Vermont Fish and Wildlife Department
Annual Report

State: Vermont **Project No**.: F-35-R-14

Grant Title: Lake Champlain Fisheries Restoration and Management

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

Period Covered: July 1, 2011 to June 30, 2012

Summary of Activity:

Fall electrofishing surveys of selected Lake Champlain tributaries and nearshore areas yielded collections of 739 landlocked Atlantic salmon, 495 lake trout, 17 steelhead rainbow trout and 44 brown trout.

Sea lamprey wounding rates on lake trout in the index 533-633 mm TL class declined from 40 wounds per 100 fish in 2010 to 30 wounds per 100 fish in 2011. Wounding rates on 432-533 mm TL salmon collected in the Main Lake increased slightly in 2011 to 19 wounds per 100 fish after meeting the management objective (15 wounds per 100 fish) in 2010. Inland Sea/Mallets Bay salmon of the same size class met the management objective for the first time in 2011 (14 wounds per 100 fish).

The Winooski One fish lift operated for 57 days in the fall, 2011 and 60 days in the spring, 2012. A record 189 adult salmon were captured in the fall, along with 18 steelhead rainbow trout; 16 steelhead were collected in the spring**.**

Salmon parr sampling in Huntington River index stations was not conducted in 2011 due to flooding caused by Tropical Storm Irene. A rotary screw trap was fished in the Huntington River March 30-June 8, 2011 to capture out-migrating salmon smolts. The trap operated for 37 days within this period and 79 smolts were captured.

A total of 160 spawning adult Sebago strain salmon collected in fall 2011assessment sampling were transferred to the Ed Weed Fish Culture Station for gamete collection (130 from electrofishing and 30 from the Winooski One fish lift.

Two trapnets were set and tended November 7 and 8, 2011, in Hatchery Cove near the Ed Weed Fish Culture Station. A total of 131 lake trout and 104 salmon were captured over two trap-nights.

Details on the above activities follow.

We also began 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 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.

Prepared by: Brian Chipman
Fisheries Biologist

Date: August 29, 2012

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 population structure and response to sea lamprey control (F-35-R, Study VIII), and provide gametes for landlocked Atlantic salmon culture. Between mid-September and mid-November 2011, 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, Boquet River, and the nearshore areas of Whallon Bay, and Willsboro Bay (Figure 1). The Whallon Bay, Willsboro Bay, and Boquet River sampling was conducted in cooperation with the New York State Department of Environmental Conservation and the U.S. Fish and Wildlife Service. Sex/maturity, total length, fin clips and sea lamprey attack data were recorded for all fish collected, and subsamples were weighed. Scale samples were collected from all species for future age determination, and salmon, steelhead, and brown trout collected in the Vermont tributaries were tagged with serially numbered floy-type anchor tags. Virtually all fish collected were released alive aside from a portion of the salmon transferred to Ed Weed for culture purposes.

Salmonid Collections

A total of 739 salmon were collected from all locations and 495 lake trout were collected from the lakeshore areas; two additional lake trout were collected from Otter Creek. A total of 17 steelhead were collected from Hatchery Brook, Whallon Bay and Willsboro Bay, while 44 brown trout were collected from Hatchery Brook and Willsboro Bay. A summary of the salmonids collected is presented in 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.

A total of 123 spawning adult Sebago strain salmon collected from Hatchery Brook (66 females and 57 males), and an addition seven salmon from the Lamoille River (two females and five males) were held as boodstock at the Ed Weed Fish Culture Station, Grand Isle, VT. The Sebago strain was identified by fin clips; Sebago smolts stocked by Vermont prior to 2008 were marked an Adipose-Right Ventral fin clip. The fin clip on smolts stocked by Vermont in 2009-2011 was Right Ventral. Salmon smolts stocked by New York are not marked.

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 from lake trout and salmon collected in all fall assessments, including electrofishing, trapnetting, the Winooski River fish lift and the Boquet River fishway (NYSDEC data). The 2011 lake trout wounding rate declined to 30 wounds per 100 fish, the lowest level since 1998 (Figure 2). The 2011 lakewide salmon wounding rate increased slightly to 19 wounds per 100 fish after meeting the program objective in 2010 (Figure 2). Wounding rates on larger lake trout size classes also showed continued declines since 2009 (Figure 3). Pooled Inland Sea and Malletts Bay salmon met the wounding rate objective for the first time in 2011, at 14 wounds per 100 fish (Figure 4). This is the first time in the history of the sea lamprey control program that both lake trout and salmon wounding rates have been within 5 wounds per 100 fish of their respective targets.

Hatchery Brook Salmon Returns

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 5).

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 amounted to 25 percent of the sample in 2010 (Figure 6). 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 increased to 16% in 2010 and to 20% in 2011 (Figure 6). 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 may be a factor affecting recruitment into the 533-633mm size class.

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Date: August 29, 2012

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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.

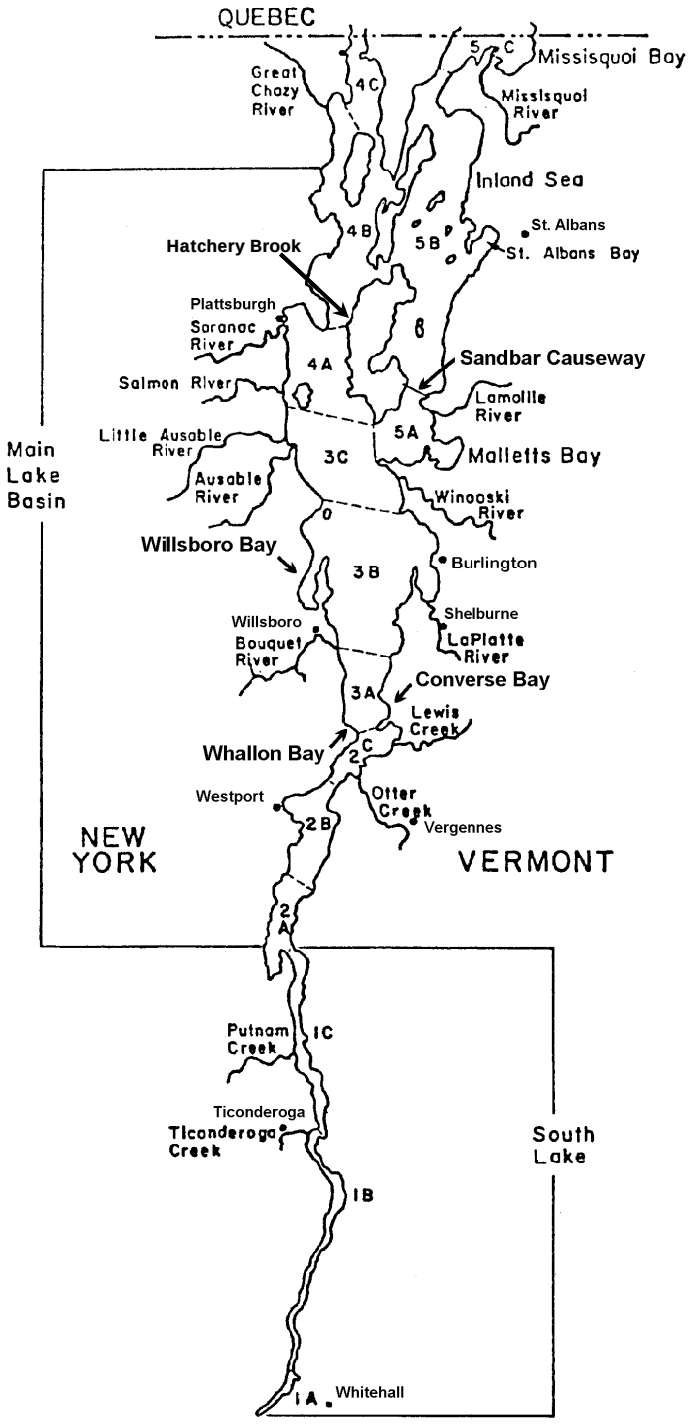

Figure 1. Lake Champlain, showing major lake basins and management zones, tributaries and salmonid sampling areas.

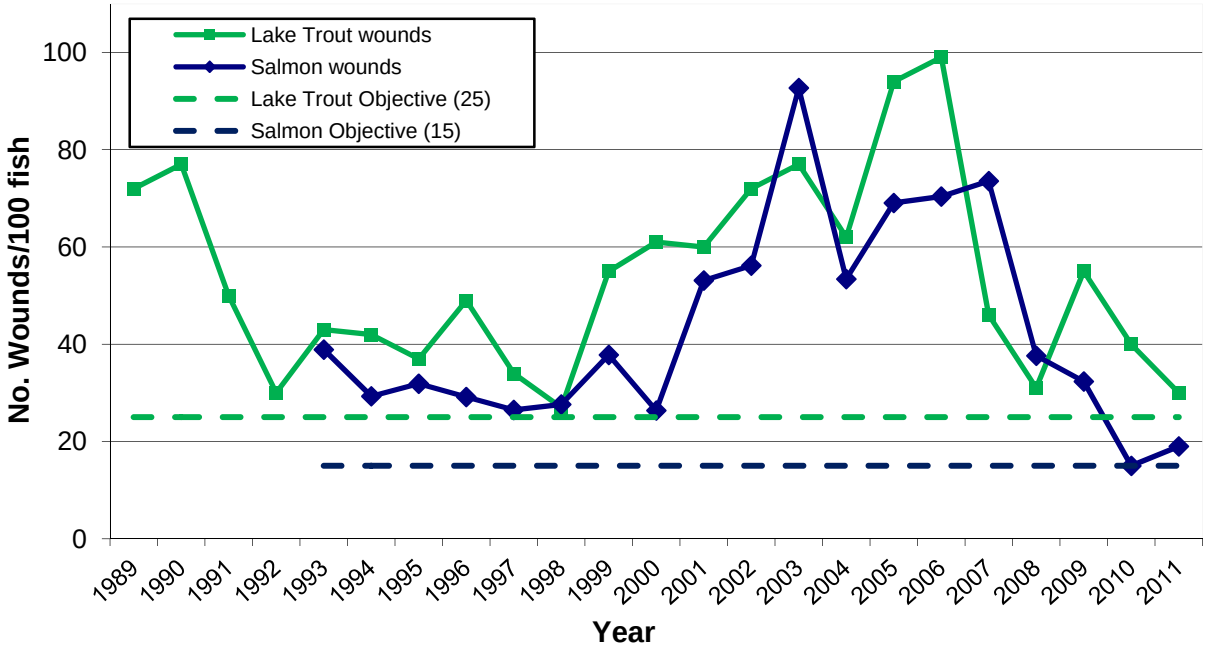

Figure 2. Sea lamprey wounding rates on 533-633 mm TL lake trout and 432-533 mm TL landlocked Atlantic salmon from Lake Champlain, 1989-2010.

