4	0	0	0	1	1	0	0	25	0	25
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	8	0	0	0	1	1	0	0	17	0	13

1992

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	0	0	0	0	0	0	0	0	0	0
432-533	20	0	0	0	2	2	0	10	10	10	10
534-634	2	0	0	0	0	0	0	0	50	0	50
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	24	0	0	0	3	3	0	8	13	8	13

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	0	0	0	0	0	0	0	0	0	0
432-533	8	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	10	0	0	0	0	0	0	0	0	0	0

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	1	1	0	0	100	0	100
432-533	3	0	0	0	0	0	0	0	0	0	0
534-634	1	0	0	0	1	1	0	0	200	0	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	5	0	0	0	2	2	0	0	150	0	100

1993

Vermont

Zone 5A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	0	0	0	0	0	1	0	0	0	0
432-533	5	1	0	1	0	1	0	25	25	25	25
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	7	1	0	1	0	1	1	14	14	14	14

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	5	0	0	0	0	0	0	0	0	0	0
432-533	12	1	0	1	2	2	0	8	33	1	16
534-634	3	0	0	0	1	1	0	0	33	0	33
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	20	1	0	1	2	2	0	10	40	5	10

1994

Vermont

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	2	1	0	1	1	1	0	50	100	50	50

534-634	1	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	1	0	1	1	1	0	33	66	33	33

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	1	1	0	1	0	100	100	100	100
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	2	0	0	0	0	0	1	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	0	1	1	0	1	1	33	33	33	33

1995

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	4	0	1	1	2	2	0	50	100	25	50
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	4	0	1	1	2	2	0	50	100	25	50

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	0	0	0	0	0	0	0
534-634	1	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	0	0	0	0	0	0	0	0	0	0

1996

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	4	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	4	0	0	0	0	0	0	0	0	0	0

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	1	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	0	0	0	0	0	0	0

1997

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	31	1	0	1	0	1	0	3	3	3	3
432-533	33	1	0	1	0	1	0	0	0	3	3
534-634	1	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	65	2	0	2	0	2	0	2	2	3	3

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	14	3	0	3	0	3	0	21	21	21	21
432-533	11	4	0	4	0	4	0	27	27	27	27
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	25	7	0	7	0	7	0	24	24	24	24

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	14	0	0	0	0	0	1	0	0	0	0
432-533	33	2	1	3	1	4	2	9	12	15	18
534-634	1	0	0	0	0	0	1	0	0	0	0
635-735	1	0	1	1	0	1	0	100	100	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	49	2	2	4	1	5	4	8	10	12	14

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	10	0	0	0	0	0	0	0	0	0	0
432-533	13	1	1	2	1	2	0	23	31	15	15
534-634	1	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	24	1	1	2	1	2	0	13	17	8	8

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	16	1	2	3	1	3	1	19	25	19	19
432-533	35	4	3	6	3	8	2	20	29	17	23
534-634	3	1	1	1	2	3	0	133	200	33	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	54	6	6	10	6	14	3	26	37	19	26

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	3	0	0	0	0	0	0	0	0	0	0
432-533	7	1	1	2	0	2	0	86	86	29	29
534-634	3	1	0	1	0	1	0	33	33	33	33
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	13	2	1	3	0	3	0	54	54	23	23

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0

432-533	8	1	0	1	2	3	0	0	50	13	38
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	9	1	0	1	2	3	0	0	36	11	33

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	0	1	1	1	1	0	200	400	100	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	1	1	1	1	0	200	400	100	100

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	3	2	0	2	2	2	1	67	133	67	67
534-634	3	0	0	0	0	0	1	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	7	2	0	2	2	2	1	29	57	29	29

Winter Creel Surveys

1991

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0

736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Zone 2C		No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	Wounds/	Attacks/	% Fish	% Fish w/
Size Class	No. Fish	w/FW	w/HW	w/W	w/Scars	w/Attacks	w/Hits	100 Fish	100 Fish	w/W	Attacks
0-431	1	0	1	1	0	1	0	100	100	100	100
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	1	1	0	1	0	100	100	100	100

Zone 5B		No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	Wounds/	Attacks/	% Fish	% Fish w/
Size Class	No. Fish	w/FW	w/HW	w/W	w/Scars	w/Attacks	w/Hits	100 Fish	100 Fish	w/W	Attacks
0-431	19	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	3	0	0	0	1	1	0	0	67	0	33
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	19	0	0	0	1	1	0	0	11	0	5

1992

Vermont

Zone 2A		No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	Wounds/	Attacks/	% Fish	% Fish w/
Size Class	No. Fish	w/FW	w/HW	w/W	w/Scars	w/Attacks	w/Hits	100 Fish	100 Fish	w/W	Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	1	0	1	0	1	0	200	200	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0

736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	1	0	1	0	1	0	200	200	100	100

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	1	1	1	0	100	0	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	1	1	1	0	100	0	100

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	6	2	0	2	2	3	0	20	40	33	50
432-533	4	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	10	2	0	2	2	3	0	20	40	20	30

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	0	0	0	1	1	0	0	50	0	50
432-533	2	0	0	0	1	1	0	0	50	0	50
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	4	0	0	0	2	2	0	0	50	0	50

1993

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	0	0	0	1	1	0	0	200	0	100
635-735	0	0	0	0	0	0	0	0	0	0	0

736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	1	1	0	0	200	0	100

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	0	0	0	0	0	0	0

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	5	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	0	0	0	0	0	0	0
534-634	2	0	0	0	1	1	0	0	50	0	50
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	9	0	0	0	1	1	0	0	11	0	11

1994

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0

534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

1997

Vermont

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	52	0	2	2	0	2	0	4	4	4	4
432-533	23	0	2	2	4	6	1	9	30	9	26
534-634	14	1	0	1	5	6	3	7	64	7	43
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	89	1	4	5	9	14	4	6	20	6	16

Tributary Creel Surveys

1991

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	5	1	0	1	0	1	0	20	20	20	20
432-533	2	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0

736-836	0	0	0	0	0	0	0	0	0	0	0
Total	7	1	0	1	0	1	0	14	14	14	14

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	1	1	0	1	0	100	100	100	100
432-533	1	0	1	1	0	1	0	100	100	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	2	2	0	2	0	100	100	100	100

Zone 5A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	0	0	0	0	0	0	0	0	0	0

1994

Vermont

Zone 5A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	5	1	0	1	4	4	1	20	120	20	80
534-634	2	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	8	1	0	1	4	4	1	13	75	13	50

1996

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	1	1	0	1	0	100	100	100	100
432-533	12	1	1	2	0	2	0	17	17	17	17
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	13	1	2	3	0	3	0	23	23	8	8

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	2	0	1	1	0	1	0	50	50	50	50
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	1	1	0	1	0	50	50	50	50

1997

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	6	0	0	0	0	0	0	17	17	0	0
432-533	14	0	0	0	0	0	0	14	14	0	0
534-634	1	0	1	1	0	1	0	100	100	100	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0

Total	21	0	1	1	0	1	0	19	19	5	5

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	3	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	0	0	0	0	0	0	0	0	0	0

Fall Electrofishing

1991

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	18	1	3	4	5	8	0	22	61	22	44
534-634	7	2	2	3	5	5	0	57	186	43	71
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	25	3	5	7	10	13	0	32	96	28	52

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	19	0	0	0	1	1	0	0	5	0	5
432-533	3	0	0	0	2	2	0	0	133	0	67

534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	22	0	0	0	3	3	0	0	23	0	14

Zone 5A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	4	0	2	2	2	3	1	50	125	50	75
432-533	10	0	2	2	3	4	1	20	80	20	40
534-634	4	1	3	4	3	4	1	100	225	100	100
635-735	2	0	2	2	2	2	0	100	450	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	20	1	9	10	10	13	3	50	120	50	65

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	7	0	0	0	1	1	0	0	14	0	14
432-533	14	0	3	3	5	7	2	29	64	21	50
534-634	5	0	2	2	5	5	1	60	220	40	100
635-735	2	0	2	2	2	2	0	250	500	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	28	0	7	7	13	15	3	43	111	25	54

Zone 5C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	1	0	0	0	1	1	0	0	100	0	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	1	1	0	0	50	0	50

1992

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	12	0	2	2	6	8	0	17	108	17	67

534-634	27	0	5	5	24	24	0	19	267	19	89
635-735	2	0	0	0	1	1	0	0	200	0	50
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	41	0	7	7	31	33	0	17	217	17	80

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	182	1	1	2	0	2	0	1	1	1	1
432-533	28	0	3	3	0	3	0	11	11	11	11
534-634	11	2	1	3	5	7	0	36	91	27	64
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	221	3	5	8	5	12	0	4	7	4	5

Zone 5A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	6	0	0	0	1	1	0	0	17	0	17
432-533	44	0	8	8	28	32	2	18	150	18	73
534-634	9	1	2	3	7	8	1	33	156	33	89
635-735	3	1	1	1	2	2	0	33	233	33	67
736-836	1	0	1	1	0	1	0	20	200	100	100
Total	63	2	12	13	38	44	3	22	143	21	70

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	8	0	0	0	1	1	0	0	13	0	13
534-634	15	1	1	2	6	8	0	13	87	13	53
635-735	11	0	3	3	7	7	0	55	173	27	64
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	34	1	4	5	14	16	0	24	97	15	47

Zone 5C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	0	1	1	0	1	0	100	100	100	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0

Total	2	0	1	1	0	1	0	50	50	50	50

1993

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	6	0	0	0	0	0	0	0	0	0	0
432-533	42	1	10	11	17	25	7	26	71	26	60
534-634	22	2	4	6	12	13	1	45	114	27	59
635-735	2	0	1	1	1	2	1	0	150	50	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	72	3	15	18	30	40	9	32	81	25	56

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	29	0	0	0	1	1	0	0	3	0	3
432-533	55	2	9	11	12	21	0	22	47	20	38
534-634	13	1	5	5	4	9	0	46	85	38	69
635-735	1	0	0	0	1	1	0	0	100	0	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	98	3	14	16	18	32	0	18	40	16	33

Zone 5A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	5	0	2	2	1	3	0	40	60	40	60
432-533	199	18	69	81	52	113	22	47	80	41	57
534-634	105	13	41	51	42	67	17	61	131	49	64
635-735	11	5	8	9	7	10	3	191	300	82	91
736-836	1	0	0	0	2	2	0	0	200	0	200
Total	321	36	120	143	104	195	42	56	105	45	61

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	90	2	30	32	18	42	10	37	59	36	47
534-634	71	3	27	30	21	37	9	47	85	42	52
635-735	5	1	5	5	3	5	0	200	260	100	100

736-836	1	0	1	1	0	1	0	100	100	100	100
Total	168	6	63	68	42	85	19	46	76	40	51

Zone 5C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	6	0	1	1	0	1	1	17	17	17	17
534-634	10	0	1	1	3	4	3	10	10	10	40
635-735	2	0	2	2	2	2	1	100	30	10	10
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	18	0	4	4	5	7	5	22	44	22	39

1995

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	0	0	0	0	0	0	0
534-634	3	1	1	2	2	3	1	100	267	67	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	5	1	1	2	2	3	1	60	160	40	60

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	48	1	2	3	0	3	0	6	6	6	6
432-533	4	0	1	1	1	2	0	50	100	25	50
534-634	5	0	2	2	2	3	0	40	80	40	60
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	57	1	5	6	3	8	0	12	19	11	14

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	32	2	4	4	15	17	3	19	88	13	53

534-634	19	3	9	11	15	18	0	74	242	58	95
635-735	7	0	7	7	5	7	2	129	229	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	59	5	20	22	35	42	5	49	153	37	71

Zone 5A		No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	Wounds/	Attacks/	% Fish	% Fish w/
Size Class	No. Fish	w/FW	w/HW	w/W	w/Scars	w/Attacks	w/Hits	100 Fish	100 Fish	w/W	Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	14	0	2	2	10	11	0	21	107	14	79
534-634	13	2	7	8	8	10	2	85	254	62	77
635-735	5	0	2	2	5	5	1	60	300	40	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	32	2	11	12	23	26	3	53	197	38	81

Zone 5B		No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	Wounds/	Attacks/	% Fish	% Fish w/
Size Class	No. Fish	w/FW	w/HW	w/W	w/Scars	w/Attacks	w/Hits	100 Fish	100 Fish	w/W	Attacks
0-431	4	0	0	0	3	3	0	0	75	0	75
432-533	40	4	16	20	9	24	2	55	78	50	60
534-634	16	8	7	13	11	13	2	125	244	81	81
635-735	6	1	1	1	6	6	1	50	317	17	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	66	13	24	34	29	46	5	68	139	52	70

New York

Zone3	No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	No. Fish	Wounds/	Attacks/	% Fish	% Fish
Size Class		w/FW	w/HW	w/W	w/Scars	w/Attacks	w/Hits	100 Fish	100 Fish	w/W	w/Attacks
0-431	239	3	2	5	2	7	2	2	2	2	3
432-533	25	5	2	7	10	15	1	28	88	28	60
534-634	15	5	2	7	6	9	2	60	133	47	60
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	279	13	6	19	18	31	5	8	18	7	11

1996

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	5	0	1	1	1	2	1	20	40	20	40
534-634	4	0	1	1	2	2	0	25	75	25	50
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	9	0	2	2	3	4	1	22	56	22	44

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	43	0	0	0	0	0	0	0	0	0	0
432-533	11	0	1	1	1	2	0	9	18	9	18
534-634	5	0	1	1	0	1	0	40	40	20	20
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	59	0	2	2	1	3	0	5	7	3	5

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	1	1	0	0	100	0	100
432-533	2	0	1	1	0	1	0	100	100	50	50
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	0	1	1	1	2	0	67	100	33	67

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	13	0	0	0	4	4	2	0	46	0	31
534-634	7	0	1	1	2	3	0	14	71	14	43
635-735	2	0	0	0	2	2	1	0	150	0	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	22	0	1	1	8	9	3	5	64	5	41

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	1	1	0	1	0	1	1	1	1

432-533	60	1	23	24	14	36	0	43	70	40	60
534-634	11	0	5	5	3	6	0	64	91	45	55
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	72	1	29	30	17	43	0	47	74	42	60

Zone 5A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	1	1	0	0	50	0	50
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	1	1	0	0	50	0	50

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	0	0	0	1	1	0	0	50	0	50
432-533	23	0	6	6	5	10	0	26	48	26	43
534-634	3	0	2	2	1	2	0	100	133	67	67
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	28	0	8	8	7	13	0	32	57	29	46

New York

Zone 3 Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/Attacks
0-431	120	1	0	1	0	1	1	1	1	1	1
432-533	37	1	7	7	7	12	7	35	57	19	32
534-634	15	2	5	7	6	9	1	47	93	47	60
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	172	4	12	15	13	22	9	12	21	88	13

1997

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	13	0	1	1	0	1	0	15	31	8	31
534-634	2	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	15	0	1	1	0	1	0	13	27	13	13

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	101	0	1	1	1	2	0	1	2	1	2
432-533	69	4	10	14	4	17	0	22	28	20	25
534-634	12	0	1	1	1	2	0	8	17	8	17
635-735	1	1	0	1	1	1	1	100	300	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	183	5	12	17	7	22	1	10	14	9	12

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	3	0	3	3	0	3	0	100	100	100	100
534-634	2	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	5	0	3	3	0	3	0	60	60	60	60

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	0	0	0	0	0	0	0	0	0	0
432-533	76	1	13	14	23	33	1	20	53	18	43
534-634	36	2	14	16	14	23	0	61	111	44	63
635-735	6	0	2	2	4	5	0	50	150	33	83
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	120	3	29	32	41	61	1	33	74	27	51

Zone 5A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	1	1	0	1	0	100	100	100	100
432-533	12	0	6	6	3	9	1	83	100	50	75
534-634	1	1	0	1	0	1	0	100	100	100	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	14	1	7	8	3	11	1	86	107	57	79

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	8	0	2	2	0	2	0	25	25	25	25
432-533	50	4	12	16	7	21	3	32	48	32	42
534-634	19	4	13	14	5	16	4	100	147	74	84
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	77	8	27	32	12	39	7	48	70	42	51

New York

Zone 3 Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/Attacks
0-431	196	0	2	2	3	5	1	1	3	1	3
432-533	87	11	15	24	10	31	4	33	46	28	36
534-634	24	6	8	13	10	17	2	67	129	54	71
635-735	1	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	308	17	25	39	23	53	7	15	25	13	17

Spring Electrofishing

1995

Vermont

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks

0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	2	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	0	0	0	0	0	0	0

Zone 5A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	8	0	1	1	0	1	0	13	13	13	13
534-634	6	0	2	2	1	3	0	33	67	33	50
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	15	0	3	3	1	4	0	20	33	20	27

New York

Zone 3 Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/Attacks
0-431	19	3	3	5	1	6	1	47	58	26	32
432-533	16	4	3	6	0	6	1	56	56	38	38
534-634	13	7	5	11	8	11	2	115	231	85	85
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	48	14	11	22	9	23	4	69	104	46	48

1996

New York

Zone 3 Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/Attacks
0-431	72	2	9	10	0	10	3	17	17	14	14

432-533	36	1	3	4	0	4	3	11	11	11	11
534-634	3	0	2	2	2	3	0	133	200	67	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	111	3	14	16	2	17	6	18	20	14	15

1997

New York

Zone3 Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/Attacks
0-431	103	10	3	13	3	16	1	15	17	13	16
432-533	21	1	2	3	1	4	1	14	19	14	19
534-634	1	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	125	11	5	16	4	20	2	14	18	13	16

Fall Fishlift

1993

Vermont

Fishlift	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	14	0	3	3	7	10	1	29	93	21	71
534-634	20	0	2	2	9	10	5	20	75	10	50
635-735	2	0	0	0	2	2	1	0	250	0	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	36	0	5	5	18	22	7	22	92	14	61

1994

Vermont

Fishlift	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks

0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	10	0	2	2	4	4	1	30	100	20	40
534-634	18	2	4	5	10	13	7	61	189	28	72
635-735	4	0	3	3	4	4	2	150	325	75	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	32	2	9	10	18	21	10	63	178	31	66

1995

Vermont

Fishlift	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	3	0	0	0	1	1	0	0	33	0	33
432-533	8	0	2	2	6	6	2	25	150	25	75
534-634	1	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	12	0	2	2	7	7	2	17	108	17	58

New York

Fishlift	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	4	0	0	0	0	0	1	0	0	0	0
534-634	5	0	0	0	1	1	1	0	20	0	20
635-735	1	0	0	0	1	1	1	0	200	0	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	10	0	0	0	2	2	3	0	30	0	20

1996

Vermont

Fishlift	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	6	0	0	0	2	2	2	0	33	0	33
534-634	4	1	0	1	2	3	0	25	75	25	75
635-735	1	0	1	1	1	1	0	100	300	100	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	11	1	1	2	5	6	2	18	73	18	55

New York

Fishlift	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	32	2	1	3	8	11	8	9	44	9	34
534-634	17	0	3	3	2	5	1	29	41	18	29
635-735	3	0	1	1	3	3	1	33	400	33	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	52	2	5	7	13	19	10	17	64	14	37

1997

Vermont

Fishlift	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	76	4	12	16	21	35	10	21	53	21	46
534-634	39	1	6	7	17	20	4	21	79	18	51
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	115	5	18	23	38	55	14	21	62	20	48

New York

Fishlift	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/Attacks
0-431	2	0	0	0	0	0	0	0	0	0	0
432-533	31	3	7	9	5	12	0	32	32	29	39
534-634	20	1	7	8	9	13	2	55	55	40	65
635-735	2	0	1	1	2	2	1	50	50	50	100
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	55	4	15	18	16	27	3	40	40	33	49

Brown Trout

Summer Gillnetting

1982

Vermont

Zone 5A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	1	1	0	1	0	100	100	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	1	1	0	1	0	100	100	100	100

1983

Vermont

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	3	0	1	1	2	2	1	33	200	33	67
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	0	1	1	2	2	1	33	200	33	67

1984

New York

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	1	1	0	0	100	0	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	1	1	0	0	100	0	100

1990

Vermont

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	1	1	0	1	0	100	100	100	100
534-634	1	1	0	1	0	1	0	100	100	100	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	1	1	2	0	2	0	100	100	100	100

1992

Vermont

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0

1994

Vermont

Zone 5C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	1	1	0	0	0	100
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	1	1	0	0	0	100

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	5	0	2	2	0	2	0	40	40	40	40
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	1	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	6	0	2	2	0	2	0	33	33	33	33

1995

Vermont

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	3	0	0	0	1	1	0	33	33	0	33
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	0	0	0	1	1	0	33	33	0	33

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	1	1	1	1	0	300	400	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	1	1	1	1	0	300	400	100	100

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	1	0	0	0	0	100
432-533	2	1	1	2	0	2	0	100	100	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	1	1	2	0	3	0	66	66	67	100

1996

Vermont

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	1	0	1	1	1	0	100	300	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	1	0	1	1	1	0	100	300	100	100

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	3	2	1	3	1	3	0	133	200	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	2	1	3	1	3	0	133	200	100	100

Summer Creel Surveys

1990

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

1991

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	1	0	1	0	1	0	100	100	100	100
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	100	100	100	100

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	1	0	1	0	1	0	50	50	50	50
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	0	0	0	50	50	50	50

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

1992

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

1996

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

1997

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	1	0	1	0	1	0	50	50	50	50
432-533	1	0	1	1	0	1	0	100	100	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	1	1	2	0	2	0	2	2	67	67

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	0	0	0	0	0	0	0

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	1	1	1	1	0	1	0	200	200	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	1	1	1	0	1	0	100	100	50	50

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	1	0	1	0	1	0	100	100	100	100
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0

Total	1	1	0	1	0	1	0	100	100	100	100

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	0	0	0	0	0	0	0	0	0	0
432-533	1	0	1	1	0	1	0	100	100	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	0	1	1	0	1	0	33	33	33	33

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	3	0	0	0	1	1	0	0	33	0	33
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	0	0	0	1	1	0	0	33	0	33

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	1	0	1	0	1	0	100	100	100	100
432-533	3	0	0	0	2	2	0	0	67	0	67
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	4	1	0	1	2	3	0	25	125	25	75

Winter Creel Surveys

1994

Vermont

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	0	0	0	0	0	0	0	0	0	0

432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	0	0	0	0	0	0	0

1997

Vermont

Zone 5B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	12	0	0	0	0	0	0	0	0	0	0
432-533	4	0	0	0	1	1	0	0	25	0	25
534-634	1	0	0	0	1	1	0	0	200	0	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	17	0	0	0	2	2	0	0	18	0	12

Tributary Creel Surveys

1991

Vermont

Zone 4A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	1	0	1	0	1	1	100	100	100	100
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	1	0	1	0	1	1	100	100	100	100

1994

Vermont

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	1	1	0	0	200	0	100
432-533	0	0	0	0	0	0	0	0	0	0	0

534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	1	1	0	0	200	0	100

1996

Vermont

Zone5A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

1997

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	1	1	1	1	1	0	200	300	100	100
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	1	1	1	1	1	0	200	300	100	100

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	1	1	1	0	1	0	400	400	100	100
432-533	1	1	0	1	0	1	0	200	200	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	1	1	1	1	1	0	300	300	100	100

Fall Electrofishing

1991

Vermont

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	1	1	0	1	0	100	100	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	1	1	0	1	0	100	100	100	100

1993

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	1	0	1	0	1	0	50	50	50	50
432-533	1	0	1	1	0	1	0	100	100	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	1	1	2	0	2	0	67	67	67	67

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	1	1	0	1	0	100	100	100	100
432-533	2	0	0	0	2	2	0	0	100	0	100

534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	3	0	1	1	2	3	0	33	100	33	100

1995

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	1	1	0	1	0	100	100	100	100
432-533	1	0	1	1	0	1	0	100	100	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	2	2	0	2	0	100	100	100	100

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	41	0	1	1	3	4	0	2	10	2	10
432-533	36	2	11	13	14	21	0	39	94	36	58
534-634	3	0	0	0	2	2	0	0	67	0	67
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	80	2	12	14	19	27	0	19	50	18	34

New York

Zone 3 Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/Attacks
0-431	24	9	4	13	0	13	1	54	54	54	54
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	0	0	0	1	1	0	0	100	0	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	25	9	4	13	1	14	1	52	56	52	56

1996

Vermont

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	1	1	0	1	0	100	100	100	100
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	1	1	0	1	0	100	100	100	100

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	1	1	0	1	0	200	200	100	100
432-533	20	1	6	7	3	9	0	40	55	35	45
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	21	1	7	8	3	10	0	48	62	38	48

Zone 5A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

New York

Zone 3 Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/Attacks
0-431	9	2	4	6	1	6	0	67	78	67	67
432-533	5	3	2	5	2	5	1	100	160	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	14	5	6	11	3	11	1	79	107	79	79

1997

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	1	1	0	0	100	0	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	1	1	0	0	100	0	100

Zone 4B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	11	0	0	0	0	0	0	0	0	0	0
432-533	25	0	4	4	9	11	1	16	52	16	44
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	36	0	4	4	9	11	1	11	36	11	31

New York

Zone 3 Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0

635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Spring Electrofishing

1994

Vermont

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

1995

New York

Zone 3 Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/Attacks
0-431	9	3	1	4	1	4	1	44	56	44	44
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	9	3	1	4	1	4	1	44	56	44	44

