TRANSCANADA HYDRO NORTHEAST INC.

ILP Study 10
Fish Assemblage Study

Final Study Report

In support of Federal Energy Regulatory Commission Relicensing of:

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

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EXECUTIVE SUMMARY

The goal of this study was to characterize the occurrence, distribution, and relative abundance of fish species present in the project-affected areas. Specifically, Study 10 sought to (1) document fish species occurrence, distribution, and relative abundance within the project impoundments, tailwaters, and downstream riverine sections, (2) compare historical records of fish species occurrence in the project-affected areas to the results of this study, and (3) describe the distribution of resident/riverine and diadromous fish species within the reaches of the river and in relationship to data gathered by related studies, state agencies' surveys, and other information as available (e.g., surveys conducted by Vermont Yankee in the Vernon impoundment). A total of 69 sites were selected for sampling during each of three seasonal periods (Spring – May-June; Summer – July-August; and Fall – September-October); 15 in the Wilder impoundment, 12 in the riverine section downstream of Wilder, 12 in the Bellows Falls impoundment, 3 in the Bellows Falls bypassed reach, 12 in the riverine section downstream of Bellows Falls, 12 in the Vernon impoundment and 3 in the 1.5 mile riverine reach downstream of Vernon. Sampled habitat included mainstem reaches, the project-effected portions of selected tributaries, and several backwater areas.

Study 10 was conducted during the period from late May through early October 2015. Sampling techniques for the collection of fish assemblage information were determined for each randomly selected location based on physical access, dominant substrate, water depth, and velocities. In general, sampling within the three impoundments consisted of a 500-m shoreline boat electrofish transect as well as a 2-hr experimental gill net set. Fish assemblage sampling within the riverine reaches consisted of a 500-m shoreline portable electrofish sample as well as a 100-ft beach seine sample. Fish assemblage sampling within the Bellows Falls bypassed reach consisted of a 500-m shoreline pram or backpack electrofish sample. Where present on the same selected bank within a particular map-unit, tributary or backwater sites were sampled for fish assemblage. Sampling at those locations consisted of a 500-m portable electrofish sample (shorter if the project-affected tributary reach was less than 500-m) and a 24-hr trap net set in backwater habitats.

A total of 204 mainstem map-units, 28 tributaries, and three backwater areas were sampled using a variety of gears during the 2015 sampling effort. A total of 11,551 fish representing 14 families and 43 species were collected when all seasons, locations and sampling gears are considered. Overall, Spottail Shiner, Fallfish, and Smallmouth Bass were the most abundant species collected. In addition to those three species, Tessellated Darter, Yellow Perch, and Rock Bass were the only other fish species representing greater than 5% each of the total number of individuals sampled.

Field efforts associated with Study 10 documented the occurrence, distribution, and relative abundance of fish species present within the Wilder, Bellows Falls, and Vernon project-affected areas. In addition, historical sampling within the sampling area was summarized and included for comparison to the presently sampled fish assemblage. Prior evaluations included standardized electrofish sampling associated with operation of Vermont Yankee and conducted in the lower Vernon

impoundment and downstream of Vernon dam annually from 1991-2014, as well as a fish assemblage assessment conducted during 2008 over a wide spatial area from the Wilder impoundment downstream through the Vernon riverine reach (Yoder et al., 2009).

This final study report incorporates comments received on the initial study report filed March 1, 2016 and provides additional study data in graphical format as requested by stakeholders.

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List of Abbreviations

AOQL	Average Outgoing Quality Limit
CPUA	catch per unit area
CPUE	catch per unit effort
CRWC	Connecticut River Watershed Council
°C	degrees Celsius
DO	dissolved oxygen
FERC	Federal Energy Regulatory Commission
FirstLight	FirstLight Power Resources
FWS	U.S. Department of the Interior – Fish and Wildlife Service
hr	hour
ILP	Integrated Licensing Process
m	meter
mm	millimeter
m/s	meters per second
mg/l	milligrams per liter
µS/cm	micro-siemens per centimeter
NHDES	New Hampshire Department of Environmental Services
NHFGD	New Hampshire Fish and Game Department
NTU	Nephelometric Turbidity Units
RSP	Revised Study Plan
SSR	Site Selection Report
su	standard units
TransCanada	TransCanada Hydro Northeast Inc.
USR	Updated Study Report
VANR	Vermont Agency of Natural Resources
VDEC	Vermont Department of Environmental Conservation
VY	Vermont Yankee Nuclear Power Plant
YOY	young of year

1.0 INTRODUCTION

This final study report presents the findings of the 2015 Fish Assemblage Study (ILP Study 10) conducted in support of Federal Energy Regulatory Commission (FERC) relicensing efforts by TransCanada Hydro Northeast Inc. (TransCanada) for the Wilder Hydroelectric Project (FERC Project No. 1892), Bellows Falls Hydroelectric Project (FERC No. 1855) and the Vernon Hydroelectric Project (FERC No. 1904). This report revises the initial study report filed March 1, 2016 to respond to comments and requests for additional data presentation received from stakeholders during the Study Report meeting on March 18, 2016 and written comments received by May 2, 2016. TransCanada provided responses to those comments in a May 31, 2016 FERC filing.

