Vermont Fish and Wildlife Department
Annual Report

State: Vermont **Project No**.: F-35-R-15

Grant Title: Lake Champlain Fisheries Restoration and Management

Study No. IV **Study Title:** Salmonid Management

Period Covered: July 1, 2012 to June 30, 2013

Summary of Activity:

Fall electrofishing surveys of selected Lake Champlain tributaries and nearshore areas yielded collections of 603 landlocked Atlantic salmon, 598 lake trout, 27 steelhead rainbow trout and 20 brown trout.

Sea lamprey wounding rates on lake trout in the index 533-633 mm TL class increased from a 14-year low of 30 wounds per 100 fish in 2011 to 40 wounds per 100 fish in 2012. The sea lamprey control program objective of 25 wounds per 100 lake trout has not yet been attained. Wounding rates on 432-533 mm TL salmon collected in the Main Lake increased slightly from 19 wounds per 100 fish in 2011, to 21wounds per 100 fish in 2012, after meeting the program objective (15 wounds per 100 fish) in 2010. Wounding rates on Inland Sea/Mallets Bay salmon of the same size class increased to 26 wounds per 100 fish in 2012, after attaining a record low of 14 wounds per 100 fish in 2011.

The Winooski One fish lift operated for 53 days in fall 2012 and 55 days in spring 2013. A total of 44 adult salmon were captured in the fall, along with 37 steelhead rainbow trout; 44 steelhead were collected in the spring**.**

Salmon fry are stocked annually in the Huntington River (tributary to the Winooski River) and fall fingerlings are stocked in the Winooski River. Electrofishing surveys were conducted in the Huntington River system and nine other Winooski River tributaries to assess these stocking efforts. Salmon parr were found in the Huntington River, Texas Brook (tributary to Huntington River), Mill Brook and Joiner Brook. Numbers encountered were substantially lower than in previous years, probably due to tropical storm Irene in 2011 and low numbers of fry stocked in 2012.

A rotary screw trap was fished in the Huntington River April 23-June 6, 2013 to capture out-migrating salmon smolts. The trap operated for 45 days within this period and 82 smolts were captured. The trap could not be fished for 15 days during peak migration due to excessive flows.

A total of 243 adult Sebago strain salmon collected in fall 2012 assessment sampling were transferred to the Ed Weed Fish Culture Station for gamete collection. The majority of these fish were returned alive to Lake Champlain.

Two trapnets were set for one night each in Hatchery Cove near the Ed Weed Fish Culture Station on November 13, 2012. The trapnets were tended the next day, and 267 lake trout and 6 salmon were captured.

Two salmonid stocking evaluations were initiated in 2012. The first evaluation will compare the performance of Sebago strain salmon smolts produced from domestic broodstock and feral broodstock collected in assessment sampling. The second evaluation will compare the performance of the Chambers Creek and Lake Memphremagog strains of steelhead rainbow trout. Stocking of smolts of each species for the evaluation began in spring 2012, and annual stockings will continue through 2016. Evaluation data will be collected during routine salmonid sampling activities.

More information on the above activities is presented in the reports that follow.

Work continued on development of a Lake Champlain salmonid stocking rate assessment process, in cooperation with the New York State Department of Environmental Conservation and the U.S. Fish and Wildlife Service. Since the current stocking targets were established in the mid 1990s, there have been substantial changes to the Lake Champlain ecosystem that may be affecting growth and survival of stocked salmonids, as well as their forage base. A number of fish community, population and fishery metrics are being identified and evaluated to determine their potential to contribute pertinent information to a stocking rate decision-making process, with the goal to maximize salmonid angling opportunities while maintaining predator-prey balance. This activity is on-going and findings will be reported in a future segment.

This project was made possible by fishing license sales and matching Dingell-Johnson/Wallop-Breaux funds, available through the Federal Aid in Sport Fish Restoration Act.

Acknowledgment: This project was conducted in partnership with staff from the US Fish and Wildlife Service working under the Lake Champlain Special Designation Act.

Fall Electrofishing Surveys

Procedures

Lake Champlain salmonids are sampled annually in fall electrofishing surveys to assess stocking, population structure and response to sea lamprey control (F-35-R, Study VIII), and provide broodstock for hatchery production. Between mid-September and mid-November 2012, lake trout, landlocked Atlantic salmon, steelhead rainbow trout and brown trout were sampled in the Lamoille River, Missisquoi River and Sandbar Causeway Bridge in the Inland Sea/Malletts Bay basins, and Main Lake basin locations including Hatchery Brook (Ed Weed Fish Culture Station discharge stream) and adjacent lake shore, Otter Creek, and the nearshore areas of Whallon Bay, and Willsboro Bay (Figure 1). The Whallon Bay and Willsboro Bay sampling was conducted in cooperation with the New York State Department of Environmental Conservation and the U.S. Fish and Wildlife Service.

A supplemental salmonid sampling method was evaluated for Hatchery Brook. Given the unique, small size of Hatchery Brook, the use of large dip nets may be an efficient collection method to reduce reliance on electrofishing. For each sampling event, a crew of three people used large sportfish landing nets (approximately 66-76 cm diameter) attached to 2.4 m handles in confined sections of the stream to collect as many salmonids as possible in a period of time similar to that of an electrofishing run. The dip-netting continued until the crew determined that the remaining fish would be very difficult to collect in a reasonable length of time. The crew followed up with electrofishing to collect the remaining fish, which typically depleted or nearly depleted the stock in each section except when very high fish densities were observed.

Sex/maturity, total length, weight, fin clip, and sea lamprey attack data were recorded for all fish collected, with the exception that subsamples of lake trout were weighed. Scale samples were taken from all salmon, steelhead, and brown trout for age determination, and those collected in Vermont waters, were also tagged with serially numbered floy-type anchor tags. Virtually all fish collected were released alive, aside from a portion of the salmon transferred to the Ed Weed Fish Culture Station for gamete collection, and limited numbers of other salmon and brown trout trout that were lethally sampled for use in other projects.

Results

Electrofishing Surveys

A total of 603 salmon were collected from all but two sampling locations, and 598 lake trout were collected from the lakeshore areas; 44 brown trout and 27 steelhead were also collected (Table 1). Eight of the lake trout collected (1.6 percent) were not marked with a fin clip. This proportion of unmarked lake trout is within normal hatchery fin clipping error rates.

Unusually low lake levels and low river flows limited sampling in the Lamoille River, and prevented electrofishing boat access to the Sandbar Causeway Bridge most of the season. A total of 40 salmon were collected in the Lamoille River, which is less than half of the number

collected in 2011. One trip was made to sample at the Sandbar Causeway in late October after rains elevated the lake level and no salmon were collected or observed. Limited sampling was conducted in two other Vermont rivers at the time of peak runs in the Lamoille River and Hatchery Brook. Two salmon were collected during one trip in Otter Creek, and no salmon were observed during two trips in the Missisquoi River.

A total of 241spawning adult Sebago strain salmon from Hatchery Brook (119 females and 121 males), and two additional females from the Winooski One fish lift were held as boodstock at the Ed Weed Fish Culture Station, Grand Isle, VT. The Sebago strain is identified by unique fin clips. The majority of these fish were released alive back into Lake Champlain.

Twenty lake trout were lethally sampled for routine disease testing, and 25 others were taken as broodstock for a University of Vermont study on lake trout reproduction and thiaminase levels. An additional 10 lake trout and 5 brown trout were lethally sampled for an EPA fish contaminants study.

Sea Lamprey Wounding Rates

Sea lamprey attacks on salmonids were categorized using the standard classification system from Ebener, et al. (2006). Stage A1 (fresh wounds) and A2-A3 (healing wounds) were used in the wounding rate calculations. Sea lamprey control and salmonid restoration objectives include wounding rate targets of 25 wounds per 100 lake trout in the 533-633 mm TL size class, and 15 wounds per 100 salmon in the 432-533 mm TL size class (USFWS et al. 2001). The wounding rate calculations include pooled data for both lake trout and salmon collected in all fall assessments, including electrofishing, trapnetting, and the Winooski River fish lift.

The 2012 lamprey wounding rate on lake trout wounding rate increased from a 14-year low of 30 wounds per 100 fish in 2011 to 40 wounds per 100 fish in 2012 (Figure 2). The 2012 lakewide salmon wounding rate increased slightly from 19 wounds per 100 fish in 2011 to 21 wounds per 100 fish in 2012 (Figure 2). Wounding rates on larger lake trout size classes showed similar trends (Figure 3). Wounding rates pooled Inland Sea and Malletts Bay salmon increased to 26 wounds per 100 fish in 2012, after attaining a record low of 14 wounds per 100 fish in 2011 (Figure 4).

Hatchery Brook Salmon Returns

The 2012 Hatchery Brook salmon catch was relatively low compared to recent years despite an increase in sampling effort, but larger salmon were more prevalent in the sample (Figure 5). This suggests a possible decline in overall salmon abundance in 2012; the greater frequency of larger fish in the sample may indicate lower survival of age 0+ and/or 1+ lake-year cohorts, or increased growth rates. Completion of scale aging and related analyses would be necessary to determine the more likely cause.

A relative abundance index of salmon returning to Hatchery Brook was calculated as the average number of salmon collected per sampling day annually, for the years 1997-2011. There are two major assumptions supporting this approach: 1) the stream is small and the hatchery discharge is

relatively constant from year to year, creating consistent and highly efficient sampling conditions; and 2) sampling is conducted through the majority of the run within the same timeframe from year to year (mid September through mid November). There is a strong relationship between the abundance of salmon returning to Hatchery Brook and sea lamprey wounding rates on salmon (Figure 6).

Dip netting appeared to be an efficient sampling method for Hatchery Brook. A total of 365 salmon were collected with dip nets, compared to 90 collected with follow-up electrofishing over the course of 11 sampling days where both methods were used. Using dip netting as an additional sampling method will substantially reduce the numbers of salmonids collected with electrofishing in Hatchery Brook, which should minimize the incidence of injury to fish that is sometimes caused by electrofishing.

Lake Trout Size Structure

Length frequency metrics indicate continuing maturation of the lake trout population. Prior to 2005, 10 percent or less of lake trout sampled were greater than 735 mm TL. The proportion of lake trout greater than 735 mm has steadily grown since 2005, and has ranged from 21 to 25 percent of the sample from 2009 through 2012 (Figure 7). There was a corresponding steady decline in the proportion of lake trout in the 533-633mm TL class, from a high of 42 percent of the sample in 1997 to 12 percent in 2009; however, the proportion of the sample observed in this size class has recently increased, ranging from 16 to 20 percent from 2010 through 2012 (Figure 7). The approximately 55% reduction in annual lake trout stocking that began in 1996 may explain some of the decline in the 533-633 mm size class through the mid 2000's, but the long term trend indicates that changes in sea lamprey-induced mortality suggested by wounding rate data (Figure 7) may be a factor affecting recruitment into the 533-633mm size class.

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Ebener, M.P., E.L. King, Jr., and T.A. Edsall. 2006. Application of a dichotomous key to the classification of sea lamprey attack marks on Great Lakes fish. Great Lakes Fisheries Commission Misc. Publication 2006-02. Ann Arbor, MI. 21pp.

U. S. Fish and Wildlife Service, Vermont Department of Fish and Wildlife, and New York State Department of Environmental Conservation. 2001. A long-term program of sea lamprey control in Lake Champlain. Final Supplemental Environmental Impact Statement FES# 01-27. Lake Champlain Fish and Wildlife Management Cooperative. 356 pp. plus appendices.

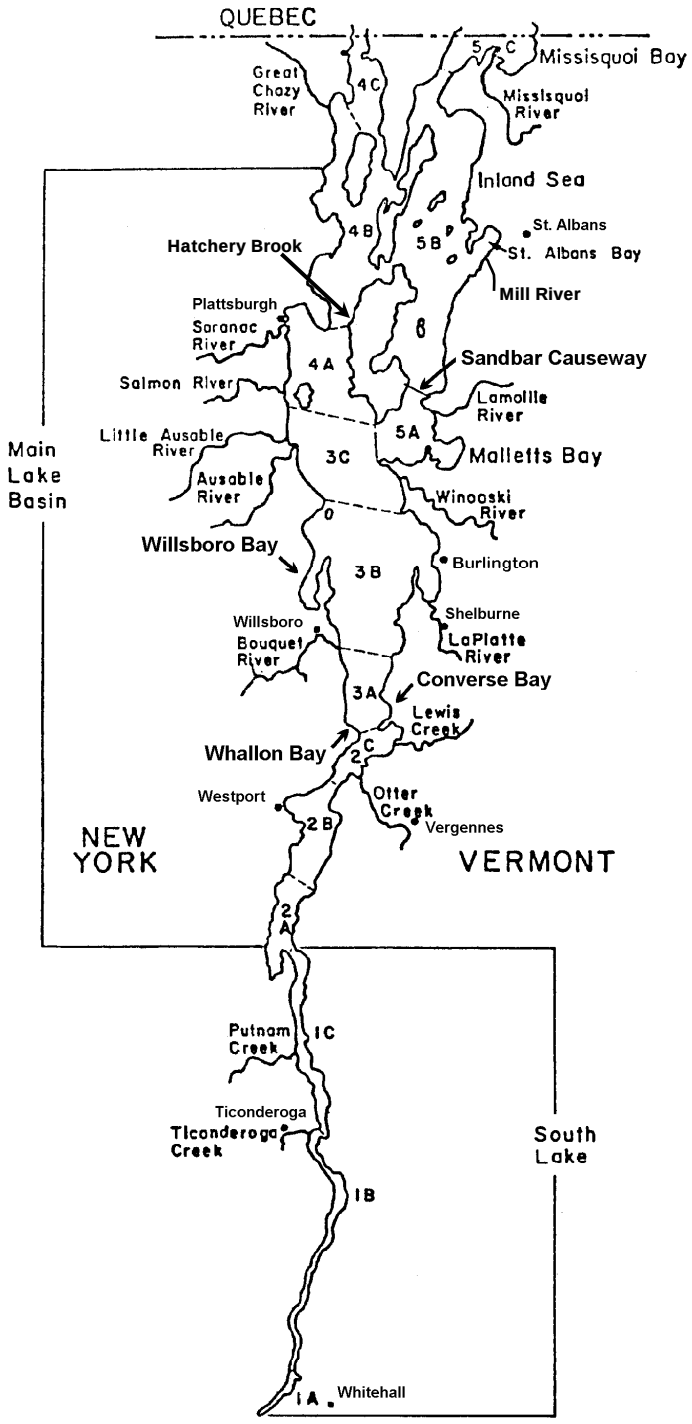

Figure 1. Lake Champlain, showing major lake basins and management zones, tributaries and salmonid sampling areas.

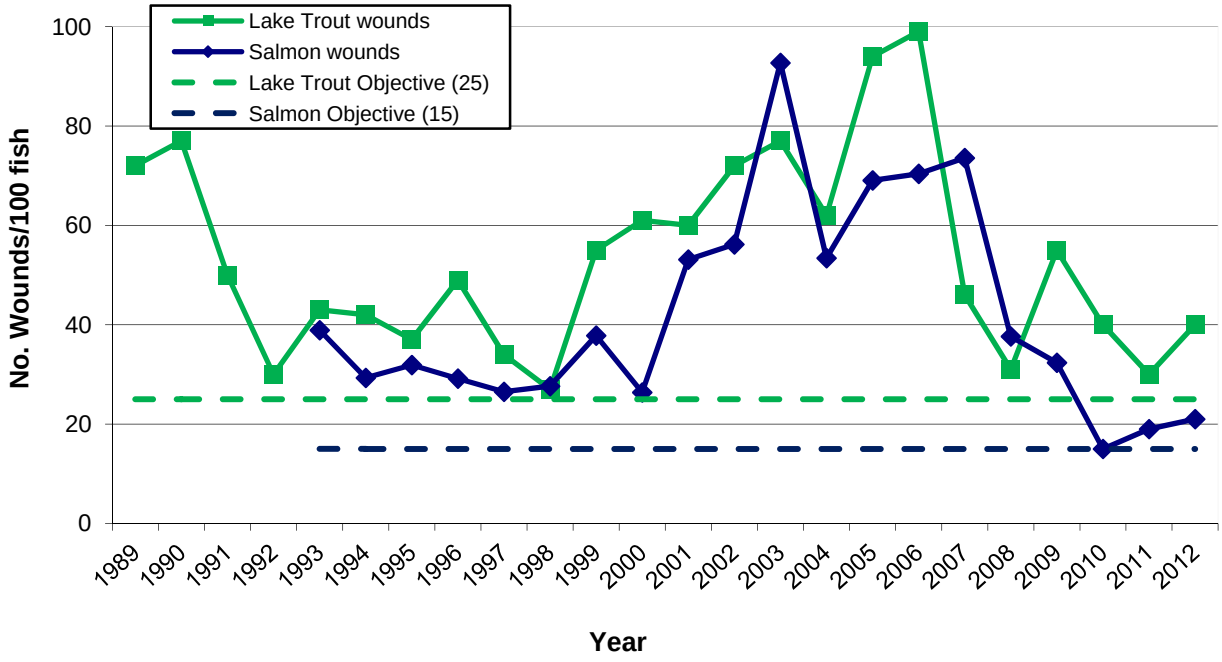

Figure 2. Sea lamprey wounding rates on 533-633 mm TL lake trout and 432-533 mm TL landlocked Atlantic salmon from Lake Champlain, 1989-2012.