1996

New York

Zone 3 Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/Attacks
0-431	9	2	4	6	1	6	0	67	78	67	67
432-533	5	3	2	5	2	5	1	100	160	100	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	14	5	6	11	3	11	1	79	107	79	79

1997

New York

Zone 3 Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Fall Fishlift

1994

Vermont

Fishlift	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0

635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

1996

Vermont

Fishlift	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

1997

Vermont

Fishlift	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Rainbow Trout

Summer Gillnetting

1991

Vermont

Zone 4B Size Class	No Fish	No Fish w/FW	No Fish w/HW	No Fish w/W	No Fish w/Scars	No Fish w/ Type A	No Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% w/Type A Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	1	1	1	0	1	1	400	400	100	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	1	1	1	0	1	1	400	400	100	100

Summer Creel Surveys

1990

Vermont

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

1991

Vermont

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Zone 5A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

1992

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	1	1	0	0	100	0	100
432-533	0	0	0	0	0	0	0	0	0	0	0

534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	1	1	0	0	100	0	100

1995

Vermont

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	1	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	0	0	0	0	0	0	0

1997

Vermont

Zone 2A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks

0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Zone 2B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	2	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	4	0	0	0	0	0	0	0	0	0	0

Zone 3A Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Zone 3B Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0

534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	1	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	0	0	0	0	0	0	0

Tributary Creel Surveys

1996

Vermont

Zone 3C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

Zone 2C Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	0	0	0	0	0	0	0

Fall Electrofishing

1995

New York

Zone 3 Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

1997

New York

Zone 3 Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	1	1	0	1	0	1	0	200	200	100	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	1	0	1	0	1	0	200	200	100	100

Spring Electrofishing

1995

New York

Zone 3 Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/Attacks
0-431	0	0	0	0	0	0	0	0	0	0	0
432-533	2	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0

635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	2	0	0	0	0	0	0	0	0	0	0

1996

New York

Zone 3 Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/Attacks
0-431	1	0	0	0	0	0	0	0	0	0	0
432-533	0	0	0	0	0	0	0	0	0	0	0
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	1	0	0	0	0	0	0	0	0	0	0

1997

New York

Zone 3 Size Class	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/Attacks
0-431	13	3	3	5	2	6	0	54	69	38	46
432-533	4	0	3	3	2	4	1	150	250	75	100
534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	17	3	6	8	4	10	1	76	112	47	59

Fall Fishlift

1993

Vermont

Fishlift	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	6	0	0	0	2	2	0	0	33	0	33
432-533	1	0	0	0	0	0	1	0	0	0	0

534-634	0	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	7	0	0	0	2	2	0	0	33	0	33

1994

Vermont

Fishlift	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	75	1	1	2	6	8	0	3	13	3	11
432-533	118	1	8	8	12	17	1	8	20	7	14
534-634	1	0	1	1	0	1	0	100	100	100	100
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	194	2	10	11	18	26	1	13	36	6	13

1995

Vermont

Fishlift	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	12	0	0	0	2	2	0	0	42	0	17
432-533	33	0	5	5	7	11	3	24	45	15	33
534-634	1	0	0	0	0	0	0	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	46	0	5	5	9	13	3	17	43	11	28

1996

Vermont

Fishlift	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	22	0	1	1	0	1	0	9	9	5	8
432-533	22	0	1	1	3	4	1	5	18	5	18
534-634	2	0	0	0	0	0	0	0	0	0	0

635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	46	0	2	2	3	5	1	7	13	4	11

1997

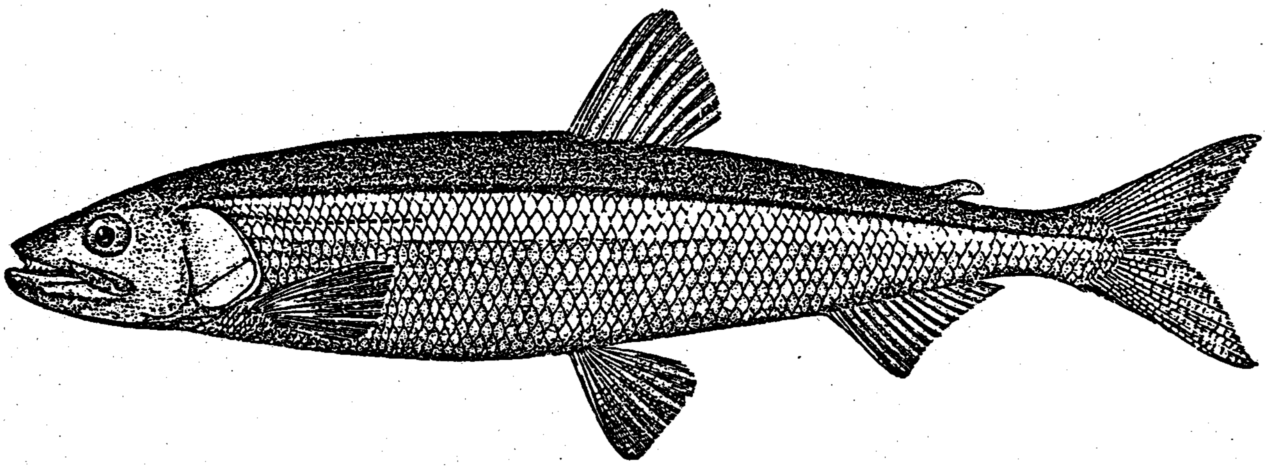
Vermont

Fishlift	No. Fish	No. Fish w/FW	No. Fish w/HW	No. Fish w/W	No. Fish w/Scars	No. Fish w/Attacks	No. Fish w/Hits	Wounds/ 100 Fish	Attacks/ 100 Fish	% Fish w/W	% Fish w/ Attacks
0-431	11	0	0	0	0	0	0	0	0	0	0
432-533	17	1	1	2	0	2	2	12	18	12	12
534-634	2	0	0	0	0	0	1	0	0	0	0
635-735	0	0	0	0	0	0	0	0	0	0	0
736-836	0	0	0	0	0	0	0	0	0	0	0
Total	30	1	1	2	0	2	3	7	7	7	7

APPENDIX J

Assessment of Rainbow Smelt Stocks During an Eight-Year Experimental Sea Lamprey Control Program on Lake Champlain

Assessment of Rainbow Smelt Stocks During an Eight-Year Experimental Sea Lamprey Control Program on Lake Champlain



By

George W. LaBar
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University of Idaho
Moscow, ID 83844

March 3, 1999

FORAGE FISH ASSESSMENT

Final Report

State: Vermont   Project No.: F-23-R

Study Title: Restoration and Enhancement of Salmonid Fisheries in Lake Champlain

Job: No. 4 Forage Fish Assessment

Period Covered: July 1, 1990-June 30, 1998

Funded by: Federal Aid to Sportfish Restoration Act

Final Report submitted to the

Vermont Department of Fish and Wildlife

by

George W. LaBar, Ph.D.
Professor and Head
Department of Fish and Wildlife Resources
University of Idaho
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December 1, 1998

Assessment of Rainbow Smelt Stocks During an Eight-Year Experimental Sea Lamprey Control Program on Lake Champlain

Executive Summary

Rainbow smelt stocks were monitored using stepped-oblique midwater trawling and hydroacoustic assessment prior to and during an 8-year experimental program to chemically control sea lamprey populations in the Lake Champlain drainage. The objectives of the study were to:

1) Determine the extent of changes in rainbow smelt population structure over the course of the study;

2) Determine the extent of changes in smelt growth rates over the course of the study; and,

3) Determine the extent of changes in diets of top predators from stomach samples taken by state and federal fisheries biologists.

Midwater trawling took place each year from 1990-1997 during the second two weeks in August. From 1990-92, four sampling sites were utilized: Shelburne Bay, the Main Lake outside Juniper Island (Juniper), Outer Malletts Bay, and the Northeast Arm. In 1993, a fifth site, Barber Point, in the Main Lake, was added and maintained for the duration of the project. At each site, from four to eight stepped-oblique midwater trawls were taken each year. Approximately 200 rainbow smelt from each station each year were weighed, measured and aged. Predator food habits were derived from information collected by the Vermont Department of Fish and Wildlife during gill-net surveys of lake trout.

Catch rates (catch per 55-min trawl=CPUE) were significantly different between years within sites and between sites within years. They fluctuated from a low of 50 at Juniper to a maximum of 6,500 in the Northeast Arm. Catch rates were highest in the Northeast Arm and Malletts Bay and lowest in the Main Lake. Because there was substantial variation in catch rates by year within sites, it was not possible to determine if there was a statistically significant downward trend over time. Mean CPUE in the latter four years of the project was lower than in the first four years at Shelburne, Juniper and Malletts Bay and higher in the Northeast Arm. What was apparent were the substantial differences in CPUE by area, with Main Lake sites being much lower than Malletts Bay or the Northeast Arm. If CPUE is an index of population density, then population density varied by more than two orders of magnitude between the Northeast Arm and Juniper.

Annual mortality rate estimated by cohort analysis varied from a high of 0.96 in 1995 in the Northeast Arm to a low of 0.17 at Barber Point in 1995. Average cohort mortality rates at the five sites for all years combined were between 0.64 and 0.86 . There was no clear trend of mortality rates either based on Chapman-Robson estimates or on cohort analysis. Mortality rates are within the range of those seen on Great Lakes smelt stocks exposed to exploitation, but somewhat higher than what is seen in unexploited stocks.

Mean age of Lake Champlain rainbow smelt changed little during the study; it was 2.5 years in both 1990 and 1997. With the exception of 1996, when mean age fell to 1.8 years, there was little variation in mean age of combined samples over the sampling period. Mean length of all rainbow smelt combined declined 10 mm from 1990 to 1997 . At individual stations, there was a greater decline in Malletts Bay and the Northeast Arm. Malletts Bay and Northeast Arm rainbow smelt stocks are most likely lightly predated, given that there have been fewer predators stocked in those areas. The result was abundant rainbow smelt stocks with slow growth, high mortality and age structure skewed towards earlier ages. Main Lake rainbow smelt were inexplicably about 100 mm shorter at age 5 than they were in the earlier part of the century (pre-1950).

Lake trout stomachs with food contained a predominance of rainbow smelt: 96% contained rainbow smelt larger than 3 inches and 40% contained smelt less than 3 inches. There was a significant downward trend in mean numbers of rainbow smelt per stomach over the study period. Although relatively few other food items were found, those that were occasionally seen were sculpin (presumably slimy sculpin) at about 2% of stomachs and cisco, generally less than 2% .

Hydroacoustic surveys also showed decreased numbers of rainbow smelt over the course of the study. The largest decline was in the Northeast Arm where estimated biomass changed from 143.1 kg/ha to 33.1 kg/ha. In each area sampled, there was a decrease by more than 50% in estimated biomass density from 1990 to 1997.

Given the decreases in CPUE and estimated biomass of rainbow smelt in most areas, the the changes in growth rates of rainbow smelt and food habits of lake trout and the unknown effects of exotic species such as zebra mussels, it is recommended that there be no increases in numbers of predators stocked in the lake at this time. It is also recommended that the bioenergetic models used by LaBar (1993) and LaBar and Parrish (1995) be revisited, using the latest information on prey and predators in the lake. It is further recommended that the rainbow smelt populations be monitored for the foreseeable future to document further changes.

Assessment of Rainbow Smelt Stocks During an Eight-Year Experimental Sea Lamprey Control Program on Lake Champlain

Introduction

In the fall of 1990, an 8-year experimental program for management of sea lamprey (*Petromyzon marinus*) in Lake Champlain began. In conjunction with chemical control measures, several assessment programs were initiated to help determine the overall effect of the program on the lake's fisheries. Rainbow smelt (*Osmerus mordax*) are the primary food for predators in the lake and also comprise an important winter sport fishery. Lake Champlain fishery managers predicted that as sea lamprey populations were reduced through chemical control, there would be concomitant changes in predator mortality rates and growth and thus increased consumption rates of rainbow smelt by predators. Therefore, a program was begun to monitor rainbow smelt stocks in several areas of the lake, using the technique of stepped-oblique midwater trawling (Kirn and LaBar 1991).

The objectives of the study were to:

1) monitor relative numbers and biological status of rainbow smelt stocks in management areas 3B (Main Lake), 4A (Malletts Bay) and 5 (Northeast Arm),
2) assess the applicability of hydroacoustic assessment techniques to Lake Champlain rainbow smelt stocks, and
3) determine changes in food habits of top predators over the course of the study.

Methods

Study area

Four sampling sites were selected based on previous work (Kirn 1986, Kirn and LaBar 1996). These sites were a shallow and deep site in the Main Lake, one station in Malletts Bay, and one site in the Northeast Arm (Fig. 1). In 1993, a new site, Barber Point, was added for reasons given in the methods section below (Fig. 1). Station locations are shown in Table 1 (north and south refer to the approximate location of the northern and southern ends of the trawled transect):

Midwater trawling

Midwater trawling was carried out at night as described by Kirn and LaBar (1991). The midwater trawl used was the same model as described in that paper, a 5 m X 5 m trawl with large mesh near the mouth grading to smaller mesh near the end, and terminating in a cod end with a 0.6 cm square mesh liner (Appendix A). For each trawl, the net was lowered to approximately 35 m depth or to near the bottom, whichever came first. We towed at the maximum depth for 10 minutes, then each five minutes thereafter, raised the net about 3 m, and towed for an additional 5 minutes. When the net was about 10 m below the surface, it was hauled back to the boat. Thus, in deep-water sites, each trawl lasted for 55 minutes, and in shallow sites, 40-45 minutes. Catches were then adjusted so that all catches were expressed in terms of catch per 55-min of trawling (catch X 55 min/trawling time).

At each site, we generally took four trawls on each of two subsequent nights. Weather interfered with the sampling schedule on a few occasions, so that the total number of trawls was not the same in all years. In 1993, because inter-trawl variability in catch rates was so low, we added a new sampling site, Barber Point. However, in general, we took 32 trawls per year at the four primary sites. In years Barber Point was sampled (1993-1997), we took only four trawls at Juniper and added four at Barber Point. During each trawl, we monitored net depth and water temperature using a remote transmitter affixed to the head rope on the net. On some occasions, however, equipment problems precluded collecting that information.

A sample of 200 fish each sampling night was randomly selected from the fish caught and their total length measured. In addition, 25 fish from each haul (different fish from those measured) were frozen for later otolith extraction, and 25 were preserved in 10% formalin. If there were fewer than 200 total fish caught, priority was given to saving fish for aging. In the laboratory, smelt that had been frozen were thawed, measured, weighed, and otoliths were extracted. The otoliths were put into vials with a small amount of a mixture of 30% glycerine and 70% ethanol for about a month to clear before being aged (Jearld 1983). Otoliths were aged using a binocular microscope at 43X magnification as described in Kirn (1986). Stomachs were extracted from the formalin-preserved fish, and the contents placed into a vial with 70% ethanol until they could be identified and quantified at a later time.

Data Analysis

Differences in length and weight were analyzed with analysis of variance using SAS software, with length and weight as dependent variables, and year, site, age, and trawl as independent variables. In addition, year/site, year/age and age/site interactions were tested. Length at age was compared by site and by year. The relationship of length and weight was examined after converting lengths and weights to natural logarithms. CPUE was compared over sites and years. Because CPUE was non-normal, it was transformed using a power transformation of -0.2.

Survival rates and their 95% confidence intervals were calculated where possible (where number at age declined with age) using the Chapman/Robson method (Ricker 1975). However, because it is unlikely that the assumption of equal recruitment was met, where the data were available, cohort survival was also estimated as follows. The number of fish at age-3 was set at age-class one, the number of 4-year old fish the following year was set as age-class 2, etc. Number in age-class was then transformed to natural log, and a linear regression of natural log of number against age-class was calculated. The slope of the resulting line was considered to be the total instantaneous mortality rate, Z. Annual survival, S, was then calculated from the formula $S = e^{-Z}$.

Predator Food Habits

Information on food habits of lake trout (*Salvelinus namaycush*) was obtained from the Vermont Department of Fish and Wildlife through their annual gillnet sampling program. Stomach sample data was recorded as number of each food item present per stomach. Total length and species was recorded for each predator. Rainbow smelt in stomachs were divided into those greater and those lesser than 3 inches (7.6 cm) fork length. Analysis of variance was used to analyze the stomach data, with number of diet items per stomach as the dependent variable.

Hydroacoustics

To assess the applicability of hydroacoustic techniques as a tool for assessing forage fish, we rented hydroacoustic assessment equipment from Biosonics, Inc., in Seattle in 1990. The equipment consisted of a dual-beam transducer towed along side the boat in about 2 m of water. The transducer was towed in a towed body or "fish" to stabilize it. The echoes were received and processed by equipment described in Thorn (1983). Basically, incoming signals were recorded and monitored in three ways: on oscilloscope, on paper chart, and on DAT tape.

At each sampling station on each sampling night, a midwater trawl was collected and at the same time, hydroacoustic data was also recorded on DAT tapes. Typically, we would record at 20 log R for the first 15-min of the transect, then record at 40 log R, so that we could later determine both biomass and size distribution of targets. We usually collected about one hour of hydroacoustic data each night. After recording, the tapes were sent to Biosonics for analysis.

In 1995 and subsequent years, hydroacoustic data was recorded using a single-beam Simrad EP500 system. Data was stored either on an external hard drive or Zip drives and was later compressed and analyzed in the laboratory using the EP500-45 analysis software (Simrad, Inc.).

Results

Catch per Unit of Effort

A total of 269 midwater trawls was taken from the five sampling sites in the eight sampling seasons (Table 2). Catch per 55-min trawl (CPUE) varied from a low mean catch of 52 in 1992 at the Juniper site, to a high of 3,553 in 1996 in the Northeast Arm (Fig.2). Catch rates were significantly different between years ($p<0.001$) and between sites ($p<0.001$) and there was also a significant site by year interaction. Multiple comparison tests showed that the only sites that were not different when all years were pooled were Juniper and Barber Point ($p=0.15$) and Shelburne and Barber Point ($p=0.10$).

Main Lake sites showed the most pronounced downward trend in CPUE (Fig. 2), with Shelburne Bay showing the largest decline. However, even at the Main Lake sites, the downward trend was not significant due to large within-year variation..

Catch rates at both Malletts Bay (Fig. 3) and the Northeast Arm (Fig. 4) were more variable than they were in the Main Lake. However, at Shelburne Bay, CPUE also varied by almost an order of magnitude from year to year. There seemed to be no synchrony in changes of catch rate by year between sites except in the Main Lake, where Shelburne Bay and Juniper varied similarly between years. However, catch was highest in the Northeast Arm in 1995, but lowest at Malletts Bay in that same year. At the Northeast Arm site, CPUE was much more variable, encompassing more than an order of magnitude, from 324 in 1991 to 3,553 in 1996. In 1987, mean CPUE was less than 200 in the Northeast Arm (Table 2). Catches were much less variable in Malletts Bay, but there were still significant differences between years (Fig. 3).

Age and Growth

Mean age of Lake Champlain rainbow smelt changed very little over the 13 years for which we have samples. In 1984 and 1985 the mean age was about 2.1 years and it was 2.4 years at the end of the project. However, the 1984 and 1985 samples did not include either Malletts Bay or Northeast Arm samples.

Mean length of all rainbow smelt declined 10 mm from 1990 to 1997 (Table 3; Fig. 6). Although mean length significantly declined in all sampled areas (ANOVA, $p<0.0001$, Fig. 6), the decline was more pronounced in Malletts Bay and the Northeast Arm (Fig. 7). Length frequency distribution clearly shows the differences in size structure between areas (Fig. 8). Northeast Arm and Malletts Bay showed a clear unimodal peak at about 120 mm, whereas the other three areas showed less pronounced, but evident bimodal distributions. Confounding this analysis, of course, is the difference in catch rate by age classes. When there is a strong year-class of age 1 or age 2 rainbow smelt, the average length declines, and conversely, when catches are dominated by older-aged fish, average length increases.

In spite of this, there were no significant changes in length-frequency distributions over time within areas. The decrease in mean length with time is shown clearly in Fig. 9. Only in Shelburne is the mean length greater in years after 1991. Except for Juniper in 1992, only in Shelburne is the mean length greater in years after 1991. Differences in mean age after 1990 were not as apparent (Fig. 10).

There was a significant difference in length by year within site and significant year by age interactions for all sites (ANOVA, $p<0.0001$ for all tests). Multiple comparison tests were run on mean length of all ages at all sites. I used these to compare mean length at age for years 1991 through 1997 with mean length at age in 1990 for all sites except Barber Point, where there sampling commenced in 1993. At Shelburne, Juniper and Malletts Bay, there were about as many age classes that were significantly different from 1990 as that were not, and those were about evenly split between those that were longer at age and those that were shorter at age. In the Northeast Arm, however, only four of twenty-four comparisons were positive and 15 were negative. Thus, although there was a significant decrease in overall mean length, there was not a statistically significant trend in length at age.

Length-at-age of Main Lake rainbow smelt has been relatively consistent for older-aged fish in recent studies, but more variable at ages one and two. Even so, it seems likely that the age-1 length of 132 mm in 1991 is the result of a small sample size (7 fish) and perhaps some aging problems given that the age-2 rainbow smelt in 1992, which should represent the same cohort, are substantially smaller than they were in 1991.

It is apparent from the length-at-age data from all sites that rainbow smelt in Malletts Bay and the Northeast Arm grow slowly when compared to rainbow smelt from the other areas (Table 3; Fig. 11). For example, for age-3 fish, in every year, Malletts Bay and Northeast Arm fish were from 10-20 mm shorter than their counterparts in the Main Lake. Although we were unable to weigh fish in the field, it was also apparent by visual inspection that the condition of those fish was very poor. When all years are compared, it became more apparent that Northeast Arm and Malletts Bay rainbow smelt were growing more slowly than those from the Main Lake sites (Fig. 11).

Although Northeast Arm fish seemed to recover their length at age-5, there were only 2 age-5 fish taken in the Northeast Arm in all four years of sampling. Sample sizes of age-5 rainbow smelt were much larger for the other sites.

There were substantial decreases in mean weight through the course of the study (Fig. 12). This was especially pronounced in Malletts Bay where there was a 57% decrease in mean weight, and in the Northeast Arm, where there was a 35% decrease in mean weight. There was more variability in weight at Shelburne (Fig. 12), where mean weight in 1993 was 24.9 g, the highest value over the eight sample years, and in 1995 it was 11.8 g, the lowest value. As with length, weights are in large part a function of age structure; stronger age-classes can have a significant impact on weight distribution.

There was uneven recruitment in both the Northeast Arm and in Malletts Bay. There were only four age-1 rainbow smelt caught in 1991 in either place, and a total of only 3 in 1993 (Table 3). In other years, however, catches were dominated by 1- or 2-year old fish.

Mortality Rates

Annual mortality rates of cohorts varied from a low of 0.17 at Barber Pt. in 1995 to a high of 0.96 at Malletts Bay for the 1995 cohort, and averaged 0.57, 0.54, 0.77, 0.78 and 0.59 respectively at Shelburne, Juniper, Malletts Bay, Northeast Arm and Barber Point (Fig. 13; Table 4). Although there were significant differences between years within sites, overall trends were difficult to discern. Mortality rates at Malletts Bay seemed to rise from the 1990 to 1993 cohorts (Table 4, Fig. 14) and increased slightly from 1990 to 1992 in the Northeast Arm. Only at Barber Point was there a significant downward trend to the mortality rate. The 1992 cohort there had a mortality rate of 0.87, and the 1995 cohort only 0.17. Mortality rate of the 1995 cohort at Shelburne and Juniper was also very low (0.18 and 0.45 respectively).

Predator Food Habits

Of 4,775 lake trout stomachs examined, 1,676 were empty. Of the 3,099 stomachs with food, 96% contained smelt larger than 7.6 cm, and 40% contained smelt less than 7.6 cm. There were significant differences between years in numbers of rainbow smelt per stomach for all sampling areas except area 4A (ANOVA $p<0.01$, Table 5). In most cases, there were significant differences in number of rainbow smelt per lake trout stomach between 1996 and other sampling years. However, from 1993 until 1997, numbers were relatively stable, with the exception of 1996, when there was a significant decrease in number of large rainbow smelt per lake trout stomach in all areas except 4A (Fig. 15).

Other food items that appeared in lake trout stomachs included white perch (*Morone americana*), yellow perch (*Perca flavescens*), sculpin (*Cottus cognatus*), cisco (*Coregonus artedii*), crayfish (unidentified), burbot (*Lota lota*), *Mysis relicta*, and bivalves (Table 6). However, these items generally appeared in quantities less than 0.001 per stomach. The exception was sculpin, where numbers per stomach exceeded 0.2 in 33% of the samples. Sculpin numbers per lake trout stomach were frequently greater than 0.02. The only other food item category that appeared with any regularity was cisco, but numbers per stomach exceeded 0.02 about 40% of the time.

Hydroacoustics

Hydroacoustic assessment showed that there were significant decreases (ANOVA, $p<0.01$) in estimated biomass and numbers of rainbow smelt in all areas sampled from 1990 until 1997 (Table 7; Fig. 16). Biggest decreases were in Shelburne and the Northeast Arm. At the Northeast Arm, estimated biomass fell from 143.1 kg/ha in 1990 to only 33.1 kg/ha in 1997. Part of that is the result of a decrease in mean weight from 14.1 g to a mean weight of 9.3 g, and part is the result of a decrease in estimated numbers from 10,155 fish/ha to 3,557 fish/ha. In each area, there was a decrease by more than 50% in estimated biomass from 1990 till 1997. At Shelburne, the decrease was 82%, which corresponds well to the decrease in CPUE.