Operations at the Wilder, Bellows Falls, and Vernon Projects potentially affect the availability of instream habitat on which fish species depend. Habitat for fish species may be related to project operations in terms of flow (water depth and velocity and their timing, duration, frequency, and rate of change), as well as the interactions of flow with other habitat variables such as substrate, vegetation, and cover. Operations both upstream (i.e., impoundment levels) and downstream (i.e., flow fluctuations) may affect habitat, which may consequently lead to changes in the distribution, abundance, and behavior of fish species. In their study requests, the Federal Energy Regulatory Commission (FERC), US Fish & Wildlife Service (FWS), New Hampshire Department of Environmental Services (NHDES), New Hampshire Fish & Game Department (NHFGD), Vermont Agency of Natural Resources (VANR), Connecticut River Watershed Council (CRWC), and The Nature Conservancy (TNC) requested a baseline fish assemblage study for the Wilder, Bellows Falls, and Vernon Projects.

Revised Study Plan (RSP) 10, as supported by stakeholders in 2013 and approved by FERC in its February 21, 2014 Study Plan Determination, specified that a subset of the project-affected area would be studied. An initial Site Selection Report (SSR) was posted on TransCanada's relicensing website on December 5, 2014 and comments were received during an aquatics working group meeting held on December 17, 2014. The final sampling locations were randomly selected and presented in the Revised SSR (Normandeau, 2015a) which included modifications that addressed all working group discussion and comments. The Revised SSR was filed with FERC on September 14, 2015 as Volumes II.B of TransCanada's Updated Study Report (USR), with corresponding geodata of final study site locations filed as Volume II.I of the USR.

2.0 STUDY GOALS AND OBJECTIVES

As stated in the RSP, the goal of this study was to characterize the occurrence, distribution, and relative abundance of fish species present in the project-affected areas. Specific objectives were to:

- document fish species occurrence, distribution, and relative abundance within the project impoundments, tailwaters, and downstream riverine sections;

- compare historical records of fish species occurrence in the project-affected areas to the results of this study; and
- describe the distribution of resident/riverine and diadromous fish species within the reaches of the river and in relationship to data gathered by related studies, state agencies' surveys, and other information as available (e.g., surveys conducted by Vermont Yankee in the Vernon impoundment).

3.0 STUDY AREA

Sampling was conducted to characterize the baseline fish assemblage within project-affected areas from the upper extent of the Wilder impoundment to approximately 1.5 miles downstream of Vernon dam, as well as in the Bellows Falls bypassed reach. This approximately 120-mile length of the Connecticut River was divided into seven geographic reaches delineated based on a combination of general river morphology and project structures:

- Wilder impoundment (RM 262.4 - 217.4);
- Wilder downstream riverine corridor (RM 217.4 – 199.7);
- Bellows Falls impoundment (RM 199.7 – 173.7);
- Bellows Falls bypassed reach (approximately 3,500 feet long);
- Bellows Falls downstream riverine corridor (RM 173.7 – 167.9);
- Vernon impoundment (RM 167.9 – 141.9); and
- Downstream of Vernon dam to the downstream extent of Stebbins Island (RM 141.9 – 140.4).

Study sites were selected in accordance with the process described in the Revised SSR and with concurrence from the aquatics working group, and are summarized below. Habitat characteristics for project-affected areas were recorded as part of Study 7 - Aquatic Habitat Mapping (Normandeau, 2014). Pertinent data collected during that study included side-scan sonar mapping and classification of bottom substrates in impoundments as well as meso-habitat within the Wilder, Bellows Falls, and Vernon riverine sections and Bellows Falls bypassed reach. The Revised SSR reviewed all available aquatic substrate/habitat data and selected proposed study locations based on a stratified random sampling design. Study locations were selected on a seasonal basis; spring (May-June), summer (July, August), and fall (September, October) and were chosen proportional to available habitat types (i.e., sand-silt-clay, gravel-cobble, boulder) within each geographic reach.