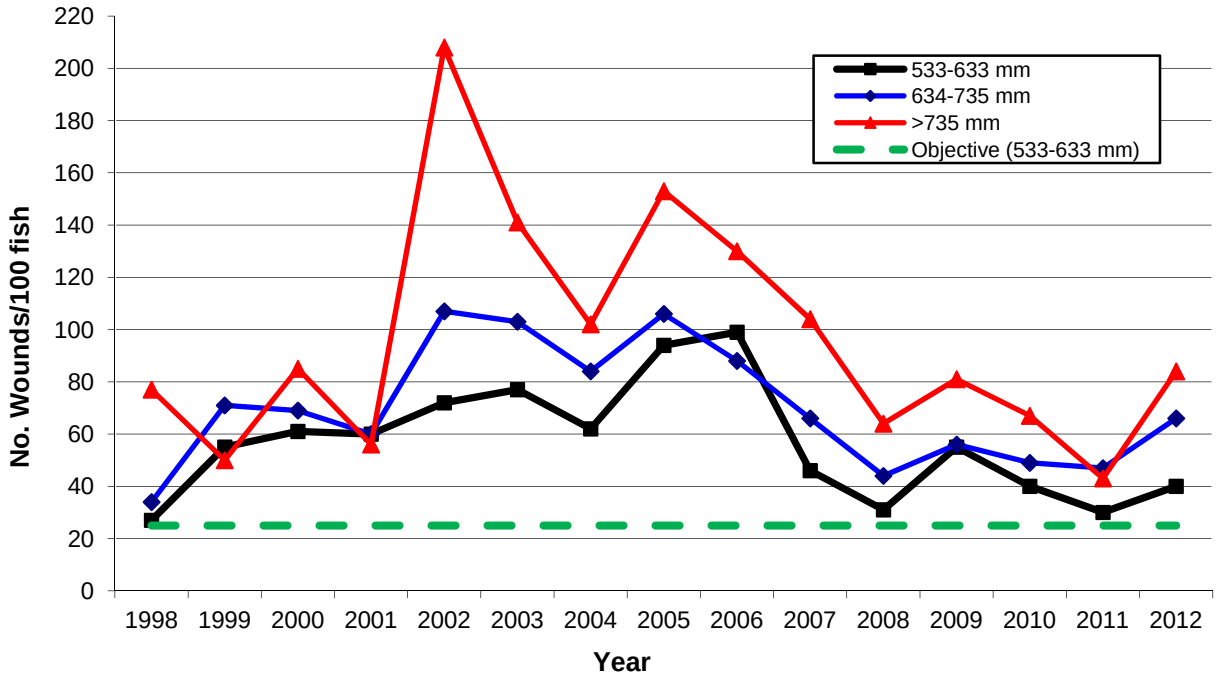

Figure 3. Sea lamprey wounding rates on three length classes (TL) of lake trout from Lake Champlain, 1998-2012.

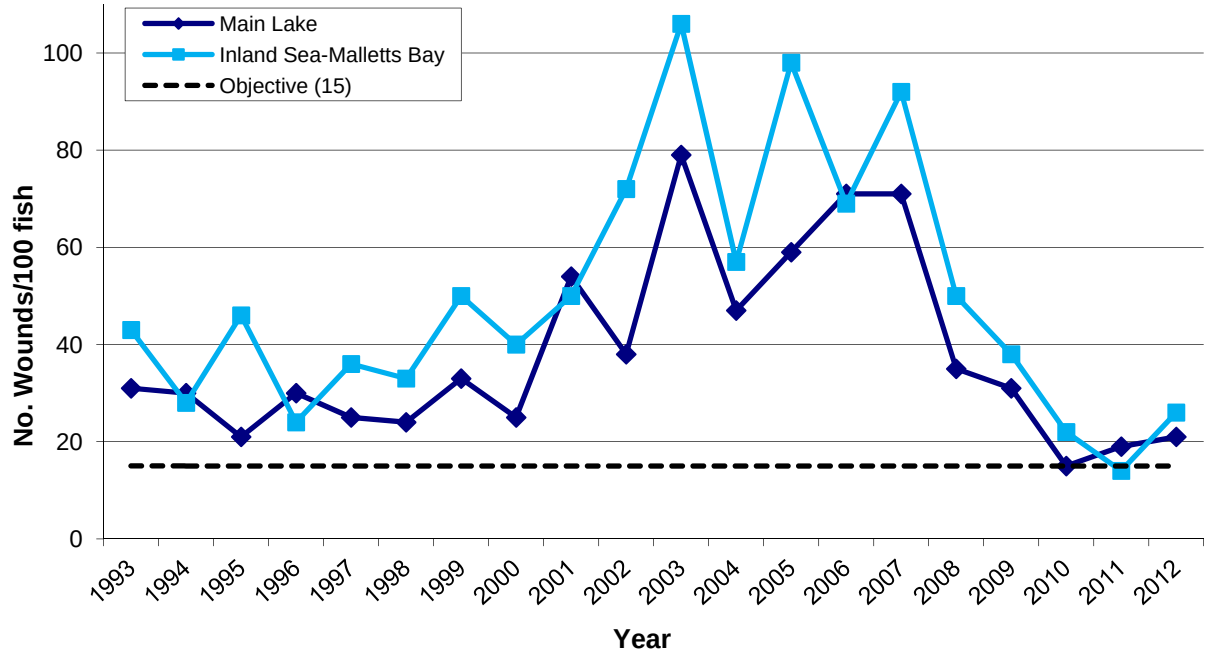

Figure 4. Sea lamprey wounding rates on 432-533 mm TL landlocked Atlantic salmon from the Main Lake and Inland Sea/Malletts Bay basins of Lake Champlain, 1993-2012.

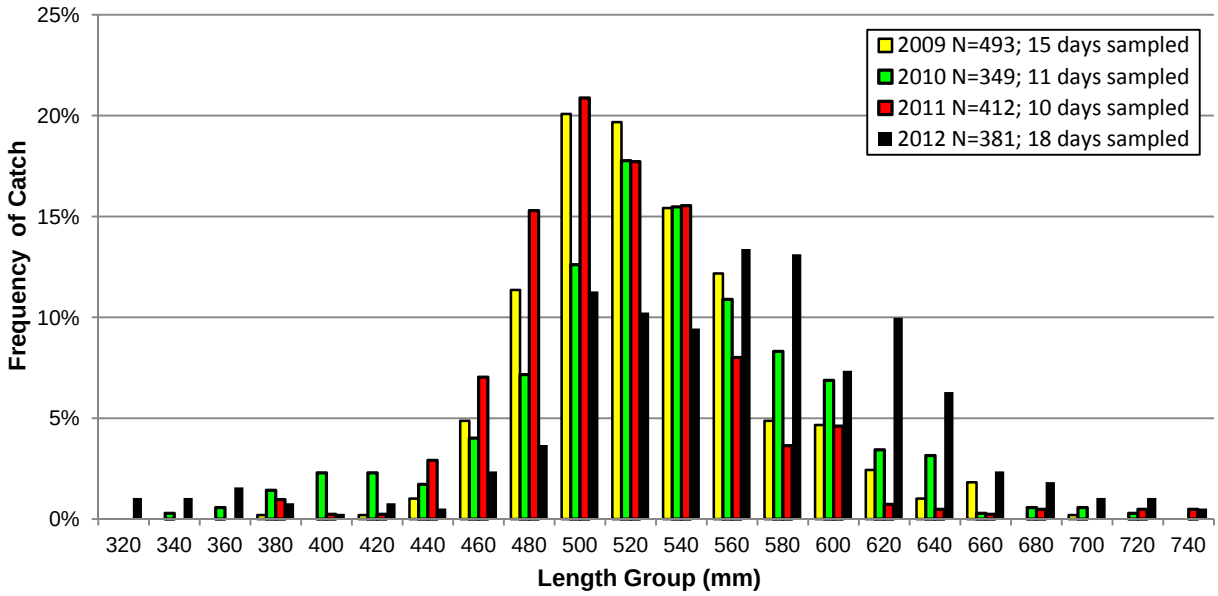

Figure 5. Length frequency distributions of landlocked Atlantic salmon collected from fall spawning runs in Hatchery Brook, 2009-2012.

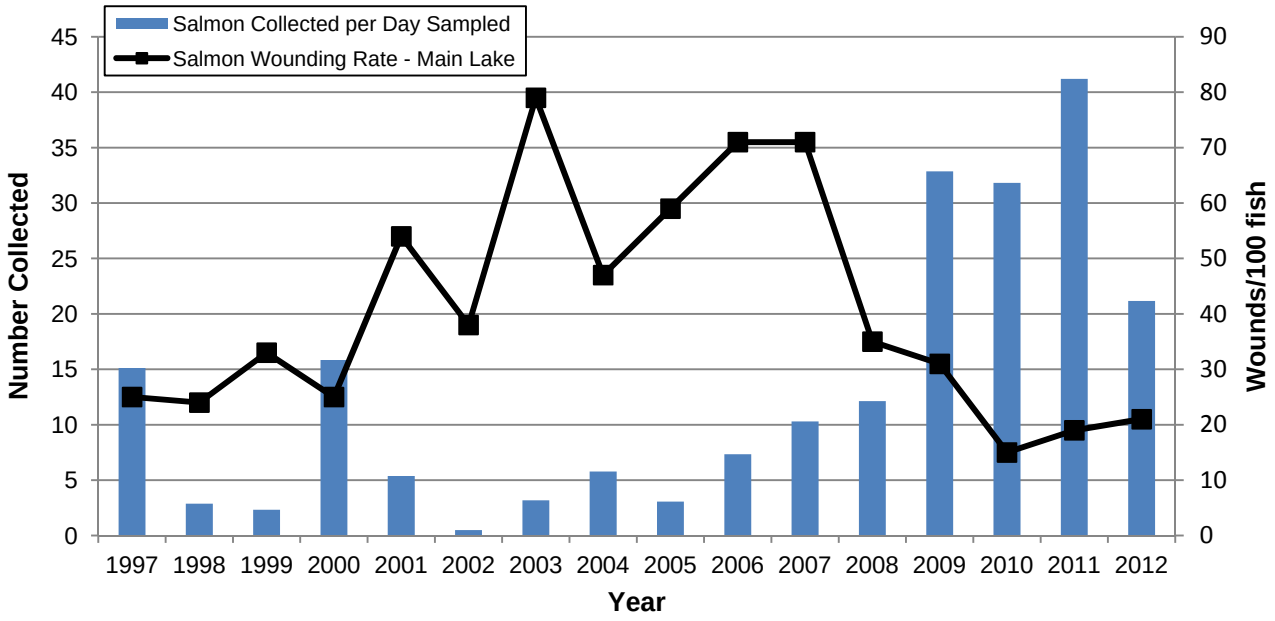

Figure 6. Relative abundance of landlocked Atlantic salmon returns to Hatchery Brook (number collected by electrofishing per day sampled) and Main Lake sea lamprey wounding rates, 1997-2012.

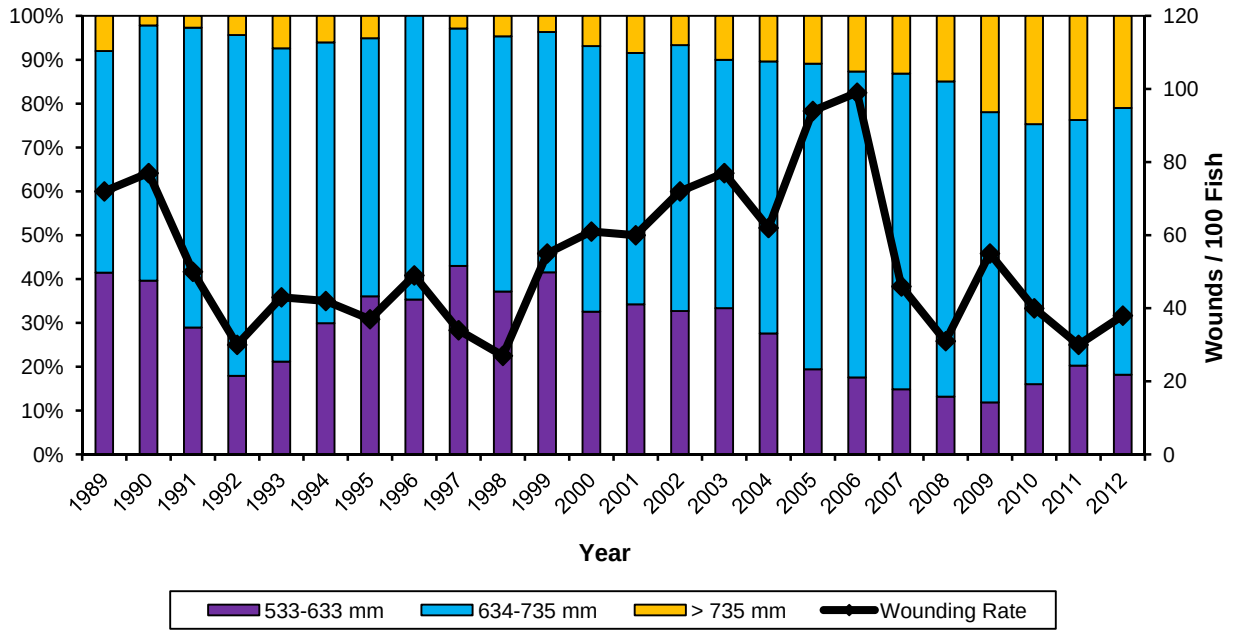

Figure 7. Percent frequency of three length classes (TL) of lake trout sampled in Lake Champlain by fall electrofishing, 1989-2012.

Table 1. Cooperative Lake Champlain salmonid electrofishing results in fall 2012. Average total length (TL) is in mm.