Discussion

Changes in catch rates, growth and survival all indicate that there has been a substantial change in the status of the rainbow smelt populations in Lake Champlain in most study sites over the eight years of the study. Rainbow smelt populations are noted for their volatility. Selgeby (1985) noted that Lake Superior smelt density varied from 8 kg/ha in 1974 to 2 kg/ha in 1975, then back up to 6.3 kg/ha in 1979, down to 1.6 kg/ha in 1980, stayed at about 2 kg/ha until 1983, then back up to 4.3 kg/ha. Leach and Nepszy (1976) found that Lake Erie rainbow smelt showed alternate-year strong year classes. Jude and Tesar (1985) showed that Lake Michigan rainbow smelt increased three-fold in response to an 86% decline in alewife populations. In Lake Champlain, it is apparent that the fluctuations are not predator driven, because those of the greatest magnitude occurred in the Northeast Arm, where predator densities are much lower than they are in the Main Lake. On the other hand, the trend in smelt density in all Main Lake sites is downward over the 10-years of the study. It seems likely, therefore, that this downward trend is predator-driven.

Changes in length-at-age in Lake Champlain rainbow smelt are not new. Zilliox and Youngs (1958) found that Lake Champlain rainbow smelt were the fastest growing rainbow smelt populations of any studied. However, by the early 1970's (Plosila 1982), they had become one of the slower-growing populations, approaching length-at-age of what were later labeled "dwarf" populations by Taylor and Bentzen (1993). O'Gorman and Bergstedt (1987) found that all ages of rainbow smelt in Lake Ontario declined in mean length from 1977 to 1984 and that the decline seemed to be related to the recovery of the alewife population from a significant die-off in 1976-77. They theorized that the alewife population reduced the zooplankton numbers, which in turn reduced the amount of food available to the rainbow smelt. Planktivores can indeed change not only numbers of zooplankton but size composition (Evans 1990).

It is unlikely, however, that the changes in length-at-age seen in the Lake Champlain populations are the result of changes in food supply entirely. The bulk of the change took place between 1929 (Greene 1930) and 1950 (Zilliox and Youngs 1958) when predator numbers were very low. Stocking of lake trout and other predators didn't commence until the late 1960's, and didn't reach current levels until in the 1980's. Ecological theory would indicate that compensatory changes in growth rates should have led to increases in growth as numbers of predators increases, not decreases.

Although there have been significant changes in length-at-age and length frequency distribution, there has not been a significant change in age structure. Mean age of all rainbow smelt in 1984 and 1985 was about 2.1 years (Kirn 1986), and it was 2.4 years at the end of the project. However, the 1984 and 1985 samples do not include either Malletts Bay or Northeast Arm samples, so the difference between the mid-1980's and the late 1990's may be more pronounced than it would seem. In addition, dominant age classes substantially influence the mean age. This is especially evident in the Northeast Arm, where mean age in 1995 was 1.3 years. As the dominant year-class moved through in subsequent years, mean age increased to 1.6 and finally to 2.1 years.

Stomach contents of lake trout show that rainbow smelt are still the most important dietary item. As with catch per unit of effort, number of smelt per lake trout stomach is highly variable. However, there seems to be a decrease in utilization of large smelt in Zone 3 and what may be a concomitant increase in utilization of small smelt (Table 5). The 1996 food habits data for lake trout presents somewhat of an anomaly. In that year, all data points converged on a similar, very low, value. However, I can find no problems with the data set that would explain the values reported. Values in 1997 seemed to return to the usual range of values.

In addition to changes in length-at-age, there seems to have been a loss of the two-race situation for rainbow smelt described by Greene (1930). Although Main Lake rainbow smelt do show bimodality in their length frequency distribution (Fig. 8), the upper peak occurs at about 150 mm, rather than the 250 mm described for the larger race by Greene (1930). It therefore seems more likely that the two peaks in Main Lake rainbow smelt length frequency have resulted from two different year classes rather than from two different races.

Survival rate is very difficult to measure in rainbow smelt because they are to at least some degree spatially segregated by age class and they are noted for producing variable year-classes. In fact there are very few studies which cite survival rates. O'Gorman and Bergstedt (1987) indicated that survival in Lake Ontario varied from a low of 20% to a high of 86%, and that it tracked alewife abundance very closely. In Lake Huron, annual mortality was about 90% during commercial exploitation, and 67% without fishing (Frie and Spangler 1985). Frie and Spangler (1985) cited Stedman and Nepszy (personal communication) that mortality was 85% and 73% respectively on Lakes Huron and Erie. Annual mortality was 65% in an anadromous population (Murawski and Cole 1978).

Given both the magnitude and variability of mortality estimates from the literature, those of Lake Champlain rainbow smelt are probably not excessive. One exception might be in the Northeast Arm and Malletts Bay, where recent mortality estimates exceeded 90% in some years. Mortality rates have been relatively high throughout the project in Malletts Bay, but in the Northeast Arm in recent years, these high rates have abated, and reached only 39% for the 1995 cohort (Table 4). It must be noted once again, however, that these rates are for the age-3 cohort and older rainbow smelt. However, greatest mortality often takes place in earlier years. Thus, actual total mortality may be higher.

Engstrom-Heg, et al. (1990) set forth specific criteria by which to judge whether or not the rainbow smelt population had been impacted by the increased number of predators resulting from increased predator survival after sea lamprey control. The following standards would indicate significant impacts:

1. Catch-per-unit-of-effort is significantly (5% level) lower at all sampling stations than in the same months as in previous years for the four consecutive years at all stations sampled.
2. Salmonids and walleyes show consistent and significant changes in selection of either prey species or sizes of prey selected. A negative impact is considered to be when the Index of Relative Importance of smelt and unidentified fish for any of the predator species mentioned above falls below 80% during summer sampling periods.
3. Analysis of length-at-age of rainbow smelt caught in midwater trawls in August indicates a significant (5% level) change, and that mean length-at-age for all age classes has changed.
4. A 25% or greated decrease in survival rate at the end of the eight year sampling period compared to 1984-85 and 1987 and accompanied by an increase in total mortality over the last four years of sampling.
5. Angler/cooperators demonstrate a significant (5% level) change in CPUE and/or a significant change in size distribution of smelt caught.
6. Male:female ratio decreases consistently over period of sampling.

Standard number 5 was not part of this study and will be presented elsewhere. It was not possible to determine sex in summer-caught rainbow smelt, so standard number six could not be evaluated.

For standard number 1, there was indeed a significant decrease in CPUE, but only at Shelburne and Juniper. Although there were significant differences in CPUE in Malletts Bay and in the Northeast Arm, because of the variability, no trend could be noted. Therefore, using a literal interpretation of standard number 1, there is not a significant impact of predators on the rainbow smelt. However, it must be remembered that in those areas were predators are most numerous, the Main Lake stations, there has been a substantial downward trend in CPUE.

For lake trout with food in their stomachs, there has not been a change in relative importance of rainbow smelt in the diet (standard 2). Although there has been somewhat of a decrease in numbers of rainbow smelt per stomach, the relative importance in the diet has remained very high. Again, using a literal interpretation of the standard, there has not been a significant impact. However, other studies of predator food habits in the Great Lakes have shown that lake trout diets may remain very stable in the face of declining availability of prey. Eby, et al. (1995) indicate that "if prey are highly aggregated or predators can search large areas, then a decrease in whole-lake prey abundance will not necessarily result in a lower predation rate until prey populations are severely reduced". They also argue that "an undesirable decline in prey resources may represent decisions made several years before the evidence appears".

Mean length of all age classes combined showed significant decreases in all areas (ANOVA, $p<0.001$), although length at age was not significantly different for all age classes and sampling sites . This is probably a reflection of changes in year class abundance in the catch, at least in part. Thus, the conclusion relative to standard number 3 is that predator on length at age of rainbow smelt populations are not likely. If predatory pressure is increasing, it seems that compensatory growth should take place and mean lengths should in fact be greater, not smaller. This has not occurred. Slower growth, on the other hand, must reflect a change in the zooplankton resources which are the primary food source for rainbow smelt. Obviously, because CPUE and presumably population size, is decreasing, the change in zooplankton is not coming from an increase in rainbow smelt consumption. Zebra mussels first came to Lake Champlain in 1993 and have subsequently flourished. However, it seems unlikely that there could be such immediate changes. In addition, the largest changes in growth rates in the rainbow smelt population took place prior not only to zebra mussel invasion, but also prior to stocking of large numbers of predators. Age-5 rainbow smelt in 1930 in the Main Lake averaged about 250 mm (Greene 1930). In the present study, mean length of age-5 rainbow smelt was 155 mm at Shelburne, 179 mm at Juniper and 160 mm at Barber Point (Table 3). Therefore, for this standard, it is unclear whether there has in fact been a significant predatory impact resulting from sea lamprey control.

The conclusion relative to standard number 4 is fairly clear. There has not been a decrease by 25% in survival of rainbow smelt at all sites. In fact, survival rates of the 1995 cohort are higher than in previous years at Shelburne, Juniper, the Northeast Arm and Barber Point. However, given the inherent variability in year-class strength, no conclusions should be drawn from that single data point. For example, although survival of the 1995 cohort at Shelburne was an unprecedented 82%, it was only 23% for the 1994 cohort. Only at Barber Point does it appear that there has been a significant upward trend in survival rate.

Management Recommendations

Rainbow smelt populations are notoriously variable, and the rainbow smelt in Lake Champlain are no exception to that pattern. There are several management implications of this variability: long-term monitoring is central to understanding trends in population parameters which are the reflection of long-term changes and not year to year variability; sampling sites and methodology should remain as constant as possible so that they do not add to the variability; stocks which depend on rainbow smelt for their primary food must be managed conservatively.

Natural variability notwithstanding, there are some changes in rainbow smelt and/or lake trout that most likely have resulted from the sea lamprey control experiment. Rainbow smelt stocks showed the greatest declines in areas where predators are most numerous. Although the proportion of rainbow smelt to other prey items in lake trout stomachs has not changed, there has been a decrease in mean numbers of rainbow smelt per stomach. There has been a significant decrease in mean length at all sites. Therefore, I recommend the following relative to forage fish monitoring and predator management:

1. Monitoring should continue on an annual basis for the foreseeable future.
2. Given the similarity of Juniper and Barber Point, it seems that one of these stations could be dropped. Although Juniper is very close to Willsboro Point, where large numbers of lake trout have been found historically, perhaps it makes sense to drop it and focus on Barber Point, because of its geographical distance from other sampling sites.
3. Hydroacoustic assessment should be continued and perhaps even expanded to include lake-wide (in deep water sections) transect surveys. An effort should also be continued to develop a trawl catch/hydroacoustic estimate relationship.
4. Predator food habits should be sampled if at all possible. The gill net effort to sample lake trout as carried out in the past is most likely not warranted, but some method of systematically and adequately sampling diets should be considered. Perhaps angler catches could be coupled with other forms of sampling. Sampling of predator food habits should be accompanied by an update of the bioenergetic models developed by LaBar (1993) and LaBar and Parrish (1995).

5. There should be no increases in predator stocking. In addition, growth rates and catch rates of predators (especially walleye, which are not stocked except by Vermont) should be closely monitored for change.

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Table 1. Rainbow smelt sampling station locations in Lake Champlain.

Station name	Depth	Location (latitude and longitude) North	Location (latitude and longitude) South
Shelburne Bay	20-45 m	44 ° 28.13' 73 ° 14.91'	44 ° 26.56' 73 ° 14.34'
Juniper Island	70-90 m	44 ° 28.87' 73 ° 18.33'	44 ° 26.75' 73 ° 18.09'
Barber Point	50-60 m	44 ° 10.85' 73 ° 23.64'	44 ° 08.97' 73 ° 23.74'
Malletts Bay	22-32 m	44 ° 36.07' 73 ° 16.59'	44 ° 34.65' 73 ° 16.82'
Northeast Arm	22-40 m	44 ° 47.02' 73 ° 15.39'	44 ° 45.36' 73 ° 14.69'

Table 2. Catch per unit of effort by site by year. The last column was calculated as CI% of Mean =mean/(95% CI*100).

Site	Year	N	CPUE ± 95% CI	CI% of Mean
Shelburne	1987	19	200 ± 54	27
	1990	2	741 ± 38	5
	1991	8	445 ± 150	34
	1992	8	205 ± 52	25
	1993	5	347 ± 19	5
	1994	7	381 ± 181	47
	1995	7	153 ± 53	35
	1996	8	172 ± 63	31
	1997	8	56 ± 2	3
				Mean = 24
Juniper	1987	15	110 ± 29	26
	1990	2	175 ± 39	22
	1991	7	173 ± 16	9
	1992	8	52 ± 13	25
	1993	4	76 ± 10	13
	1994	3	126 ± 23	18
	1995	4	72 ± 38	46
	1996	4	111 ± 54	49
	1997	4	66 ± 35	53
				Mean = 29
Malletts Bay	1987	4	230 ± 136	59
	1990	8	448 ± 66	15
	1991	5	614 ± 355	58
	1992	8	654 ± 202	31
	1993	8	654 ± 192	29
	1994	8	451 ± 111	25
	1995	8	278 ± 96	34
	1996	7	305 ± 70	23
	1997	8	465 ± 117	25
				Mean = 33

Table 2. (Cont.)

Northeast Arm	1987	2	139 ± 139	100
	1990	4	1628 ± 57	3
	1991	8	324 ± 76	23
	1992	8	1103 ± 218	20
	1993	8	1674 ± 52	3
	1994	8	977 ± 214	22
	1995	8	3553 ± 1455	48
	1996	8	2440 ±1179	41
	1997	8	398 ± 92	23
				Mean = 31
Barber Point	1987	2	139 ± 13	9
	1993	2	126 ± 51	40
	1994	4	315 ± 212	67
	1995	4	202 ± 77	38
	1996	4	79 ± 22	28
	1997	4	124 ± 55	44
				Mean = 38

Table 3. Length at age (mm) by site and year of Lake Champlain rainbow smelt . Sample size in parenthesis.

Site	Year	Age 1	Age 2	Age 3	Age 4	Age 5	Total
Shelburne	1990	111	118	147	162	170	132
Bay		(68)	(121)	(59)	(45)	(10)	(194)
	1991	120	143	155	174	206	158
		(3)	(50)	(124)	(35)	(10)	(222)
	1992	94	109	141	166	176	136
		(11)	(66)	(60)	(52)	(9)	(198)
	1993	100	126	152	170	187	150
		(8)	(26)	(78)	(26)	(11)	(149)
	1994	107	121	148	160	172	137
		(25)	(67)	(70)	(38)	(9)	(209)
	1995	99	130	144	150	161	129
		(68)	(23)	(16)	(60)	(19)	(186)
	1996	120	147	152	157	173	140
		(64)	(62)	(49)	(13)	(4)	(194)
	1997	101	116	140	145	155	129
		(40)	(33)	(41)	(37)	(20)	(171)
Juniper	1990	114	117	156	174	190	148
		(12)	(38)	(25)	(28)	(16)	(119)
	1991	141	144	154	177	192	158
		(4)	(24)	(104)	(32)	(7)	(171)
	1992	114	126	154	166	184	162
		(0)	(16)	(83)	(63)	(14)	(176)
	1993	110	117	153	166	190	142
		(1)	(42)	(34)	(15)	(6)	(108)
	1994	112	117	134	153	168	137
		(5)	(33)	(18)	(26)	(12)	(104)
	1995	110	125	148	154	162	138
		(26)	(10)	(10)	(27)	(13)	(86)
	1996	127	141	153	163		139
		(35)	(33)	(22)	(5)		(95)
	1997	107	128	146	154	163	132
		(16)	(35)	(21)	(16)	(4)	(92)
Malletts Bay	1990	101	116	130	152	163	131
		(12)	(108)	(59)	(16)	(3)	(198)
	1991	106	136	144	156		141
		(1)	(49)	(70)	(5)		(127)
	1992	114	128	139	146	148	130
		(3)	(53)	(102)	(34)	(4)	(196)

Table 3. (Cont.)

	1993	85	104	132	162	180	123
		(2)	(87)	(88)	(8)	(12)	(197)
	1994	100	109	117	118	129	116
		(6)	(20)	(84)	(74)	(18)	(204)
	1995	109	122	134	141	164	125
		(62)	(42)	(70)	(17)	(4)	(200)
	1996	115	125	126	133	138	118
		(135)	(43)	(8)	(3)	(2)	(191)
	1997	99	115	122	130	132	112
		(66)	(77)	(35)	(13)	(6)	(197)
Northeast Arm	1990	119	120	131	140		131
		(4)	(83)	(27)	(3)		(117)
	1991	115	134	138	141		135
		(3)	(71)	(115)	(1)		(190)
	1992	111	125	141	144		129
		(1)	(35)	(145)	(8)		(189)
	1993	103	118	131	142		122
		(1)	(140)	(57)	(3)		(201)
	1994	120	116	127	130		122
		(12)	(34)	(43)	(11)		(100)
	1995	113	116	150	172	171	110
		(188)	(6)	(8)	(12)	(2)	(216)
	1996	120	123	129	144		122
		(86)	(98)	(10)	(1)		(195)
	1997	116	121	124	130		120
		(55)	(84)	(46)	(11)		(196)
Barber Pt.	1993		116	147	159	166	130
			(30)	(13)	(3)	(3)	(49)
	1994	120	123	143	153	157	138
		(20)	(81)	(97)	(59)	(22)	(279)
	1995	111	127	142	156	160	141
		(9)	(24)	(20)	(24)	(13)	(90)
	1996	120	136	144	148	159	138
		(24)	(12)	(24)	(18)	(5)	(83)
	1997	111	118	134	146	190	131
		(18)	(20)	(22)	(20)	(14)	(94)

Table 4. Mortality rates of cohorts (A_Z) and year catches (A_{CR}) where Z=total, instantaneous mortality rate, R^2=variance of Z, A_Z = annual mortality rate from linear regression of cohort (see methods) and A_CR=annual mortality calculated by Chapman/Robson method.

Cohort Year	Site	Z	R^2	A_Z	A_{CR}
1990	Shelburne	0.94	0.93	0.61	0.56
1991	Shelburne	1.21	0.97	0.71	0.74
1992	Shelburne	0.94	0.99	0.62	0.50
1993	Shelburne	0.71	0.99	0.51	0.69
1994	Shelburne	1.43	0.80	0.77	0.51
1995	Shelburne	0.20	0.99	0.18	N/A
1990	Juniper	N/D	N/D	N/D	N/D
1991	Juniper	1.21	0.88	0.71	0.75
1992	Juniper	0.81	0.83	0.56	0.63
1993	Juniper	0.48	0.93	0.39	0.53
1994	Juniper	0.94	0.98	0.61	0.47
1995	Juniper	0.60	0.88	0.45	0.41
1990	Malletts Bay	0.91	0.81	0.60	0.59
1991	Malletts Bay	1.37	0.92	0.75	--
1992	Malletts Bay	1.30	0.77	0.73	0.34
1993	Malletts Bay	1.63	0.91	0.81	0.57
1994	Malletts Bay	1.54	0.97	0.79	0.61
1995	Malletts Bay	3.22	0.99	0.96	N/A
1990	NE Arm	1.64	0.75	0.81	0.67
1991	NE Arm	2.37	0.98	0.91	--
1992	NE Arm	2.49	0.90	0.92	0.93
1993	NE Arm	1.67	0.99	0.82	0.75
1994	NE Arm	1.88	0.97	0.85	--
1995	NE Arm	0.49	0.22	0.39	N/A
1990	Barber Pt.	N/D	N/D	N/D	--
1991	Barber Pt.	N/D	N/D	N/D	--
1992	Barber Pt.	2.04	0.98	0.87	0.62
1993	Barber Pt.	1.48	0.99	0.78	0.42
1994	Barber Pt.	0.75	0.80	0.53	0.39
1995	Barber Pt.	0.18	0.95	0.17	0.18

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[1] Annual mortality rate from linear regression of cohort (see methods).

[2] Annual mortality according to Chapman-Robson method.

Table 5. Mean number of smelt per lake trout stomach by size category, year and study site, for those lake trout with food in their stomachs.

Year	3A		3B		3C		4A		2C	
	<3"	>3"	<3"	>3"	<3"	>3"	<3"	>3"	<3"	>3"
1992	0.21	2.93	0.19	3.12	0.23	2.68	0	1.53	0.58	2.74
1993	0.20	0.67	0.55	1.47	0.39	1.88	1.19	1.58	0.27	1.09
1994	0.24	0.79	0.53	1.70	0.24	2.10	0.04	1.21	0.39	1.58
1995	0.52	1.30	0.71	1.34	0.57	1.31	1.36	0.91	2.93	2.57
1996	0.92	0.13	0.95	0.19	1.01	0.19	0.46	0.18	0.91	0.16
1997	0.53	0.74	0.88	1.21	0.62	0.77	0.96	0.41	0.22	1.00

Table 6. Mean number of food items by category and zone per lake trout stomach for those lake trout stomachs that had food. Food categories that appeared only sporadically were not included in this analysis.

Year	Zone	N	Smelt<3"	Smelt>3"	Sculpin	Cisco	Y.Perch
1992	2	202	0.58	2.74	0.01	0	0.01
1993	2	70	1.43	1.70	0.03	0.01	.0.03
1994	2	64	0.47	1.95	0	0.03	0
1995	2	388	1.09	2.35	0.07	0	0.07
1996	2	69	1.86	0.34	0	0.03	0
1997	2	48	.035	1.58	0.25	0.06	0.02
1992	3	433	0.20	3.01	0.02	0	0.02
1993	3	333	0.70	2.05	0.21	0.03	0.21
1994	3	428	0.66	2.35	0.28	0	0.28
1995	3	332	1.06	2.25	0.08	0	0.08
1996	3	486	1.86	0.33	0.05	0.02	0.05
1997	3	388	1.09	1.47	0.14	0.06	0.14
1992	4	15	0.13	1.53	0	0	0
1993	4	13	1.46	2.23	0	0	0
1994	4	27	0.15	1.67	1.15	0.07	1.14
1995	4	34	2.20	1.38	0.68	0	0.67
1996	4	19	1.05	0.42	0	0	0
1997	4	63	1.16	0.68	0.02	0.05	0.02
Total		3430	0.95	1.19	0.12	0.01	0.02

Table 7. Mean of the estimated number from hydroacoustic surveys (number per hectare), mean weight and estimated biomass (kg/ha) of rainbow smelt in the five sampling areas of Lake Champlain.

Site	1990			1994			1997		
	No./ha	Wt.(g)	Biomass(kg/ha)	No./ha	Wt. (g)	Biomass(kg/ha)	No./ha	Wt. (g)	Biomass
Shelburne	6,935	13.4	93.2	2,231	14.5	32.3	1,030	12.9	13.3
Juniper	1,875	18.3	34.3	1,484	16.1	23.9	919	13.5	12.4
Malletts	3,490	13.4	46.8	2,803	8.7	24.2	2,657	7.4	19.7
NE Arm	10,155	14.1	143.2	3,551	9.6	34.1	3,557	9.3	33.1
Main Lake				461	15.3	7.0	1,515	13.0	19.7

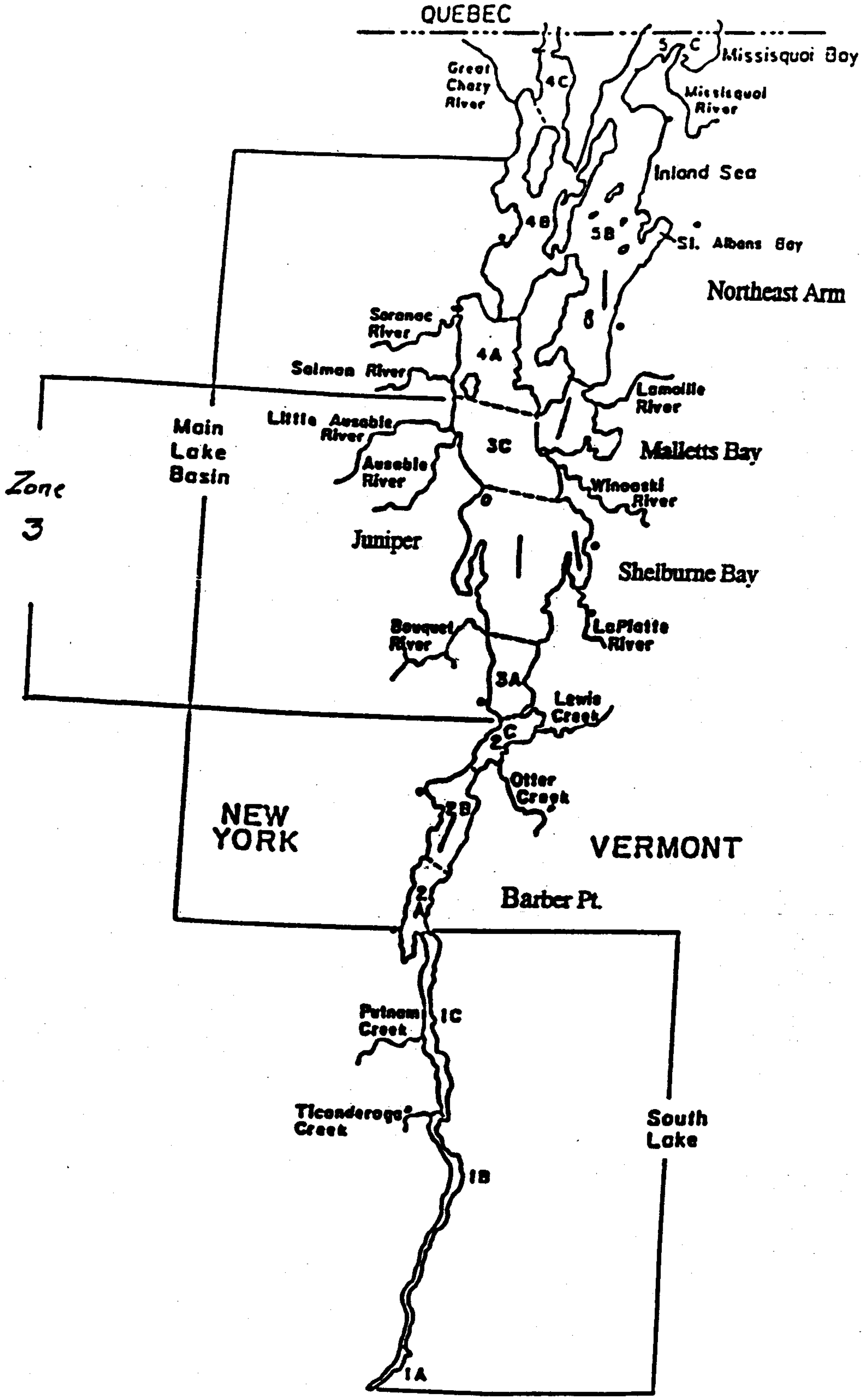


Figure 1. Lake Champlain, showing approximate location of trawling transects.