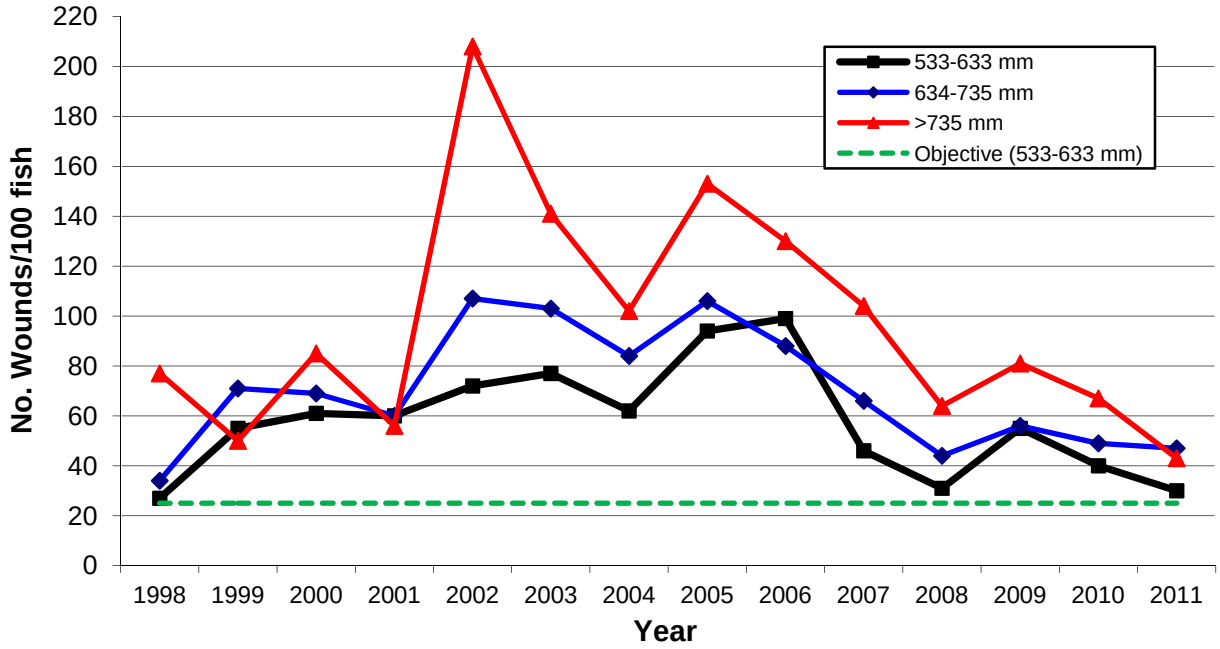

Figure 3. Sea lamprey wounding rates on three length classes (TL) of lake trout from Lake Champlain, 1998-2011.

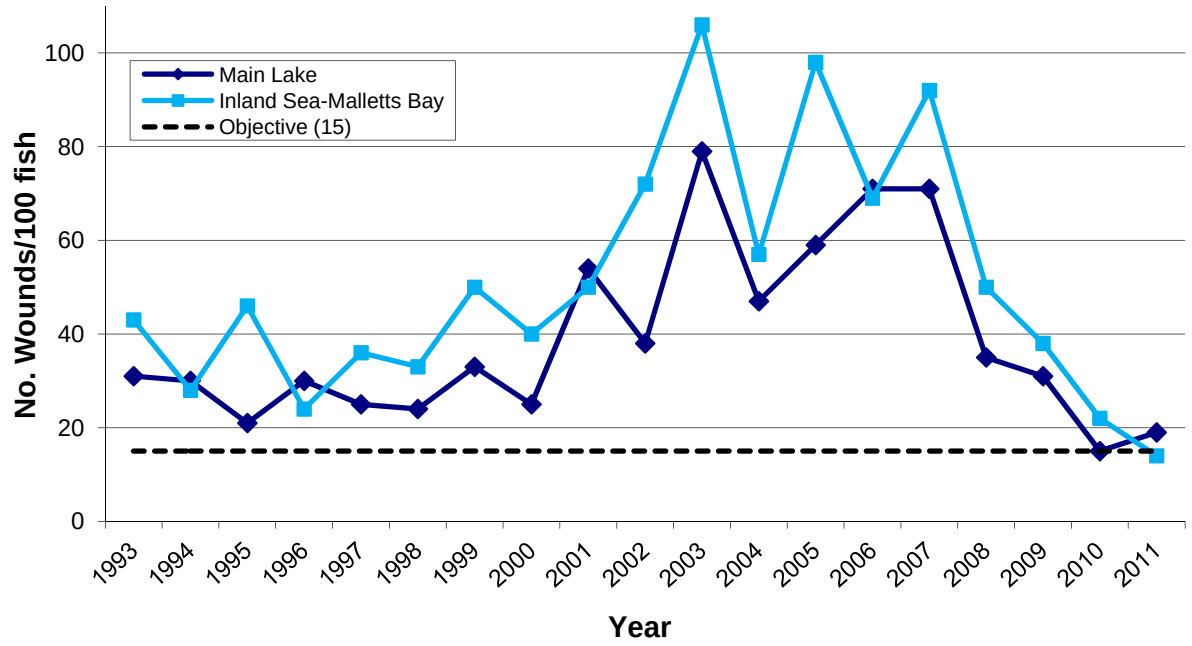

Figure 4. Sea lamprey wounding rates on 432-533 mm TL landlocked Atlantic salmon from the Main Lake and Inland Sea/Malletts Bay basins of Lake Champlain, 1993-2011.

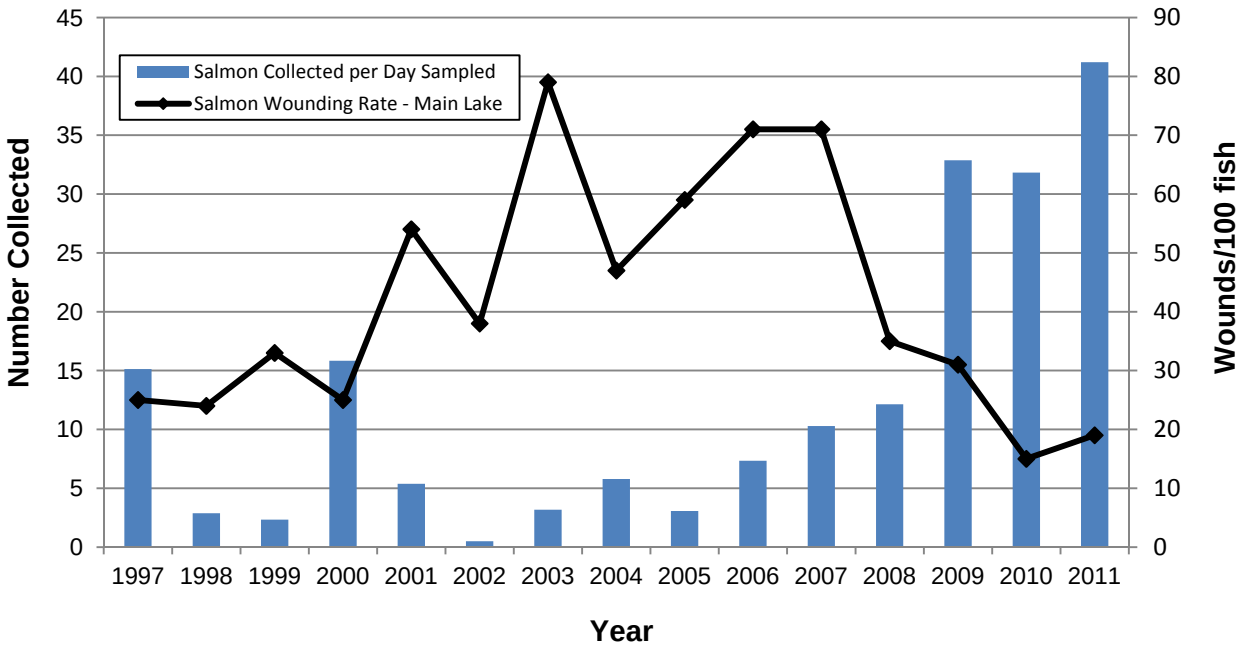

Figure 5. Relative abundance of landlocked Atlantic salmon returns to Hatchery Brook (number collected by electrofishing per day sampled) and Main Lake sea lamprey wounding rates, 1997-2011.