Species/Area	Sampling Period (No. Days Sampled)	Number Collected	Males Ave. TL (n)	Females Ave. TL (n)	Juvenile or unknown Ave. TL (n)
Landlocked Atlantic salmon					
Lamoille River	Sep. 24 - Nov. 20 (9)	50	514 (26)	537 (21)	343 (3)
Sandbar Causeway	Oct. 31 (1)	0	-	-	-
Hatchery Brook	Sep. 24 - Nov. 13 (18)	381	559 (200)	542 (168)	398 (13)
Missisquoi River	Nov. 6 (1)	0	-	-	-
Otter Creek	Oct. 11 (1)	2	534 (1)	612 (1)	-
Whallon Bay	Nov. 6-20 (4)	87	665 (1)	574 (28)	533 (58)
Willsboro Bay	Nov. 13-19 (2)	83	551 (2)	636 (1)	498 (77)
	Total	603			
Lake trout					
Hatchery Cove/Breakwater	Nov. 13 (1)	255	683 (166)	710 (88)	-
Whallon Bay	Nov. 6-15 (3)	300	678 (116)	692 (174)	614 (10)
Willsboro Bay	Nov. 13-19 (2)	43	689 (20)	697 (22)	518 (1)
	Total	598			
Steelhead					
Lamoille River	Sep. 24 - Nov. 20 (9)	1	-	-	385 (1)
Sandbar Causeway	Oct. 31 (1)	0	-	-	-
Hatchery Brook	Sep. 24 - Nov. 13 (18)	22	434 (3)	505 (4)	418 (15)
Missisquoi River	Nov. 6 (1)	0	-	-	
Otter Creek	Oct. 11 (1)	0	-	-	-
Whallon Bay	Nov. 6-20 (4)	3	-	512 (1)	511 (2)
Willsboro Bay	Nov. 13-19 (2)	1	-	-	515 (1)
	Total	27			
Brown trout					
Lamoille River	Sep. 24 - Nov. 20 (9)	0	-	-	-
Sandbar Causeway	Oct. 31 (1)	0	-	-	-
Hatchery Brook	Sep. 24 - Nov. 13 (18)	19	413 (7)	480 (11)	320 (1)
Missisquoi River	Nov. 6 (1)	0	-	-	-
Otter Creek	Oct. 11 (1)	0	-	-	-
Whallon Bay	Nov. 6-20 (4)	0	-	-	-
Willsboro Bay	Nov. 13-19 (2)	1	-	-	420(3)
	Total	20			

Winooski River Fish Lift and Salmon Investigations

Introduction

On November 3, 1988 the City of Burlington Electric Department and the Winooski One Partnership was issued a Federal Energy Regulatory Commission (FERC) License to construct, operate, and maintain the Chase Mill Hydroelectric Project No. 2756. This hydroelectric facility is located on the Winooski River at the Winooski Falls in the City of Winooski, Vermont, approximately 18.4 kilometers (km) upstream of Lake Champlain (Figure 1). This facility has three large generating units with a capacity of producing 7.5 megawatts.

The installation and operation of a fish passage facility was a requirement of licensing. FERC license article 408 states "The licensee, after consultation with the Vermont Department of Fish and Wildlife (VTDFW) and the U.S. Fish and Wildlife Service shall develop plans for a trap and truck facility immediately downstream of the project dam to ensure upstream fish passage past the project dam". Winooski One is also required to operate in an "instantaneous run-of-river mode" (article 405) which provides protection of fish downstream of the dam.

The Winooski One project is the first upstream barrier on the Winooski River. Two more hydroelectric facilities owned by the Green Mountain Power Corporation, Gorge #18, 1.4 km upstream of Winooski One, and Essex #19, 3.7 km upstream, are additional barriers to fish migration. Favorable salmonid habitat is accessible upstream of Essex #19 dam for approximately 33.6 km to Green Mountain Power's Bolton Falls dam.

The Winooski One fish lift has allowed fisheries managers the opportunity to restore wild migratory salmonid populations and fisheries in the lower Winooski River that have been restricted by barriers built on the river. The lift has enabled migrating Lake Champlain landlocked Atlantic salmon and steelhead rainbow trout access to critical spawning and nursery habitat above the Winooski One hydroelectric station. The goals of the project are:

1. To create a quality stream fishery for lake-run steelhead rainbow trout and landlocked Atlantic salmon in the Winooski River.

2. To encourage natural reproduction of Lake Champlain landlocked Atlantic salmon and steelhead rainbow trout in the Winooski River watershed.

Viral Hemorrhagic Septicemia

Viral hemorrhagic septicemia (VHS) is considered to be one of the most serious fish diseases in freshwater environments in Europe and now, in North America. Outbreaks of the VHS virus can result in severe fish mortality events in aquaculture as well as in wild populations. The VHS virus is readily transmissible to fish of all ages, and survivors of infection can be lifelong carriers. The virus is shed from infected fish in urine, feces, and reproductive fluids and transmission can occur through water or direct contact.

VHS has recently been confirmed in the Great Lakes following several large fish mortality events, and has spread to several inland lakes in New York State. At least 37 fish species have been documented to carry the virus, including such recreationally important species as walleye, yellow perch, smallmouth bass, northern pike and muskellunge, and virtually all species of trout and salmon. In response to the rapid spread of VHS, the US Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) issued a Federal Order restricting the importation of fish and bait from two Canadian provinces into the United States and the interstate movement from eight states bordering the Great Lakes. Similar measures have been taken by the states of New York and Vermont to prevent the spread of VHS including new importation rules and regulations on the personal and commercial collection and movement of baitfish.

Since Lake Champlain has a high probability of becoming infected with VHS, the Vermont Department of Fish and Wildlife is evaluating and considering modification, where necessary, of certain fishery management practices including stocking and fish passage to minimize the risk to wild fish populations. To this end, upstream movement of salmon and steelhead collected the Winooski One fish passage facility was suspended in 2008. The fish lift, however, will continue to operate since it has become an important fish population assessment tool (e.g., relative abundance, size, age, and lamprey wounding data), as well as a source of salmon brood stock for the Lake Champlain culture program. Downstream passage facilities will also continue to operate as salmon parr still exist in the Winooski watershed as the result of fry stocking. This change of operating procedure will be re-evaluated on an annual basis.

Fish Lift Monitoring

Objective: To move migratory landlocked Atlantic salmon and steelhead rainbow trout above the first three dams on the Winooski River.

Procedures

The fish lift was scheduled to operate in the spring (March 15 – May 15) and in the fall (September 15 – November 15). Power company personnel activated the lift 1-3 times a day (0800 hr, 1300 hr, and 1600 hr). Lift frequency was determined based on the numbers of fish being lifted. Lifted fish were emptied into a sorting tank where targeted species were separated from the other catch. A daily log was kept of the number of lifts, time, species numbers, flows, water temperature, and general weather.

Targeted species were saved for processing by state or federal biologists while other catch was released back downstream. Biological data recorded from fish collected include length, weight, sex (when possible), scales for age analysis, fin erosion and sea lamprey attacks. Fish were tagged with a serially numbered floy-type tag (yellow for salmon, red for steelhead) under the dorsal fin to determine movements and contribution to the fishery, and the release site recorded.

In addition to the biological information collected at the lift, an hourly flow history was provided by United States Geological Survey as well as the power company for the fish lift period. Hourly temperature data at the lift was also recorded by the power company.

Findings

Fall lift season

The fish lift operated continuously from September 12 thru November 9, 2012 (Figure 2). The fish hopper was lifted 115 times during the fall with 6 days of in-operation due to high flows. A total of 44 adult salmon were recorded (Table 1). Many salmon were captured more than once. There were 31 recaptures recorded with 7 salmon having been recaptured twice and two fish recaptured 3 times.

There were 20 male and 22 female salmon processed at the lift (two were sex not determined). Thirty-four of the 39 salmon aged had spent one year in the lake (1-lake-year). Mean lengths of male and female 1-lake-year salmon were 560 and 533 millimeters (mm), respectively (Table 2). Four salmon were 2-lake-year fish with a mean length of 656 mm for males (3 fish) and 672 mm for females (1 fish).

In addition to the salmon, 37 steelhead were lifted in the fall, 2012 (Table 1). The majority of steelhead trapped had a fin clipped indicating they were stocked in the spring (i.e. age 0+ lake-year). There were 16 Chambers Creek steelhead (left ventral fin removed or LV clip) and 13 Lake Memphremagog (right ventral or RV clip) processed. The Chambers Creek steelhead were larger with a mean length of 435 mm (SD=27) then the Memphremagog fish (398 mm, SD=20).

Spring lift season

The fish lift operated from March 15 thru May 13, 2013. The fish hopper was lifted 130 times in 55 days of operation. Forty-four adult steelhead rainbow trout (21 male and 13 female) were trapped (Table 1). One steelhead had been previously lifted in the fall, 2012. Several fish were re-captured during the season. The majority of steelhead trapped had a fin clipped indicating they were stocked in the spring of 2012 (i.e. age 1-lake-year). There were 7 Chambers Creek steelhead (LV clip) and 31 Lake Memphremagog (RV clip) processed. The Chambers Creek steelhead were larger with a mean length of 455 mm (SD=27) then the Memphremagog fish (441 mm, SD=27).

Lamprey wounding rates

The goal of the Lake Champlain sea lamprey control program is to achieve or surpass the fish population, recreational fishery and economic benefits realized during the 1990-97 experimental sea lamprey control program (Fisheries Technical Committee 2001). To this end, a lamprey wounding rate objective of 15 wounds per 100 fish was established for landlocked salmon in the 432-533 mm length class. In 2012, 13 salmon fell within this length class with a

calculated lamprey wounding rate of 77 wounds per 100 fish (Table 3). This is a substantial increase from the two previous years.

Evaluation of Fry and Smolt Stocking

Objective: To establish runs of adult landlocked Atlantic salmon and steelhead rainbow trout that will provide a stream fishery as well as encourage natural reproduction.

Procedures

A total of 29,577 Sebago strain salmon smolts were stocked in the Winooski River in spring 2013, (Table 4). The salmon lots had mean lengths ranging from 178 - 197 mm and were reared at the Dwight D. Eisenhower National Fish Hatchery in Chittenden, Vermont and the State of Vermont's Ed Weed Fish Culture Station in Grand Isle, Vermont. Salmon raised at Eisenhower received a left ventral fin clip before stocking and salmon from Ed Weed were marked with a right ventral fin clip as well as being nose-tagged with a coded wire tag (CWT). Salmon were stocked at the dam or at the fishing access near the mouth on April 3rd and 4rth. An additional 1000 smolts were stocked in the Huntington River as part of a USFWS initiated salmon smolt river-run project (see below).

On September 18, 2012, 20,350 fingerling salmon were stocked in the main stem Winooski from Richmond, Vermont upstream. These fish came from the Eisenhower National Fish Hatchery and averaged 102 mm total length. This stocking replaces past fry stocking of the Winooski River. It is hoped that these larger fish will have better survival. All fingerlings received an adipose fin clip for future identification.

In addition to the spring 2013 salmon smolt and fall 2012 fingerling stocking, the Huntington River was stocked with approximately 47,500 salmon fry in May, 2013. This number is about half of what is normally stocked in the Huntington River (see Winooski River Tributary Salmonid Assessment).

A total of 20,000 steelhead rainbow trout were stocked in the Winooski River in 2013. These fish came from the Ed Weed Fish Culture Station. Half of the fish were stocked below the fish lift while the other half was released at the fishing access near the mouth. Equal numbers of the Chambers Creek (LV clipped) and Lake Memphremagog strains (RV clipped) were stocked at each site. The fish were stocked on March 13th and 14th (Table 5).

The success of the salmon fry, fingerling and smolt stocking is assessed by the subsequent adult returns to the Winooski River trap. Returning salmon were identified as being fry, fingerling or smolt stocked by fin clips. Furthermore, in 2010 the USFWS initiated a salmon river-run project which entailed collecting genetic samples from the brood stock salmon providing the progeny used to stock the Winooski watershed. The subsequent collection of genetic samples from returning adult salmon will confirm their stocking history. The procedures and results for this study will be included in a future report.

In spring 2012 it was brought to our attention that large numbers of recently stocked smolts were being lifted and released during the spring season. In 2013, these fish were collected to identify to species (Salmon or steelhead) and collect pertinent biological data.

Findings

During the fall 2012 trapping season 25 returning adult salmon had an RV clip versus 18 without a clip (Table 6). The majority of both the clipped and non-clipped salmon were lake-age 1 fish. It's presumed that the RV fish were originally stocked in 2011 in the Winooski River while the non-clipped fish are from salmon stocked as fry. One LV clipped salmon also was trapped, which was determined to be lake-age 1. This fish may have been marked as a fry-stocked parr in the Huntington River in 2008 or 2009.

The proportion of non-clipped to clipped fish increased from 2011 to 2012 and probably reflects the lower return of smolt-stocked salmon in 2012, compared to the large salmon returns in 2011.

One-hundred steelhead smolts were collected at the lift in 2013; no salmon smolts were observed. These fish were stocked on March 14th and were first observed the following day (Figure 3). The last day the smolts were counted was April 29th – 45 days after stocking. Chambers Creek strain (LV clip) made up the majority (69 smolts) of checked fish. The Chambers Creek smolts were also larger with a mean length of 205 mm (SD=15, n=69) then the Memphremagog fish (181 mm, SD=26, n=29).

Winooski River and Tributary Habitat Assessment

Objective: To assess present salmonid habitat within the Winooski River watershed.

Procedures

No habitat assessment was conducted in 2012. However, temperature data was collected for the Winooski and several tributaries using temperature loggers from Onset Instruments, (Pocasset, MA); model HOBO Water Temp Pro v2. Temperature loggers were programmed to record every hour.

Findings

Table 7 depicts water temperature measurements in the Winooski River and several tributaries. Mean water temperatures during the months of May through October ranged from 10 to 23 degrees °C. Some of the high maximum water temperatures are due to loggers being exposed because of fluctuating water flows.

Winooski River Tributary Salmonid Assessment

Objective: To assess present natural reproduction of resident salmonids, survival of stocked salmon fry and spawning success of lifted adult salmonids.

Procedures

Salmon fry stocking

Stocked salmon fry originated from eggs of Sebago strain salmon and were incubated at the Eisenhower National Fish Hatchery. Fry were transported from the hatchery in fine mesh cages stacked in a large insulated tank mounted on a pickup truck equipped with oxygen. Once on site, the correct amount of fry was determined by weight and acclimated to stream water temperature before hand planted into suitable habitat in the Huntington River. Target stocking density in 2013 was 32 fry per salmon habitat unit (100 square meters).

Salmon parr and trout sampling

The subsequent status of juvenile salmon stocked as fry and other salmonid populations were evaluated during August and September. Salmon and trout were sampled on the Huntington River, including four tributaries, and nine other Winooski River tributaries.

Sampling accessibility and general habitat characteristics determined site selection. Tributary stations varied in length from approximately 100 to 175 meters. Sampling was accomplished by electrofishing with a Georator Corporation portable electric generator at 500 volts or ABP-2 backpack electrofishing unit (Univ. of Wisconsin, Engineering Technical Services, Madison, WI).

Population size was estimated using a maximum weighted likelihood modification of the Zippin removal method (Carl and Strub 1978). Multiple sampling runs (usually 3) were conducted at each station until the last run collected no more than 20 percent of the total trout collected in the previous runs. This ensured that allowable coefficient of variation values resulted from calculated population estimates.

Captured salmon and trout were identified, measured, weighed. A scale sample was taken from some salmon. Scale samples from these and salmon captured in the out-migration study (see Salmon Smolt Out-Migration below) as well as length-frequency analysis were used to assign ages to salmon. Young-of-year fish were weighed collectively.

Findings

Salmon fry stocking

The total number of salmon fry stocked into the Winooski watershed in 2013 was about 47,500. This is about a half of what is typically stocked in the river. All the fry were put into the lower 6 kilometers the Huntington River (figure 1). These fry averaged 25 mm in length and were stocked at a density of 31 fish per salmon unit.

Salmon parr sampling

Salmon parr were found at the two Huntington River index stations as well as in its tributary, Texas Brook. Numbers encountered were substantially lower than in previous years probably due to tropical storm Irene in 2011 and low numbers of fry stocked in 2012. Density of YOY salmon found at the lower and upper sampling locations was 1.0 and 3.2 fish per salmon unit, respectively (Table 8, Figure 4). Survival estimates for salmon fry stocked in 2012 are presented in Table 9. Mean total lengths at the time of sampling for the young-of-year (YOY) and age 1+ salmon were 79 mm (SD=7.6; n=87) and 157 mm (SD=14; n=6), respectively.

Salmon were also collected in Mill Brook and Joiner Brook. The two fish collected in Joiner Brook were adipose fin clipped (AD) indicating they were stocked as fall fingerlings in the Winooski River in the fall of 2011. The two salmon in Mill Brook were not clipped and presumed to have strayed from the Huntington River.

A total of 1333 trout were collected during the 2012 tributary sampling effort. Table 10 summarizes population estimates and biomass for the Winooski River tributaries sampled in 2012. Young-of-year trout made up 85 percent of the fish collected in the 14 tributaries sampled with the majority of those being brook trout (49 %) (Figure 5). Figure 6 illustrates the variability of YOY rainbow trout population estimates over time for three tributaries sampled.