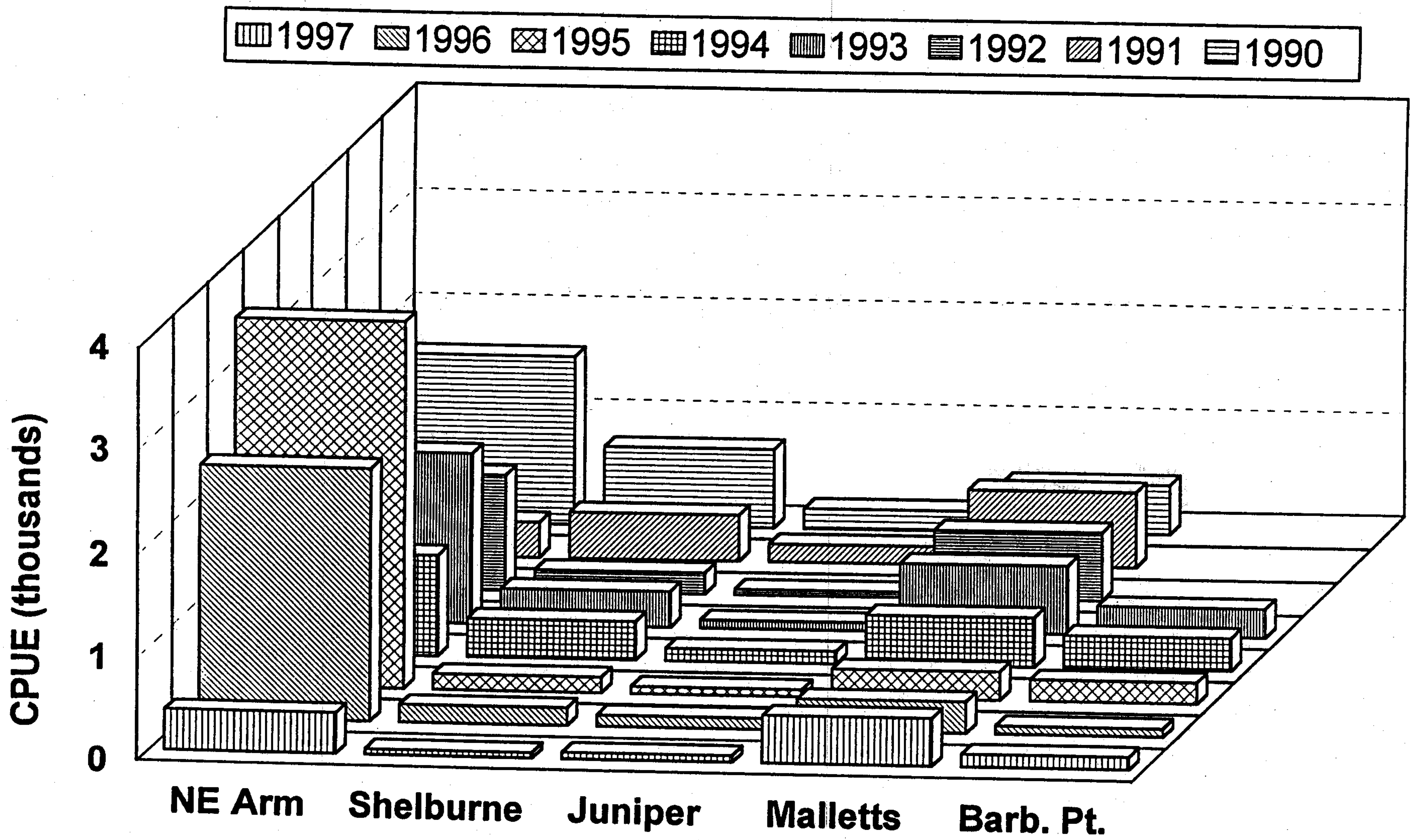


Figure 2. Catch of rainbow smelt per 55-min midwater trawl at five sampling sites over eight years.

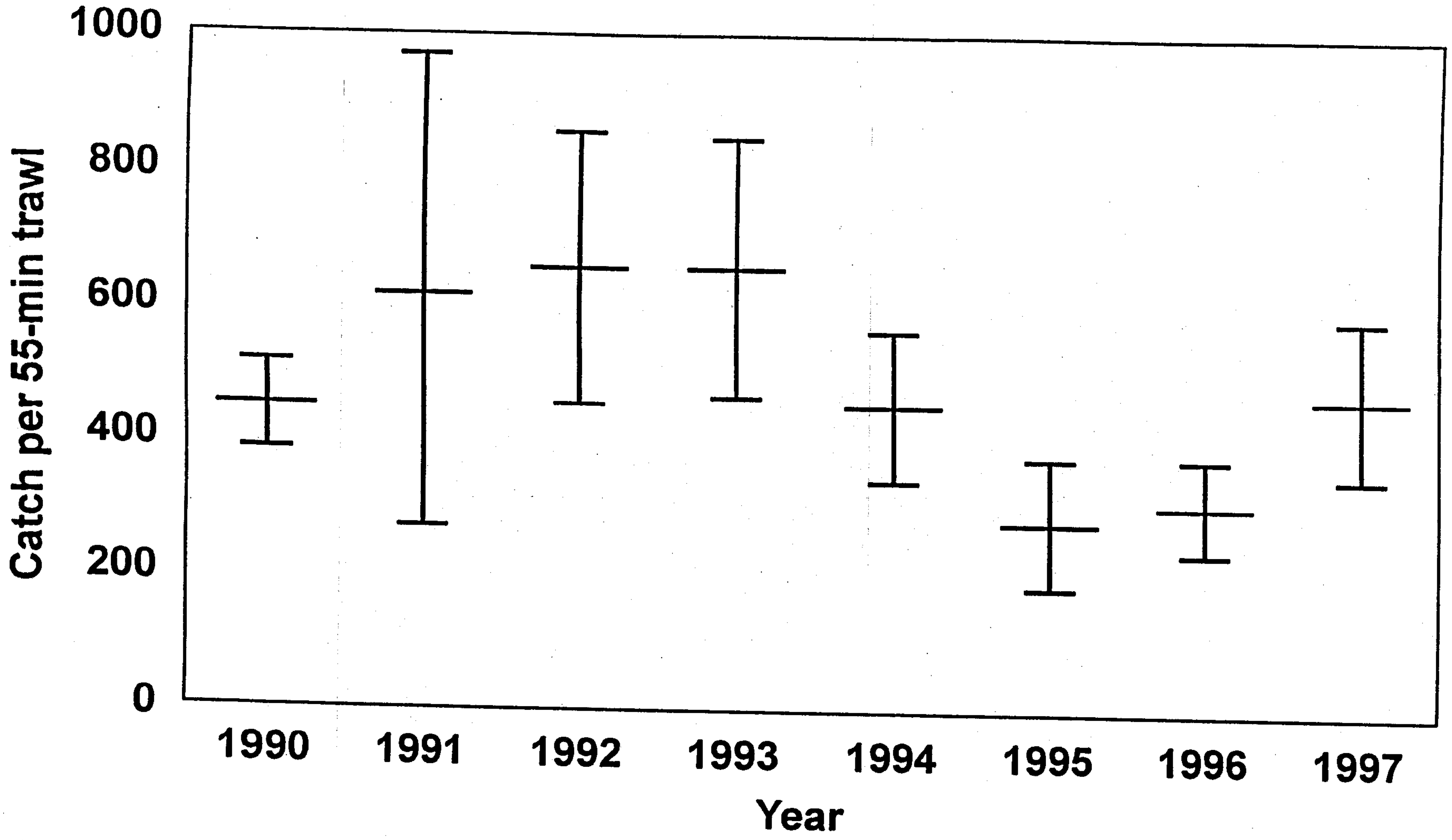


Figure 3. CPUE at Malletts Bay over the eight year sampling period. Error bars show 95% confidence limit.

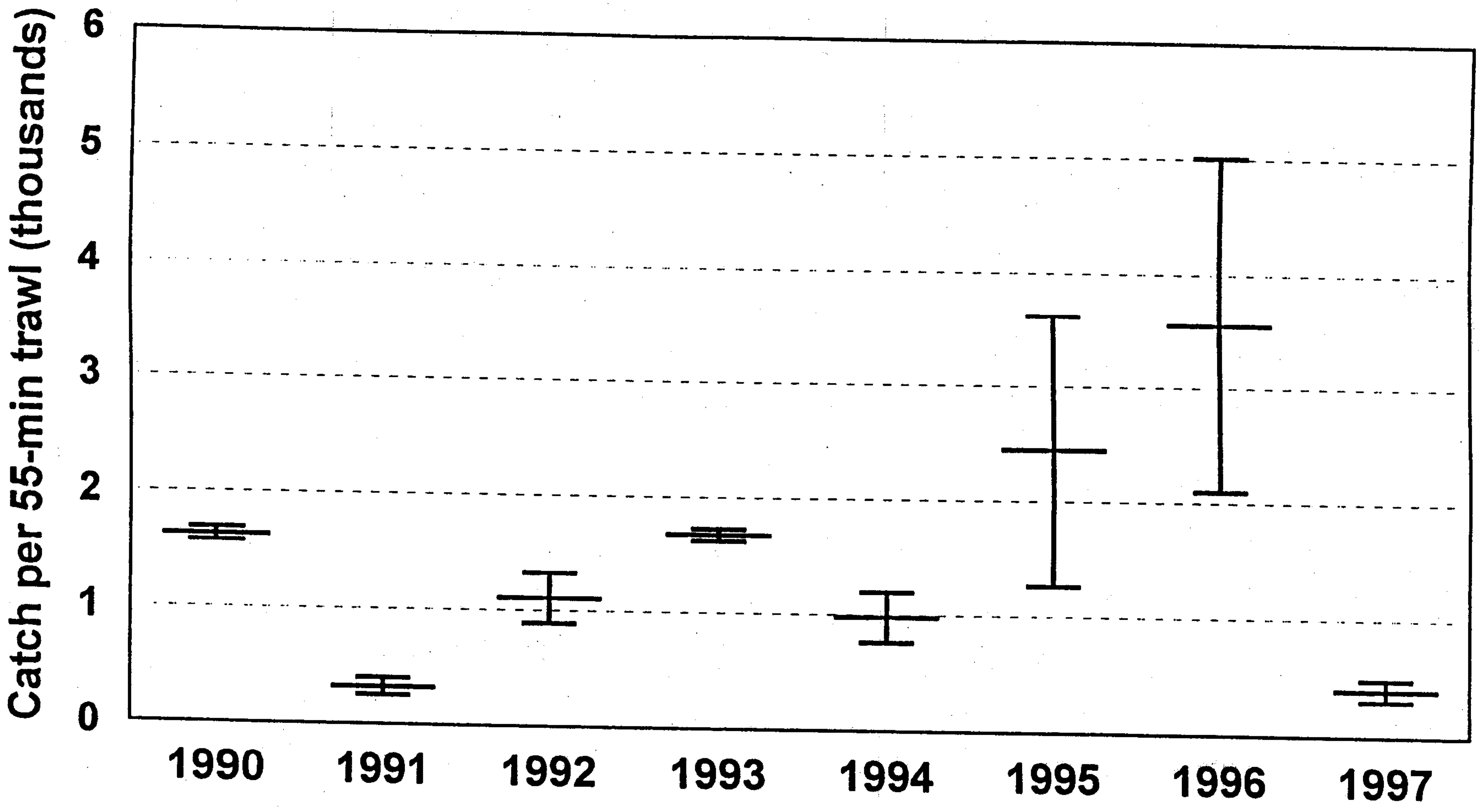


Figure 4. CPUE at the Northeast Arm over the eight year sampling period. Error bars show the 95% confidence limit.

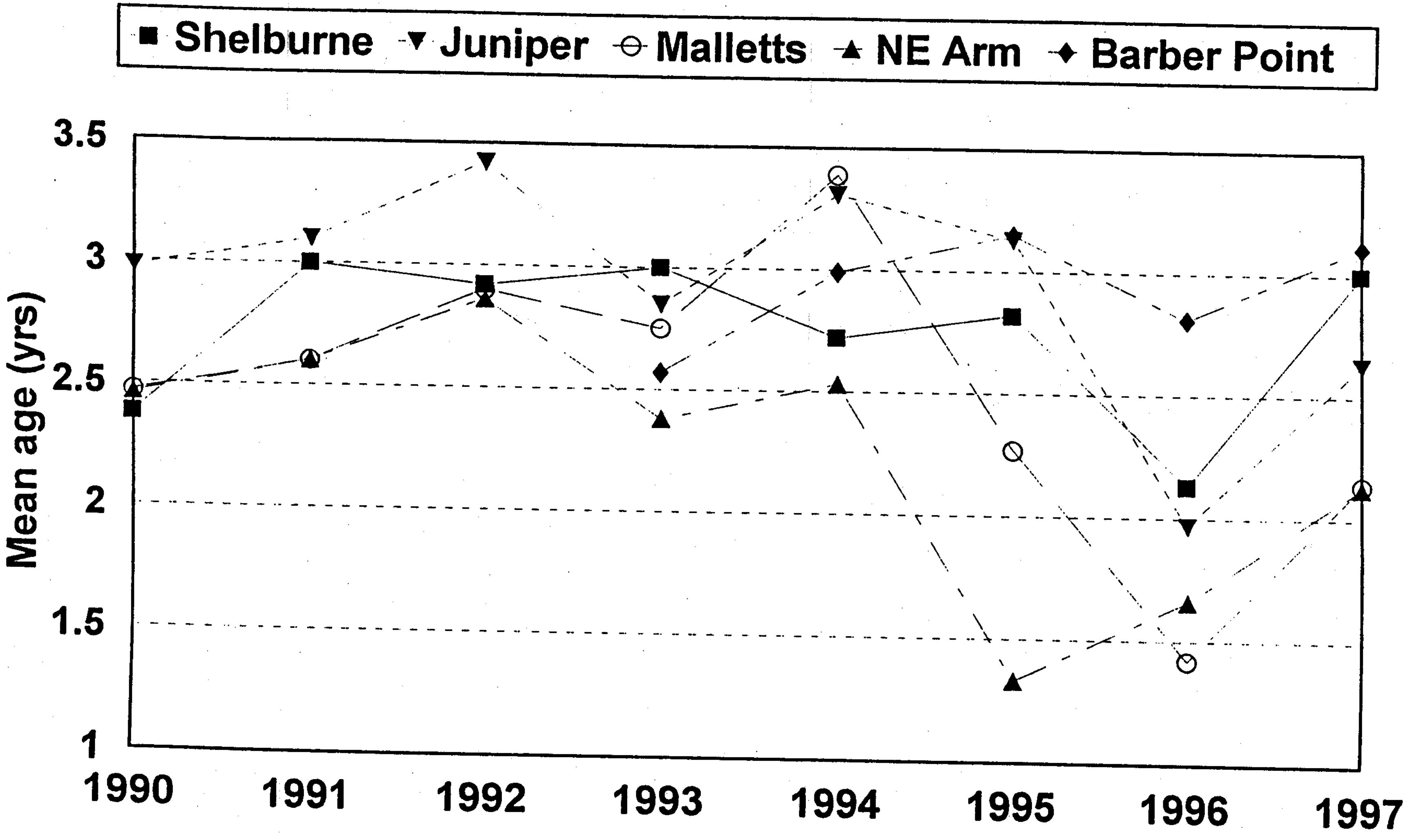


Figure 5. Mean age of rainbow smelt at five study sites from 1990 to 1997.

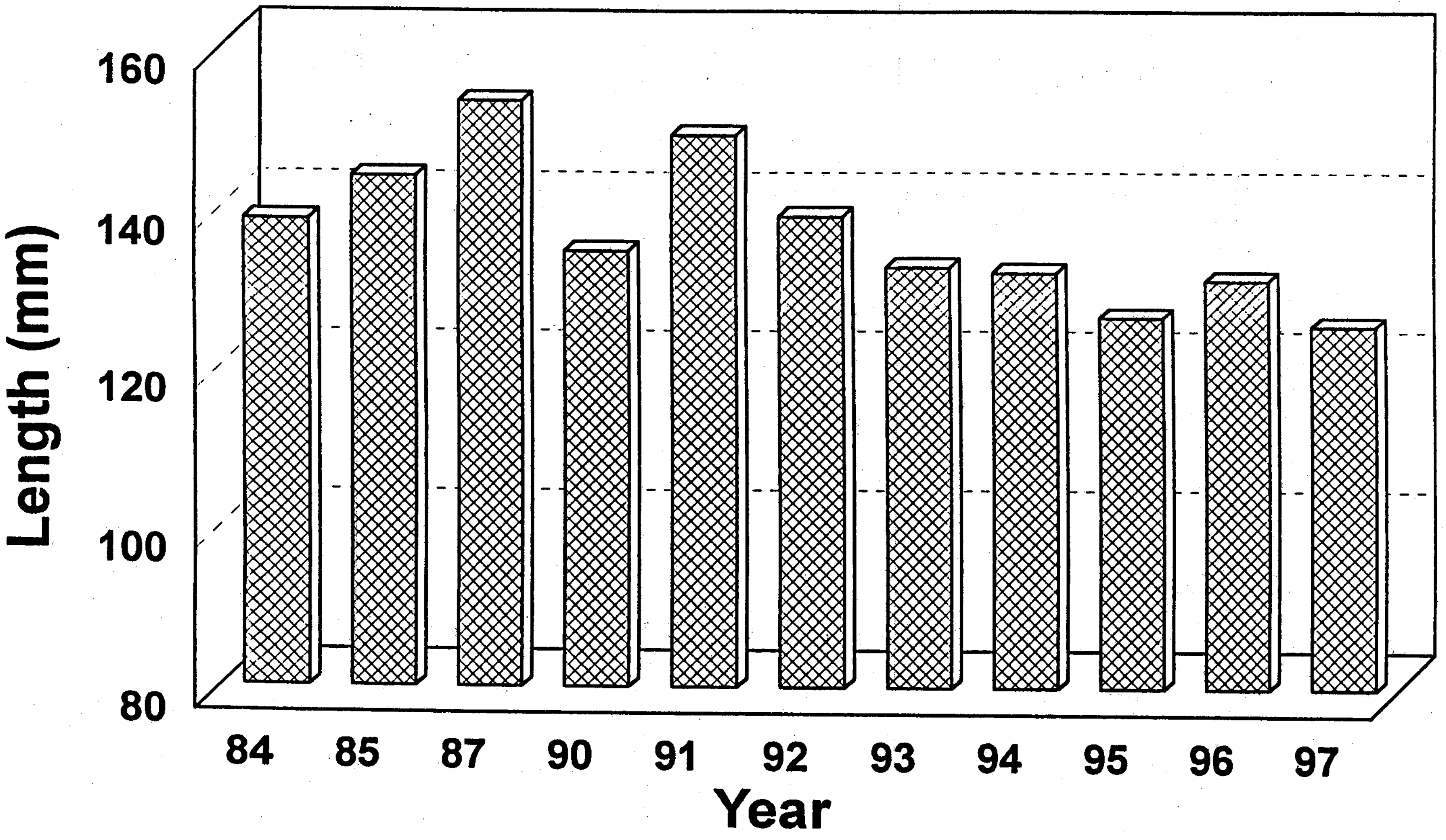


Figure 6. Mean length of all fish from all sites over the sampling period.

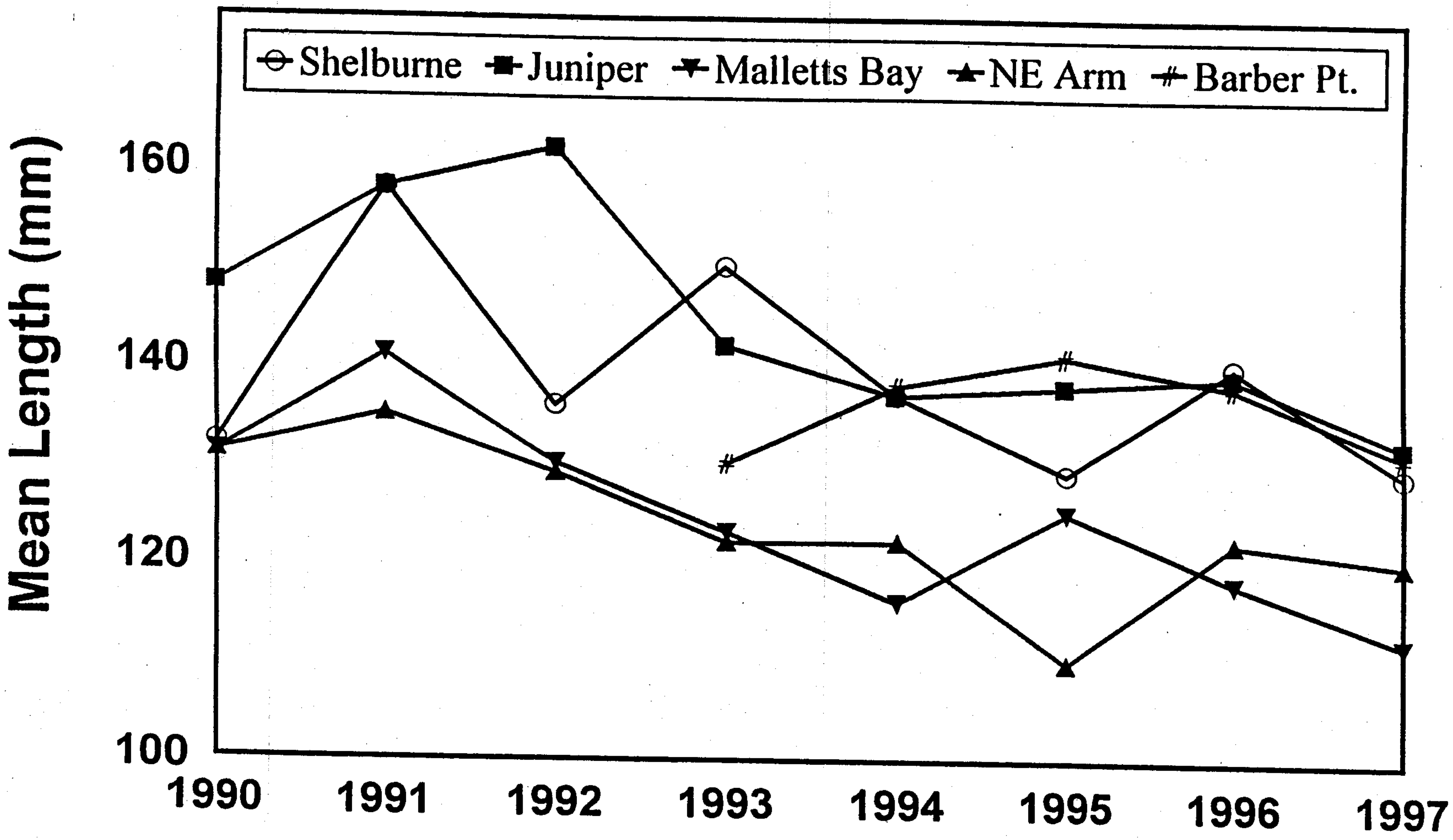


Figure 7. Mean length of all rainbow smelt by station and year.