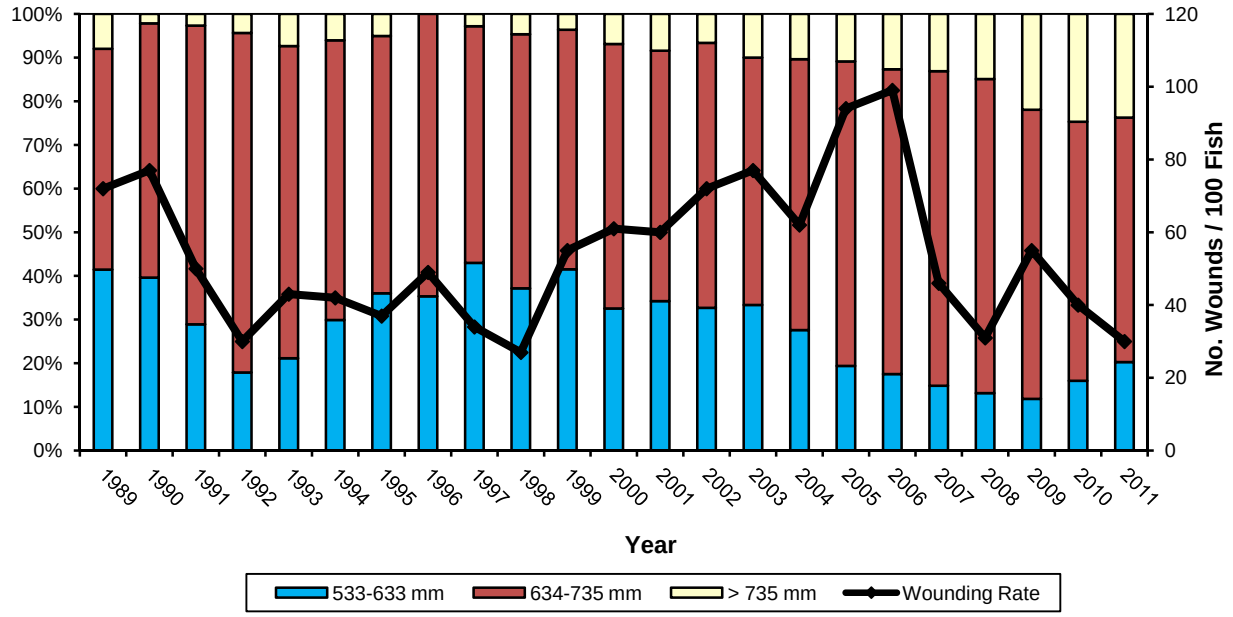

Figure 6. Percent frequency of three length classes (TL) of lake trout sampled in Lake Champlain by fall electrofishing, 1989-2011.

Table 1. Cooperative Lake Champlain salmonid electrofishing results in fall 2011. 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. 19 - Nov. 9 (11)	90	515 (46)	504 (37)	426 (7)
Sandbar Causeway	Sep. 19 - Nov. 9 (7)	19	499 (7)	539 (9)	505 (3)
Hatchery Brook	Oct. 5 - Nov. 8 (10)	414	516 (196)	501 (212)	439 (4)
Missisquoi River	Sep. 19 - Nov. 9 (3)	0	-	-	-
Otter Creek	Sep. 21 - Nov. 1 (2)	1	-	627 (1)	-
Whallon Bay	Oct. 21 - Nov. 1 (2)	42	592 (1)	513 (2)	456 (39)
Boquet River	Nov. 21 (1)	21	525 (12)	514 (9)	-
Willsboro Bay	Oct. 25 - Nov. 21 (4)	150	547 (2)	484 (1)	409 (147)
	Total	739			
Lake trout					
Hatchery Cove/Breakwater	Nov. 8 (1)	102	667 (56)	680 (46)	
Otter Creek	Sep. 21 - Nov. 1 (2)	2	792 (1)	742 (1)	-
Willsboro Bay	Oct. 25 - Nov. 21 (3)	49	694 (10)	712 (25)	663 (14)
Whallon Bay	Oct. 26 - Nov. 15 (1)	342	677 (170)	693 (158)	683 (14)
	Total	495			
Steelhead					
Lamoille River	Sep. 19 - Nov. 9 (11)	0	-	-	-
Sandbar Causeway	Sep. 19 - Nov. 9 (7)	0	-	-	-
Hatchery Brook	Oct. 5 - Nov. 8 (10)	8	-	508 (3)	455 (5)
Missisquoi River	Sep. 19 - Nov. 9 (3)	0	-	-	
Otter Creek	Sep. 21 - Nov. 1 (2)	0	-	-	-
Whallon Bay	Oct. 21 - Nov. 1 (2)	6	-	-	509 (6)
Boquet River	Nov. 21 (1)	0	-	-	-
Willsboro Bay	Oct. 25 - Nov. 21 (4)	3	-	-	488 (3)
	Total	17			
Brown trout					
Lamoille River	Sep. 19 - Nov. 9 (11)	0	-	-	-
Sandbar Causeway	Sep. 19 - Nov. 9 (7)	0	-	-	-
Hatchery Brook	Oct. 5 - Nov. 8 (10)	41	501 (16)	488 (23)	403 (1)
Missisquoi River	Sep. 19 - Nov. 9 (3)	0	-	-	-
Otter Creek	Sep. 21 - Nov. 1 (2)	0	-	-	-
Whallon Bay	Oct. 21 - Nov. 1 (2)	0	-	-	-
Boquet River	Nov. 21 (1)	0	-	-	-
Willsboro Bay	Oct. 25 - Nov. 21 (4)	3	-	-	420(3)
	Total	44			

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 being infected with VHS, the Vermont Department of Fish and Wildlife is evaluating and considering modification where necessary, 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 collected using a temperature logger from Onset

Instruments, (Pocasset, MA), model HOBO Water Temp Pro v2. The temperature logger was programmed to record every hour.

Findings

Fall lift season

The fish lift operated continuously from September 15 thru November 10, 2011 (Figure 2). The fish hopper was lifted 150 times in 57 days of operation. A total of 189 adult salmon were recorded (Table 1). Many salmon were captured more than once (see Fish Lift Efficiency Assessment). This number of salmon lifted is the largest ever recorded since the facility began operation in 1993. Most of the salmon (71%) were trapped in the first 2 weeks of the season (September 15-30). These fish probably were pulled into the Winooski River as a result of tropical storm Irene which caused the river flows to increase in late August (Figure 3.)

There were 82 male and 107 female salmon processed at the lift. Eighty-four percent of the salmon aged had spent one year in the lake (1-lake-year). Mean lengths of male and female 1-lake-year salmon were 536 and 521 millimeters (mm), respectively (Table 2). Twenty-five salmon were 2-lake-year fish with a mean length of 605 mm for males (9 fish) and 599 mm for females (16 fish). Six salmon were lake-age 3 fish. Thirty salmon were transported to the Ed Weed fish culture station. These fish were utilized for brood stock.

In addition to the salmon, 18 steelhead, and 1 lake trout were lifted in the fall, 2011 (Table 1). The steelhead trapped ranged from 0-lake-year fish to 3-lake-year fish (Table 2).

Spring lift season

The fish lift operated from March 12 thru May 10, 2012. The fish hopper was lifted 122 times in 60 days of operation. Only 16 adult steelhead rainbow trout (11 male and 5 female) were trapped (Table 1). Two of the steelhead had been previously lifted in the fall, 2011. Several fish were re-captured during the season. Mean length of the steelhead were 462 (SD = 45, n = 10) and 617 (SD = 27, n = 4) for 2 and 3-year old steelhead, respectively.

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 2011, 96 salmon fell within this length class with a calculated lamprey wounding rate of 31 wounds per 100 fish (Table 3). This is a substantial decrease from previous years.

Fish Lift Efficiency Assessment

Objective: To evaluate landlocked Atlantic salmon and steelhead rainbow trout movement and trapping efficiencies from fish tagged below the dam.

Procedures

Steelhead and salmon were captured below the Winooski One dam, tagged, and released. The ratio of the number of tagged fish recaptured in the trap to the total number of fish lifted would be a measure of the effectiveness of the fish trapping system. Sampling was conducted during the spring and fall lift seasons below the Winooski One dam using an electrofishing boat equipped with a Coffelt VVP-15 pulsator unit set on DC-pulse output.

Findings

No electrofishing for salmon or steelhead below the Winooski One dam was conducted in the fall of 2011 or the spring of 2012. However, during the fall 2011 lift season many of the tagged salmon that were released below the lift were recaptured. There was 147 recaptures recorded during the fall lift season.

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 35,308 Sebago strain salmon smolts were stocked in the Winooski River in spring 2012, (Table 4). The salmon had mean lengths ranging from 174 - 198 mm and were reared at the Eisenhower National Fish Hatchery in Chittenden, Vermont. All the salmon stocked received a left ventral fin clip (LV) before stocking at the dam or at the fishing access near the mouth on April 3rd.

In fall 2011, 38,862 fingerling salmon were stocked in the main stem Winooski from Richmond, Vermont upstream. These fish came from the Eisenhower National Fish Hatchery and averaged 105 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 salmon smolt and fingerling stocking, the Huntington River was stocked with approximately 25,900 salmon fry in May, 2012 (see Winooski River Tributary Salmonid Assessment).

A total of 21,676 Chambers Creek strain steelhead were stocked in the Winooski River in 2012. 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 15 and April 3 (Table 5).

The success of the salmon fry, 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. Salmon stocked as smolts through 2007 have adipose and right ventral (ADRV) fin clips; in 2008 the smolt fin clip changed to RV.

Beginning in 2007, salmon parr were collected from several areas on the Huntington River and fin clipped. Salmon parr (young-of-year) were collected by electrofishing, anesthetized, total length measured and the left ventral (LV) fin removed. Prior to 2007, salmon parr were tagged with magnetized metal nose tags and adults were scanned for the tags at the lift.

Findings

Five times as many RV clipped adult salmon returned to the trap as did non-clips (155 vs. 31; Table 6). The majority of both the clipped and non-clipped salmon were lake-age 1 fish. The proportion of non-clipped to clipped fish increased from 2009 to 2010 but decreased in 2011 (Figure 4).

Two LV clipped adult salmon were observed in 2011. This is the first confirmed time an adult salmon from fry stocking has returned to the lift. One salmon was lake-age 1and one was a lake-age 3; both were females. These fish could have originated from stockings occurring from 2007 to 2010. Numbers clipped in each year up to 2010 are as follows: 1264, 430, 827, and 372.