Salmon Smolt Out-Migration

Objective: (1) describe timing and rates of migration, (2) assessing in-river migration factors, (3) evaluating inter-year variability in magnitude of out-migration.

Procedures

In spring 2004, the first attempt at capturing salmon smolts stocked as fry out-migrating to Lake Champlain was conducted utilizing a rotary screw trap. This trap was placed in the lower Huntington River, performed well and a total of 57 salmon were captured. In 2007 a new trap was purchased from E.G. Solutions of Corvallis, Oregon. The new trap has a larger fish capturing cone (2.4 meters diameter vs. the old traps cone of 1.8 meters).

In 2013 the rotary screw trap was deployed in the Huntington River at river kilometer 0.5. The trap consists of two 8-meter floating pontoons between which a revolving mesh–covered cone is suspended. The large end of the cone (2.4 m diameter) is facing upstream and an internal screw built into the cones center axle rotates the cone as the water current exerts pressure on it. Downstream migrating fish that enter the cone are passed to the end of the cone and collected in a live box. The trap was tied to the shore and positioned in the upstream end of a pool at the end of a shallow riffle that funneled much of the flow into the cone.

Discharge in the Huntington River was monitored daily with a staff gauge placed near the trap location. Stream temperature was monitored using a temperature logger from Onset Instruments, (Pocasset, MA), model HOBO Water Temp Pro v2. The temperature logger was programmed to record every hour.

The trap was checked at least once per day in the morning. Captured salmon were measured for total length, weighed and a scale sample taken for age verification. Salmon were marked by punching a 3.5 mm (1/8 inch) hole in the tail to help identify potential re-captures. After processing, salmon were placed in a cage 400 meters upstream and held from 8-24 hours before being released in order to estimate trap efficiency (see below).

Rotary screw traps sample only a portion of the cross-sectional area of the stream. For this reason, numbers of migrants were estimated by the trap-efficiency method. Trap efficiency was calculated by releasing marked salmon upstream of the trap. The estimated numbers of migrants was calculated by the following formula:

Efficiency = Recaptured marked salmon / Marked fish released

The total number of fish migrating past the trap site was then estimated by:

Number of fish = unmarked fish caught / Efficiency

Findings

The trap was deployed on April 23 and fished until June 6, 2013 (Table 11). The trap fished 28 days during the period and captured 82 salmon smolts (Figure 7). The trap could not be fished for 15 days during peak migration due to excessive flows. The month of May recorded a total rain fall of 222 mm (8.74 in), a new record, and was 134 mm above the norm. Calculation of trap efficiency and subsequent estimation of out-migration numbers was not attempted in 2013.

The majority of smolts captured (96%) were from fry stocking (no fin clip). The remaining salmon trapped (3 fish) were AD clipped smolts which were stocked as fall fingerlings in 2011 or 2012. Sixty-two smolts were aged and analysis reveals an age structure similar to previous years and split between age 2 and 3 year old smolts (figure 8). Mean lengths were similar to what has been found in the past: age 2 - 157 mm, SD = 23.4; age 3 – 193 mm, SD = 15.

Angler Exploitation

Objective: To estimate angler fishing effort and catch of returning salmonids.

Procedures

Angler exploitation was measured by angler tag returns and volunteer reporting on angler creel survey forms posted at the Winooski One fish lift.

Findings

Two salmon and 3 steelhead tagged at the Winooski One fish lift were reported caught by anglers between June 1, 2012 and June 30, 2013 (Table 12). All of the reports were fish caught outside of the Winooski River. The largest fish caught was a 762 mm salmon in July, 2012 which was tagged September, 2011 at the lift and was 724 mm at that time.

There were 13 entries in the volunteer angler survey forms between September 11, 2012 and January 7, 2013. Based on information provided by anglers, it took approximately 5.1 hours of fishing effort to catch either a salmon or steelhead during this period. Only 6 steelhead trout were reported to have been caught in 30.75 hours of fishing effort reported below Winooski One dam. All but one of the steelhead were reported to have been released by anglers.

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Table 1. Summary of landlocked Atlantic salmon and rainbow steelhead trout lifted at the Winooski One fish passage facility, 1993 – spring 2013.

Year	Spring		Fall	
	Steelhead	Salmon	Salmon	Steelhead
1993	NA	0	36	7
1994	179	0	32	15
1995	38	0	12	9
1996	45	0	11	3
1997	8	0	115	24
1998	23	0	85	80
1999	54	0	53	13
2000	22	0	29	3
2001	7	0	6	0
2002	5	1	21	3
2003	4	2	14	3
2004	3	0	10	1
2005	4	0	15	5
2006	2	2	23	7
2007	0	0	35	2
2008	6	1	26	0
2009	1	0	38	26
2010	13	3	130	61
2011	37	0	189	18
2012	16	0	44	37
2013	44	0	na	na

Table 2. Summary of mean total lengths of aged landlocked Atlantic salmon collected at the Winooski One fish passage facility, fall 2012. All lengths in millimeters ± one standard deviation. Number of fish in parenthesis.

Sex	Lake Age 0	Lake Age 1+	Lake Age 2+	Lake Age 3+	Total
Landlocked Atlantic Salmon					
Male	416 (1)	560 ± 35 (14)	656 ± 28 (3)	---	18
Female	---	533 ± 38 (20)	672 (1)	---	21
Total	1	34	4	---	39

Table 3. Summary of sea lamprey attacks on Landlocked Atlantic salmon in the 432-533 mm length class lifted at the Winooski One fish lift, 1993 - 2012.

Year	Number of Salmon	Fresh wounds	Healing wounds	Scars	Total wounds	Wounds/ 100 fish
1993	14	0	4	9	4	28.6
1994	10	0	3	7	3	30.0
1995	3	0	0	4	0	0
1996	6	0	0	2	0	0
1997	112	4	21	30	25	22.3
1998	15	0	1	5	1	6.7
1999	14	3	7	9	10	71.4
2000	6	0	4	3	4	66.7
2001	4	1	2	2	3	75.0
2002	7	0	3	10	3	42.8
2003	3	2	3	8	5	166.6
2004	4	0	0	6	0	0
2005	7	7	4	9	11	157.1
2006	16	4	18	29	22	137.5
2007	10	2	5	13	7	70.0
2008	11	0	9	12	9	81.8
2009	12	0	10	14	10	83.3
2010	20	1	8	15	9	45.0
2011	96	4	26	73	30	31.3
2012	13	1	9	8	8	76.9

Table 4. Summary of recent landlocked Atlantic salmon smolt stocking in the Winooski River, 2006 – 2013. Stockings are typically split between the boat access near the river mouth and below the Winooski One dam. Sources include the State of Vermont's Ed Weed Fish Culture Station, White River National Fish hatchery, and Dwight D. Eisenhower National Fish Hatchery.

Year Stocked	Stocking Location	Number Stocked	Size (mm)	Source	Total Stocked	Clip
2006	W. One Mouth	26,046 3,954	196-239 251	Ed Weed and Eisenhower	30,000	ADRV
2007	W. One Mouth	9,865 13,290	219 219	White River	23,155	ADRV
2008	W. One Mouth	33,689 26,302	178-203	Ed Weed and White River	59,991	RV
2009	W. One Mouth	15,706 17,040	155 - 171	Eisenhower	32,290	RV
2010	W. One Mouth	15,466 15,703	178 - 192	Ed Weed	31,169	RV
2011	W. One Mouth	15700 16010	178 - 203	Ed Weed	31,710	RV
2012	W. One Mouth	16,514 18,794	174 - 198	Eisenhower	35,308	LV
2013	W. One W. One Mouth Mouth W. One	7,387 7,757 4,563 2,370 7,500	197 180 178 194 194	Eisenhower (well) Eisenhower (brk) Eisenhower (brk) Ed Weed Ed Weed	29,577	LV LV LV RV/CWT RV/CWT

Table 5. Summary of recent steelhead rainbow trout smolt stocking in the Winooski River, 2007 – 2013. All steelhead are raised at State of Vermont's Ed Weed Fish Culture Station.

Year Stocked	Stocking Location	Number Stocked	Size (mm)	Strain	Total Stocked	Clip
2007	Mouth W. One	9,000 9,000	179 179	Chambers	18,000	AD
2008	No steelhead stocked in 2008					
2009	Mouth W. One	10,000 10,000	211	Chambers	20,000	AD
2010	Mouth W. One	10,410 10,270	203	Chambers	10,680	None
2011	Mouth W. One	11,876 9,000	203	Chambers	20,876	None
2012	W. One W. One Mouth Mouth	5900 5776 5900 4100	201 182 201 182	Chambers Magog Chambers Magog	21,676	LV RV LV RV
2013	W. One W. One Mouth Mouth	5000 5000 5000 5000	200 171 203 171	Chambers Magog Chambers Magog	20,000	LV RV LV RV

Table 6. Comparison of aged returning RV fin clipped and non-clipped landlocked Atlantic salmon lifted at the Winooski One fish passage facility, 2009 - 2012.

Age	RV clipped Salmon				Non-Clipped Salmon			
	2009	2010	2011	2012	2009	2010	2011	2012
0	0	17	0	0	0	0	0	1
1	29	56	136	20	6	40	20	15
2	2	9	16	5	1	4	9	0
3	0	0	3	0	0	0	3	0
Not aged	-	-	-	0	-	-	-	2
Total	**31**	**82**	**155**	**25**	**7**	**44**	**31**	**18**

Table 7. Summary of average water temperature measurements on Winooski River tributaries in 2012. Temperature measurements are in Celsius with maximum temperatures in parentheses. Measurements from May 1 – October 31, 2012. The high maximum measured water temperatures are due to loggers being exposed because of fluctuating water flows.

River	May	June	July	August	September	October
Huntington – 5.3 km	13 (22)	18 (29)	21 (28)	23 (--)	16 (24)	10 (16)
Mill Brook	14 (21)	17 (26)	20 (26)	20 (26)	15 (22)	10 (15)
Joiner Brook	12 (19)	16 (24)	19 (25)	19 (24)	15 (21)	10 (15)
Preston Brook	11 (17)	14 (19)	17 (20)	17 (20)	14 (18)	10 (14)
Ridley Brook	12 (17)	15 (20)	17 (20)	17 (20)	13 (18)	10 (14)
Pinneo Brook	11 (16)	14 (20)	17 (21)	17 (22)	14 (19)	10 (14)
Snipe Island Bk	13 (19)	16 (22)	18 (22)	18 (22)	14 (20)	10 (15)
Winooski – Jonesville	14 (22)	19 (32)	21 (29)	20 (29)	15 (24)	12 (16)

Table 8. Population estimates (with standard error) and calculated densities by age class for landlocked Atlantic salmon collected in Winooski River tributaries in 2012.

Tributary	Age group	Sample Size	Population Estimate	Density (no./unit)	95% C.I.
Huntington 0.9	0+ 1+	22 0	25 ± 4.2	1.0	0.9 – 1.3
Huntington 7.7	0+ 1+	65 6	67 ± 2.3 6 ± 2.0	3.2 0.3	3.1 – 3.3 0.3 – 0.3

Table 9. Population densities and survival estimates by age groups for the 2011 and 2012 age class of landlocked Atlantic salmon in Winooski River tributaries. No sampling was conducted in 2011.

Tributary	Density (no./salmon unit)			Survival (percent)			Fry/0+ Surival 95% C.I.
	Fry	0+	1+	Fry/0+	0+/1+	Fry/1+	
2011 Year Class							
Huntington 0.9	42	na	na	na	na	na	na
Huntington 7.7 km	42	na	na	na	na	na	na
2012 Year Class							
Huntington 0.9	26	1.0	na	3.8	na	na	3.4 – 5.0
Huntington 7.7 km	26	3.2	na	12.3	na	na	11.9 – 12.7

LEGEND

Stream – Name of tributary; may be followed by river kilometer from mouth of stream
Elev. – Elevation (feet)
Date – Day, month
Len. – Survey section length (feet)
Wth – Average stream width (feet)

Species –

RBT = Rainbow trout
BNT = Brown trout
BKT = Brook trout
LLS = Landlocked Atlantic salmon

Class – Size/age class

YOY – young-of-year
<6 – yearling or older trout measuring less than 6.0 inches total length
6-9.9 - yearling or older trout measuring between 6.0 and 9.9 inches total length
10 - yearling or older trout measuring between 10.0 and 11.9 inches total length
12+ - yearling or older trout measuring greater than 11.9 inches total length
1+ and 2+ - Salmon age class

Num – Number of fish collected
Est. – Population estimate
UpCi/LoCi – Upper and Lower 95% confidence interval expressed as a percentage of the population estimate

Popmi – Population estimate expressed as number per mile
Popkm - Population estimate expressed as number per kilometer

MnWt – Mean weight of fish (grams)
Lbac – Estimated pounds per acre
Kghec – Estimated kilograms per hectare

Table 10. Population estimates for salmon and trout collected in Winooski River tributaries in 2012

Stream	Elev.	Date	Len	Width	Species	Class	Num	Est.	LOCI	UPCI	Popmi	Popkm	Mn Wt	Lbac	Kghec
"Interchange" Brook	335	22-Aug	331	6.2	BKT	YOY	144	163	10.8	10.8	2600	1616	2.7	20.86	23.39
						<6	9	9	0.0	0.0	144	89	22.4	9.45	10.60
						6-10	8	8	0.0	2.7	128	79	55.4	20.72	23.24
							161				2871	1784		51.04	57.22
					TOTALS		**161**				**2871**	**1784**		**51.04**	**57.22**
Mill Brook	300	30-Aug	321	24.8	RBT	YOY	3	3	0.0	17.4	49	31	3.3	0.12	0.14
						<6	2	2	0.0	101.7	33	20	28.5	0.69	0.77
						6-10	2	2	0.0	0.0	33	20	66.5	1.60	1.80
							7				115	72		2.41	2.70
					BNT	YOY	28	28	0.0	6.3	461	286	6.0	2.04	2.29
						<6	1	1	0.0	0.0	16	10			
						6-10	1	1	0.0	397.26	16	10	39.0	0.47	0.53
						10-12	1	1	0.0	0.0	16	10	211.0	2.54	2.85
						12+	1	1	0.0	0.0	16	10	609.0	7.34	8.23
							32				526	327		12.40	13.90
					LLS	1+	2	2	0.0	0.0	33	20	53.5	1.29	1.45
					TOTALS		**41**				**674**	**419**		**16.10**	**18.05**
Snipe Island Brook	300	22-Aug	465	10.7	RBT	YOY	40	40	0.0	3.6	454	282	2.6	1.97	2.21
						<6	5	5	0.0	17.4	57	35	18.6	1.79	2.01
						6-10	5	5	0.0	6.5824	57	35	73.4	7.08	7.94
							50				568	353		10.84	12.16
					BNT	YOY	36	36	0.0	5.0	409	254	3.1	2.16	2.42
					BKT	YOY	12	13	7.7	35.2	148	92	2.7	0.67	0.75
					TOTALS		**98**				**1124**	**699**		**13.67**	**15.33**

Table 10. (continued)

Stream	Elev.	Date	Len	Width	Species	Class	Num	Est.	LOCI	UPCI	Popmi	Popkm	Mn Wt	Lbac	Kghec
Duck Brook	320	20-Aug	334	7.7	RBT	YOY	37	45	17.8	33.3	711	442	1.3	2.18	2.44
						<6	9	9	0.0	10.0	142	88	17.8	5.97	6.70
						6-10	2	2	0.0	0.0	32	20	43.5	3.25	3.64
							48				885	550		11.40	12.78
					BNT	YOY	54	58	6.9	12.2	917	570	2.5	5.49	6.16
					BKT	YOY	11	13	15.4	62.7	206	128	3.7	1.81	2.03
					TOTALS		**113**				**2007**	**1120**		**18.70**	**20.97**
Preston Brook	365	21-Aug	381	12.3	RBT	YOY	78	80	2.5	5.1	1109	689	3.3	5.36	6.01
						<6	3	3	0.0	0.0	42	26	22.3	1.37	1.54
						6-10	4	4	0.0	0.0	55	34	69.0	5.65	6.34
							85				1206	749		12.38	13.89
					BNT	YOY	3	3	0.0	17.4	42	26	4.7	0.29	0.32
					BKT	YOY	7	7	0.0	9.2	97	60	4.1	0.59	0.67
					TOTALS		**95**				**1345**	**835**		**13.26**	**14.88**
Gleason Brook	355	23-Aug	201	9.5	RBT	YOY	33	33	0.0	6.6	867	539	1.8	2.92	3.27
					BNT	YOY	27	27	0.0	4.1	709	441	3.3	4.47	5.02
						6-10	2	2	0.0	0.0	53	33	41.0	4.12	4.62
							29				762	473		8.60	9.64
					BKT	YOY	16	16	0.0	6.9	420	261	3.3	2.61	2.93
						<6	1	1	0.0	0.0	26	16	14.0	0.70	0.79
							17				446	277		3.31	3.72
					TOTALS		**79**				**2075**	**1289**		**14.83**	**16.63**