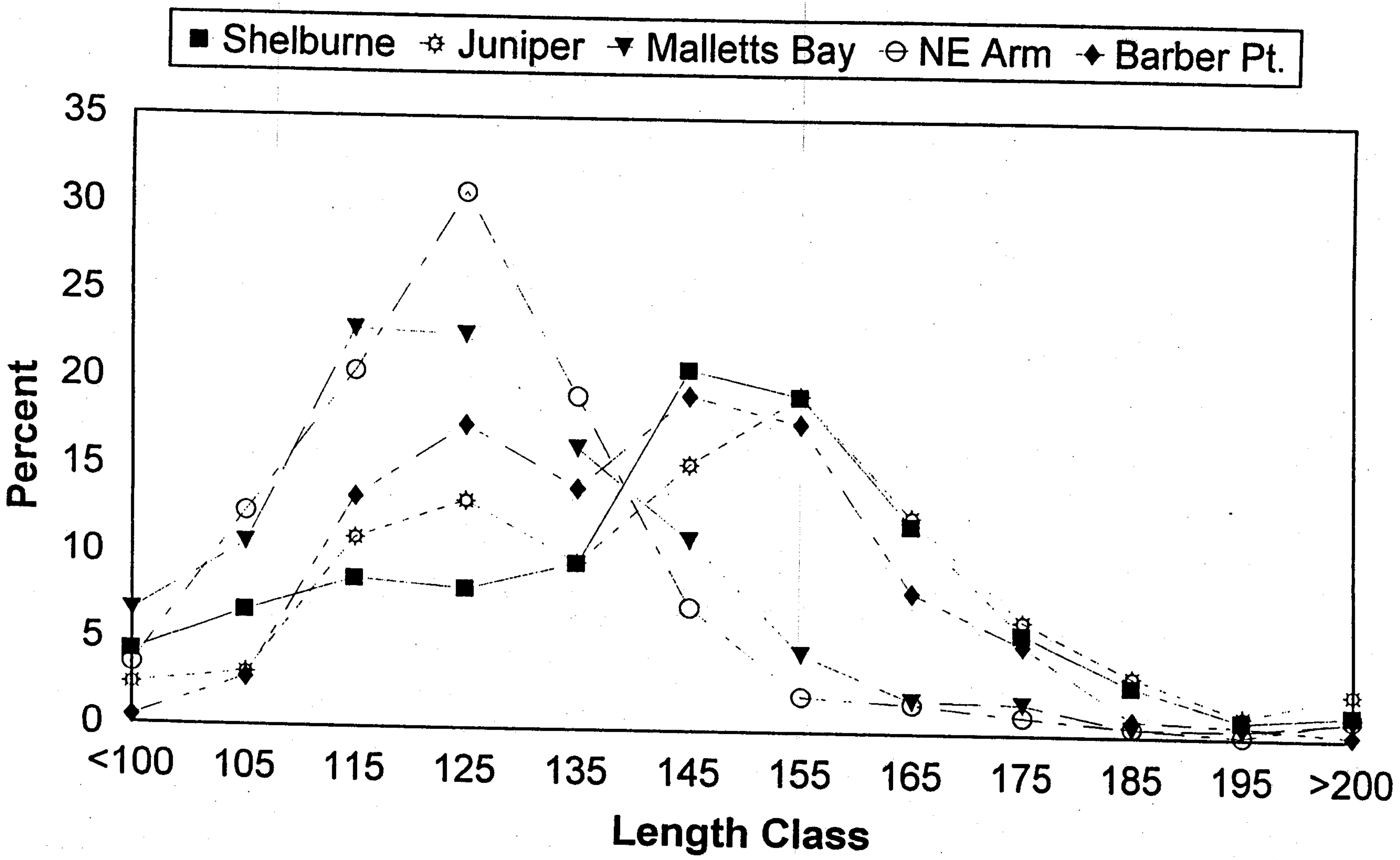


Figure 8. Length frequency (percent of total) distribution of rainbow smelt with all sampling years combined.

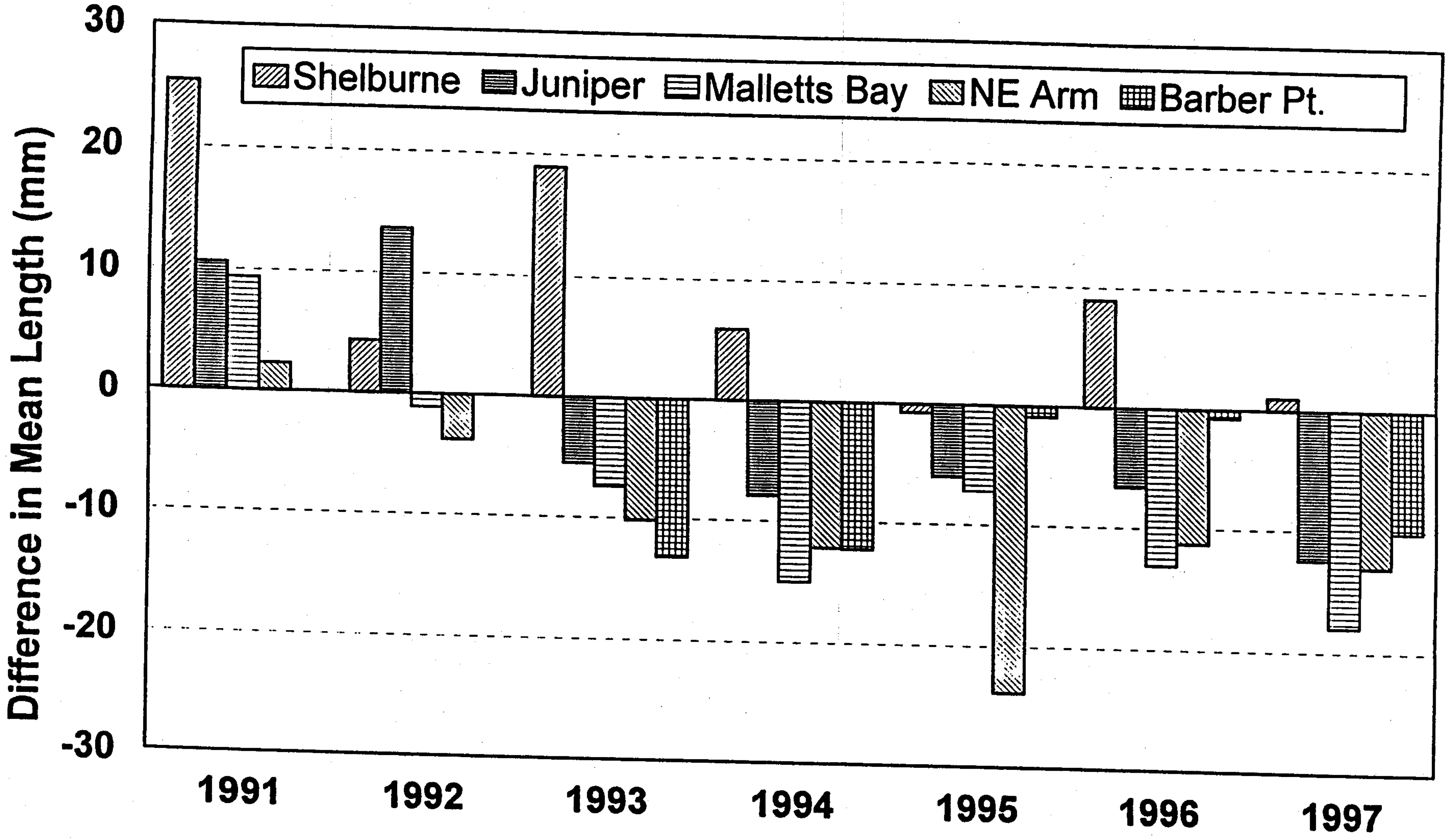


Figure 9. Difference in mean length between 1990 samples (zero difference) and subsequent sampling years at the five sampling sites.

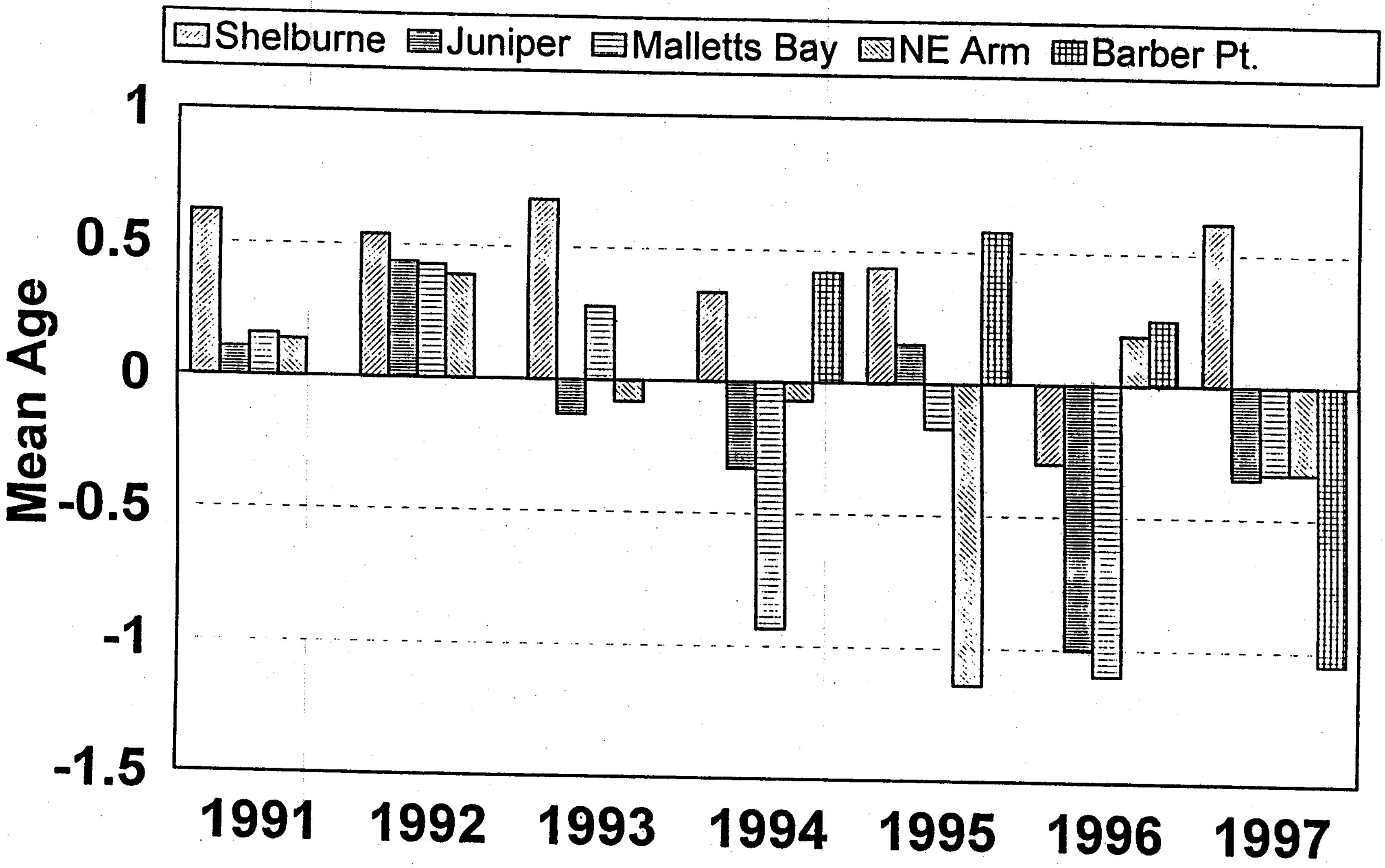


Figure 10. Difference in mean age from 1990 samples (zero difference) and subsequent years at all sampling sites.

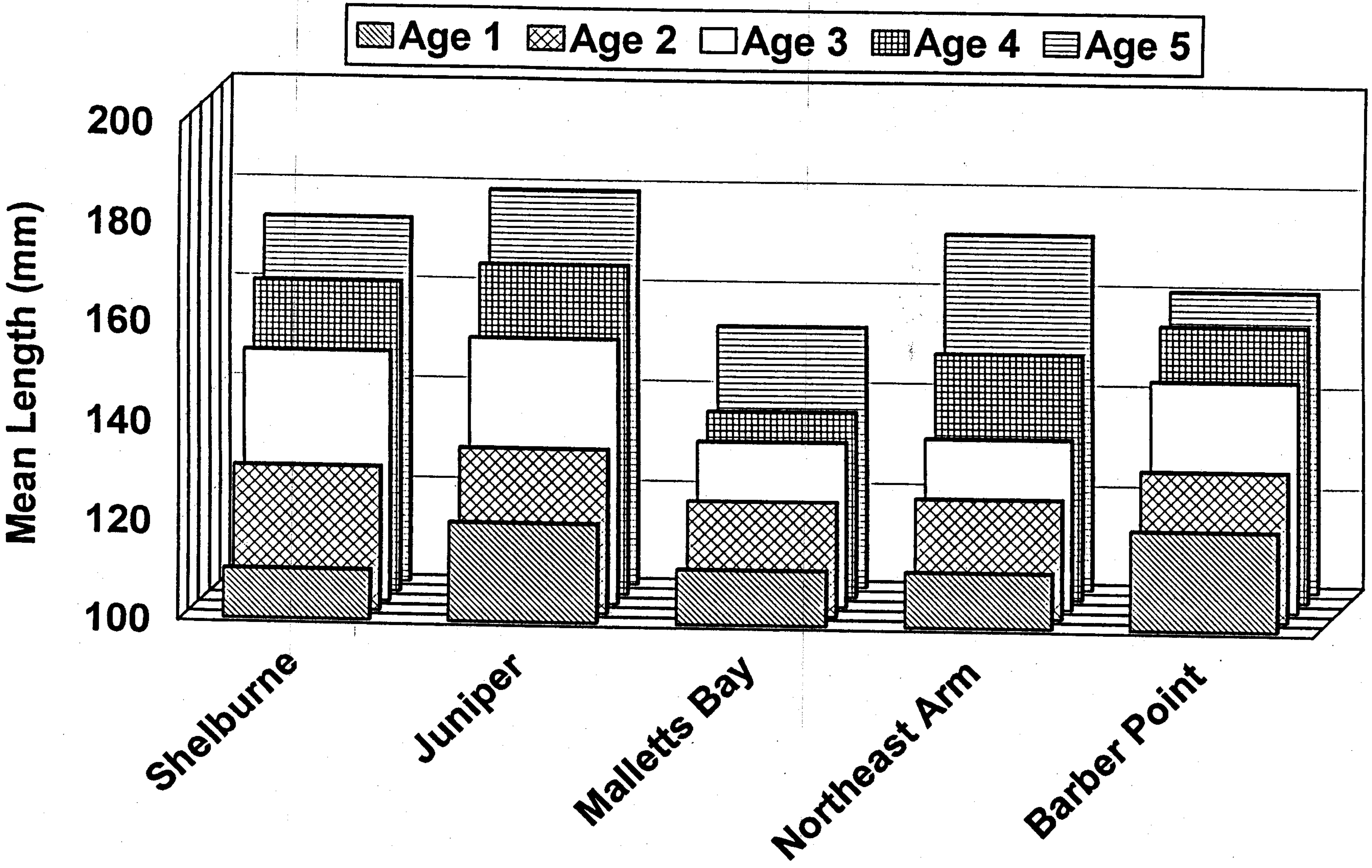


Figure 11. Mean length (mm) at age by site for all years combined.

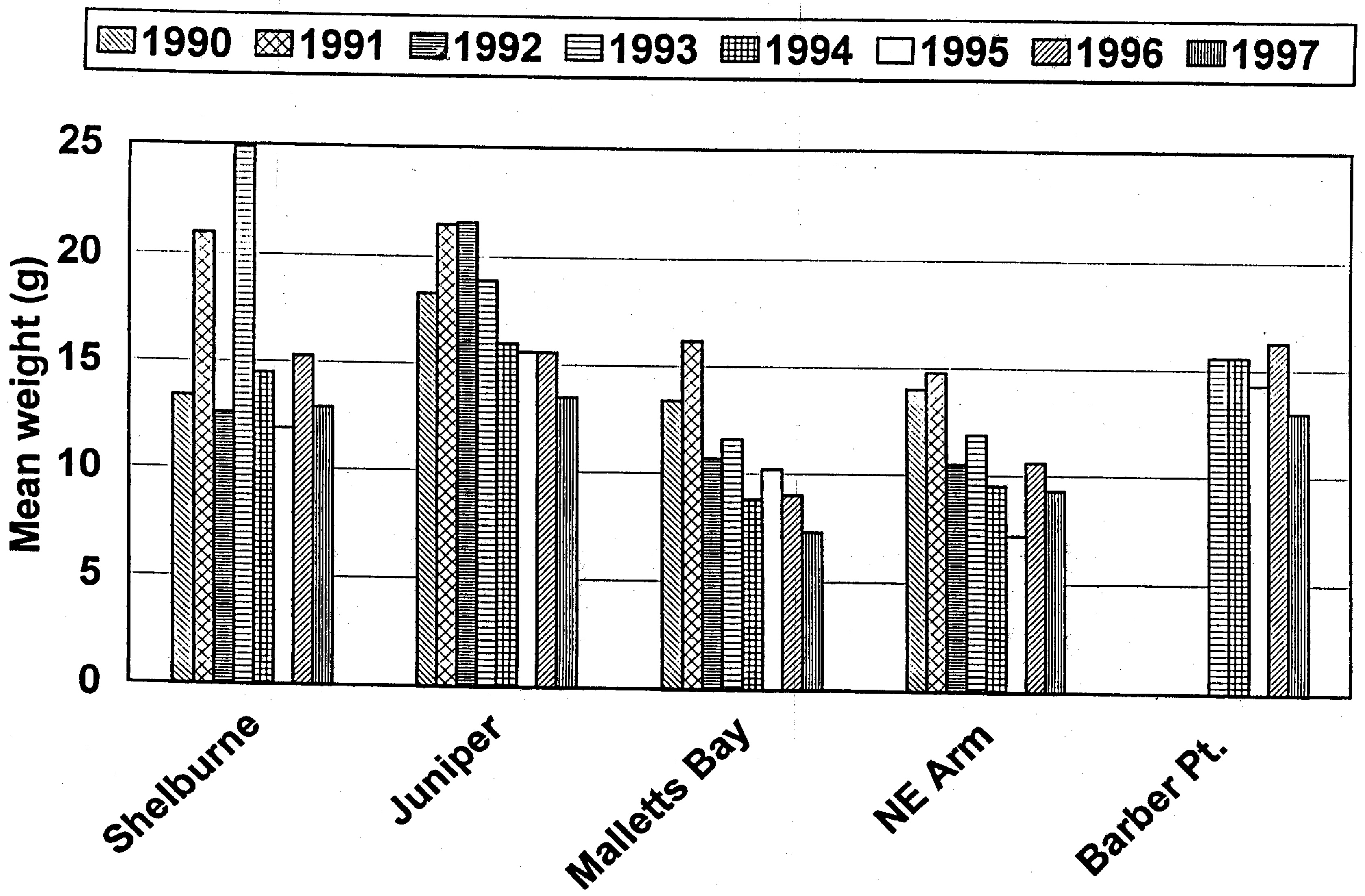


Figure 12. Mean weight (g) of rainbow smelt by site by year.

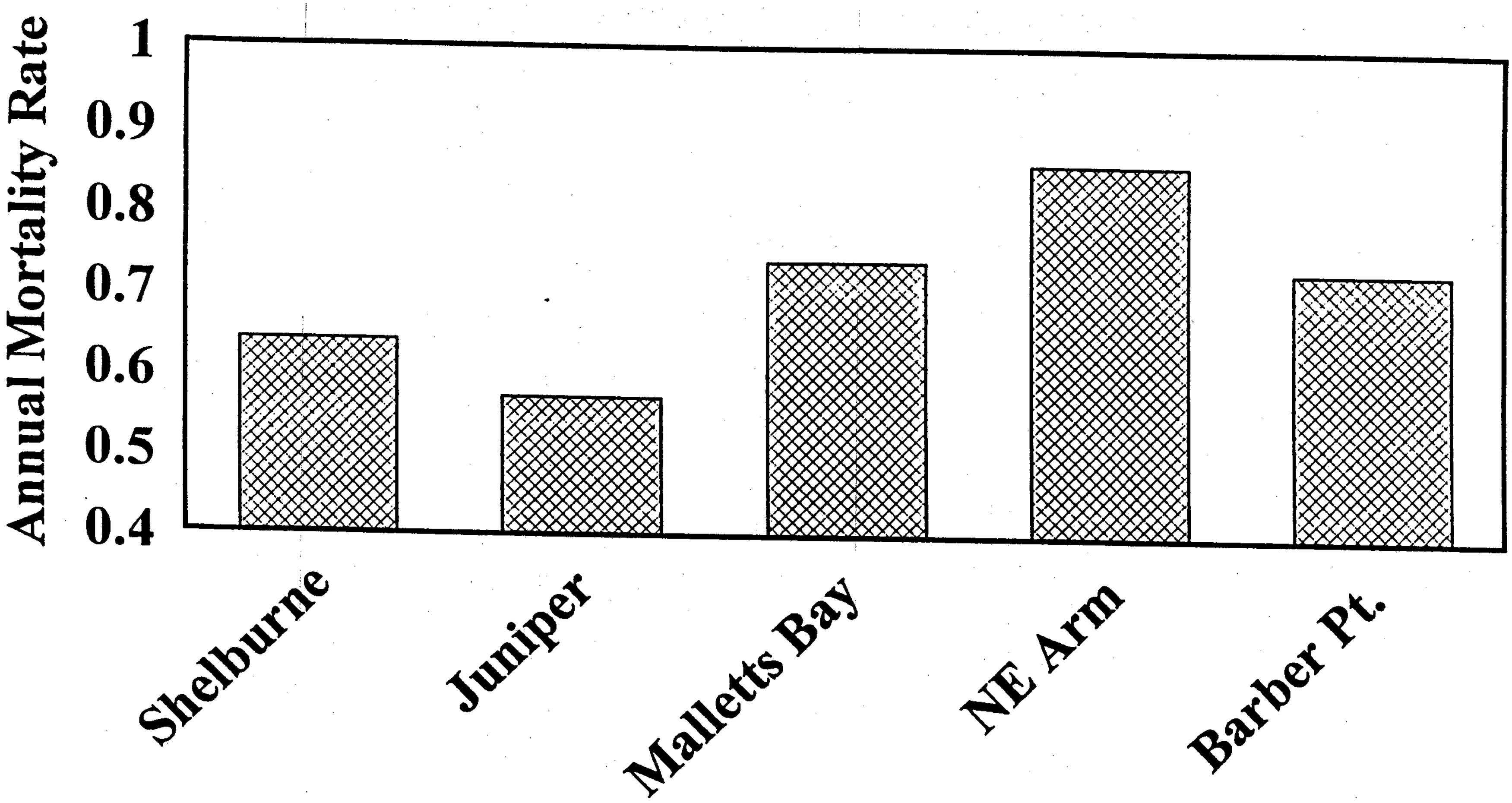


Figure 13. Mean annual mortality rates by sampling site for all years.

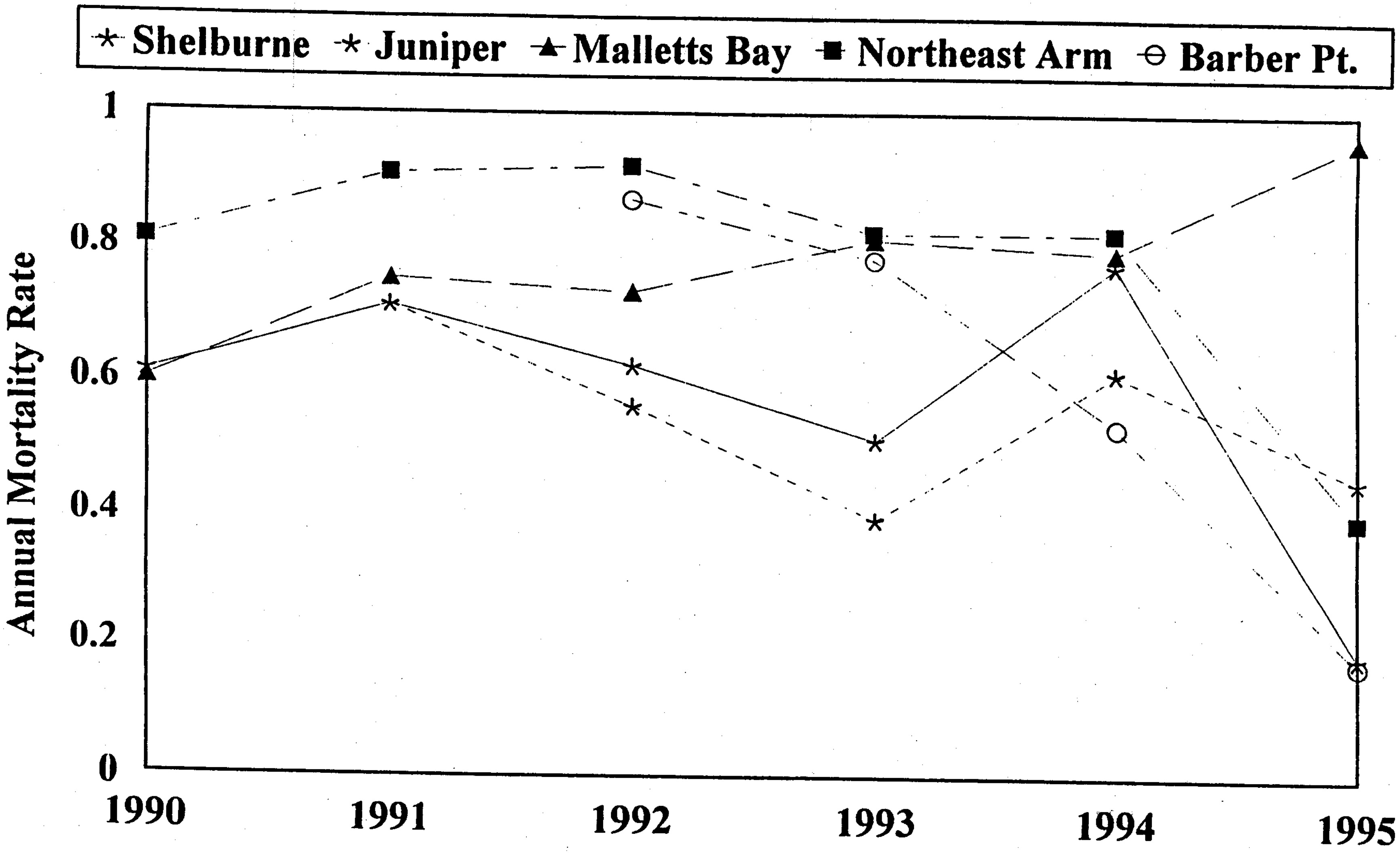


Figure 14. Annual cohort mortality rates at the five sampling sites for all years.