Winooski River and Tributary Habitat Assessment

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

Procedures

No habitat assessment was conducted in 2011. 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 for three tributaries to the Winooski River. Unfortunately, several loggers were lost during late summer floods. Mean water temperatures during the months of May through mid-October ranged from 10 to 20 degrees °C. The highest maximum measured water temperature was 26 °C measured in the Huntington River in July.

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 2012 was 29 fry per salmon habitat unit (100 square meters).

Salmon parr 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 and other tributaries to the Winooski as time permitted.

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 2012 was about 25,900. This is about a fourth 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 27 mm in length and were stocked at an average density of 26 fish per salmon unit.

Salmon parr sampling

Due to late summer flooding and scheduling conflicts, salmon stocked in the Huntington River could not be sampled. Five smaller tributaries were sampled – 2 prior to tropical storm Irene on August 28th and 3 after the flood.

A total of 212 trout were collected during the 2011 tributary sampling effort. Table 8 and 9 summarizes YOY mean lengths, population estimates and biomass for the Winooski River tributaries sampled in 2011. Rainbow trout made up 81 percent of the trout collected in the 5 tributaries sampled with the majority of those being YOY (91 %) (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 2012 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 injecting a small amount of non-toxic acrylic paint in-between two of the anal fin rays 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 March 30 - which is the earliest start date ever – and fished until June 8, 2012 (Table 10). The trap fished 37 days during the period and captured 79 salmon smolts (Figure 7). Calculation of trap efficiency and subsequent estimation of out-migration numbers was not attempted in 2012 because the salmon were being utilized in a smolt physiology study. Table 12 compares the spring trapping efforts to previous years.

The majority of smolts captured (75%) were from fry stocking (no fin clip). Age structure of these salmon was split between age 2 (42 fish) and age 3 (15 fish) (figure 8). Mean length was: age 2 - 157 mm (SD = 12), age 3 – 183 mm (SD = 9). The remaining salmon trapped (20 fish) were AD clipped smolts which were stocked as fall fingerlings in 2011. These age 1 smolts had a mean length of 153 mm (SD = 8).

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

Seven salmon and 3 steelhead tagged at the Winooski One fish lift were reported caught by anglers between June, 2011 and July, 2012 (Table 13). Eight of the reports were fish caught outside of the Winooski River. The furthest away from the Winooski River a fish was angled was near Port Henry, NY - which is about 60 kilometers south.

There were 18 entries in the volunteer angler survey forms between September 19 and November 18, 2011. Based on information provided by anglers it took approximately 5.9 hours of fishing effort to catch either a salmon or steelhead during this period. Two salmon and 11

steelhead trout were caught in 76.25 hours of fishing effort reported below Winooski One dam. All the salmon and steelhead were reported to have been released by anglers.

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Date: August 28, 2012

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Zydlewski, G. B., A. Haro, and S. D. McCormick. 2005. Evidence for cumulative temperature as an initiating and terminating factor in downstream migratory behavior of Atlantic salmon (Salmo salar) smolts. Canadian Journal of Fisheries and Aquatic Sciences 62:68-78.

Table 1. Summary of landlocked Atlantic salmon and rainbow steelhead trout lifted at the Winooski One fish passage facility, 1993 – spring 2012.

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	na	na

Table 2. Summary of mean total lengths of aged landlocked Atlantic salmon and steelhead rainbow trout collected at the Winooski One fish passage facility, fall 2011. 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	---	536 ± 33 (69)	605 ± 69 (9)	691 ± 40 (3)	81
Female	---	521 ± 42 (88)	599 ± 48 (16)	577 ± 64 (3)	107
Total	---	157	25	6	188
Steelhead Rainbow Trout					
na	423 ± 33 (8)	594 ± 33 (5)	600 ± 32 (4)	---	17

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 - 2011.

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

Table 4. Summary of recent landlocked Atlantic salmon smolt stocking in the Winooski River, 2005– 2012. Stockings are typically split between the boat access near the river mouth and below the Winooski One dam.

Year Stocked	Stocking Location	Number Stocked	Size (mm)	Strain	Total Stocked	Clip
2005	W. One Mouth Mouth	16,359 4,617 8,104	203 216 190	Sebago Sebago Sebago	29,080	ADRV
2006	W. One Mouth	26,046 3,954	196-239 251	Sebago Sebago	30,000	ADRV
2007	W. One Mouth	9,865 13,290	219 219	Sebago Sebago	23,155	ADRV
2008	W. One Mouth	33,689 26,302	178-203	Sebago	59,991	RV
2009	W. One Mouth	15,706 17,040	155 - 171	Sebago	32,290	RV
2010	W. One Mouth	15,466 15,703	178 - 192	Sebago	31,169	RV
2011	W. One Mouth	15700 16010	178 - 203	Sebago	31,710	RV
2012	W. One Mouth	16,514 18,794	174 - 198	Sebago	35,308	LV

Table 5. Summary of recent steelhead rainbow trout smolt stocking in the Winooski River, 2004 – 2012.

Year Stocked	Stocking Location	Number Stocked	Size (mm)	Strain	Total Stocked	Clip
2004	Mouth	24,000	178	Chambers	24,000	AD
2005	Mouth W. One	12,000 8,000	183 188	Chambers	20,000	AD
2006	Mouth W. One	10,000 10,000	183 183	Chambers	20,000	AD
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	Mouth W. One Mouth W. One	5900 5776 5900 4100	201 182 201 182	Chambers Magog Chambers Magog	21,676	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 - 2011.

Age	RV clipped Salmon			Non-Clipped Salmon		
	2009	2010	2011	2009	2010	2011
0	0	17	0	0	0	0
1	29	56	136	6	40	20
2	2	9	16	1	4	9
3	0	0	3	0	0	3
Total	**31**	**82**	**155**	**7**	**44**	**31**

Table 7. Summary of average water temperature measurements on Winooski River tributaries in 2011. Temperature measurements are in Celsius with maximum temperatures in parentheses. Measurements from May 1 – October 14, 2011.

River	May	June	July	August	September	October
Huntington – 5.3 km	12 (16)	16 (19)	21 (26)	20 (23)	16 (21)	10 (14)
Mill Brook	---	16 (21)	19 (25)	19 (23)	16 (21)	---
Preston Brook	---	14 (17)	17 (21)	17 (19)	15 (24)	---

Table 8. Summary of mean total lengths of young-of-year trout collected in Winooski River tributaries in 2011. All lengths in millimeters ± one standard deviation.

Tributary	Date	Rainbow trout	Brown trout	Brook trout
Duck Brook	8/26	56.3 ± 7.4 n = 88	66.8 ± 8.6 n = 8	---
Texas Brook	8/26	---	---	73.5 ± 10.4 n = 4
Preston Brook	9/12	68.9 ± 8.1 n = 30	---	80.0 ± 12.7 n = 2
Joiner Brook	9/1	65.3 ± 7.8 n = 10	76.5 ± 7.8 n =2	---
Pinneo Brook	8/8	61.3 ± 6.0 n = 27	---	69.0 ± 8.5 n = 2

Table 9. Population estimates for salmon and trout collected in Winooski River tributaries in 2011.

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 9. Population estimates for salmon and trout collected in Winooski River tributaries in 2011

Stream	Elev.	Date	Len	Width	Species	Class	Num	Est.	LOCI	UPCI	Popmi	Popkm	Mn Wt	Lbac	Kghec
Duck Brook	320	26-Aug	310	11.1	RBT	YOY	88	90	2.2	4.2	1533	952	1.8	4.39	4.93
						<6	8	8	0.0	7.1	136	85	17.1	3.82	4.29
							96				1669	1037		8.21	9.21
					BNT	YOY	8	10	20.0	103.1	170	106	3.0	0.84	0.94
						6-10	1	1	0.0	0.0	17	11	28.0	0.78	0.88
							9				187	117		1.62	1.82
					TOTALS		**105**				**1720**	**1154**		**9.83**	**11.03**
Joiner Brook	350	1-Sep	290	20.4	RBT	YOY	10	10	0.0	6.8	182	113	2.8	0.45	0.51
						<6	4	4	0.0	0.0	73	45	23.0	1.49	1.67
						6-10	3	3	0.0	0.0	55	34	63.0	3.08	3.46
							17				310	192		5.02	5.64
					BNT	YOY	2	2	0.0	0.0	36	22	4.5	0.15	0.16
						<6	1	1	0.0	0.0	18	11	26.0	0.42	0.47
						6-10	1	1	0.0	0.0	18	11	38.0	0.62	0.69
							4				72	44		1.19	1.32
					BKT	<6	3	3	0.0	0.0	55	34	20.0	0.97	1.09
						6-10	1	1	0.0	0.0	18	11	40.0	0.65	0.73
					TOTALS		**4**				**73**	**44**		**1.62**	**1.82**
Pinneo Brook	370	8-Aug	360	11	RBT	YOY	27	28	3.6	11.7	411	255	2.1	1.41	1.58
					BKT	YOY	2	2	0.0	0.0	29	18	3.5	0.17	0.19
						<6	3	3	0.0	0.0	44	27	23.7	1.72	1.93
						6-10	4	4	0.0	0.0	59	36	54.8	5.31	5.95
							9				132	81		7.20	8.07
					TOTALS		**36**				**543**	**336**		**8.61**	**9.65**

Table 9. (continued)

Stream	Elev.	Date	Len	Width	Species	Class	Num	Est.	LOCI	UPCI	Popmi	Popkm	Mn Wt	Lbac	Kghec
Preston Brook	365	12-Sep	350	19.1	RBT	YOY	30	30	0.0	7.1	453	281	3.0	1.31	1.47
						6-10	1	1	0.0	144.0	15	9	76.0	1.09	1.22
							31				468	290		2.40	2.69
					BNT	YOY	1	1	0.0	0.0	15	9	4.0	0.06	0.06
					BKT	YOY	2	2	0.0	101.7	30	19	4.0	0.11	0.13
						<6	1	1	0.0	143.8	15	9	25.0	0.36	0.40
						6-10	3	3	0.0	17.4	45	28	72.7	3.13	3.51
							6				90	56		3.60	4.04
					TOTALS		**38**				**573**	**355**		**6.06**	**6.79**
Texas Brook	700	26-Aug	282	12	BKT	YOY	4	4	0.0	0.0	75	46	4.0	0.45	0.51
						<6	2	2	0.0	0.0	37	23	28.0	1.13	1.27
						6-10	1	1	0	339.0	19	12	38.0	1.08	1.21
							7				131	81		2.66	2.99
					BNT	6-10	1	1	0.0	00.0	19	12	173.0	4.91	5.50
					LLS	1+	2	2	0.0	0.0	37	23	23.5	1.33	1.49
					TOTALS		**10**				**187**	**116**		**8.90**	**9.98**

Table 10. Summary of out-migrating smolt trapping on the Huntington River, 2004 – 2012.