Table 10. (continued)

Stream	Elev.	Date	Len	Width	Species	Class	Num	Est.	LOCI	UPCI	Popmi	Popkm	Mn Wt	Lbac	Kghec
Joiner Brook	350	20-Aug	297	14.9	RBT	YOY	34	35	2.9	9.0	622	387	2.1	1.59	1.78
						<6	1	1	0.0	397.3	18	11	21.0	0.46	0.51
						6-10	2	2	0.0	0.0	36	22	42.0	1.82	2.04
						10-12	1	1	0.0	143.8	18	11	259.0	5.62	6.30
							38				693	431		9.48	10.63
					BNT	YOY	14	14	0.0	8.9	249	155	3.5	1.06	1.19
					BKT	YOY	5	5	0.0	30.9	89	55	2.6	0.28	0.32
						6-10	1	1	0.0	0.0	18	11	150.0	3.25	3.65
							6				107	66		3.54	3.96
					LLS	1+	2	2	0.0	0.0	36	22	18.5	0.80	0.90
					TOTALS		**60**				**1084**	**674**		**14.89**	**16.68**
Pinneo Brook	370	2-Aug	375	11.6	RBT	YOY	9	9	0.0	20.6	127	79	1.7	0.33	0.37
					BNT	YOY	15	15	0.0	7.8	211	131	2.5	0.82	0.92
					BKT	YOY	57	59	3.4	7.8	831	516	2.1	2.76	3.10
						6-10	1	1	0.0	0.0	14	9	66.0	1.46	1.63
							58				845	525		4.22	4.73
					TOTALS		**82**				**1183**	**735**		**5.37**	**6.02**
Ridley Brook	360	21-Aug	380	14.7	RBT	YOY	42	45	6.7	13.8	625	389	2.5	1.95	2.19
					BNT	YOY	29	29	0.0	6.7	403	250	3.6	1.80	2.02
					BKT	6-10	1	1	0.0	0.0	14	9	93.0	1.60	1.79
					TOTALS		**72**				**1042**	**648**		**5.35**	**6.00**

Table 10. (continued)

Stream	Elev.	Date	Len	Width	Species	Class	Num	Est.	LOCI	UPCI	Popmi	Popkm	Mn Wt	Lbac	Kghec
Huntington River 0.9 km	310	29-Aug	490	54.7	RBT	YOY	3	3	0.0	17.4	32	20	2.3	0.03	0.03
					BNT	YOY	9	9	0.0	20.6	97	60	4.3	0.14	0.16
						<6	1	1	0.0	0.0	11	7	10.0	0.04	0.04
							10				108	67		0.18	0.20
					LLS	YOY	22	25	12.0	32.6	269	167	4.8	0.43	0.48
					TOTALS		**35**				**377**	**234**		**0.61**	**0.68**
Huntington River 7.7 km	590	29-Aug	340	67.1	BNT	YOY	5	5	0.0	46.6	78	48	3.4	0.07	0.08
					LLS	YOY	65	67	3.0	6.7	1040	647	4.7	1.32	1.48
						1+	6	6	0.0	0.0	93	58	33.5	0.85	0.95
							71				1134	704		2.17	2.43
					TOTALS		**76**				**1212**	**752**		**2.24**	**2.51**
Huntington River Hanksville ~22 km	1145	30-Aug	275	13.2	BNT	YOY	2	1	0.0	37.7	38	24	4.5	0.24	0.27
						6-10	1	1	0.0	0.0	19	12	84.0	2.22	2.49
							3				57	36		2.46	2.76
					BKT	YOY	32	33	3.0	11.8	634	394	3.8	3.27	3.67
						<6	4	4	0.0	47.5	77	48	25.3	2.67	2.99
						6-10	2	2	0.0	0.0	38	24	51.5	2.72	3.05
							38				826	466		8.66	9.71
					TOTALS		**41**				**883**	**502**		**11.12**	**12.47**

Table 10. (continued)

Stream	Elev.	Date	Len	Width	Species	Class	Num	Est.	LOCI	UPCI	Popmi	Popkm	Mn Wt	Lbac	Kghec
Texas Brook	605	23-Aug	282	11.4	BNT	YOY	10	10	0.0	8.2	187	116	4.7	1.40	1.57
					BKT	YOY	21	21	0.0	4.1	393	244	4.3	2.72	3.05
						<6	2	2	0.0	101.7	37	23	19.5	1.16	1.31
						6-10	5	5	0.0	6.6	94	58	68.6	10.24	11.48
							28				524	326		14.13	15.84
					LLS	1+	1	1	0.0	0.0	19	12	21.0	0.63	0.70
					TOTALS		**39**				**730**	**454**		**16.16**	**18.12**
Cobb Brook	775	24-Aug	361	14.5	BNT	YOY	26	27	3.7	12.6	395	245	3.3	1.62	1.82
						6-10	1	1	0.0	0.0	15	9	60.0	1.10	1.23
							27				410	254		2.72	3.05
					BKT	YOY	109	114	4.4	6.0	1667	1036	2.5	5.14	5.76
						<6	3	3	0.0	0.0	44	27	16.3	0.90	1.01
							112				1711	1063		6.04	6.77
					TOTALS		**139**				**2121**	**1317**		**8.76**	**9.82**

Table 10. (continued)

Stream	Elev.	Date	Len	Width	Species	Class	Num	Est.	LOCI	UPCI	Popmi	Popkm	Mn Wt	Lbac	Kghec
Bakers Brook	1075	27-Aug	303	7.2	BKT	YOY	118	129	8.5	9.3	2248	1397	2.4	13.52	15.16
						<6	34	35	2.9	9.0	610	379	20.7	31.89	35.76
						6-10	6	6	0.0	32.7	105	65	52.8	13.95	15.64
							158				2962	1841		59.36	66.55
					TOTALS		**158**				**2962**	**1841**		**59.36**	**66.55**
Beaver Meadow Brook	1135	27-Aug	308	8.9	BNT	YOY	1	1	0.0	0.0	17	11	2.0	0.07	0.08
					BKT	YOY	123	128	3.9	5.2	2194	1363	2.6	11.59	12.99
						<6	16	16	0.0	6.9	274	170	24.7	13.83	15.51
						6-10	2	2	0.0	0.0	34	21	52.5	3.68	4.12
							141				2503	1555		29.10	32.63
					TOTALS		**142**				**2520**	**1566**		**29.17**	**32.71**

Table 11. Summary of out-migrating smolt trapping on the Huntington River and fry stocking, 2004 – 2013.

Year	Start Date	End date	Days Fished	Number new , unmarked Trapped	Number Marked and released[1]	Number Recaptured	Estimate	Trap style[2]	First fish	Fry stocked
2013	April 23	June 6	28	82	na	na	na	New	Apr 26	47,500
2012	Mar 30	June 8	37	79	na	na	na	New	May 6	25,896
2011	May 9	May 26	10	43	na	2	na	New	May 10	110,000
2010	April 19	June 1	41	205	214	16	1,783	New	Apr 26	98,000
2009	April 16	June 12	52	76	88	16	418	New	May 2	102,000
2008	April 24	June 13	49	360	412	66	2,247	New	May 6	89,955
2007	May 1	June 15	44	288	276	19	4,184	New	May 9	89,955
2006	April 11	June 9	49	60	39	0	Nd	Old	May 3	66,074
2005	April 14	June 9	49	126	135[3]	6	2,835	Old	Apr 21	67,200
2004	May 6	June 4	25	57	0	na	na	Old	May 12	74,480

1 Includes recaptured smolts released again.
2 The old trap had a 1.8 meter diameter; the new trap has a 2.4 m diameter.
3 Includes 35 hatchery smolts.

Table 12. Summary of Winooski One tagged Salmon and steelhead caught by anglers, June, 2012 through June, 2013.

Species	Date Caught	Location	Year/Season Tagged
Steelhead	June 3, 2012	Willsboro Bay	2011 / Spring
Steelhead	July 15, 2012	Willsboro Bay	2012 / Spring
Salmon	July 18, 2012	Corlaer Bay	2011 / Fall
Salmon	July 27, 2012	Willsboro Point	2011 / Fall
Steelhead	September 11, 2012	Schuyler Island	2012 / Spring

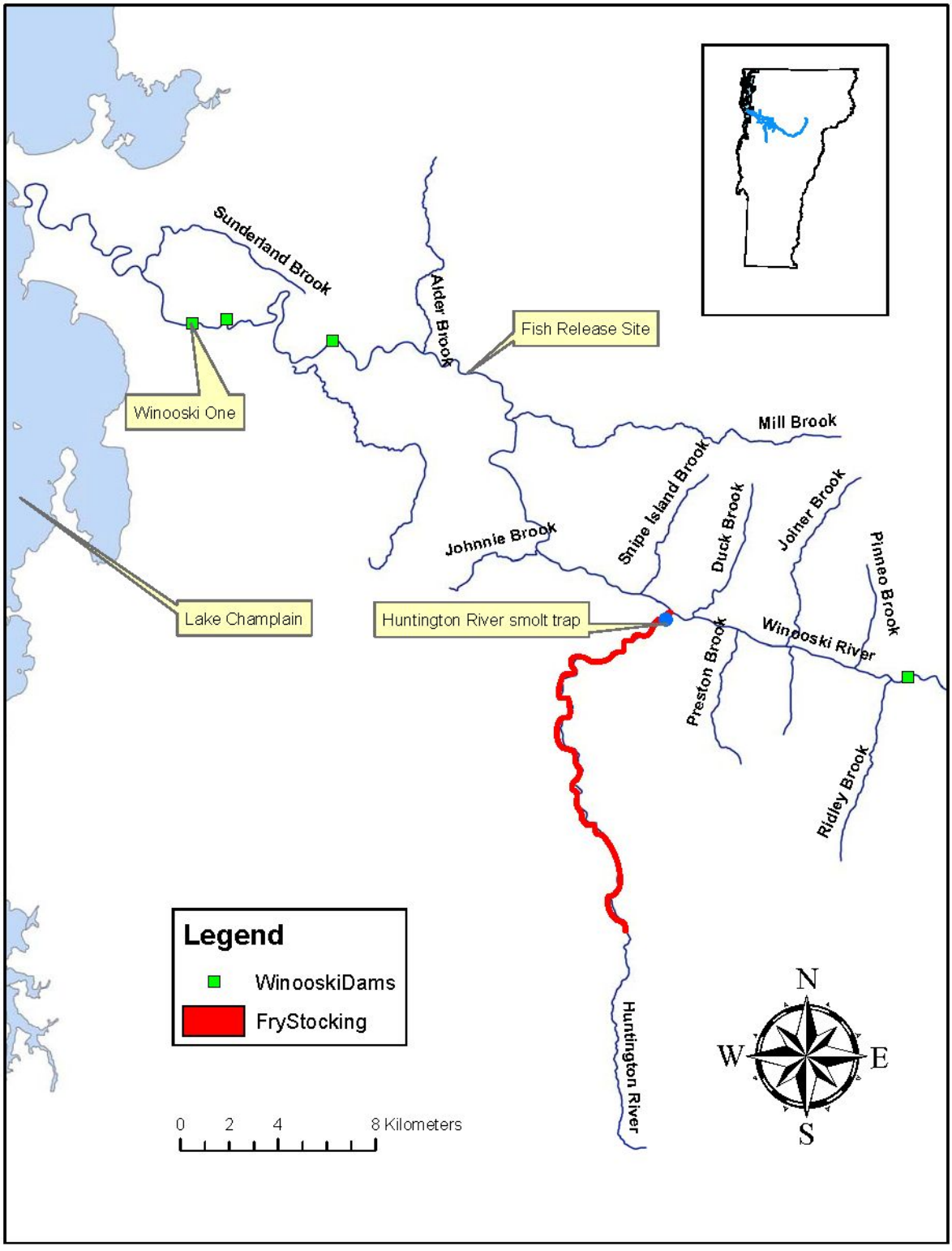


Figure 1. Map of lower Winooski River drainage showing Winooski One Dam, the fish release site, named tributaries, and fry stocking areas.

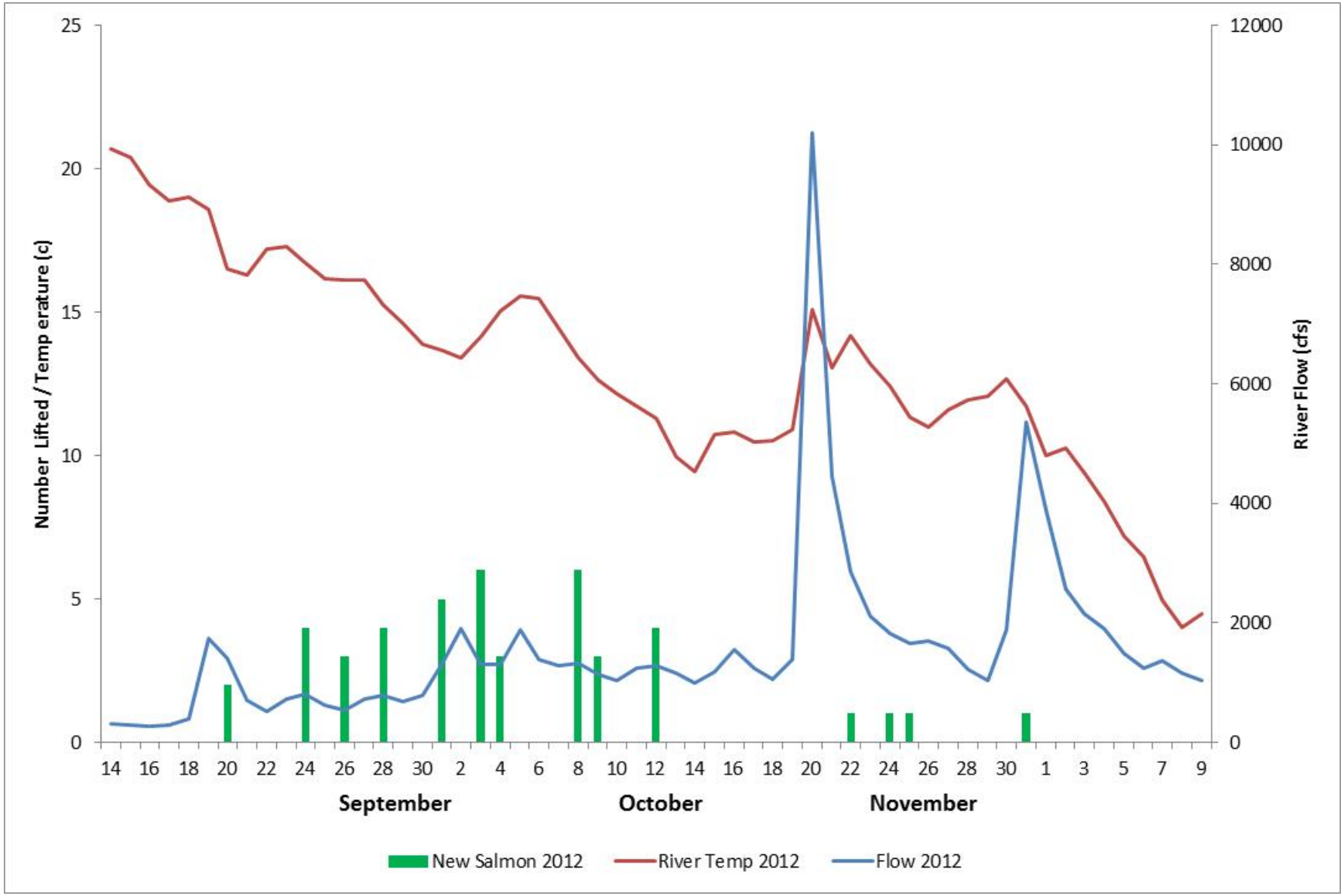


Figure 2. Comparison of 2012 Winooski River flows (cubic feet per second), mean water temperatures (Celsius) and numbers of new salmon processed by date at the Winooski One fish facility.