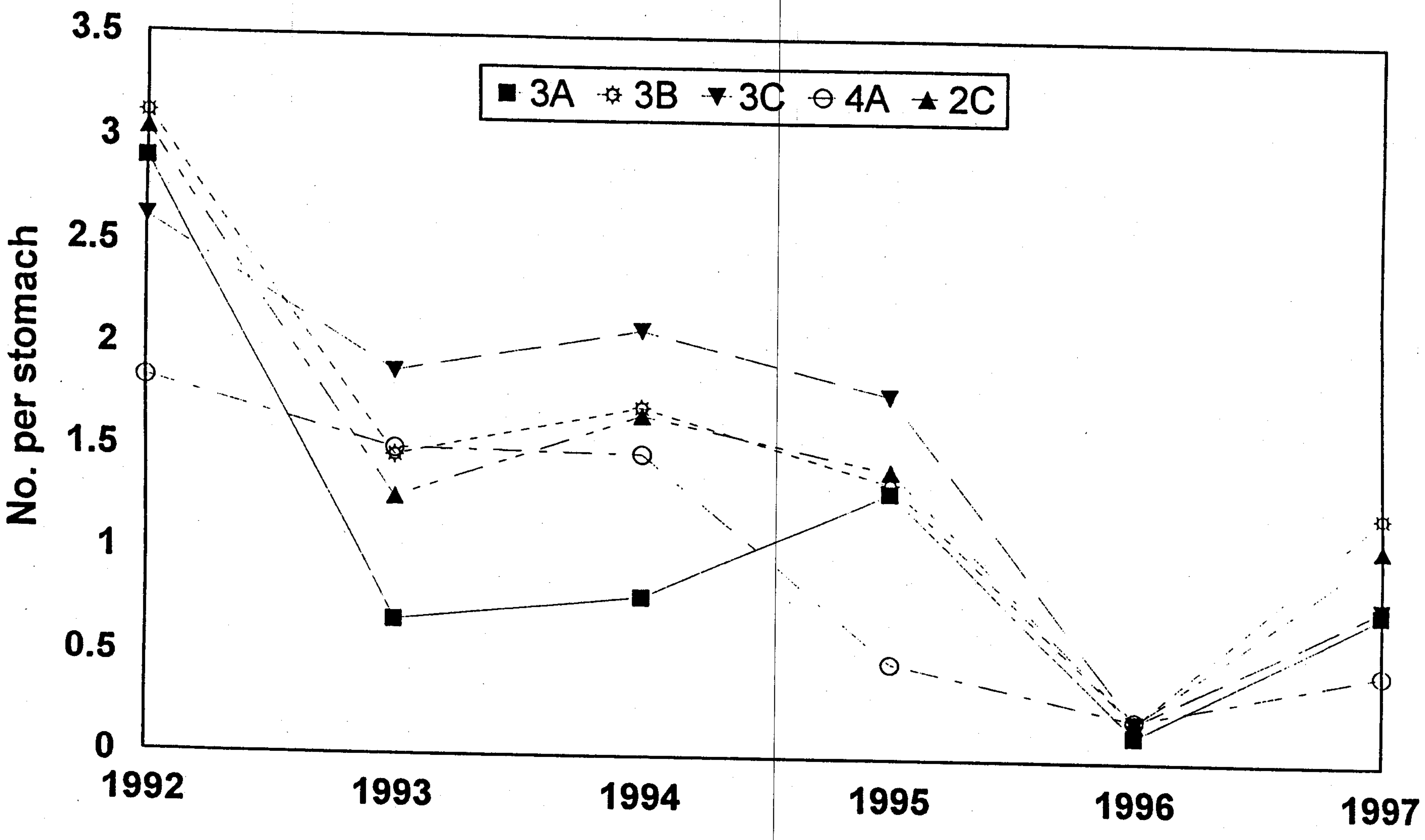


Figure 15. Mean number of large rainbow smelt (larger than 3 in) per lake trout stomach.

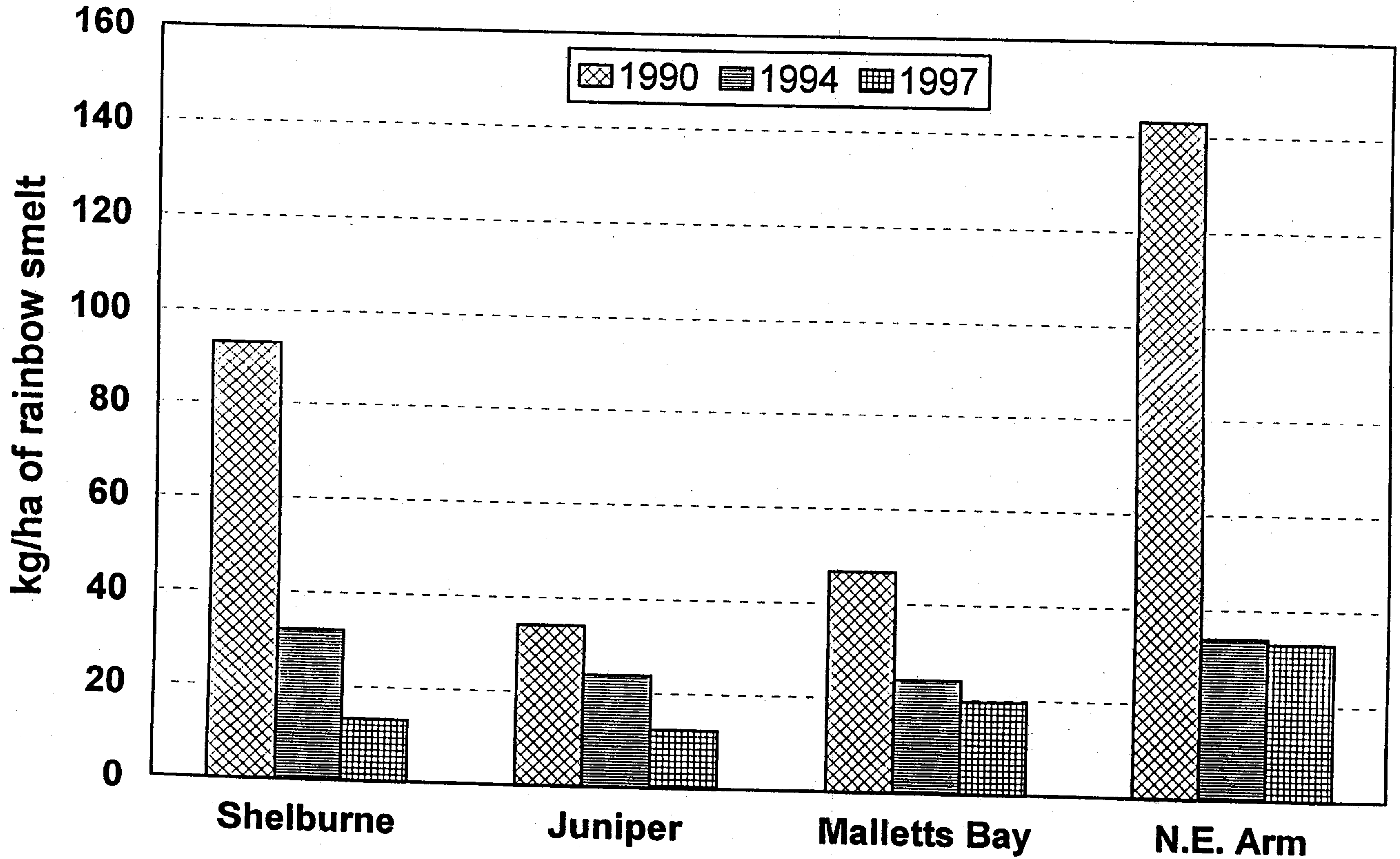
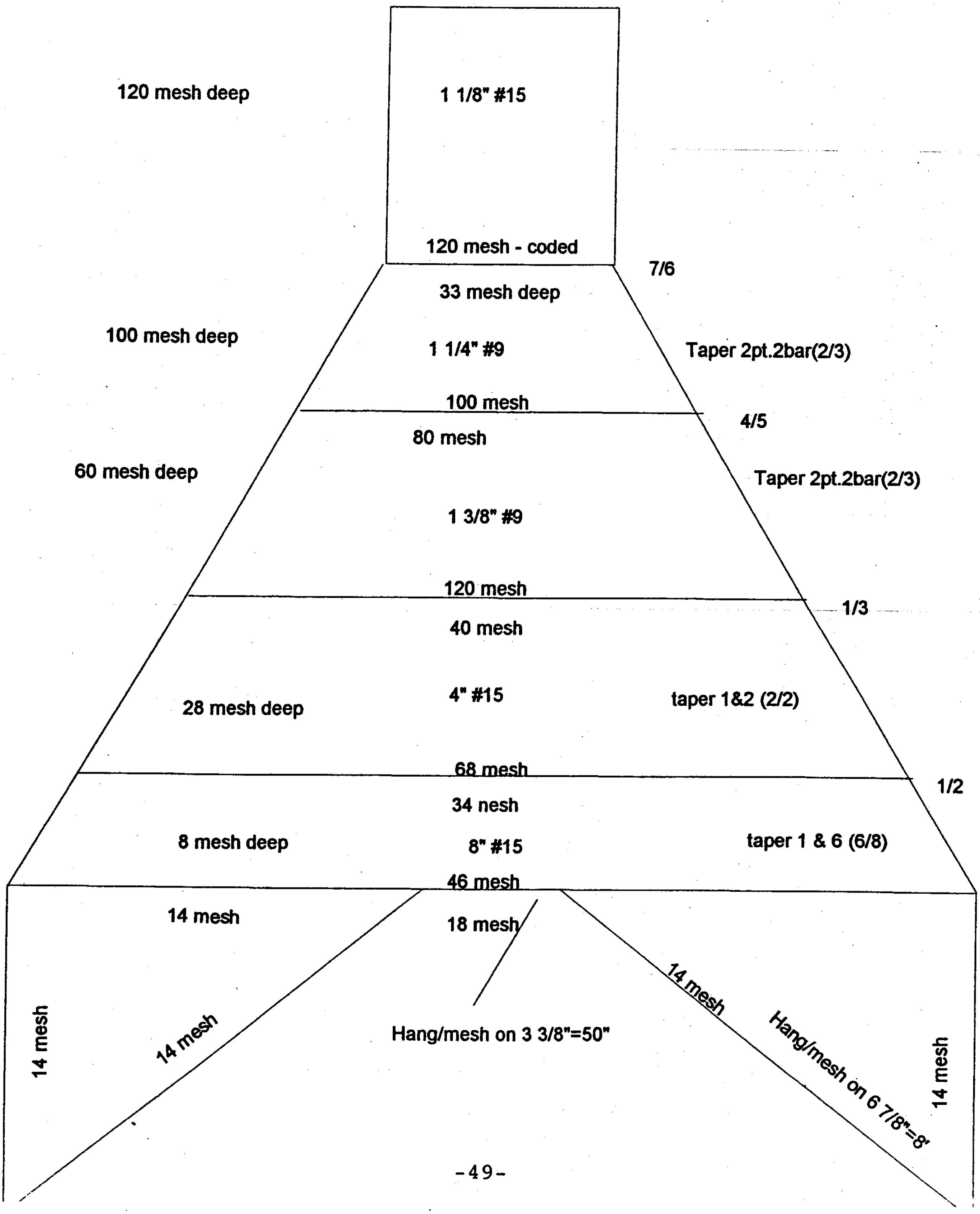
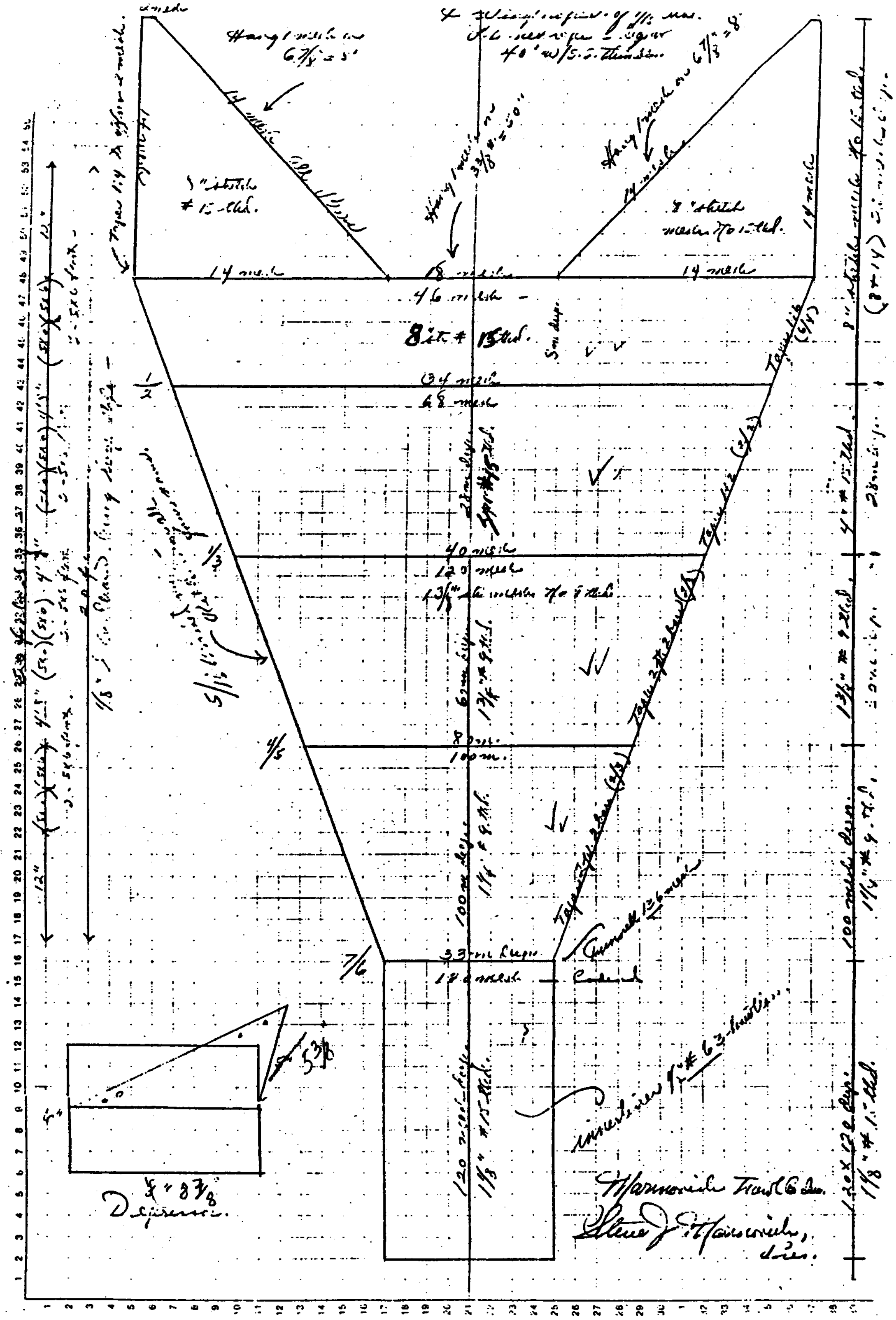


Figure 16. Biomass (kg/ha) of rainbow smelt in Lake Champlain estimated from hydroacoustic surveys.

Appendix A. Diagram of midwater trawl design. Original plans from net builder also attached.




Hang 1 mesh on 6 7/8" = 3'
40' w/5.5 thimbles
Hang 1 mesh on 6 7/8" = 8
Hang 1 mesh on 3 3/8" = 30"
14 mesh
3" stretch # 15 thd.
8" stretch mesh No 15 thd.
14 mesh
18 mesh
14 mesh
46 mesh
8" st. # 15 thd.
Sm dep.
Taper 6/4
1/2
34 mesh
68 mesh
28 m. dep.
Taper 2/3
1/3
40 mesh
120 mesh
1 3/8" st. mesh No 9 thd.
62 m. dep.
1 3/8" # 9 thd.
4/5
80 m.
100 m.
100 m. dep.
1 1/4" # 9 thd.
7/6
33 m. dep.
120 mesh
Codend
120 mesh deep
1 1/8" # 15 thd.
63
8" stretch mesh No 15 thd.
(8 + 14)
28 m. dep.
1 3/8" # 9 thd.
100 mesh deep
1 1/4" # 9 thd.
120 x 120 dep.
1 1/8" # 15 thd.
12"
12"
5 3/8
3/4 x 8 7/8"
Depressor
Taper 1:4
Harmonich Trawl Co. Inc.
Steve J. Harmonich, Pres.

APPENDIX K

Benefit Cost Analysis of the Eight-Year Experimental Sea Lamprey Control Program on Lake Champlain

Restoration and Enhancement of Salmonid Fisheries in Lake Champlain

Federal Aid in Sport Fish Restoration
Grant Number: F-23-R
Job Number: 5 Economic Evaluation

Benefit Cost Analysis

Vermont Fish and Wildlife Department
103 South Main Street
Waterbury, VT 05676

May 1999

This work was funded through the Federal Aid in Sport Fish Restoration Program

Acknowledgment

This project was paid for by fishing license sales and matching Dingell-Johnson / Wallop-Breaux funds available through the Federal Sportfish Restoration Act.

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Benefit Cost Analysis
of the
Eight-Year Experimental Sea Lamprey Control Program
on
Lake Champlain

Submitted to the

Fisheries Technical Committee

Lake Champlain Fish and Wildlife Management Cooperative

1999

Submitted by

Dr. Alphonse H. Gilbert
School of Natural Resources
University of Vermont
Burlington, Vermont 05405

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INTRODUCTION

In 1990, the states of New York and Vermont, in cooperation with the U.S. Fish and Wildlife Service, began an eight-year experimental sea lamprey control program on Lake Champlain[1]. The overall goal of the program was to improve the quality of Lake Champlain fishing through an aggressive chemical-based program to reduce sea lamprey predation on sport fish in the Lake. A benefit-cost analysis was also undertaken in 1990 to estimate the pre-control benefits and costs of the program. Surveys of Lake Champlain anglers, and heads of households living within a 35-mile radius of the Lake, were conducted to determine the value of successful sea lamprey control. Actual control costs for the initial 1991-92 phase of the Program, and estimated costs for the period 1992 through 1997, were obtained from the participating states and the federal cooperators. Estimated infrastructures costs, to accommodate the expected increase in fishing activity, were obtained from state and town officials and the U.S. Coast Guard. Costs imposed on landowners during the treatment period were obtained through a survey of landowners living along treated streams/rivers and lake deltas.

The Eight-Year Experimental Sea Lamprey Control Program (ESLCP) was completed in 1997 and the current benefit-cost analysis was begun. The 1997 benefit-cost analysis was conducted to estimate the actual post-control benefits of anglers and heads of households living within the 35 mile radius of the Lake and to use the actual control, infrastructure and landowner costs incurred during the eight-year ESLCP. The benefits were obtained from surveys similar to those conducted in 1990 and actual costs were obtained from town, state and federal officials.

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[1] This project was completed under contract with the Vermont Fish and Wildlife Department, with funding from Federal Aid to Sportfish Restoration Act Project F-23-R, Job 5.

This benefit-cost analysis will measure (1) the estimated benefits of the eight-year ESLCP to Lake Champlain anglers and current heads of households living within a 35-mile radius of Lake Champlain, and (2) the actual costs incurred to conduct the Program, (3) cost incurred to provide infrastructure support for anglers and, (4) costs incurred by landowners along treated streams and river deltas. It does not include benefits received by people living beyond the 35-mile radius of the Lake, anglers who did not purchase New York or Vermont fishing licenses during the study period or environmental costs resulting from the use of chemical lampricides to kill sea lamprey larvae in treated streams, rivers and river deltas.

BENEFITS AND COSTS

The benefit-cost analysis provides a partial estimate of the benefits and costs of the Eight-Year Experimental Sea Lamprey Control Program (ESLCP) on Lake Champlain. It is only a partial estimate because the estimated benefits were obtained from 1990 and 1997 Lake Champlain anglers and heads of households with telephone service living within a 35-mile radius of Lake Champlain. The benefits were derived through the use of the dichotomous choice form of contingent valuation which solicits respondent willingness-to-pay for effective sea lamprey control on Lake Champlain.

Omitted from the analysis were sea lamprey control-related benefits by: (1) Lake Champlain anglers that did not purchase a New York or a Vermont fishing license in 1990 or 1997, (2) people living within the 35-mile radius of Lake Champlain who were not represented by the sampled population in 1990 and 1997 (heads of households with telephone service) and (3) all people living beyond the 35-mile radius that derived use or nonuse benefit from the ESLCP on Lake Champlain.

The costs of the ESLCP on Lake Champlain consist of actual costs incurred: (1) for infrastructure renovation and development along Lake Champlain and its major tributaries between 1990 and 1997 (e.g., boat launching facilities, parking, fishing sites) directly attributable to sea lamprey control, (2) by landowners who live along lampricide-treated streams and river deltas who incurred property damage or activity loss (e.g., bathing, drinking) during the lampricide treatment advisory periods and, (3) state and federal treatment, assessment and propagation costs incurred to administer and conduct the ESLCP on Lake Champlain.

The omitted costs consisted of the loss of nontargeted fish and aquatic organisms during lampricide treatment of streams, rivers and river deltas and costs associated with any currently unknown damage to the environment caused by the lampricide treatment. Existing scientific evidence on fish and organism loss suggest that the loss will be minimal and temporary. Programs to collect and hold "threatened" species such as the American brook lamprey, and their subsequent release back into streams after lampricide treatment, have reduced the most serious recognized losses. No costs to human health have been reported and none are anticipated as lampricide use in the Great Lakes over the last 30+years has not had any known detrimental effect on humans.

The omission of the above mentioned benefits and costs from this benefit-cost analysis was due to financial and time constraints or the unavailability of evidence of loss. For example, the cost of effectively sampling the population that includes all existing use and nonuse beneficiaries of the ESLCP on Lake Champlain, and those experiencing a use or nonuse loss, would be prohibitively time consuming and expensive. While this potential omission of benefits and costs is a source of concern, it is not considered a serious threat to the integrity of this benefit-cost analysis. Results of the five 1991 studies and four 1998 studies that form the data base for this benefit-cost analysis, show that the costs incurred by landowners along treated rivers and river deltas, costs to renovate and/or construct boat launching sites, etc. were low compared to the benefits received by anglers and the heads of households living within the study zone's 35-mile radius of Lake Champlain. This suggests that the extension of the survey to people less directly impacted, both negatively and positively, would not significantly alter the benefit to cost ratio. While it would provide a more complete estimate of total benefits and costs, the survey costs required to obtain these additional data would likely be greater than the sum of the derived benefits and costs.

VALUE OF SEA LAMPREY CONTROL

This section provides a brief description of the benefits and costs included in the benefit-cost analysis. A more detailed description of these benefits and costs, and the methodology used to derive them, can be found in the four reports that are appendices to this benefit-cost analysis.

Benefits

Angler Values

The value that an angler derives from the eight-year ESLCP on Lake Champlain is equal to the maximum amount that he/she would be willing to pay to achieve program goals. Table 1 lists the annual values that were derived from dichotomous choice responses to requested voluntary payments into three hypothetical trust funds—a lake trout fund; a salmon, a steelhead and a brown trout fund and an "other" (bass, walleye, northern pike, etc.) fund. These trust funds would be used to continue the current program of sea lamprey control in the event that all state and federal funding for sea lamprey control was stopped. The dichotomous choice form of contingent valuation was selected because previous research by Hanemann (1984), Loomis (1988), U.S. Department of Commerce (1993), etc., suggests that the dichotomous choice form of contingent valuation provides the best estimate of maximum willingness to pay. It closely simulates a normal market transaction and reduces the affects of outliers and extreme values common in other forms of contingent valuation.

The median values in Table 1 show that the annual willingness to pay into the lake trout, salmon/steelhead/brown trout and "other" trust funds dedicated to sea lamprey control on Lake Champlain was $23.83, $25.78 and $15.18 respectively in 1997. The total annual willingness to pay is estimated to be $3,329,957. Of this amount, $1,377,597 (41.4%) is attributed to lake trout, $1,072,549 (32.2%)to salmon/steelhead/brown trout and $879,811 (26.4%) to "other" species.

These values represent the minimum annual angler value of sea lamprey control on Lake Champlain because they are limited to anglers that actually fish Lake Champlain. Successful sea lamprey control will increase the quality of Lake Champlain fishing and, in turn, should increase the number of anglers that fish the Lake and the aggregated value of sea lamprey control.