Year	Start Date	End date	Days Fished	Number new , unmarked Trapped	Number Marked and released[1]	Number Recaptured	Estimate	Trap style[2]
2012	Mar 30	June 8	37	79	na	na	na	New
2011	May 9	May 26	10	43	na	2	na	New
2010	April 19	June 1	41	205	214	16	1,783	New
2009	April 16	June 12	52	76	88	16	418	New
2008	April 24	June 13	49	360	412	66	2,247	New
2007	May 1	June 15	44	288	276	19	4,184	New
2006	April 11	June 9	49	60	39	0	Nd	Old
2005	April 14	June 9	49	126	135[3]	6	2,835	Old
2004	May 6	June 4	25	57	0	na	na	Old

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 11. Summary of Winooski One tagged Salmon and steelhead caught by anglers, July, 2011 through June, 2012.

Species	Date Caught	Location	Year/Season Tagged
Steelhead	July 17, 2011	Juniper Island	2011 / Spring
Salmon	October 26, 2011	Boquet River	2011 / Fall
Salmon	November 1, 2011	Winooski River	2011 / Fall
Salmon	November 28, 2011	Saranac River	2011 / Fall
Salmon	March 24, 2012	Burlington Bay	2011 / Fall
Salmon	April 28, 2012	Town Farm Bay	2011 / Fall
Salmon	May 6, 2012	Malletts Bay (Outer)	2010 / Fall
Steelhead	May 9, 2012	Winooski River	2012 / Spring
Salmon	May 13, 2012	Port Henry	2011 / Fall
Steelhead	May 13, 2012	Town Farm Bay	2011 / Fall

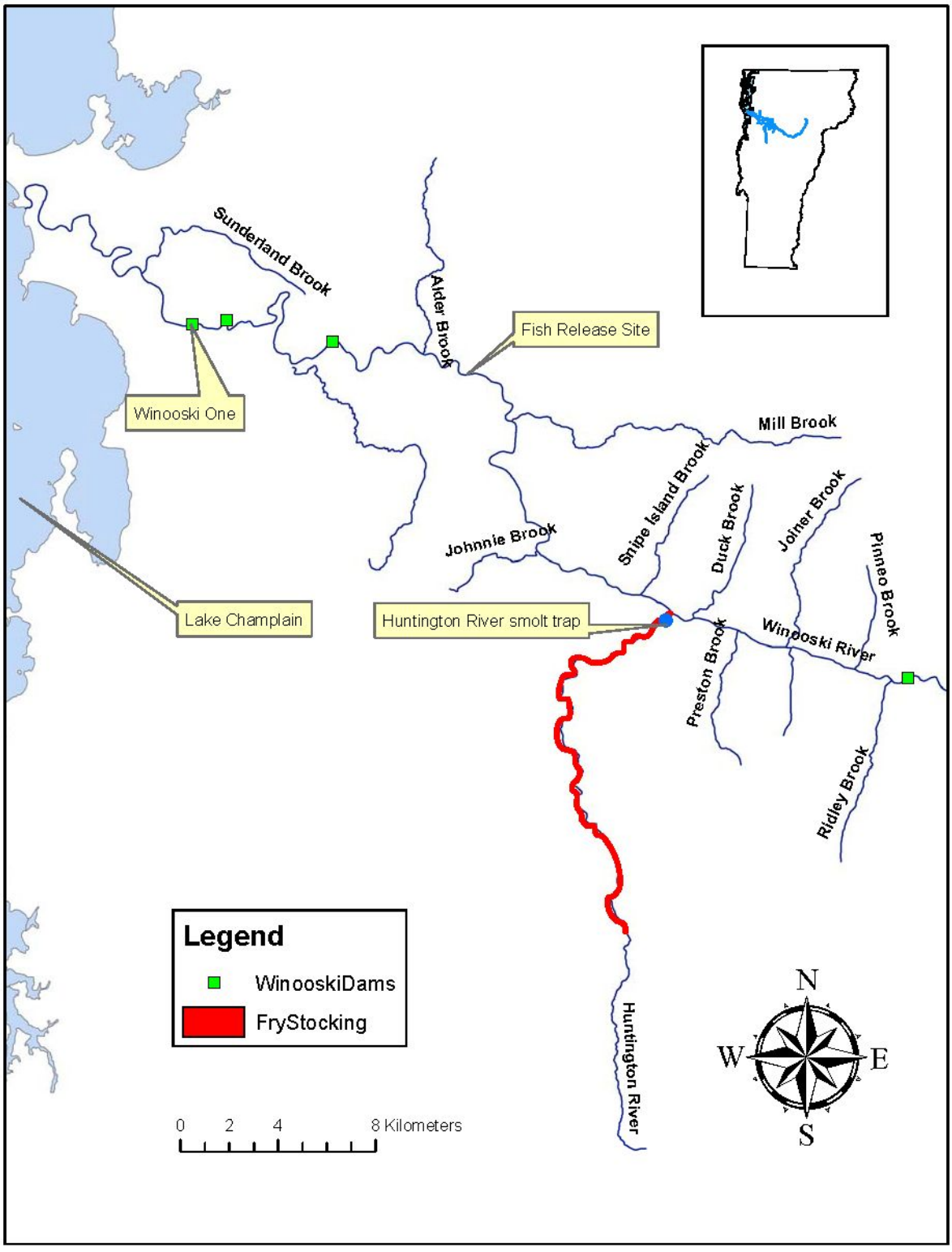


Figure 1. Map of lower Winooski River drainage showing Winooski One Dam, the fish release site, named tributaries, and fry stocking areas.

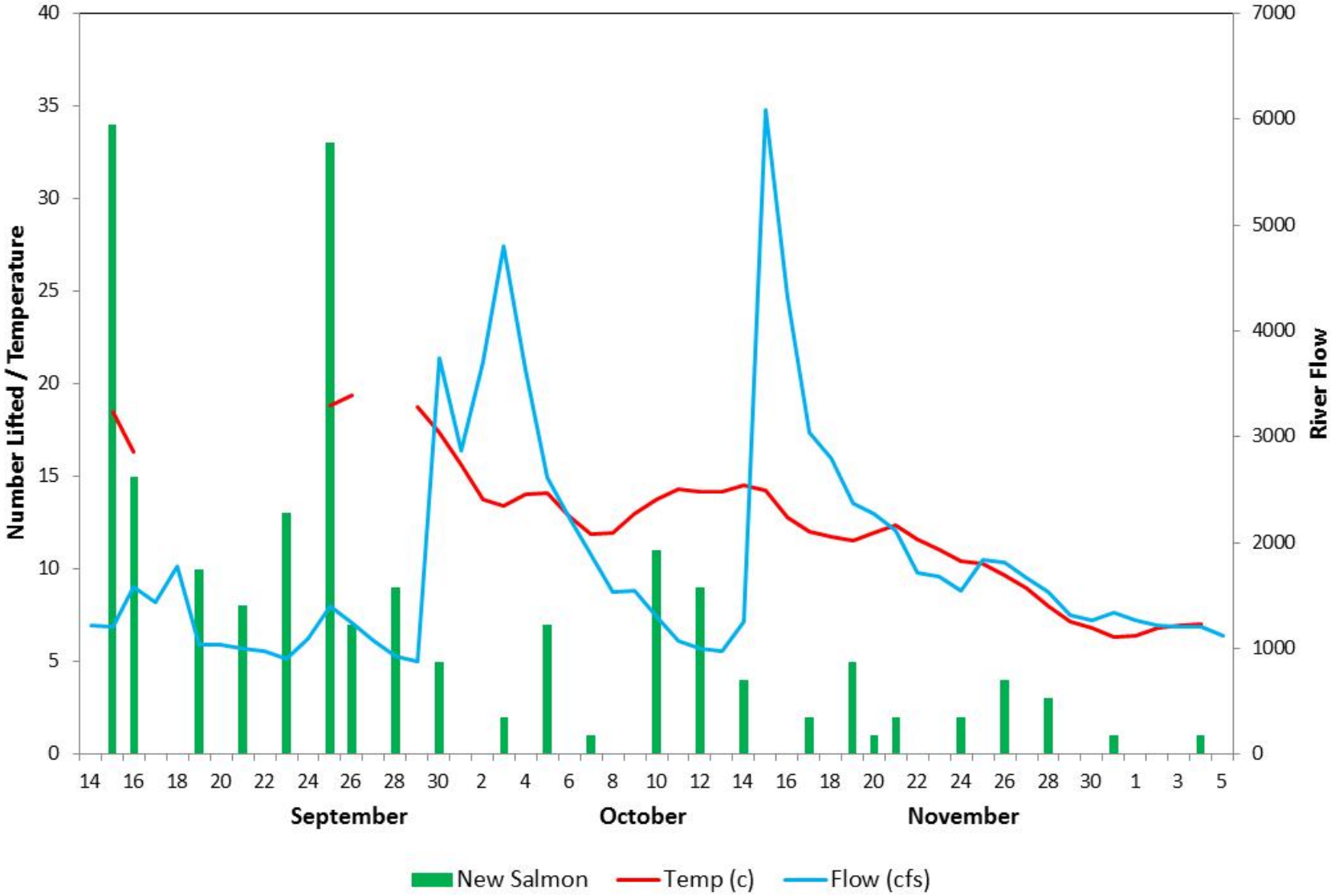


Figure 2. Comparison of 2011 fall river flows (cubic feet per second), mean water temperatures (Celsius) and numbers of new salmon processed by date at the Winooski One fish facility