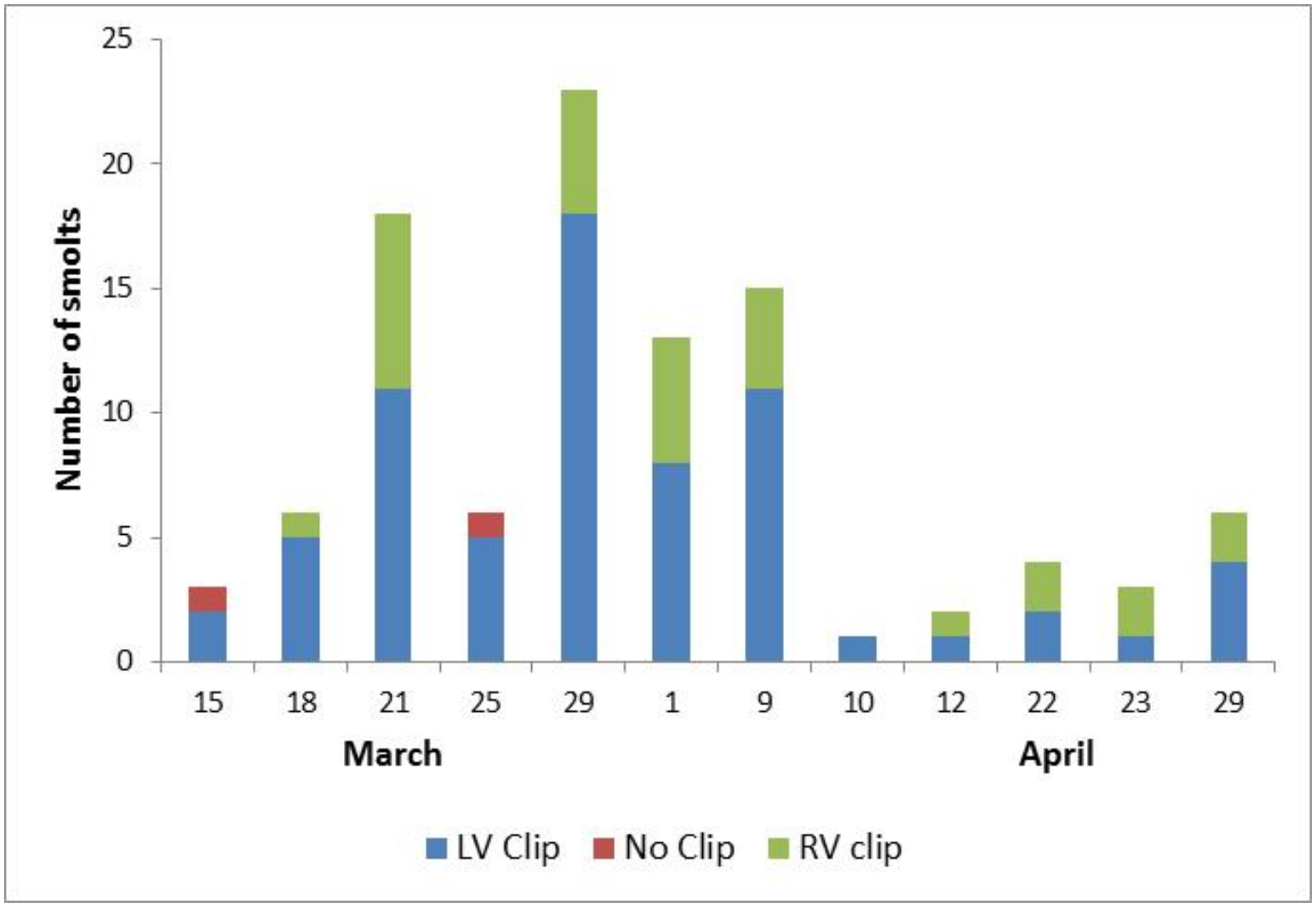


Figure 3. Summary of steelhead rainbow trout smolts collected at the Winooski One fish lift in the spring, 2013. Chambers Creek steelhead have a left ventral fin clip (LV); Lake Memphremagog steelhead have a right ventral fin clip (RV). Fish were stocked on March 14th, 2013.

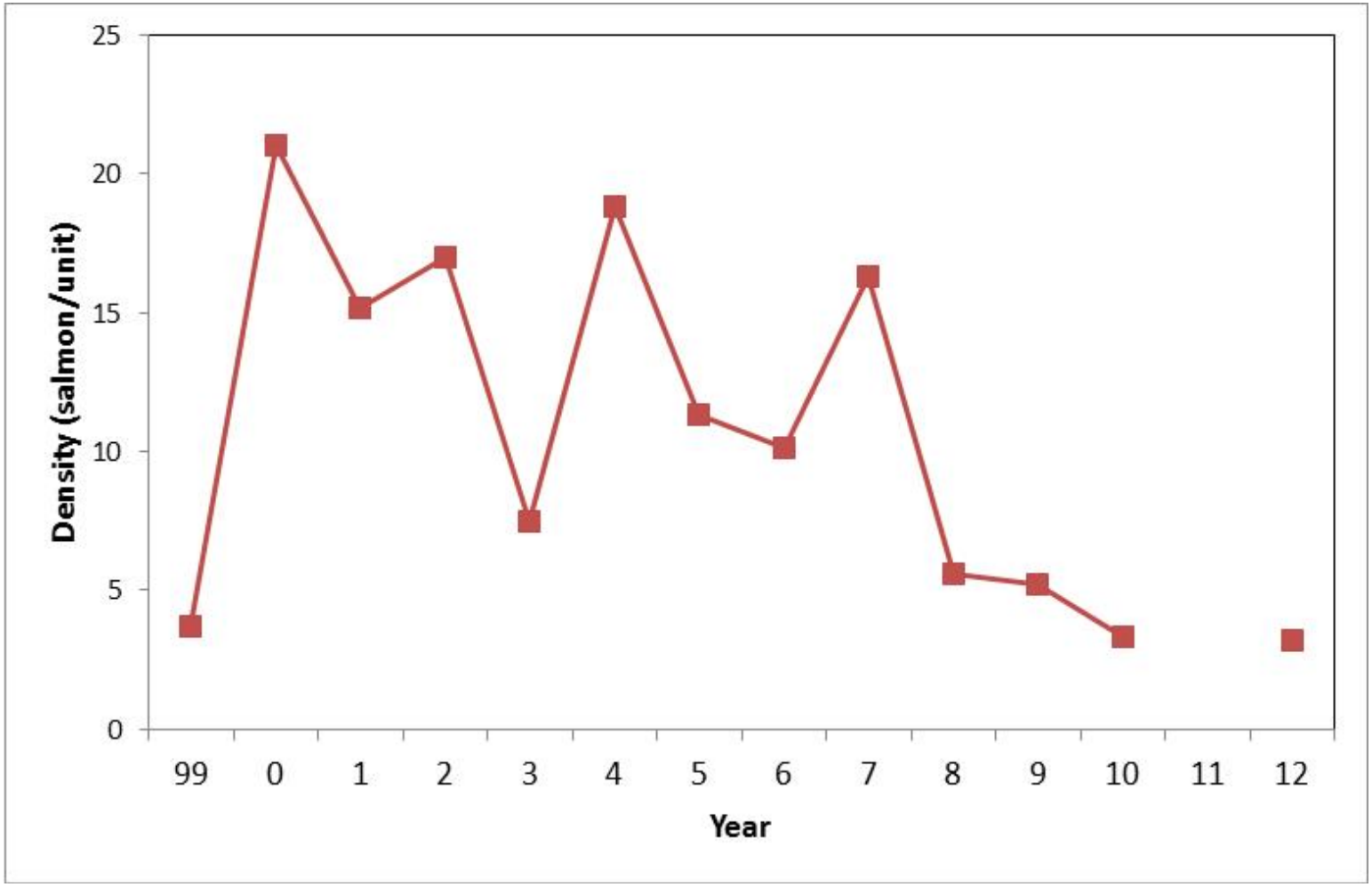


Figure 4. Summary of young-of year salmon density at the Huntington River 7.7 km station, 1999-2012. No sampling occurred during 2011 due to high water. Density is number of salmon per 100 square meters.

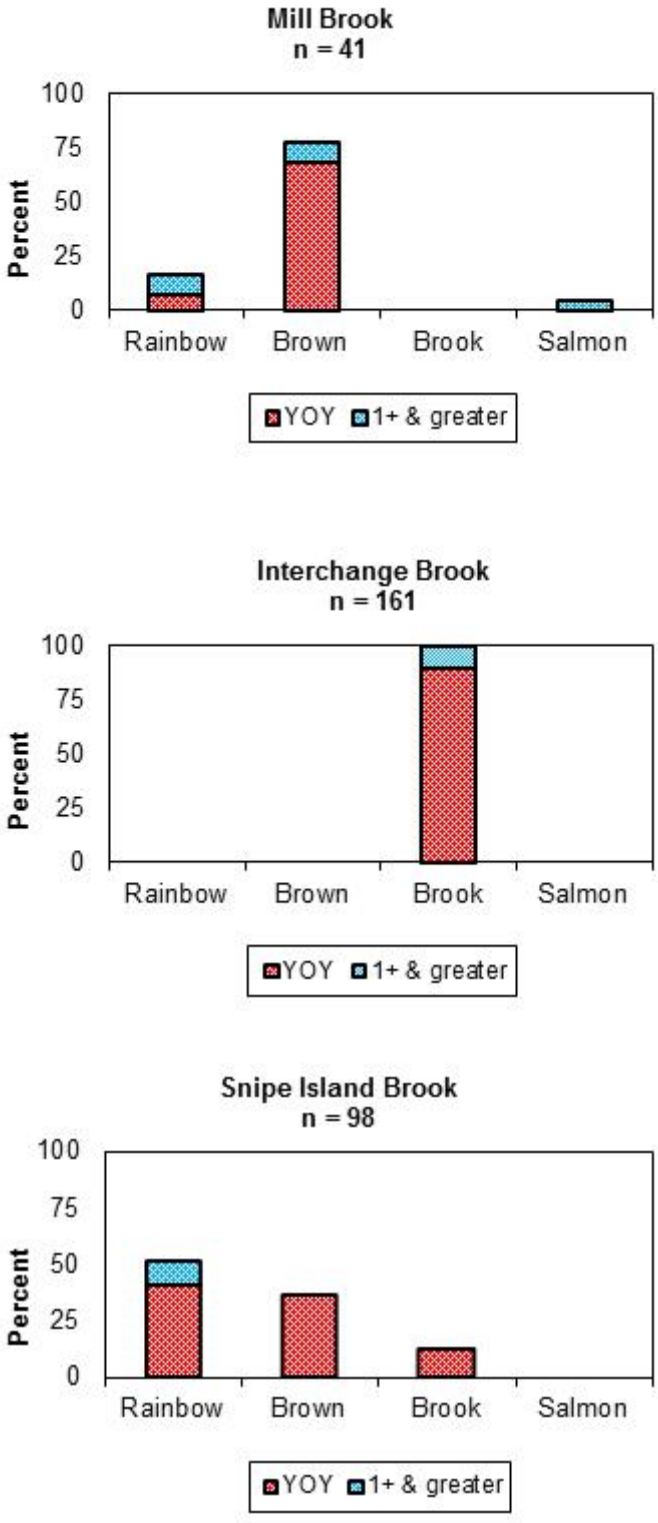


Figure 5. Percent composition of trout and salmon collected by site in 2012.

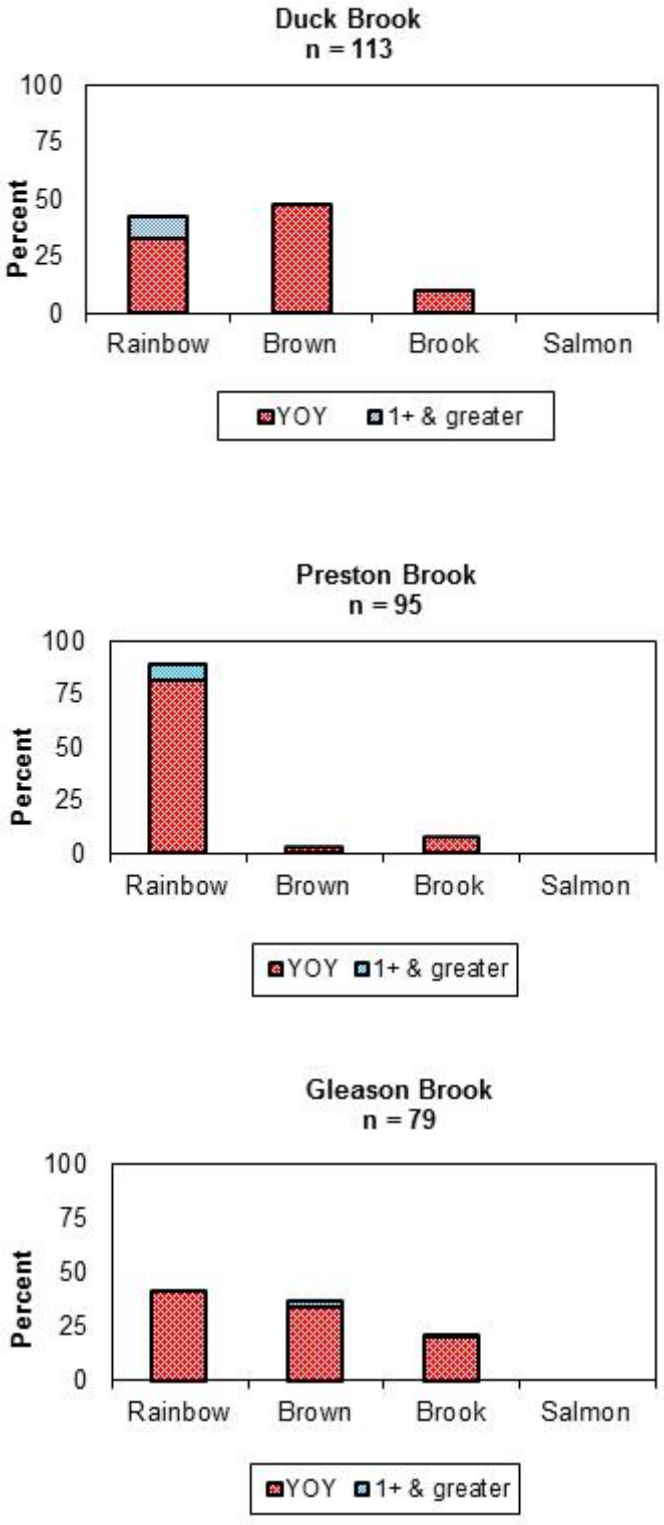
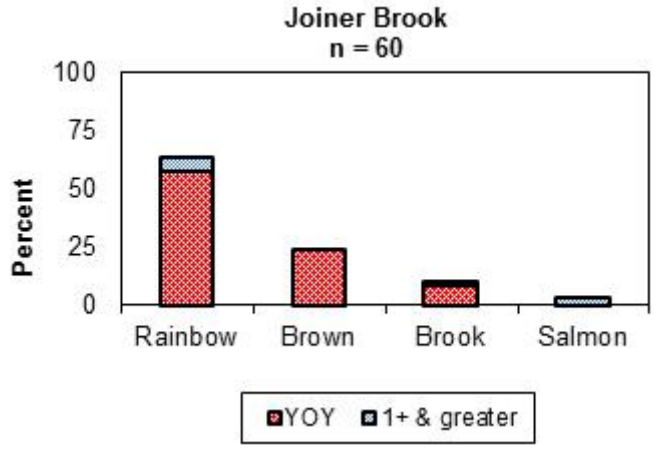
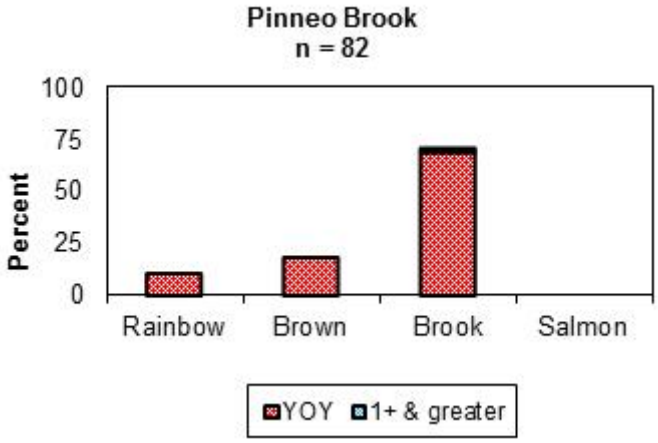


Figure 5. Continued.