Table 1. Median (logit) willingness to pay for sea lamprey control, in the event that current state and federal funding is terminated, by New York and Vermont residents and residents of other states and countries, 1997.

State	Median Value ($)	Total Value ($)
New York		
Lake trout	17.87	212,081
Salmon, steelhead & brown trout	26.24	240,988
Other	44.14	540,406
Vermont		
Lake trout	42.96	968,748
Salmon, steelhead & brown trout	31.47	709,649
Other	5.99	171,703
Other States/Countries		
Lake trout	20.30	196,768
Salmon, steelhead & brown trout	16.73	121,912
Other	23.63	167,702
Combined Total		
Lake trout	23.83	1,377,597
Salmon, steelhead & brown trout	25.78	1,072,549
Other	15.18	879,811
Total		**$3,329,957**

User/Nonuser Values

The user/nonuser value of sea lamprey control was estimated for heads of households living within a 35-mile radius of Lake Champlain. A 35-mile radius was arbitrarily selected to enhance the possibility of surveying recreational users and nonuser beneficiaries of the Lake—use and nonuse benefit tends to diminish as the distance from the Lake increases—and to keep survey costs within reasonable limits. Value was estimated using the dichotomous choice form of contingent valuation described under the angler values above. The willingness-to-pay request was prefaced by a brief statement that the ESLCP on Lake Champlain had ended, state and federal agencies were trying to determine if sea lamprey control should be continued, that future control may include both chemical and nonchemical control measures and that lamprey numbers and attachments to boats, windsurfers, etc. have been reduced. Respondents were then asked if they would contribute a specified, randomly selected dollar amount to a sea lamprey control fund in the event that all state and federal funding was stopped.

The estimated 1997 annual median willingness-to-pay for sea lamprey control on Lake Champlain by New York and Vermont heads of households, living within a 35-mile radius of Lake Champlain, was $21.10 and $21.71 respectively (Table 2). The combined median value was $21.52 and the estimated total annual willingness-to-pay was $5,295,357.

Table 2. Median and total values of sea lamprey control on Lake Champlain for New York and Vermont residents.

Residents	Median Value ($)	Total Value ($)
New York	21.10	1,609,846
Vermont	21.71	3,685,511
Total	**21.52**	**5,295,357**

These values represent a minimum estimate of the annual value of sea lamprey control because the analysis is limited to heads of households with telephones living within a 35-mile radius of the Lake. Missing are the values of non-heads of households and heads of households without telephones living within the study zone, New York and Vermont users and nonusers (80.6% of head of household willingness-to-pay was attributed to nonuse benefits) living beyond the 35-mile zone and residents of other states and countries that derive use and/or nonuse value from a reduced sea lamprey population in Lake Champlain. These latter values were not obtained because of the difficulty and cost of identifying and sampling these individuals.

Costs

Landowner Costs

The estimated costs of the eight-year ESLCP on Lake Champlain to landowners living along lampricide-treated rivers/streams and river deltas is estimated to be $25,736.[2] This cost consists of: (1) the cost associated with the loss of water-based activities (e.g., boating, swimming), (2) cost of purchasing drinking water, (3) cost (loss) of water used for nondrinking purposes (e.g., bathing, washing clothes) and, (4) cost of physical damage to the landowner's property during lampricide treatment and collection of dead lamprey (Table 3). Landowners attributed the greatest cost to the loss of water-based activities ($19,848). In addition to these incurred costs, an estimated 13% of the landowners were inconvenienced (e.g., forced to carry water longer distances, restricted use of property) during the water-use advisory period following lampricide treatment.

Infrastructure Costs

The infrastructure costs contained in this report (Tables 4 and 5) represent actual incurred costs for the development expansion and/or renovation of public fishing-related infrastructure (e.g., fishing piers, boat launching sites) on Lake Champlain and its major tributaries between 1990-1997. The cost data were obtained from the New York Department of Environmental Conservation, Vermont Department of Fish and Wildlife and town officials in New York and Vermont.

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[2] The value was derived from a detailed landowner study conducted in 1992. It was estimated that landowners along the treated rivers/deltas incurred $12,868 in control-induced costs. This study was not repeated for the current benefit-cost analysis because it was decided that the low costs incurred by the landowners did not warrant another costly survey. Consequently, it was decided to assign the same costs incurred during the 1990-91 lampricide treatment to the 1997 treatment.

Table 3. Landowner costs directly attributable to the 1990 and 1991 lampricide treatment of Lake Champlain river deltas and tributary rivers and streams.

	1990			1991			
Type of cost/loss	(a) mean cost	(b) Percent of landowner population	(c) Total cost	(d) mean cost	(e) Percent of landowner population	(f) Total cost	Total cost (c + f)
Water-based activity loss	$19.43	26.4	$4,469.90	$45.83	33.9	$5,453.77	$9,923.67
Cost of purchased drinking water	5.79	01.8	86.85	5.13	01.5	25.65	112.50
Loss of nondrinking water	9.02	22.3	1,749.88	40.06	07.7	1,081.72	2,831.60
Physical damage to property	0	0	0	0	0	0	0
Inconvenience loss[1]	--	13.5	--	--	11.7	--	--
Total			$6,306.63			$6,561.14	$12,867.77

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[1] No cost estimates are available for inconvenience loss.

It should be noted that these costs (Table 4 and 5) are not directly related to the Eight-Year Experimental Sea Lamprey Control Program) ESLCP) that was underway on Lake Champlain during that period. State and town officials said that the decision to develop, expand and/or renovate the fishing-related infrastructure was based on long-term planning efforts designed to enhance fishing opportunities on Lake Champlain. They acknowledged that sea lamprey control-induced increases in angler use of the fishing-related infrastructure may have been a factor in the decision to develop, expand or renovate these facilities but it appeared to play only a minor roll.

The officials responsible for fishing access sites and other fishing-related infrastructure in New York and Vermont estimate that only 6% of the New York and 5% of the Vermont cost of development, expansion and renovation of fishing-related infrastructure was attributable to increased fishing activity generated by the eight-year ESLCP on Lake Champlain.

The infrastructure cost, attributable to sea lamprey control-induced increases in angler use is estimated to be $61,531 for New York (6% of New York's $1,025,523 infrastructure cost) and $89,873 for Vermont (5%of Vermont's $1,797,454 infrastructure cost).

Table 4. Costs incurred by New York and Vermont towns for development, expansion, and/or renovation of fishing infrastructure, 1990-1997

State/County/Town	Cost estimates of facilities and services			
	Boat access and fishing sites	Fishing sites	Search and rescue	Total cost per town
NEW YORK				
Clinton County				
Village of Rouses Point	$35,000		$18,000	$53,000
Essex County				
Essex	$18,000	$7,000		$25,000
Crown Point	$78,000			$78,000
Port Henry	$140,000			$140,000
Washington County				
Subtotal	**$271,000**	**$7,000**	**$18,000**	**$296,000**
VERMONT				
Grand Isle County				
South Hero			$35,000	$35,000
Grand Isle			$3,200	$3,200
Franklin County				
Swanton	$10,000			$10,000
Chittenden County				
Burlington	$180,000			$180,000
Colchester	$75,000			$75,000
Addison County				
Subtotal	**$265,000**		**$38,200**	**$303,200**
GRANDTOTAL	**$536,000**	**$7,000**	**$56,200**	**$599,200**

Table 5. Costs incurred by the States of New York and Vermont, and by the Federal Government for fishing-related infrastructure, 1990-1997.

Site	Year	Description	Cost
New York DEC & State Parks			
Willsboro, Ticonderoga, & Peru Dock	1997	Rebuilt boat pump-out	$14,530
Port Henry & Willsboro	1996	Rehabilitate toilet buildings	$17,900
Ticonderoga, Willsboro, Peru	1996	dredging	$34,019
Port Douglas	1996	Floating dock	$25,000
Town of Chesterfield	1995	Additional docks (cooperative effort with DEC), fix paving in parking lot & repair drainage problem	$35,200
Ticonderoga	1995	Toilet roof replacement	$4,000
Willsboro Fish Ladder	1995	Replace viewing window and install alarms, sensors, & awning over viewing area	$4,700
Saranac (Plattsburgh)	1995	Handicap pier built	$18,824
Port Douglas	1994	36" corrugated pipe for parking lot drainage, two-lane boat ramp, catch basin for drainage & docks	$175,000
Port Henry	1994	Paving	$20,000
South Bay	1992	Docks and door for toilet	$6,350
South Bay	1992	Toilet building renovation	$4,000
Port Henry	1991	Rubble mount breakwater	$300,000
Subtotal			**$659,523**

Table 5 (Continued). Costs incurred by the States of New York and Vermont, and by the Federal Government for fishing-related infrastructure, 1990-1997.

Site	Year	Description	Cost
Vermont DFW			
Grand Isle Hatchery	1997	Fishing dock and parking area	$12,000
Winooski River	1997	Major streambank stabilization, universal shorefishing platform, and parking improvement	$125,000
Coast Guard Access	1996	Parking and dock construction	$50,000
Winooski River	1996	Major streambank stabilization, universal shorefishing platform, and parking improvement—Phase I	$125,000
Coast Guard Ramp, Burlington	1995	New boat ramp and parking area	$55,000
Van Evirst Georgia	1995	Land acquisition	$60,000
Holcomb Bay	1994	Ramp reconstruction and parking improvements	$46,000
Winooski River	1994	Shore stabilization, new ramp, universal shorefishing area, docks & parking improvements	$196,449
Colchester Point	1993	Shore stabilization and ramp construction	$270,000
Malletts Bay, Colchester	1992	Upgrade concrete ramp & launch area	$34,270
St. Albans Bay	1992	Upgrade ramps (extensions), repair breakwater	$23,198
Colchester Point	1991	Design, engineering for construction	$23,258
Kelly Bay, Alburg	1991	Upgrade ramp/parking	$35,106
Kings Bay, North Hero	1991	Upgrade ramp/parking	$35,106
Malletts Bay, Colchester	1991	Design, engineering for construction	$18,170
Rouses Point, Alburg	1991	Handicap access for shorefishing	$66,258
Subtotal			$1,175,254
New York State Police	1997	Purchase of 24" power boat	$70,000
Vermont State Police marine Division	1991-97	Purchase of six power boats	$319,000
Subtotal			$389,000
TOTAL			$2,223,777

State and Federal Costs

The states of New York and Vermont, in cooperation with the U.S. Fish and Wildlife Service, were responsible for conducting the eight-year ESLCP on Lake Champlain. Costs to conduct the program consisted of treatment, assessment and propagation costs incurred by New York, Vermont and the U.S. Fish and Wildlife Service and costs covered by a one-time U.S. Congressional appropriation for selected treatment and assessment costs.

The total incurred costs for treatment, assessment and propagation by the four governmental agencies during the eight-year ESLCP on Lake Champlain was $10,091,367 (Tables 6, 7, 8 and 9). New York accounted for 26.9% ($2,715,297) (Table 6), Vermont for 44.9% ($4,526,950) (Table 7), the U.S. Fish and Wildlife Service for 26.2% ($2,664,197) (Table 8) and the U.S. Congressional appropriation for the remaining 2% ($204,923) (Table 9) of the actual, total dollars spent on treatment, assessment and propagation to conduct the eight-year ESLCP on Lake Champlain. It should be noted that approximately nine percent of the state and federal costs were developmental and will not be assessed if the sea lamprey control program is continued on Lake Champlain. The developmental costs incurred by New York that will be excluded if sea lamprey control is continued are listed in Appendix I.

Table 6. Costs incurred by the state of New York to conduct the Eight-Year Experimental Sea Lamprey Control Program on Lake Champlain, 1990-1997.

BENEFITS AND COSTS	1990	1991	1992	1993	1994	1995	1996	1997
TREATMENT COSTS								
A. PERSONAL SERVICES								
1. Fisheries Staff	$164,319	$108,574	$97,982	$21,819	$90,318	$95,315	$90,525	$38,225
2. Fringe (28.96%)	47,587	26,536	28,033	6,655	27,746	26,764	26,442	11,850
Subtotal	211,906	135,110	126,015	28,474	118,064	122,079	116,967	50,075
B. TRAVEL	10,814	8,690	10,265	113	9,621	4,350	12,191	1,470
C CONTRACTUAL								
1. Postage	44	2,883	1,217	1,065	579	4,352	2,727	0
2. Legal Notice	213	579	625		594	1,024	1,568	
3. Hot Line	774	522	613		437	440	450	
4. Economic								
5. Forage								
6. Rentals								
7. U.S. F&W Team	65,800				20,316			
8. Radio Maintenance								
9. Lewis Creek Barrier								
10. Misc.	1,905	1,401	423		423	730	24	
11. Cropduster		15,000				48,873		
12. G-P Water		38,142	25,051			35,119	0	
13. HPLC		3,418	3,528	3,996	3,996	3,996	4,116	0
Subtotal	68,736	61,945	31,457	5,061	26,345	94,534	8,885	0
D. EQUIPMENT	3,088	4,936	9,678	0	2,541	0	0	0
E. SUPPLIES AND MATERIALS								
1. Chemical	89,900	214,370				30,000	74,635	
2. Water	431	814	875		514	554	728	
3. Misc.		1,554	3,178	199	6,409	1,951	1,147	
4. Lab.		5,207	2,804		972		3,121	
SUBTOTAL	90,331	221,945	6,857	199	7,895	32,505	79,631	

Table 6 (Continued). Costs incurred by the state of New York to conduct the Eight-Year Experimental Sea Lamprey Control Program on Lake Champlain, 1990-1997.

BENEFITS AND COSTS	1990	1991	1992	1993	1994	1995	1996	1997
F. OPERATION (VEHICLE & BOAT)	5,472	4,886	5,195	661	3,751	2,753	5,195	661
TOTAL TREATMENT COST	390,347	437,512	189,467	34,508	168,217	256,221	222,869	52,206
ASSESSMENT COST								
A. PERSONNEL SERVICES								
1. fisheries staff	35,022	44,042	53,909	75,345	90,615	65,092	93,119	87,047
2. Fringe (28.96%)	10,142	10,764	15,423	22,980	27,837	18,277	27,200	26,985
SUBTOTAL	45,164	54,806	69,332	98,325	118,452	83,369	120,319	114,032
B. TRAVEL	0	674	114	293	45	697	747	1,484
C. CONTRACTUAL								
1. Postage				33	293			0
2. Legal Notice								
3. Hot Line				398				250
4. Economic								
5. Forage								
6. Rentals								
7. U.S. F&W Team								
8. Radio Maintenance								
9. Lewis Creek Barrier								
10. Misc.			399		1,058		0	0
Subtotal	0	0	399	431	1,351	0	0	250
D. EQUIPMENT	0	0	0	0	4,642	11,180		0
E. SUPPLIES AND MATERIALS								
1. Chemical								
2. Water								
3. Misc.				1,858	5,253	4,164	720	1,728
Subtotal	0	0	0	1,858	5,253	4,164	720	1,728

Table 6 (Continued). Costs incurred by the state of New York to conduct the Eight-Year Experimental Sea Lamprey Control Program on Lake Champlain, 1990-1997.

BENEFITS AND COSTS	1990	1991	1992	1993	1994	1995	1996	1997
F. OPERATION (Vehicle & Boat)	2,745	1,989	5,327	4,695	7,417	4,026	6,832	5,103
TOTAL ASSESSMENT COST	47,909	57,469	75,172	105,602	137,160	103,436	128,618	122,597
FISH PROPAGATION COSTS	153,626	149,386	144,446	92,722	121,203	108,508	111,855	103,616
LANDOWNER COSTS								
A. Water-Based Activity Loss	2,235	2,727				2,235	2,727	
B. Purchased Drinking Water	44	13				44	13	
C. Loss of Nondrinking Water	875	541				875	541	
D. Property Damage								
TOTAL LANDOWNER COST	3,154	3,281				3,154	3,281	
INFRASTRUCTURE COSTS	0	20,925	3,593	0	14,673	6,719	7,590	8,031
TOTAL COSTS	595,036	668,573	412,678	232,832	441,253	478,038	474,213	286,450
BENEFITS								
A. Angler	451,332	528,804	606,276	683,748	761,220	838,692	916,164	993,475
B. Nonresident Angler	18,110	32,828	47,546	62,264	76,982	91,700	106,418	121,109
C. User/Nonuser	164,091	370,689	577,287	783,885	990,483	1,197,081	1,403,679	1,609,846
TOTAL BENEFITS	633,533	932,321	1,231,109	1,529,897	1,828,685	2,127,473	2,426,261	2,724,430

Table 7. Costs incurred by the state of Vermont to conduct the Eight-Year Experimental Sea Lamprey Control Program on Lake Champlain, 1990-1997.

BENEFITS AND COSTS	1990	1991	1992	1993	1994	1995	1996	1997
TREATMENT COSTS								
A. PERSONAL SERVICES								
1. Fisheries Staff	46,300	51,200	45,276	29,140	44,765	50,000	50,000	10,000
2. Security	4,980	675	200					
Subtotal	51,280	51,875	45,476	29,140	44,765	50,000	50,000	10,000
B. TRAVEL	4,300	3,500	1,653	164	1,390	500	2,200	500
C. CONTRACTUAL								
1. Postage	300	200	300	100	300	300	300	
2. Legal Notice	300	200	200		300	300	300	
3. Hot Line	400	400	400	400	400	400	400	
4. Economic								
5. Forage								
6. Rentals			100					
7. U.S. F & W Team		37,000	16,00			0		
8. Radio Maintenance	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
9. Lewis Creek Barrier								
10. Misc.								
Subtotal	2,000	38,800	18,000	1,500	2,000	2,000	2,000	1,000
D. EQUIPMENT	1,500	4,936	3,163	10,000	7,000	24,000	15,000	5,000
E. SUPPLIES AND MATERIALS								
1. Chemical	89,987	197,880	16,000			50,000	35,000	
2. Water	600	300	200		300	300	300	
3. Misc.	12,700	1,000	2,000	4,289	2,000	5,000	5,000	5,000
SUBTOTAL	103,287	199,180	18,200	4,289	2,300	55,300	40,300	5,000
F. OPERATION (vehicle & boat)	8,500	10,850	9,711	3,526	22,500	10,000	11,000	1,000
TOTAL TREATMENT COST	170,867	309,141	96,203	48,619	79,955	141,800	120,500	22,500

Table 7 (Continued). Costs incurred by the state of Vermont to conduct the Eight-Year Experimental Sea Lamprey Control Program on Lake Champlain, 1990-1997.

BENEFITS AND COSTS	1990	1991	1992	1993	1994	1995	1996	1997
ASSESSMENT COST								
A. PERSONNEL SERVICES								
1. Fisheries Staff	70,828	43,969	108,632	135,912	126,240	121,005	175,400	210,000
2. Security								
SUBTOTAL	70,828	43,969	108,632	135,912	126,240	121,005	175,400	210,000
B. TRAVEL	2,030	1,570	2,000	7,000	7,560	8,000	12,000	15,000
C. CONTRACTUAL								
1. Postage								
2.Legal Notice								
3. Hot Line								
4. Economic	10,000	10,000	33,000				0	66,354
5. Forage	30,000	30,000	40,000	30,000	30,000	30,000	30,000	30,000
6. Rentals								
7. U.S. F & W Team								
8. Radio Maintenance								
10. Misc.								
Subtotal	40,000	40,000	73,000	30,000	30,000	30,000	30,000	96,354
D. EQUIPMENT	8,750	8,000	21,249	11,342	17,000	20,000	60,000	75,000
E. SUPPLIES AND MATERIALS								
1. Chemical								
2. Water								
3. Misc.	3,000	2,519	2,000	4,000	5,000			
Subtotal	3,000	2,519	2,000	4,000	5,000	0	0	0
F. OPERATION (Vehicle & Boat)	33,419	13,434	33,289	26,660	14,500	40,000	60,000	80,000
TOTAL ASSESSMENT COST	158,027	109,219	240,170	214,914	200,300	219,005	337,400	476,354

Table 7 (Continued). Costs incurred by the state of Vermont to conduct the Eight-Year Experimental Sea Lamprey Control Program on Lake Champlain, 1990-1997.

BENEFITS AND COSTS	1990	1991	1992	1993	1994	1995	1996	1997
FISH PROPAGATION COSTS	158,900	168,850	200,321	207,690	218,625	229,556	200,034	200,000
LANDOWNER COST								
A. Water-Based Activity Loss	2,235	2,727				2,235	2727	
B. Purchased Drinking Water	44	13				44	13	
C. Loss of Nondrinking Water	875	541				875	541	
D. Property Damage	0	0						
TOTAL LANDOWNERS COST	3,154	3,281				3,154	3,281	
INFRASTRUCTURE COSTS	0	13,377	7,324	17,960	16,550	10,204	13,201	11,262
TOTAL COSTS	490,948	601,868	544,018	489,183	515,430	603,719	674,416	710,116
BENEFITS								
A. Angler	633,977	807,761	981,545	1,155,329	1,329,113	1,502,897	1,676,681	1,850,100
B. Nonresident Angler	18,109	67,718	117,327	166,936	216,545	266,154	315,763	365,273
C. User/Nonuser	519,649	972,051	1,424,453	1,876,855	2,329,257	2,781,659	3,234,061	3,685,511
TOTAL BENEFITS	1,171,735	1,847,530	2,523,325	3,199,120	3,874,915	4,550,710	5,226,505	5,900,884

Table 8. Costs incurred by the U.S. Fish and Wildlife Service to conduct the Eight-Year Experimental Sea Lamprey Control Program on Lake Champlain, 1990-1997.

BENEFITS AND COSTS	1990	1991	1992	1993	1994	1995	1996	1997
TREATMENT COSTS								
PERSONNEL SERVICES								
US FWS Personnel		3,584	2,343	3,900	2,184	2,890	0	0
LCFWRO Staff	7,879	8,251	5,000	7,017	5,482	5,676	5,646	5,432
Pittsford NFH Staff	0	0	0	0	0	0	0	0
Technicians	268	428	2,641	5,658	1,435	286	260	1,726
VT Substation	0	0	1,134	3,492	3,061	3,759	4,177	4,432
NY Substation	0	0	4,030	2,452	4,161	2,488	3,173	0
Subtotal	8,147	12,263	15,148	22,519	16,323	15,099	13,256	11,590
TRAVEL	376	689	2,160	671	5,787	1,242	1,222	0
CONTRACT SERVICES	0	0	384	1,413	608	2,370	2,662	0
EQUIPMENT	0	0	18,076	0	0	0	816	0
SUPPLIES AND EQUIPMENT	589	418	11,161	1,914	2,021	485	600	0
OPERATION	234	250	354	660	705	747	299	0
MAINTENANCE/REHAB.	0	0	0	0	0	0	0	0
Total Treatment Cost:	9,346	13,620	47,283	27,177	25,444	19,943	18,855	11,590

Table 8 (Continued). Costs incurred by the U.S. Fish and Wildlife Service to conduct the Eight-Year Experimental Sea Lamprey Control Program on Lake Champlain, 1990-1997.

BENEFITS AND COSTS	1990	1991	1992	1993	1994	1995	1996	1997
ASSESSMENT COST								
PERSONNEL SERVICES								
USFWS		6,790	13,808	19,160	12,792	14,773	0	0
LCFWRO Staff	70,912	74,261	44,993	67,856	49,336	51,083	50,816	48,889
Pittsford NFH Staff	0	0	0	0	0	0	0	0
Technicians	2,417	3,854	23,769	50,923	12,914	2,570	2,340	15,537
VT Substation			7,938	32,464	33,180	26,314	29,243	31,025
NY Substation			7,616	14,467	20,415	14,570	15,364	10,410
Subtotal	73,329	84,905	98,124	184,870	128,637	109,310	97,763	105,861
TRAVEL	3,382	6,200	19,435	5,423	3,866	3,127	2,420	2,898
CONTRACT SERVICES	0	0	3,456	12,715	5,476	21,330	23,963	0
EQUIPMENT	0	0	41,338	4,667	0	2,495	7,342	3,825
SUPPLIES AND MATERIALS	5,297	3,767	10,608	8,288	3,453	9,099	5,407	5,338
OPERATION	2,105	2,260	3,188	5,937	3,131	7,732	2,688	3,108
MAINTENANCE/REHAB.	0	0	0	0	0	0	0	0
Total Assessment Cost:	84,113	97,132	176,149	221,900	144,563	153,093	139,583	121,030

Table 8 (Continued). Costs incurred by the U.S. Fish and Wildlife Service to conduct the Eight-Year Experimental Sea Lamprey Control Program on Lake Champlain, 1990-1997.