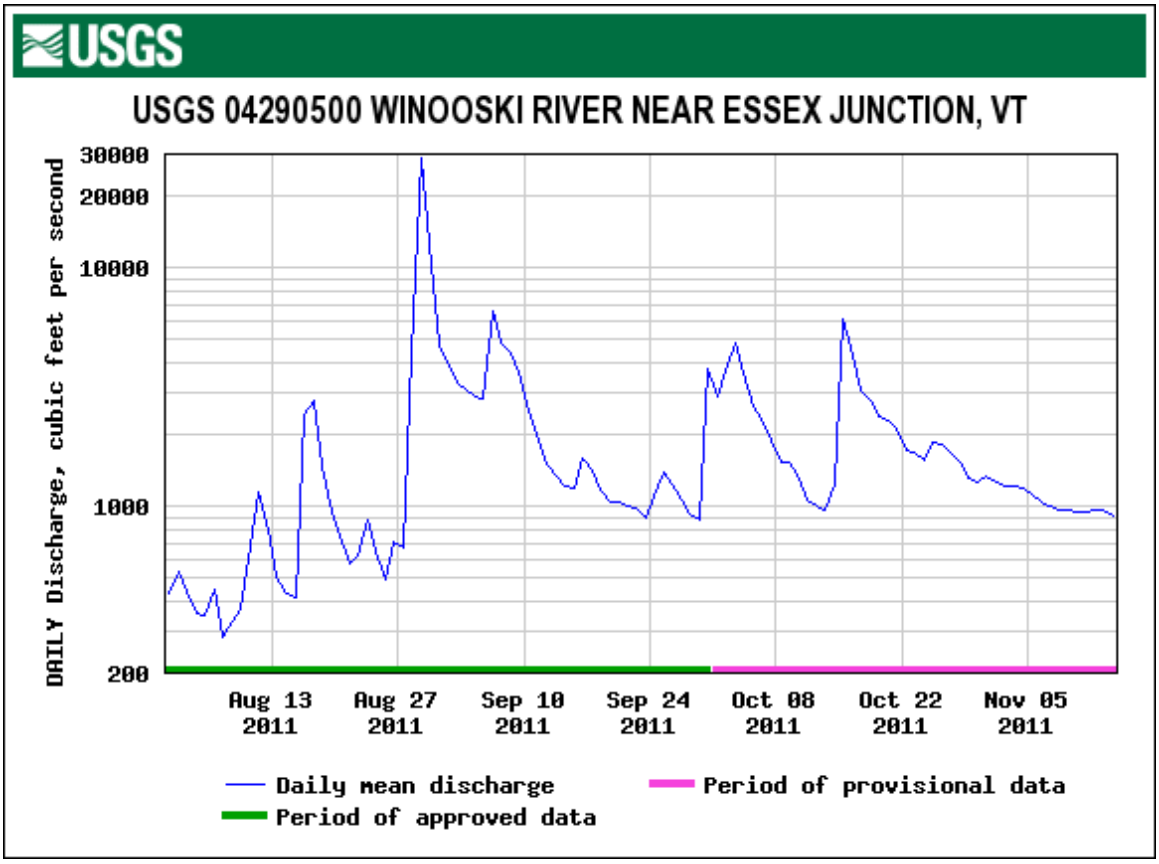


Figure 3. Hydrograph of the Winooski River, August – November, 2011.

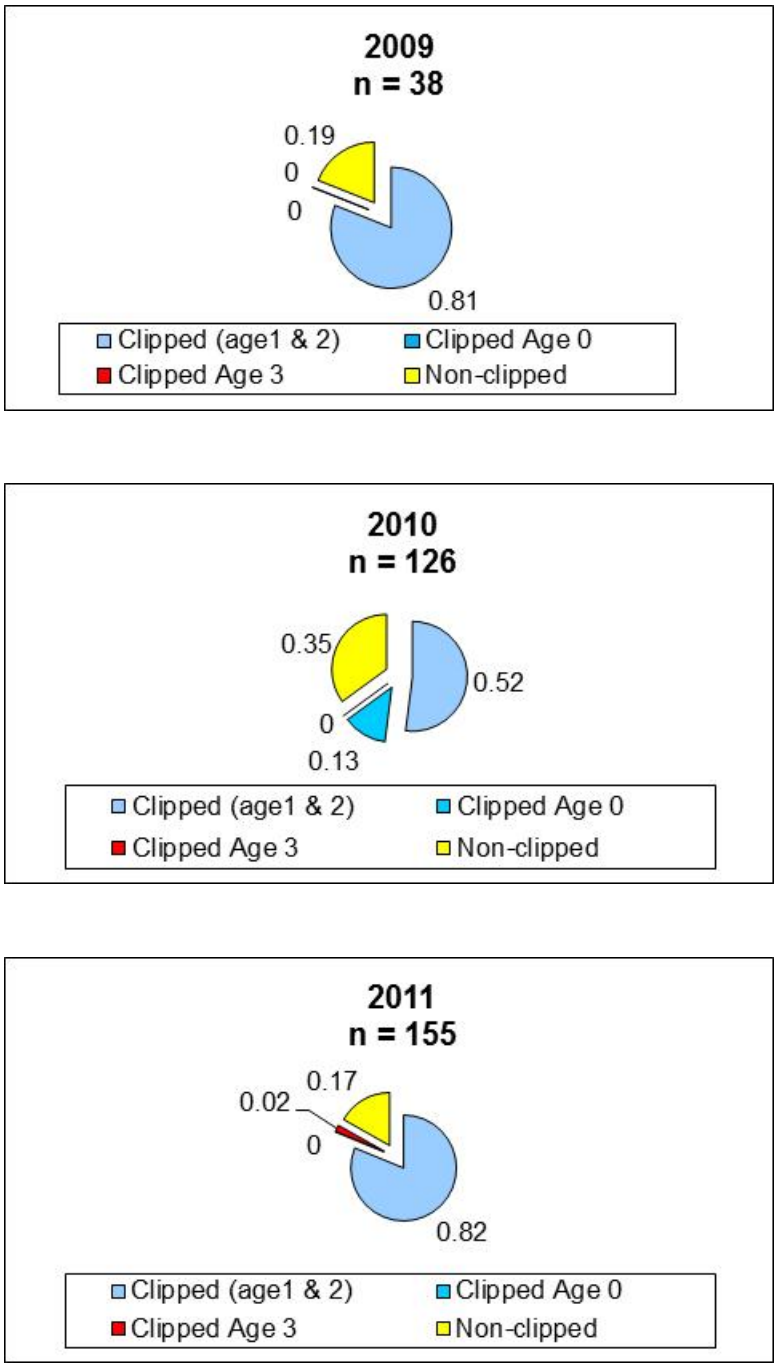
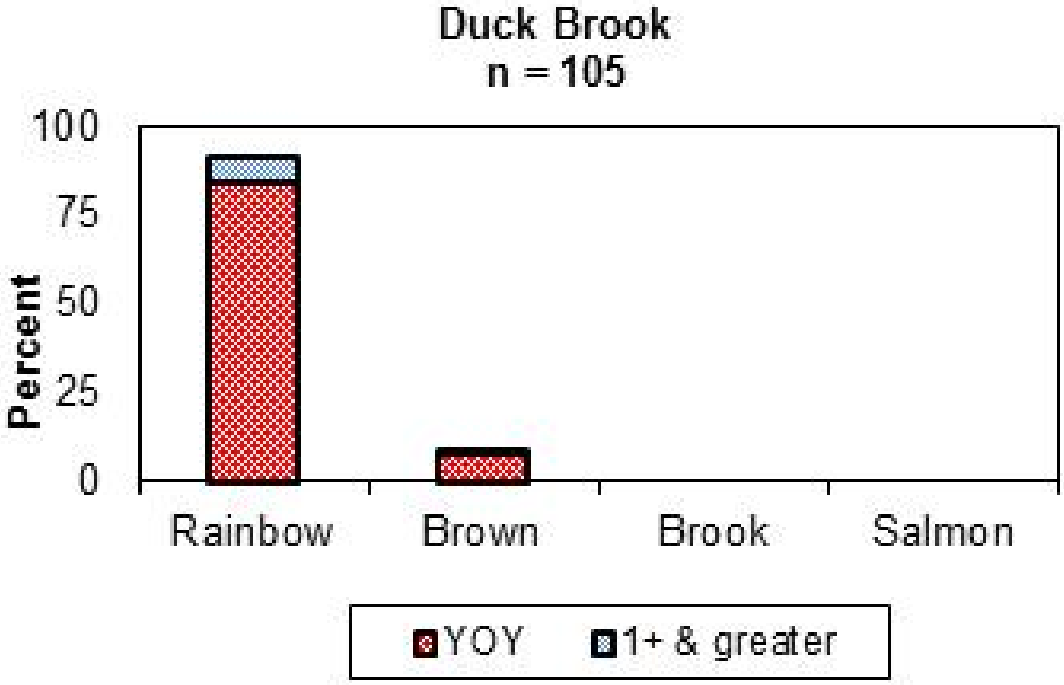


Figure 4. Comparison of percent composition of clipped and non-clipped salmon collected at the Winooski One lift in the fall of 2009, 2010 and 2011.