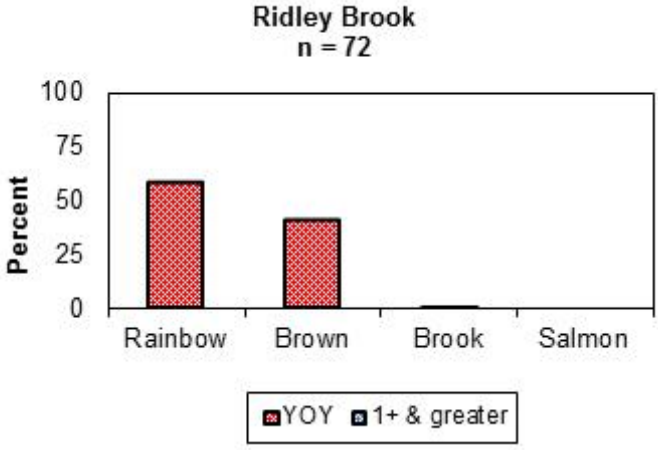
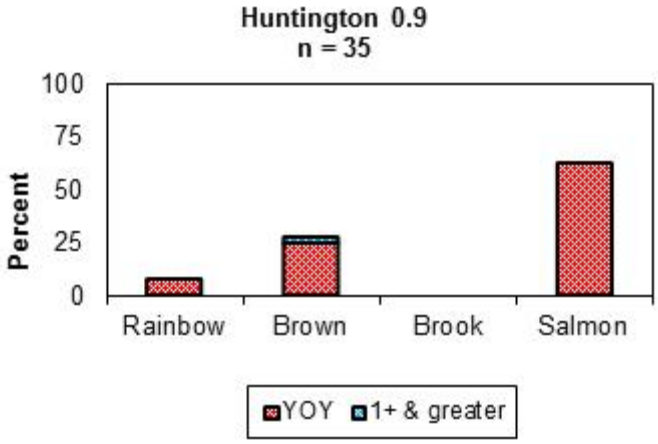
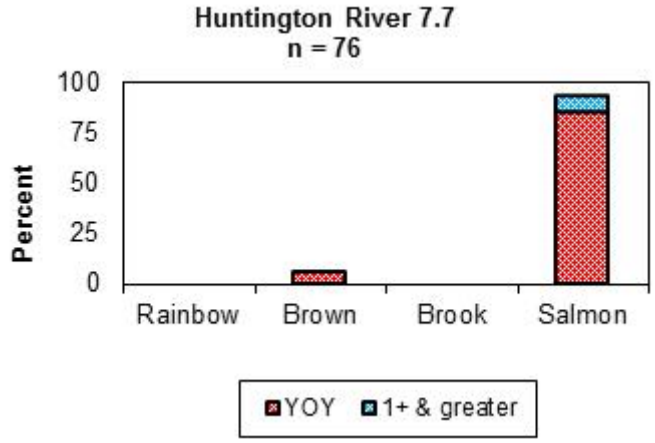


Figure 5. Continued.





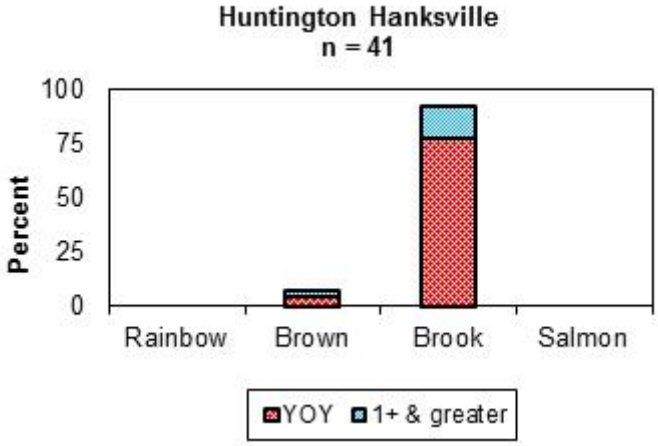
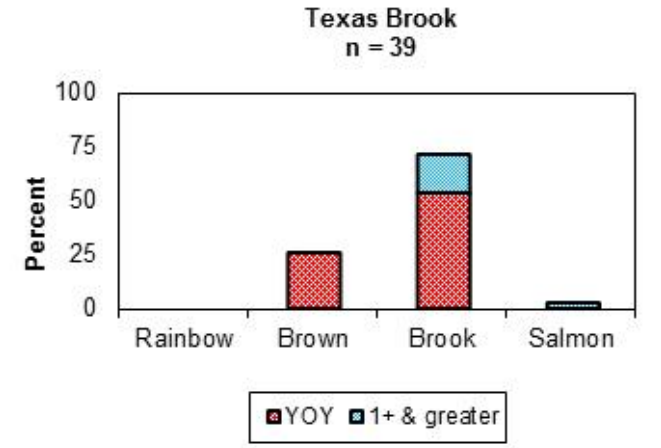
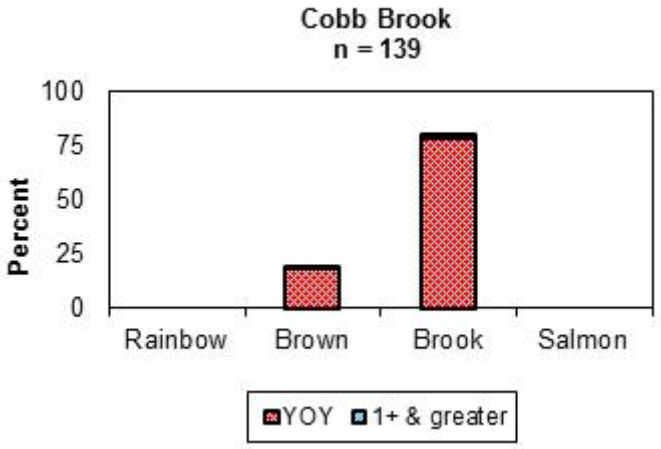


Figure 5. Continued.





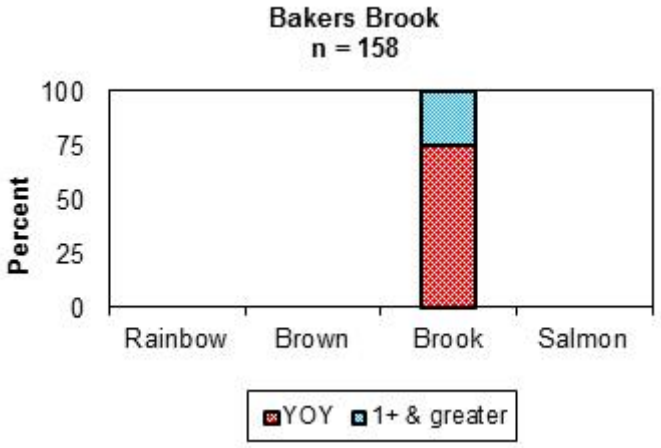


Figure 5. Continued.

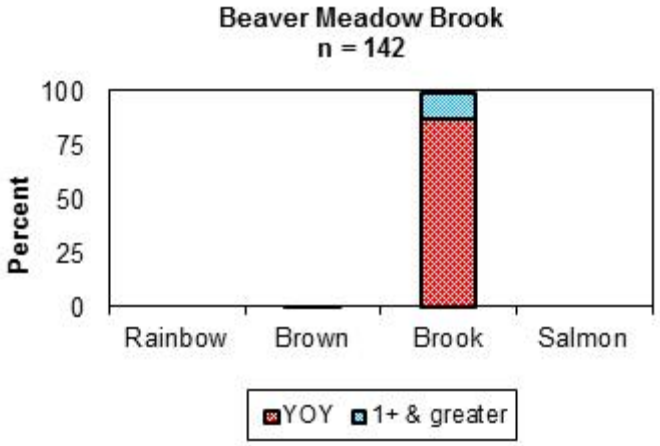


Figure 5. Continued.

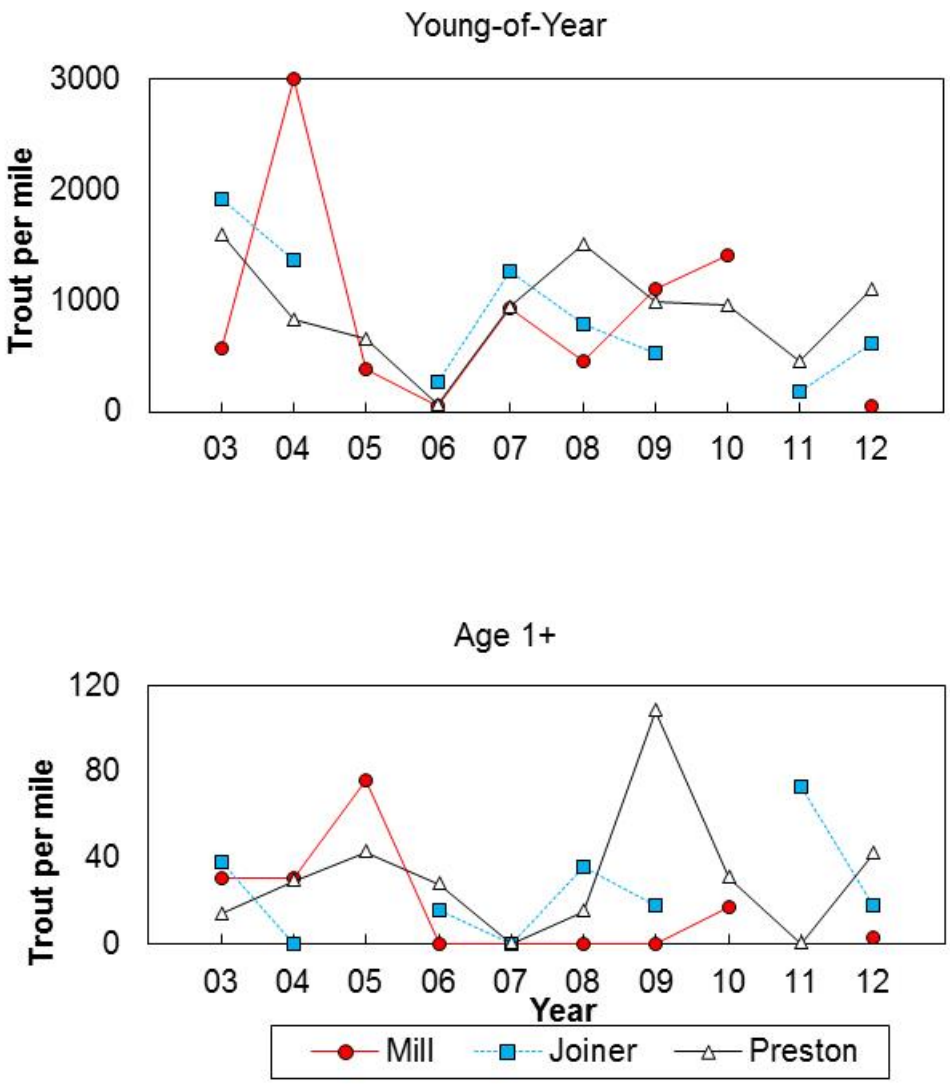


Figure 6. Estimated number per mile of young-of-year and 100-152 mm length class (age 1+) rainbow trout for Mill, Joiner, and Preston Book, 2003 – 2012.

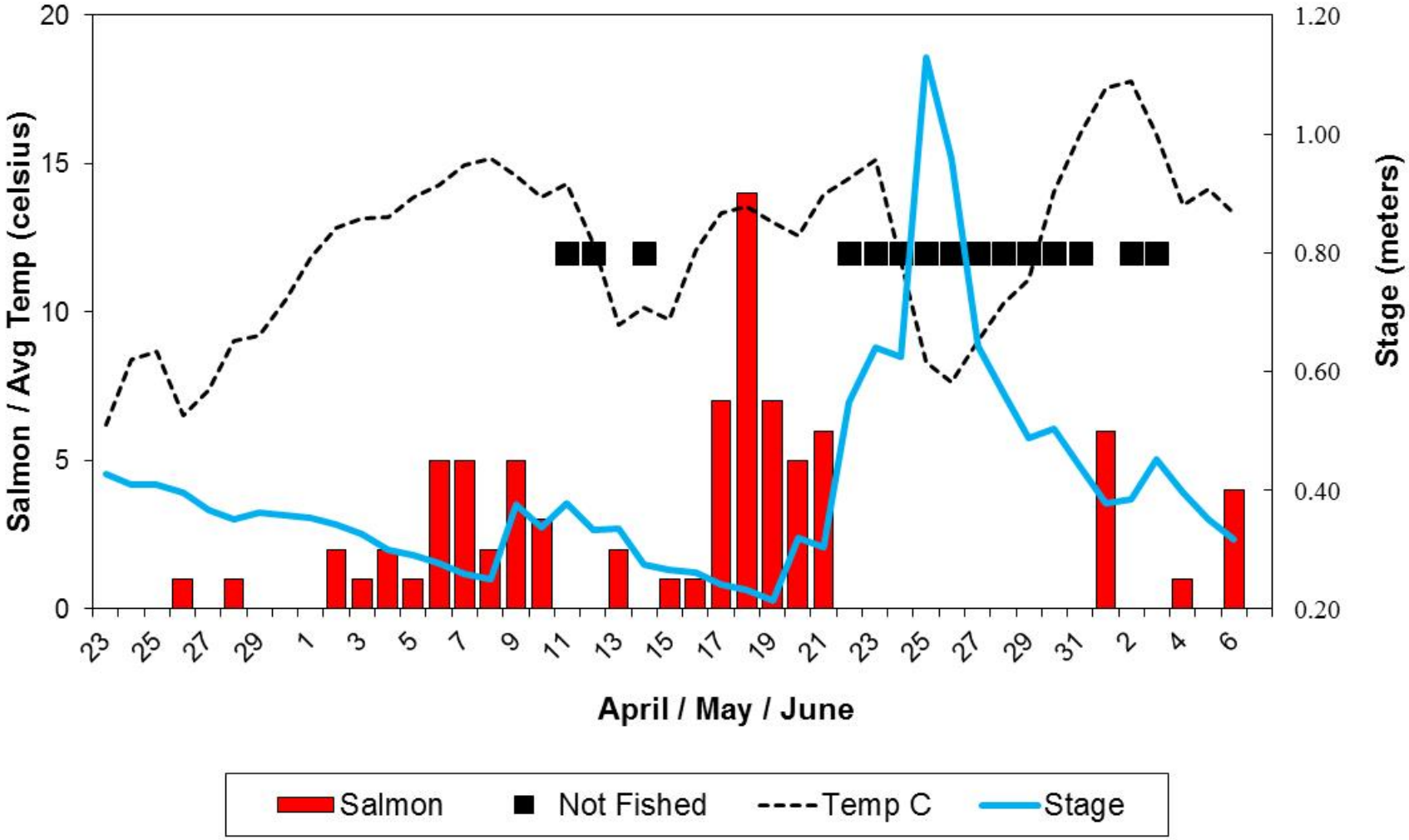


Figure 7. Comparison of stream stage, mean daily stream temperature and number of landlocked Atlantic salmon smolts trapped in the Huntington River, 2013.