BENEFITS AND COSTS	1990	1991	1992	1993	1994	1995	1996	1997
FISH PROPAGATION COST								
PERSONNEL SERVICES								
LCFWRO Staff	0	0	0	0	0	0	0	0
Pittsford NFH Staff	91,483	105,178	91,348	113,925	119,021	121,656	125,306	129,065
Technicians			0	0	0	0	0	0
VT Substation			0	0	0	0	0	0
NY Substation			0	0	0	0	0	0
Subtotal	91,483	105,178	91,348	113,925	119,021	121,656	125,306	129,065
TRAVEL	0	0	0	0	0	0	0	0
CONTRACT SERVICES	0	0	0	0	0	0	0	0
EQUIPMENT	12,000	7,168	0	14,140	1,326	0	0	0
SUPPLIES AND MATERIALS	0	0	0	0	0	0	0	0
OPERATION	17,734	18,353	22,706	23,668	19,018	20,446	21,059	21,691
MAINTENANCE/REHAB.	4,019	27,464	39,690	48,000	4,700	763	0	0
Total Propagation Cost:	125,236	158,163	153,744	199,733	144,065	142,865	146,365	150,756
OTHER		2,688	30,700	15,750	16,224	14,772	16,700	15,615
TOTAL COST:	218,695	271,603	407,876	464,560	330,296	330,673	321,503	298,991

BENEFIT/COST ANALYSIS

This benefit-cost analysis estimates the 1990 discounted benefits and costs[3] of the eight-year (1990 - 97)ESLCP on Lake Champlain. The benefits were derived from 1991 and 1997 surveys of New York and Vermont resident and nonresident anglers and heads of households living within a 35-mile radius of Lake Champlain.

Benefits. The annual values(benefits) derived from these two surveys -- $1,805,268 and $8,625,314 respectively – established the 1990 and 1997 benefits of the eight-year ESLCP. The 1991 through 1996 annual benefits were derived by taking the difference between the 1990 and 1997 annual values for each activity (e.g., New York resident angler) and distributing it in equal incremental increases over the six year period. These values were then discounted to a 1990 value (Tables 6 and 7). For example, the 1990 value of sea lamprey control to resident New York anglers ($451,332), was increased by $77,449 – one-seventh of the difference between the 1990 and 1997 value (Table 6) – to establish the 1991 value of $528,804. The same procedure was followed to derive the 1992 through 1996 values. This procedure is based on the assumption that annual value of sea lamprey control increased uniformly between 1990 and 1997 in response to the increased quality of the fishing. Through the use of this procedure, the estimated1990 benefit of the eight-year ESLCP on Lake Champlain is $29,379,211 (Table 10).

It can also be assumed that the true annual benefit of sea lamprey control is equal to the benefit realized when the results of the eight-year ESLCP are maximized. In this case, it would be the estimated 1997 benefit of the program. Under this assumption, each of the eight-years of the program would be assigned a benefit equal to the 1997 benefit and these benefits would be

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[3] Discounting is a procedure for equating benefits and costs, that occur in different time periods, to a present, point in time, value.

Table 9. U.S. Congressional Appropriations in Support of the Eight-Year Experimental Sea Lamprey Control Program on lake Champlain, 1990-1997.

Cost Category	Cost in Dollars							
	1990	1991	1992	1993	1994	1995	1996	1997
TREATMENT COST	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
A. Personnel Services	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Travel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Contractual	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Postage	0.00	0.00	0.00	0.00	0.00	2,552.00	2,600.00	0.00
2. Crop Duster	0.00	0.00	0.00	0.00	0.00	48,873.00	0.00	0.00
3. G-P Water	0.00	0.00	0.00	0.00	0.00	35,119.00	0.00	0.00
D. Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Supplies and Materials								
1. Chemicals	0.00	0.00	0.00	0.00	0.00	30,000.00	74,635.00	0.00
ASSESSMENT COSTS								
A. Personnel Services	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B. Travel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Contractual	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Equipment	0.00	0.00	0.00	0.00	0.00	11,180.00	0.00	0.00
FISH PROPAGATION COSTS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	$0.00	$0.00	$0.00	$0.00	$0.00	$127,724	$77,235	$0.00

Table 10. Discounted estimated benefits and actual costs of the Eight-Year Experimental Sea lamprey Control Program on Lake Champlain for 1990-1997.

Benefit/Cost Category	1990 Discounted Benefits and Costs				
BENEFITS AND COSTS	New York $	Vermont $	U.S. Fish & Wildlife $	U.S. Congress $	Total $
TREATMENT COSTS					
1. PERSONNEL SERVICES					
USFWS Personnel	0.00	0.00	11,844.74	0.00	11,844.74
LWFWRO Staff	0.00	0.00	39,484.39	0.00	39,484.39
Pittsford NFH Staff	0.00	0.00	0.00	0.00	0.00
Technicians	0.00	0.00	9,695.67	0.00	9,695.67
NY Substation			11,944.97	0.00	11,944.97
Fisheries Staff	570,341.92	0.00	0.00	0.00	570,341.92
Fringe	161,789.12	0.00	0.00	0.00	161,789.12
VT Substation	0.00	256,612.89	13,469.87		13,469.87
Fisheries Staff	0.00	5,772.01	0.00	0.00	256,612.89
Security			0.00	0.00	5,772.01
Subtotal	732,131.04	262,384.90	86,439.64	0.00	1,080,919.50
2. TRAVEL	45,769.47	12,024.81	9,121.93	0.00	66,916.21
3. CONTRACT SERVICES			5,078.97	0.00	5,078.97
Postage	9,552.30	1,417.33	0.00	3,290.85	14,260.48
Legal Notice	3,348.27	1,254.09	0.00	0.00	4,602.36
Hotline	2,659.60	2,221.44	0.00	0.00	4,881.04
Economic	0.00	0.00	0.00	0.00	0.00

Table 10 (Continued). Discounted estimated benefits and actual costs of the Eight-Year Experimental Sea lamprey Control Program on Lake Champlain for 1990-1997.

Benefit/Cost Category	1990 Discounted Benefits and Costs				
BENEFITS AND COSTS	New York $	Vermont $	U.S. Fish & Wildlife $	U.S. Congress $	Total $
Foreage	0.00	0.00	0.00	0.00	0.00
Rentals	0.00	84.95	0.00	0.00	84.95
US F&W Team	80,459.50	47,692.67	0.00	0.00	128,152.17
Radio Maintenance	0.00	6,118.51	0.00	0.00	6,118.51
Lewis Creek Barrier	0.00	0.00	0.00	0.00	0.00
Miscellaneous	4,360.98	0.00	0.00	0.00	4,360.98
Cropduster	46,327.65	0.00	0.00	32,205.77	78,533.42
G-P Water	79,789.35	0.00	0.00	23,355.73	103,145.08
HPCL	17,339.42	0.00	0.00	0.00	17,339.42
Subtotal	243,837.07	58,788.99	0.00	0.00	302,626.06
4. EQUPMENT	17,691.86	49,596.14	15,854.92	0.00	83,142.92
5. SUPPLIES & MATERIALS			14,102.13	0.00	14,102.13
Chemical	353,174.56	340,661.50	0.00	65,698.52	759,534.58
Water	3,110.05	1,646.26	0.00	0.00	4,756.31
Miscellaneous	10,912.75	29,336.20	0.00	0.00	40,248.95
Laboratory	9,795.32	0.00	0.00	0.00	9,795.32
Subtotal	376,992.68	371,643.96	14,102.13	0.00	762,738.77
6. OPERATION (Vehicle/Boat)	23,000.81	59,702.79	2,470.61	0.00	85,174.21
7. MAINTENANCE/REHAB.	0.00	0.00	0.00	0.00	0.00
TOTAL TREATMENT COST	1,439,422.90	814,141.59	133,068.20		2,386,632.60

Table 10 (Continued). Discounted estimated benefits and actual costs of the Eight-Year Experimental Sea lamprey Control Program on Lake Champlain for 1990-1997.

Benefit/Cost Category	1990 Discounted Benefits and Costs				
BENEFITS AND COSTS	New York $	Vermont $	U.S. Fish & Wildlife $	U.S. Congress $	Total $
ASSESSMENT COSTS					
1. PERSONNEL SERVICES					
USFWS	0.00	0.00	52,042.96	0.00	52,042.76
LWFWRO Staff	0.00	0.00	359,038.08	0.00	359,038.08
Pittsford NFH Staff	0.00	0.00	0.00	0.00	0.00
Technicians	0.00	0.00	87,266.94	0.00	87,266.94
NY Substation			57,514.61	0.00	57,514.61
Fisheries Staff	395,321.77	0.00	0.00	0.00	395,321.77
Fringe (28.96%)	115,313.26	0.00	0.00	0.00	115,313.26
Subtotal	510,635.03	0.00	0.00	0.00	510,635.03
VT Substation			109,052.34	0.00	109,052.34
Fisheries Staff	0.00	707,495.90	0.00	0.00	707,495.90
Security	0.00	0.00	0.00	0.00	0.00
Subtotal	0.00	707,495.90	664,914.91	0.00	1,372,410.80
2. TRAVEL	2,739.66	37,260.97	37,840.85	0.00	77,841.48
3. CONTRACTUAL			45,715.16	0.00	45,715.16
Postage	237.26	0.00	0.00	0.00	237.26
Legal Notice	0.00	0.00	0.00	0.00	0.00
Hotline	452.83	0.00	0.00	0.00	452.83
Economic	0.00	84,733.74	0.00	0.00	84,733.74
Forage	0.00	192,050.00	0.00	0.00	192,050.00

Table 10 (Continued). Discounted estimated benefits and actual costs of the Eight-Year Experimental Sea lamprey Control Program on Lake Champlain for 1990-1997.

Benefit/Cost Category	1990 Discounted Benefits and Costs				
BENEFITS AND COSTS	New York $	Vermont $	U.S. Fish & Wildlife $	U.S. Congress $	Total $
Rentals	0.00	0.00	0.00	0.00	0.00
US F & W Team	0.00	0.00	0.00	0.00	0.00
Radio Maintenance	0.00	0.00	0.00	0.00	0.00
Lewis Creek Barrier	0.00	0.00	0.00	0.00	0.00
Miscellaneous	1,102.36	0.00	0.00	0.00	1,102.36
Subtotal	1,792.44	276,783.70	45,715.16	0.00	324,291.30
4. EQUPMENT	10,784.76	147,766.90	47,088.99	7,435.21	213,075.86
5. SUPPLIES & MATERIALS			39,141.26		39,141.26
Chemical	0.00	0.00	0.00	0.00	0.00
Water	0.00	0.00	0.00	0.00	0.00
Miscellaneous	9,431.84	13,760.07	0.00	0.00	23,191.91
Subtotal	9,431.84	13,760.04	39,141.26	0.00	62,333.14
6. OPERATION (Vehicle/Boat)	27,878.83	213,985.90	22,348.91	0.00	264,213.64
7. MAINTENANCE/REHAB.	0.00	0.00	0.00	0.00	0.00
TOTAL ASSESSMENT COST	563,262.55	1,397,053.50	857,050.08	0.00	2,817,366.13
FISH PROPAGATION COSTS	0.00	0.00	0.00	0.00	0.00
1. PERSONNEL SERVICES					
LCFWRO Staff	0.00	0.00	0.00	0.00	0.00
Pittsford NFH Staff	0.00	0.00	671,717.30	0.00	671,717.30
Technicians	0.00	0.00	0.0	0.00	0.00

Table 10 (Continued). Discounted estimated benefits and actual costs of the Eight-Year Experimental Sea lamprey Control Program on Lake Champlain for 1990-1997.

Benefit/Cost Category	1990 Discounted Benefits and Costs				
BENEFITS AND COSTS	New York $	Vermont $	U.S. Fish & Wildlife $	U.S. Congress $	Total $
VT Substation	0.00	0.00	0.00	0.00	0.00
NY Substation	0.00	0.00	0.00	0.00	0.00
Subtotal	0.00	0.00	671,717.27	0.00	671,717.27
2. TRAVEL	0.00	0.00	0.00	0.00	0.00
3. CONTRACT SERVICES	0.00	0.00	0.00	0.00	0.00
4. EQUIPMENT	0.00	0.00	30,633.58	0.00	30,633.58
5. SUPPLIES & MATERIALS	0.00	0.00	0.00	0.00	0.00
6. OPERATION	0.00	0.00	124,949.05	0.00	124,949.05
7. MAINTENANCE/REHAB.	0.00	0.00	104,524.74	0.00	104,524.74
TOTAL PROPAGATION COSTS	773,318.27	1,191,459.90	931,824.65	0.00	2,896,601.80
OTHER	0.00	0.00	81,474.88	0.00	81,474.88
TOTAL LANDOWNER COSTS	10,286.59	10,286.59	0.00	0.00	20,573.18
TOTAL INFRASTRUCTURE COSTS	46,583.08	65,793.34	0.00	0.00	112,376.42
TOTAL COST	2,832,873.40	3,478,734.20	2,003,417.80	131,986.08	8,447,011
BENEFITS					
Angler	4,218,868.60	7,148,184.40			11,367,053
Nonresident Angler	387,680.37	1,044,037			1,431,717
User/Nonuser	4,890,472.10	11,689,968			16,580,440
TOTAL BENEFITS	9,497,021.10	19,882,190			29,379,211
Benefit-Cost Ratio	3.35:1	5.71:1			3.48:1

discounted to a 1990 value. Using this procedure, the estimated 1990 benefit of the eight-year ESLCP on Lake Champlain would be $52,774,101 (Appendix II). The problem with this procedure is that it assumes that the value of sea lamprey control is realized as soon as the program is implemented. This procedure would better represent the value of sea lamprey if the program is continued and the level of control achieved in 1997 is maintained or enhanced. This benefit-cost analysis, therefore, will use the first procedure (i.e., uniform increase in benefits between 1990 and 1997) to estimate the benefits of the program because the purpose of this benefit-cost analysis is to estimate the value of the eight-year ESLCP on Lake Champlain.

Costs. The costs directly attributable to the eight-year ESLCP on Lake Champlain consist of: (1) the actual treatment, assessment and propagation costs incurred by New York, Vermont, the U.S. Fish and Wildlife Service, and costs covered by a one-time U.S. Congressional appropriation; (2) estimated costs (e.g., water-based activity loss, cost of purchasing bottled water), to landowners living along lampricide-treated streams, rivers and river deltas, during the two treatment advisory periods; and (3) actual infrastructure costs (e.g., development/renovation of boat and fishing access sites, search and rescue) incurred by local, state and federal governments. These costs are tabulated for each of the eight years and discounted to establish a total, 1990 discounted cost for the program. The 1990 discounted cost of the eight-year ESLCP on Lake Champlain is $8,447,011 (Table 10).

Benefit-Cost Ratio. The benefits and costs of the eight-year ESLCP on Lake Champlain were determined by the procedures described above and were discounted to 1990 values using the mean federal government "discount rate for water and related projects" for the period 1990 to 1997. The estimated total benefits of the eight-year ESLCP on Lake Champlain was $29,379,211 and the total costs were $8,447,011 (Table 10). This produces net benefits of $20,902,200 and a benefit-cost ratio of 3.48:1 ($3.48 in benefits were received for every dollar of incurred cost). The benefit-costs ratios for New York and Vermont were 3.35:1 and 5.71:1 respectively.[4] This is a conservative estimate of net benefits and a conservative benefit-cost ratio because of the limited nature of the benefits used (see Benefits and Costs, p. 3) and the time period over which benefits were calculated. Benefits of the eight-year ESLCP will continue at a diminishing annual rate for several years after the program ends while costs were only estimated for the eight-year control period.

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[4] These individual state ratios are not true ratios because they do not include costs incurred by the Federal government. They are state ratios based on state benefits and state costs. Federal costs were not included because Federal funds for sea lamprey control were allocated to the project and not to the individual states.

BENEFICIAL ANGLER IMPACTS OF SEA LAMPREY CONTROL

Angler Impacts

The additional beneficial angler impacts of sea lamprey control consist of: (1)increase in the number of days fished annually and the associated increase in expenditures by current and noncurrent[5] salmonid (lake trout, salmon, etc.) and nonsalmonid (bass, walleye, etc.) anglers and, (2) increase in the number of fishing days on Lake Champlain and associated expenditures by anglers who also fished for trout and/or salmon in water bodies other than Lake Champlain in 1997[6].

It is estimated that 35.2% of the current (1997) salmonid anglers, 27% of the noncurrent salmonid anglers, 32.2% of current nonsalmonid anglers and 25.9% of noncurrent, nonsalmonid anglers plan to increase the number of days they fish Lake Champlain annually "if the success of the Sea lamprey Control Program maintains or continues to improve the quality of trout and salmon fishing." The average expected increase in the number of planned fishing days ranged from 14.3 days (current salmonid anglers) to 12.6 days (noncurrent, nonsalmonid anglers). The overall total is estimated to be 1,217,609 days. Assuming that the associated current average daily expenditure by each of the four angler groups would be the same for the increased days of fishing, the estimated increase in expenditure would be $4,150,768.

A portion of the sea lamprey control-induced increase in the number of fishing days and associated expenditure on Lake Champlain will be generated by Lake Champlain anglers who also fish other water bodies and transfer some or all of their fishing activity to Lake Champlain in response to increased fishing quality on Lake Champlain. An estimated 49.4%of all Lake Champlain anglers (41,782) fished other water bodies in 1997 and 41.4% (17,298) of these

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[5] Anglers not currently fishing for salmonids on Lake Champlain.

anglers said they would increase their fishing activity on Lake Champlain if the size and number of fish caught on Lake Champlain was the same as the other water bodies they are now fishing. The average annual increase in fishing on Lake Champlain would be 16 days and the estimated total annual increase would be 330,642 days. Since this is a subgroup of the anglers, discussed above, who said they would increase the number of days they fished Lake Champlain in response to the observed success of the ESLCP, it is assumed that the stated increase in fishing days (and associated expenditures) by this subgroup of anglers is already reflected in the above totals.

Beneficial User/Nonuser Impacts of Sea Lamprey Control

The additional beneficial user/nonuser impacts of sea lamprey control consist of: (1) increase, control-induced participation and associated expenditure, on lake-based recreation during the eight-year ESLCP on Lake Champlain, (2) planned increase in participation and associated expenditures by current users of Lake Champlain if the success of the ESLCP is continued or enhanced and, (3) planned increase in participation and associated expenditures by noncurrent users of Lake Champlain if the success of the ESLCP is continued or enhanced.

During the eight-year ESLCP on Lake Champlain, the members of an estimated 32,528 households (17.5% of all households in the 35-mile zone) increased their annual participation by an average of 6.75 days. Assuming that the per-day expenditure on lake-based recreation is equal to respondents current (1997) per-day expenditure, the increased participation generated an additional $8,781,969 in annual expenditures.

The members of 9,916 New York households accounted for $3,766,703 of the additional expenditure and the members of 22,612 Vermont households accounted for the remaining $5,015,266.

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[6] Some of these anglers may be a subset of the noncurrent salmonid anglers in (1) above.

It is estimated that the members of 92,025 households (26.7% of all households in the 35-mile zone) currently recreating on Lake Champlain and the members of 58,542 households (17% of all households in the 35-mile zone) not currently recreating on the Lake will increase their annual participation if the success of the ESLCP is continued or enhanced. The increase will consist of an estimated 1,546,784 additional days of recreation annually and additional lake-based recreation expenditures of $59,289,994. The members of 33,312 New York households currently recreating on Lake Champlain and the members of 25,709 households not currently recreating on the Lake will account for $14,970,084 and $11,458,944 respectively of the additional expenditures. Members of Vermont's 58,713 households currently participating in water-based recreation and Lake Champlain and members of 32,832 households not currently participating will account for $26,096,056 and $6,764,910 respectively of the $59,289,994 in additional expenditures.

Beneficial Fishing-Related Business Impacts of Sea Lamprey Control

There are 98 fishing and fishing-related businesses within an approximate 10 mile radius of Lake Champlain that sell goods and services to Lake Champlain anglers. The owners of these businesses estimate that $5,545,040 of their $7,239,281 gross fishing-based income in 1997 was derived from anglers fishing Lake Champlain and/or its tributaries. Of this amount, $1,798,781 was directly attributable to lake trout and salmon angling on Lake Champlain. While there is no way of knowing how much of this expenditure is directly attributable to the ESLCP on Lake Champlain, it is important to note that lake trout and salmon anglers are the most recognized beneficiaries of the program – sea lamprey predation is most prevalent on salmonids.

Other indicators of the impact ESLCP has had on fishing-related businesses include changes in business income and business expansion. The income of the fishing and fishing-related businesses serving Lake Champlain anglers increased 32.9% during the eight-year ESLCP while Vermont sales tax data show that other amusement and recreation businesses only increased 18.4% during the same period. The 14.5% difference may not be totally attributable to the ESLCP but numerous testimonials by charter captains and other business owners suggest that the ESLCP played a major role in generating the increase.

Regarding business expansion, 48.5% of the fishing and fishing-related businesses serving Lake Champlain anglers expanded their businesses during the eight-year ESLCP and business owners cited the success of the ESLCP as the reason for 29.2% of the expansion. In addition, 35.4% of the business owners plan to expand their businesses during the period 1998-2004. They said that 21%of the planned expansion was directly attributable to the anticipated continuation of the ESLCP on Lake Champlain.

It was obvious during the personal interviews with the 98 business owners/managers that they strongly support sea lamprey control and are ready and willing to expand their businesses if sea lamprey control, and the observed success of the ESLCP, continues.

SUMMARY AND CONCLUSIONS

The eight-year (1990-1997) Experimental Sea Lamprey Control Program (ESLCP) on Lake Champlain generated estimated 1990 discounted benefits of $29,379,211 and discounted costs of $8,447,011. This resulted in a net benefit of $20,902,200 and a benefit-cost ratio of 3.48:1. In addition to these benefits, continuation of the sea lamprey control program on Lake Champlain is expected to generate an additional 1,217,609 days of fishing and $4,150,768 in increased fishing-related expenditures annually.

The success of the eight-year ESLCP also induced the members of an estimated 32,528 households to increase their annual participation in water-based recreation on Lake Champlain by 219,564 days during the eight-year period and spend an additional $8,781,969 on these activities. If the program is continued, it is estimated that the members of 92,025 households currently recreating on Lake Champlain, and members of 58,542 households not currently recreating on Lake Champlain, will increase their annual participation by 1,546,784 days and generate an estimated $59,289,994 in additional annual water-based recreation expenditures.

The owners of the 98 fishing and fishing-related businesses serving Lake Champlain anglers were not able to estimate what percent of their $5,545,040 Lake Champlain-based 1997 gross fishing/fishing-related income is attributable to the ESLCP on Lake Champlain but they voiced unanimous support for the program. Study results did show that 48.5% of these businesses expanded during the eight-year ESLCP and business-owners attributed 29.2% of the expansion directly to the program. Another 35.4% of the business owners plan further expansion and 21% of the planned expansion was directly attributable to the anticipated continuation of the ESLCP on Lake Champlain.

It is evident that the eight-year ESLCP has had a major impact on Lake Champlain anglers and on current and future participants in water-based recreation on Lake Champlain. Anglers and other water-based recreationists placed a very high value on the eight-year ESLCP on Lake Champlain ($29,379,211 with a 3.48:1 benefit-cost ratio) and said that they would substantially increase their participating in angling and other water-based recreation activities if the program is continued. These findings suggest that the eight-year ESLCP on Lake Champlain is justifiable on economic grounds – benefits greatly exceed costs. Continuation of the sea lamprey control program on Lake Champlain, however, will depend upon the importance of economic considerations in the overall decision process.

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APPENDIX I

Developmental Costs Incurred by New York During the Eight-Year Experimental Sea Lamprey Control Program That Will Be Excluded If Sea Lamprey Control On Lake Champlain Is Continued

1990 -	$22,704	(straight security force salary estimates - without fringe)
	$33,020	(Bayer Wetlands Impact study - contract cost)
	$ 8,779	(computer equipment)
	$26,278	(supplies and materials for construction of pesticides storage building)
	$90,781	
1991 -	$11,777	(straight security force salary estimates - without fringe)
	$60,812	(Georgia-Pacific Paper Co. - water supply pipeline construction)
	$20,800	(Bayer Wetlands Impact study - contract cost)
	$93,389	
1992 -	$ 9,827	(straight security force salary estimates - without fringe)
	$13,253	(Bayer Wetlands Impact study - contract cost)
	$ 6,000	(175 hp outboard for 22' Mako)
	$29,080	

From 1993 - 1997 no potentially controversial costs were excluded from the previously submitted tables. However, in 1994 some unusual costs incurred which were excluded which are explained below:

1994 -	$ 1,640	(airfare/other travel expenses for flight to Marquette to borrow deepwater electrofisher)
	$ 1,183	(airfare to Marquette to represent Department at G. Steinbach's funeral)
	$ 801	(business reply mail account, etc., for inland angler surveys billed to Champlain)
	$ 3,975	(cost of lifetime licenses in exchange for a land access lease agreement for Old Water Works Dam)

Costs were also incurred to reconstruct the Old Water Works Dam on the Great Chazy River as a barrier to upstream migrating sea lamprey between 1991 and 1997. However, this was not an essential part of the eight-year experimental program, and these costs, totaling approximately $20,931.04 in personal services and $405,062 in construction costs, have been excluded.

APPENDIX II

Table A. Estimated benefits and actual costs of the Eight-Year Experimental Sea Lamprey Control Program on Lake Champlain for 1990-1997.

Benefit/Cost Category	1990 Discounted Benefits and Costs				
BENEFITS AND COSTS	New York $	Vermont $	U.S. Fish & Wildlife $	U.S. Congress $	Total $
TOTAL COST	2,832,873.40	3,478,734.20	2,003,417.80	131,986.08	8,447,011
TOTAL BENEFITS					
Angler	6,078,590	7,148,184.40			17,398,452
Nonresident Angler	741,007	1,044,037			2,975,935
User/Nonuser	9,849,865	22,549,849			32,399,714
TOTAL BENEFITS	16,669,462	36,104,639			52,774,101
Benefit-Cost Ratio	5.88:1	10.38:1			6.25:1

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