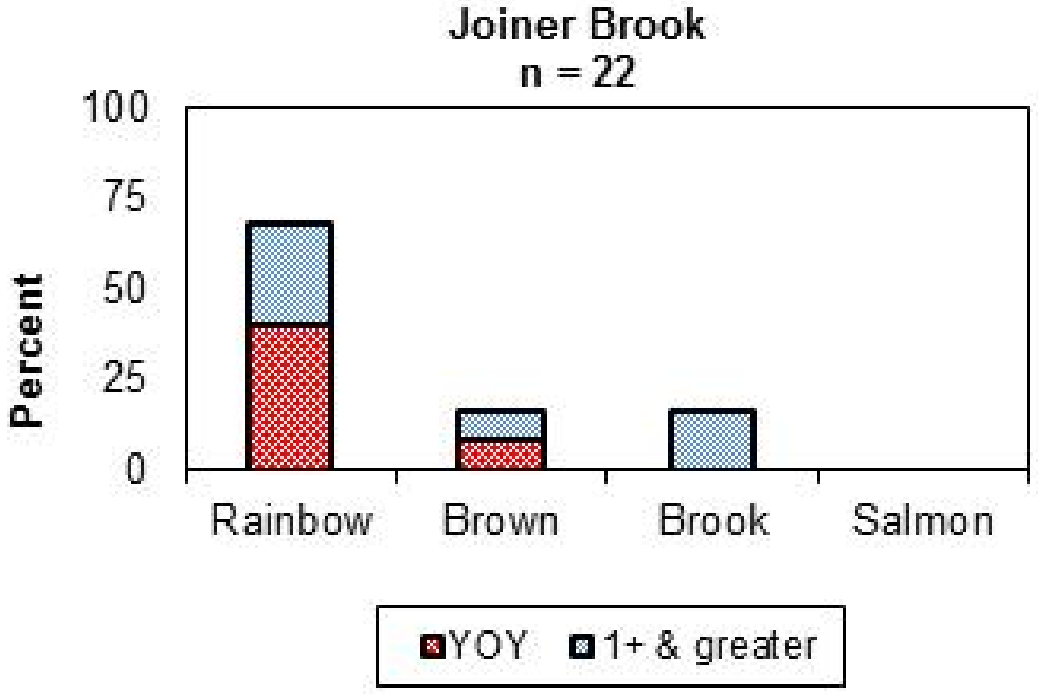


Figure 5. Percent composition of trout and salmon collected by site in 2011.

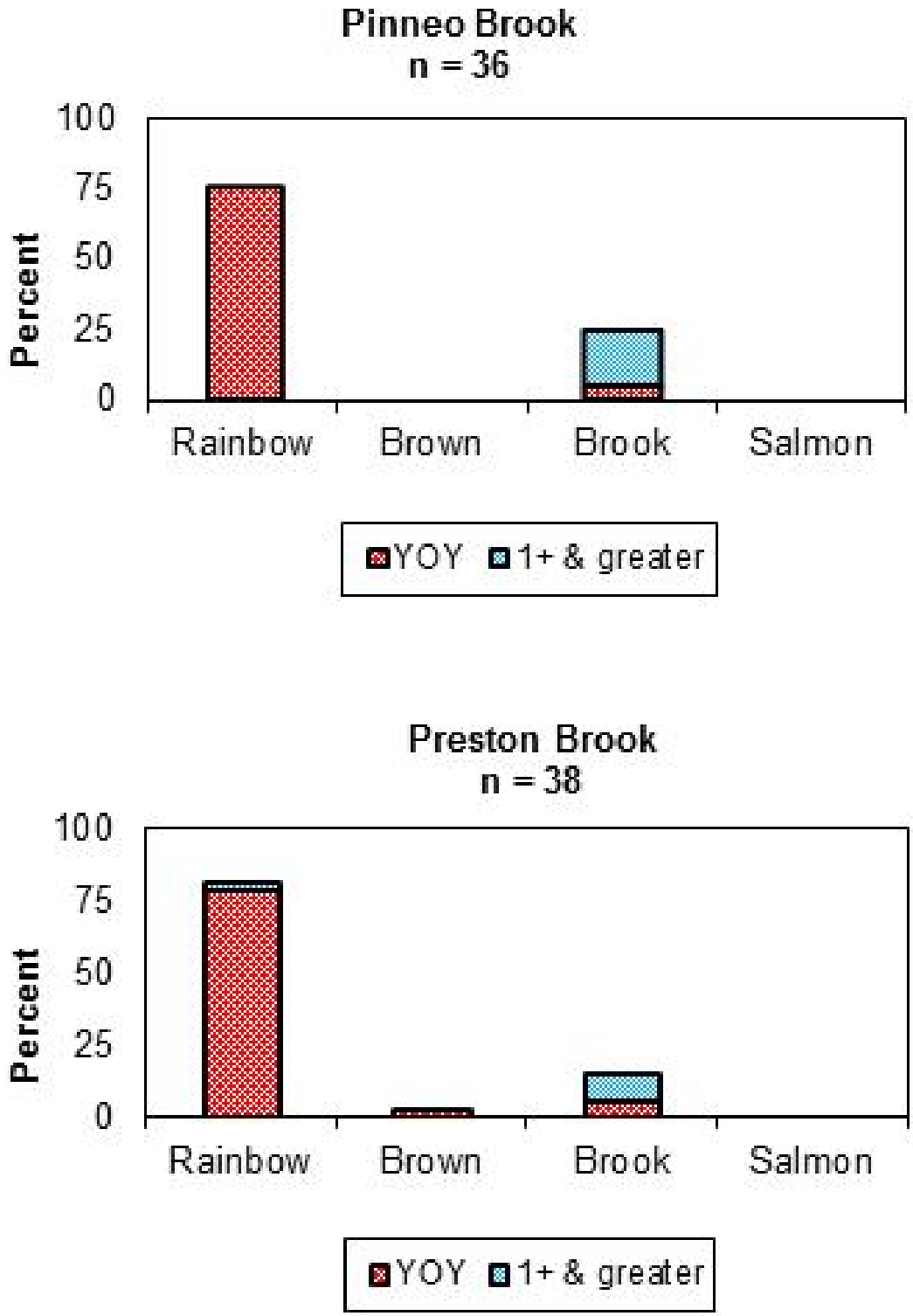


Figure 5. Continued.

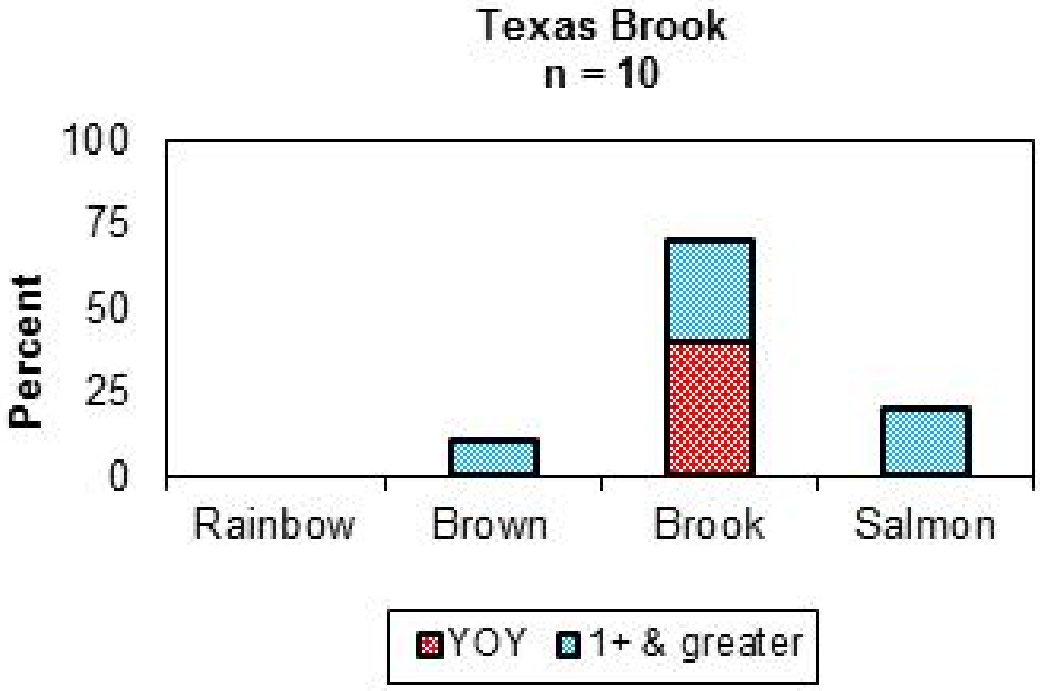


Figure 5. Continued.