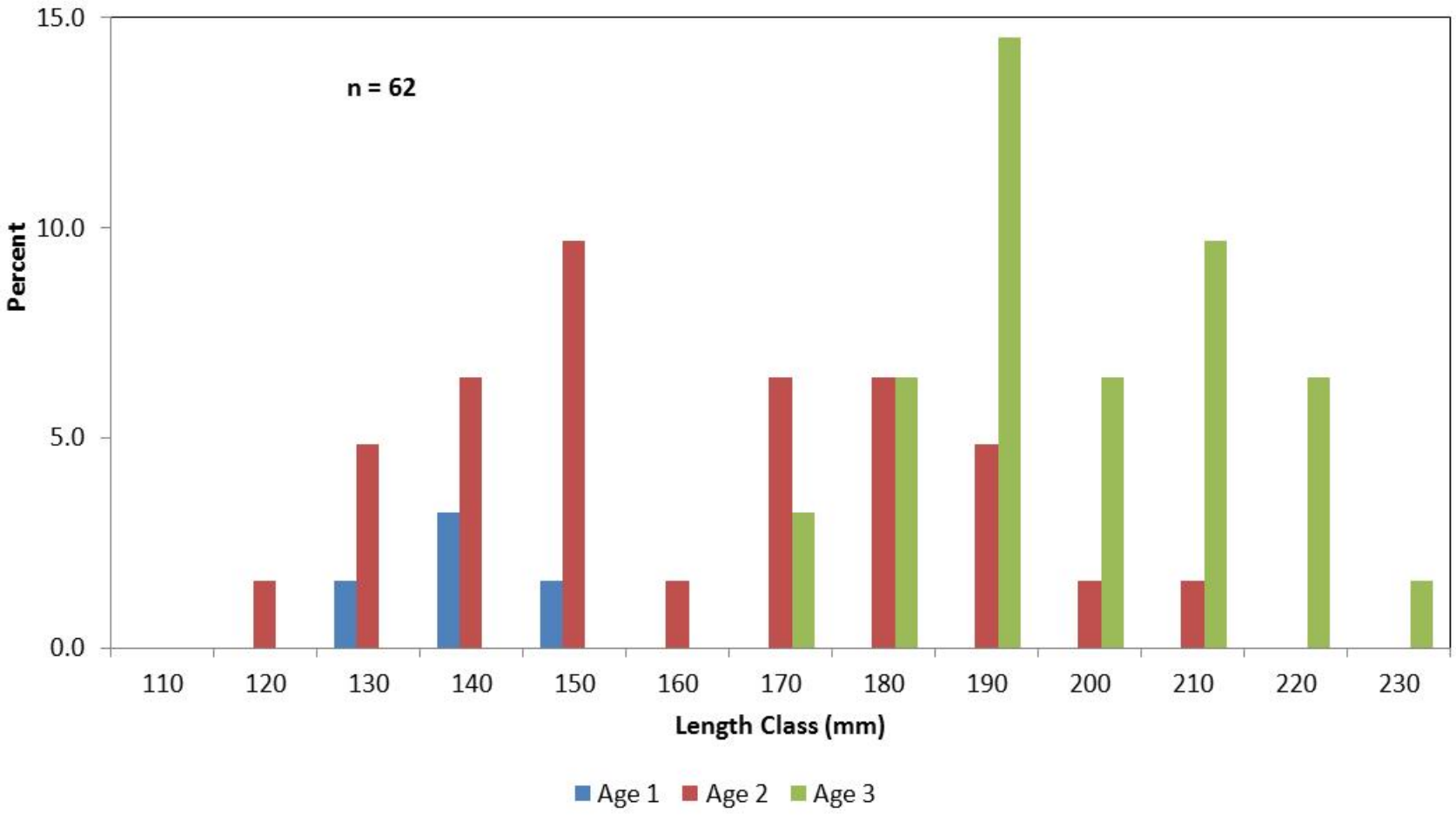


Figure 8. Length/age frequency graph expressed as a percent of landlocked Atlantic salmon smolts trapped in the Huntington River, 2013.

Lake Trout Trapnet Survey – Hatchery Cove

Procedures

Two trapnets were set in Hatchery Cove near the Ed Weed Fish Culture Station to evaluate an alternative technique for capturing lake trout and landlocked Atlantic salmon returning to the Hatchery Cove area for spawning. Electrofishing is currently used to capture most salmonids for the Lake Champlain Salmonid restoration evaluation.

Trapnets were set overnight in two locations in Hatchery Cove on Tuesday, 11/13/2012, and pulled on Wednesday, 11/14/2012 (Figure 1). The trapnet crib measured 6' × 6' × 11'4" and was made of 380-18 black knotted polypropylene twine. Mesh size measured 1 ¾-inch stretched. The trapnet had 2 attached 6' × 25' wings set on a 45° angle to the lead line. The lead line was 6' × 150' long with 2 ½-inch stretched mesh made from twine of the same type and weight as the rest of the trapnet. One trapnet was set just north of Hatchery Brook and the other trapnet was set north of the first net near the water intake for the hatchery.

A boat was left at the site, which reduced the time required to monitor the net. The boat was locked with a chain to a large cable on shore beneath the street light at the end of the ferry dock. Three people were usually involved with emptying the net, processing the fish, and transporting fish.

Lake trout and landlocked Atlantic salmon were measured for total length, examined for fin clips and sea lamprey wounds, sexed, marked with a lower caudal fin punch and released. Sea lamprey were measured for total length and destroyed. Non-target species were counted and released.

Results

A total of 267 lake trout and were captured in both nets during the single night of sampling in 2012. The average total length (TL) of male lake trout was 658 mm (range 535-823 mm), and females averaged 688 mm TL (range 527 to 822 mm). Six landlocked Atlantic salmon were also captured. The average total length (TL) of male landlocked Atlantic salmon was 463 mm (range 352-574 mm). Female salmon averaged 542 mm TL (range 487-593 mm).

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Fisheries Biologist

Shawn Good
Fisheries Biologist

Brian Chipman
Fisheries Biologist

Date: August 8, 2013

Figure 1. Locations of trapnets set in Hatchery Cove in 2012. Hatchery Brook is to the right of Trapnet #1.

Salmon and Steelhead Stocking Evaluations

Two Lake Champlain salmonid stocking evaluations were initiated in 2012. The first evaluation will compare the performance of Sebago strain salmon smolts produced from domestic broodstock and feral broodstock collected in assessment sampling. The second evaluation will compare the performance of the Chambers Creek and Lake Memphremagog strains of steelhead rainbow trout. The fish were reared at the Ed Weed Fish Culture Station and marked prior to stocking with fin clips specific to each evaluation group. Stocking of yearling smolts of each species for the evaluation began in spring 2012, and annual stockings will continue through 2016. Table 1 summarizes the salmon smolt stocking for the brood source comparison. Table 2 summarizes the steelhead smolt stocking for the strain comparison. A study plan for these evaluations is included in Appendix 1. Some preliminary findings are presented below.

Precocious age 0 lake-year fish of both species from the evaluation groups were collected during fall 2012 spawning run sampling. Age 0 lake-year salmon from the evaluation groups were also collected during nearshore sampling in Willsboro Bay and Whallon Bay. Salmon from feral broodstock dominated the samples from both Hatchery Brook and the Lamoille River, while greater numbers from domestic broodstock were found in the nearshore sample; feral salmon were also slightly larger in all three samples (Table 3). Age 0 lake-year Chambers Creek strain steelhead were more abundant and substantially larger than the Memphremagog strain steelhead collected from Hatchery Brook and the Winooski River fish lift in fall 2012 (Table 4). However, the steelhead sample collected from the Winooski River fish lift in spring 2013 (age 1 lake-year) was dominated by the Memphremagog strain, and the size differential between the two strains was smaller than observed in the fall (Table 5).

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August 8, 2013

Table 1. Numbers stocked and average total length (TL) of landlocked Atlantic salmon smolts from domestic and feral brood stocks.

	Domestic (ADRV clip)		Feral (ADLV clip)	
Location	Number stocked	Ave. TL (mm)	Number stocked	Ave. TL (mm)
Missisquoi River	11,030	196	11,014	203
Inland Sea	26,400	191-196	26,521	201-208
Lamoille River	11,000	196	11,121	201
Hatchery Cove	8,053	196	7,090	203
Total	56,483		55,746	

Table 2. Numbers stocked and average total length (TL) of Chambers Creek and Memphremagog strain steelhead smolts in 2012.

	Chambers Creek		Lake Memphremagog	
Location	Number stocked	Ave. TL (mm)	Number stocked	Ave. TL (mm)
Mill River	2,250	203	2,250	183
Hatchery Cove	7,080	198	4,920	180
Winooski River	11,800	203	4,938	183
LaPlatte River	1,500	198	1,500	183
Lewis Creek	8,416	198	8,416	183
Total	31,046		22,024	

Table 3. Age 0 lake-year Sebago strain landlocked Atlantic salmon from two different brood sources, collected during fall 2012 sampling in Hatchery Brook, the Lamoille River, and nearshore areas of Whallon Bay and Willsboro Bay.

		Hatchery Brook		Lamoille River		Nearshore	
Brood Source	Mark	N	Ave. TL (mm)	N	Ave. TL (mm)	N	Ave. TL (mm)
Feral	ADLV	13	344	5	367	5	433
Domestic	ADRV	3	340	2	349	11	412

Table 4. Two strains of Age 0 lake-year steelhead collected during fall 2012 sampling in Hatchery Brook and the Winooski River fish lift.

		Hatchery Brook		Winooski River	
Strain	Mark	N	Ave. TL (mm)	N	Ave. TL (mm)
Chambers Creek	LV	15	438	16	435
Memphremagog	RV	4	339	13	398

Table 5. Two strains of Age 1 lake-year steelhead from spring 2013 collections at Winooski River fish lift.

Strain	Mark	N	Ave. TL (mm)
Chambers Creek	LV	7	455
Memphremagog	RV	31	441

APPENDIX 1

Study Plan

An evaluation of the performance of landlocked Atlantic salmon reared from 2 brood sources and of 2 steelhead strains stocked into Lake Champlain

An evaluation of the performance of landlocked Atlantic salmon reared from 2 brood sources and of 2 steelhead strains stocked into Lake Champlain

Objectives: **1)** Compare the performance of salmon smolts stocked into Lake Champlain reared from eggs collected from Sebago Lake strain salmon captured from Lake Champlain to that of salmon smolts reared from the Sebago Lake strain domestic brood stock held at the Bald Hill FCS.

2) Compare the performance of steelhead trout reared from the Chambers Creek and Memphremagog strains stocked into Lake Champlain

Background: The Department currently maintains captive brood stocks for Sebago strain Landlocked Atlantic Salmon and the Lake Memphremagog and Chambers Creek strains of steelhead trout to supply eggs for the management request for cultured fish. Department staff also collect eggs from Sebago Lake strain landlocked salmon (feral broodline) stocked into Lake Champlain when they return to spawn during the fall.

Maintenance of domestic brood stocks has the potential benefits of providing a reliable egg source, reduced risk of disease, and maintenance of genetic diversity. Costs of maintaining a domestic brood stock include staffing and rearing costs, space requirements, loss of fitness due to domestication selection, inbreeding depression, or deleterious mutation accumulation (Araki et al.2008).

Potential benefits of using feral fish as a brood source include reduced fish culture costs and space requirements and unknown fitness benefits. Costs include increased staff requirements for egg collection efforts and the increased risk of disease introduction to the fish culture facility and increased disease management efforts.

The potential benefits of stocking salmon reared from feral parents versus those reared from domestic stocks are unclear. There have been multiple investigations of the relative fitness of hatchery- reared salmonids and wild-origin salmonids and of the genetic effects of captive breeding programs (Araki et al., 2008; Araki et al. 2007; Chilcote et al. 1986; Houde et al. 2010; McDermid et al. 2010) but there is no information available on the relative performance of fish reared from feral parents versus domestic brood lines.

The purpose of the landlocked salmon comparison study is to provide information on the relative performance of the 2 brood sources after stocking.

The purpose of the comparison study of the 2 steelhead strains is to determine if there is a measurable difference in strain performance after stocking. If not, there is the potential to eliminate one broodline to reduce costs and free up space.

Experimental design:

Landlocked Salmon

Stock 39,000 (78,000 total) salmon smolts reared from feral and domestic eggs in equal numbers at the 7 stocking locations listed below for 4 years.

Table 1: Stocking locations and numbers of salmon stocked

Locations	**Number of Smolts**
Hatchery Cove	10,000
Lamoille River	20,000
Missisquoi River	20,000
Inland Sea – Stephenson Point Access	7,000
Inland Sea – Van Everest Access	7,000
Inland Sea – Grand Isle State Park	7,000
Inland Sea – Appletree Bay	7,000

Smolts from the 2 brood sources will be differentiated by marking with an AD/LV clip (feral group) or AD/RV clip (domestic egg).

Seventy pairs of salmon will be collected from Lake Champlain. Fish collected from Lake Champlain will be handled according to the facility biosecurity protocols that have been established for the Ed Weed Fish Culture Station.

Approximately 50 pairs will be spawned for 125,000 green eggs that will produce the 80,000 to 90,000 eyed eggs required to rear 39,000 smolts. The number of adults collected each fall will be adjusted if fewer or more eggs are required to reach the goal of 39,000 smolts. Bald Hill FCS will provide the rest of the eggs needed for salmon production at the Ed Weed FCS. Smolts used in the comparison will be reared at the Ed Weed FCS.

Smolts from the 2 brood sources will be reared to similar sizes before stocking. Performance of fish from the 2 brood sources will be assessed using standard hatchery practices while they are held in the hatchery. Condition of 100 salmon from each raceway will be assessed just prior to stocking.

If we are able to raise 39,000 smolts from both brood sources, we will stock equal numbers of marked smolts from the 2 brood sources in Hatchery Cove, the Lamoille and Missisquoi Rivers, and 4 locations in the Inland Sea. If, in any given year, we are unable to stock 39,000 smolts from one group, we will increase the numbers of the other group if possible, so that a total of 78,000 salmon can be stocked in these seven locations. The proportion of each group stocked will be the same at each of the seven stocking sites.

Steelhead trout

Stock 29,000 (58,000 total) steelhead smolts reared from the Memphremagog and Chambers Creek strains in equal numbers at the 5 stocking locations listed below for 4 years. As with the

salmon evaluation, if we are unable to stock equal numbers, we will stock the same proportion of the two strains at each location.

Table 2: Stocking locations and total numbers of steelhead stocked

Locations	**Number of Smolts**
Hatchery Cove	12,000
Winooski River	20,000
Lewis Creek	18,000
Mill River	5,000
LaPlatte River	3,000

Steelhead from the 2 strains will be reared to similar sizes before stocking. Performance of fish from the 2 strains will be assessed using standard hatchery practices while they are held in the hatchery. Condition of 100 steelhead from each raceway will be assessed just prior to stocking. Smolts from the 2 brood sources will be differentiated by finclips.
Magog - RV; Chambers Creek – LV. (updated 8/5/11)

Timeline:

1) 2010 thru 2013 – egg collection, begin rearing feral and domestic landlocked salmon families and 2 strains of steelhead trout at Ed Weed FCS
2) 2012 thru 2015 - stocking of marked smolts
3) 2013 – first returns of one lake year marked fish
4) 2014 thru 2017 – Continue assessment

Assessment: Comparison of the performance of salmon from the 2 brood sources and 2 strains of steelhead will be based on the numbers, sizes, condition factors and lamprey wounding rates of fish collected during the ongoing fall assessments (shoreline and river electrofishing and Hatchery Cove captures, etc), and spring and fall operation of the Winooski River fish lift. Steelhead may also be collected during spring tributary electrofishing assessments. If an angler survey is conducted on Lake Champlain during this study the relative return to anglers of salmon and steelhead from the 2 treatment groups will also be considered.

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McDermid, J. L., W. N. Sloan, C. C. Wilson, and B. J. Shuter. 2010. Early life history variation among hatchery- and wild-origin lake trout reared in a hatchery environment. Transactions of the American fisheries Society 139: 21 – 28.

Study Plan Prepared by: Chet MacKenzie, October 4, 2010