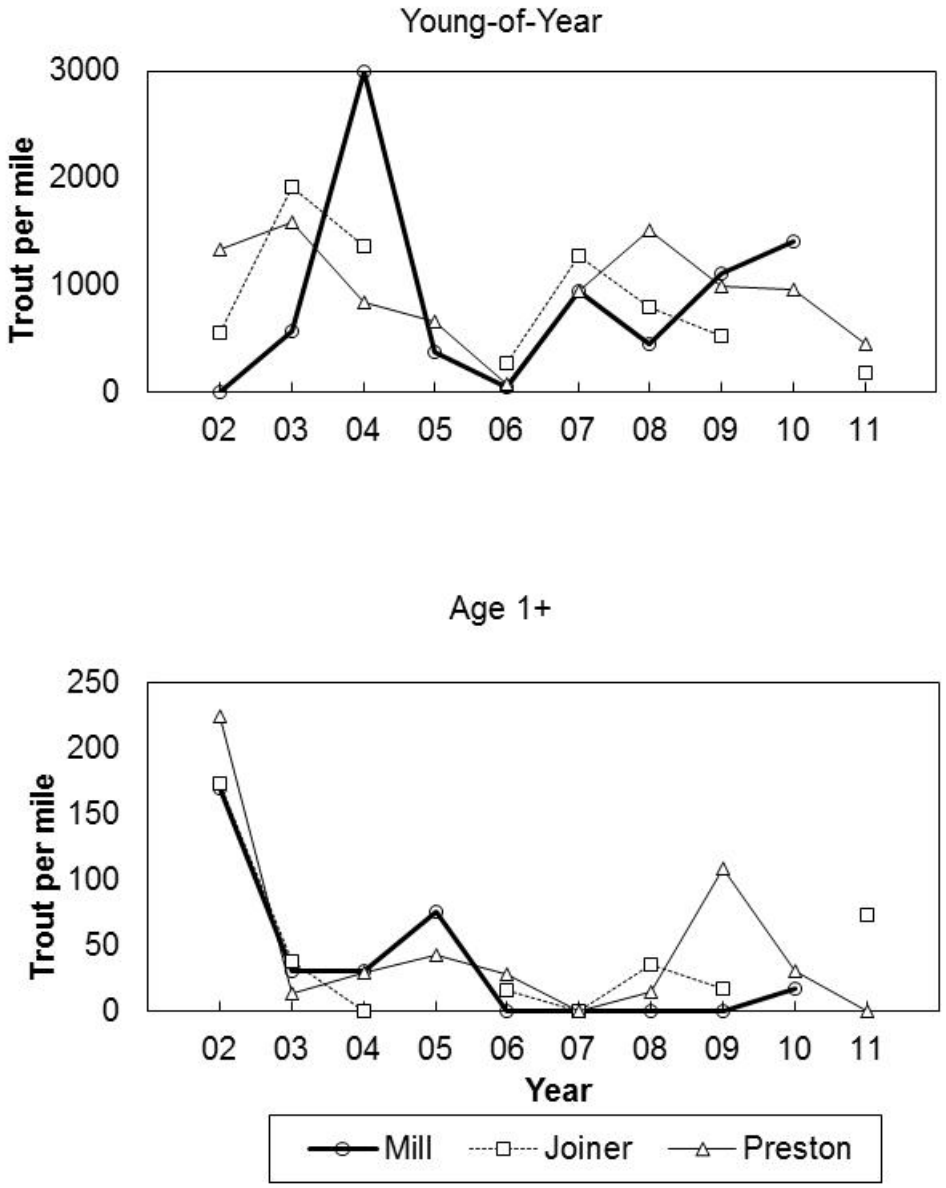


Figure 6. Estimated number per mile of young-of-year and 100-152 mm length class (age 1+) rainbow trout for Mill, Joiner, and Preston Book, 2002 – 2011.

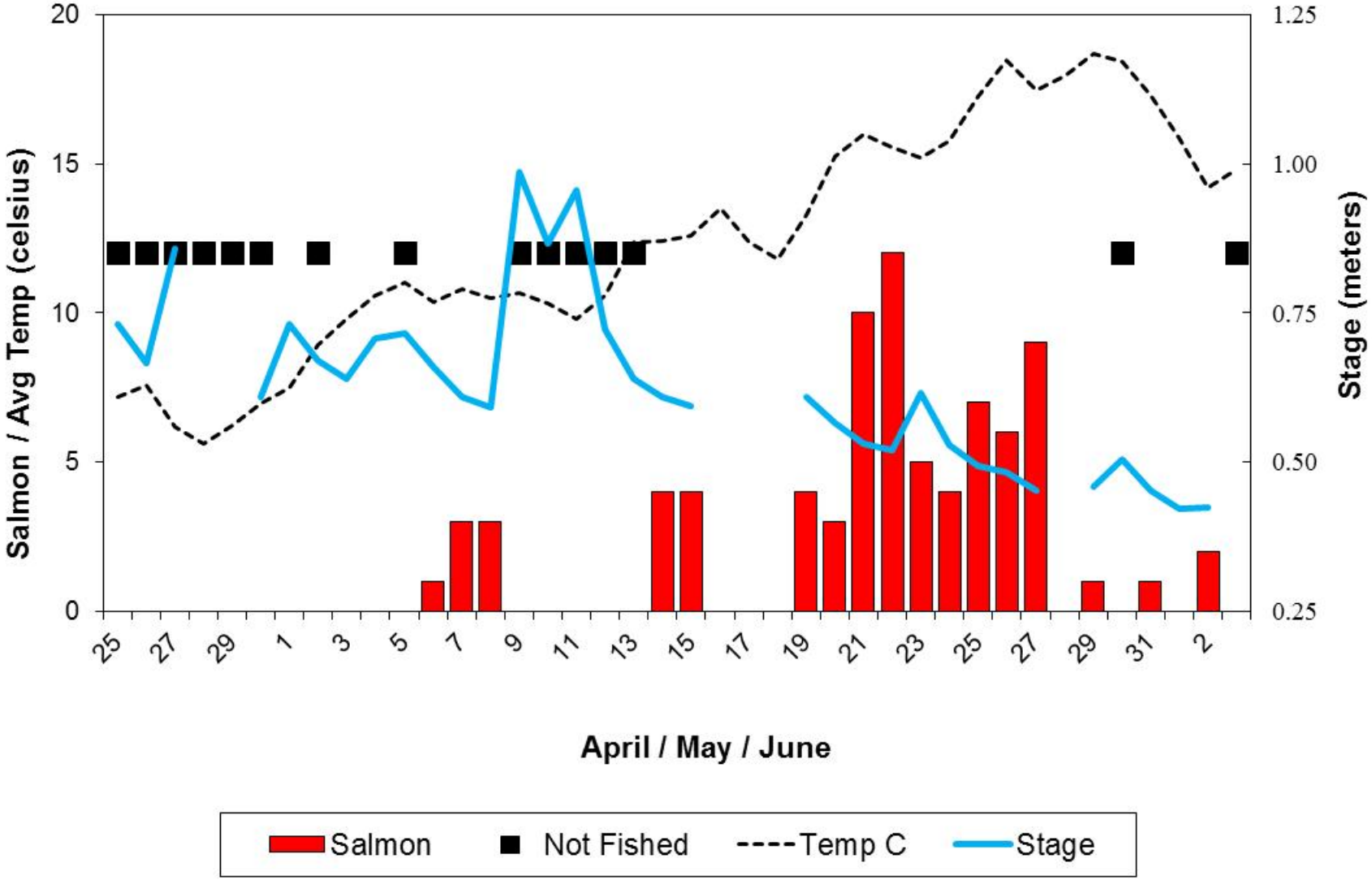


Figure 7. Comparison of stream stage, mean daily stream temperature and number of landlocked Atlantic salmon smolts trapped in the Huntington River, 2012.

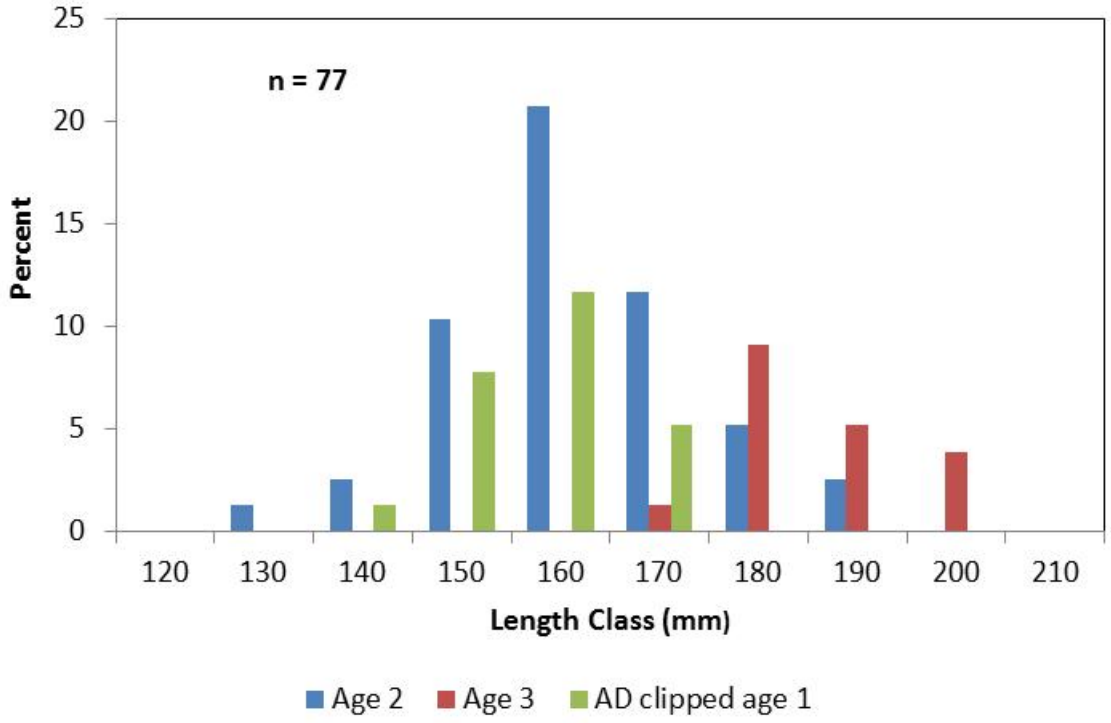


Figure 8. Length/age frequency graph expressed as a percent of landlocked Atlantic salmon smolts trapped in the Huntington River, 2012.

Lake Trout Trapnet Survey – Hatchery Cove

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 in two locations in Hatchery Cove on Monday, 11/07/11, and pulled on Tuesday, 11/08/11 (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. The trap was emptied each day. 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. Twenty lake trout pairs were spawned for a study of thiamine levels by researchers at the University of Vermont.

Results:

A total of 131 lake trout and were captured during the single night of sampling in 2011. The average total lengths (TL) of male and female lake trout were 24.3 and 25.2 inches respectively with males ranging in length from 20.3 to 32.3 inches and females ranging in length from 20.7 to 28.4.

A total of 104 landlocked Atlantic salmon were captured in 2011. The average total length (TL) of male landlocked Atlantic salmon was 20.1 inches with males ranging in length from 14.2 to 27.8 inches. Female salmon averaged 20.3 inches TL and ranged in length from 17.0 to 25.0 inches.

Sampling occurred during the same week that the 2010 trapnetting occurred but water temperatures were about 4 degrees (F) warmer in 2011.

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Figure 1. Locations of trapnets set in Hatchery Cove in 2011. Hatchery Brook is to the right of Trapnet #1.