A total of 69 sites were selected for sampling during each seasonal period; 15 in the Wilder impoundment, 12 in the riverine section downstream of Wilder, 12 in the Bellows Falls impoundment, 3 in the Bellows Falls bypassed reach, 12 in the riverine section downstream of Bellows Falls, 12 in the Vernon impoundment and 3 in the riverine reach downstream of Vernon.

Prior to the selection of study locations, each geographic reach (or stratum) was delineated into 500-meter map-unit segments using ArcGIS. Within each map-unit, the substrate or meso-habitat present was quantified. An overall dominant type

was assigned based on the proportions of varying substrates or meso-habitats present within each individual unit. For example, if a particular 500-meter map-unit was determined to contain 70% cobble-gravel, 25% sand-silt-clay, and 5% boulder then a dominant substrate type of cobble-gravel was assigned. For map-units with existing side-scan substrate data (in the impoundment reaches), the dominant type was assigned using that information.

For map-units where meso-habitat mapping was conducted (in the riverine reaches), the proportional contribution of meso-habitat units identified in the field during Study 7 in 2013 (i.e., run, riffle, glide, etc.) was first determined. The dominant substrate type identified at the time of the field survey within each meso-habitat unit was then substituted for meso-habitat unit from Study 7, and the resulting proportions of varying substrate types present were used to make the determination of dominant type within the 500-meter map-unit. For example, if 70% of the area of a particular map-unit was represented by one run meso-habitat unit and the remaining 30% was represented by one pool meso-habitat habitat unit, with the run being dominated by cobble-gravel substrate and the pool being dominated by sand-silt-clay, then a dominant substrate type of cobble-gravel was assigned. In some instances, both side-scan substrate data and meso-habitat mapping data were available for a particular map-unit. In those cases, dominant type was determined from the side-scan substrate data. Data on substrate/habitat acreage, percent of total acreage by substrate type and the resulting dominant type for each map-unit were presented in the Revised Studies 10 and 12 Substrate Data Attachment filed as Volume II.J of the USR.

In accordance with the RSP, sampling locations within each geographic reach were randomly placed proportional to substrate/habitat type frequency (e.g., if 50 percent of a particular geographic reach was cobble-gravel then 50 percent of the total number of sampling locations for that geographic reach would be randomly placed within that type). As long as habitat was available, effort was made to ensure that a minimum of three sampling locations were placed within each strata within a particular geographic reach.

Sampling map-units were randomly selected for each of the spring, summer, and fall sampling periods. Sampling banks (east or west) were also randomly selected. In some cases, tributary or backwater sites identified during 2014 in Study 13 – Tributary and Backwater Fish Access and Habitats (Normandeau, 2015b) were present on the same selected bank, and were therefore included in this study to be sampled for fish assemblage during 2015. The upstream extent of sampling within a tributary was determined by the ability of available gear types to effectively sample the habitat as well as visual observations made by the field crew at the time of sampling to identify the apparent upper bound of the project-affected reach of the tributary. Observations made by field biologists transiting the study reach during 2013 and 2014 as part of data collection for other studies were considered during the preliminary selection process of sampling gears from the suite of techniques identified in the RSP (boat electrofish, pram electrofish, back pack electrofish, experimental gill net, trap net, and beach seine). The Revised SSR presented the preliminary sampling gears identified for each map-unit to be sampled. All preliminary selections of sampling gear were subject to change based

on appropriateness for observed field conditions at a particular map-unit at the time of sampling.

A table summarizing the results of the random selection of map-units originally presented in the Revised SSR is reproduced in Table 3.1-1 and provides substrate and location information for the spring, summer and fall seasons. Modifications to those sampling locations or sampling gears originally provided in the Revised SSR are presented in Sections 3.1, 3.2, and 3.3, below.

3.1 Spring Sampling

Fish assemblage sampling during the spring period (May-June 2015) followed the location and sampling gears presented in the Revised SSR with the following exceptions:

- The unnamed, stream order 2, tributary originally identified during the desktop assessment portion of Study 13 from the National Hydrography Dataset and associated with Wilder impoundment map unit 10-W035 was not located during field sampling. As a result, no electrofish sample was collected from that site (originally selected due to location within a selected mainstem map-unit).
- The backwater originally identified during the desktop assessment portion of Study 13 and associated with map unit 10-W073 was too small and shallow for proper deployment of a trap net. An electrofish sample was obtained at that location.
- The mainstem river at map-unit 10-B004 was too shallow to properly fish an experimental gill net, so this gear type was replaced with boat electrofishing.
- Spring samples within the Bellows Falls bypassed reach [10-BF001 (east bank), 10-BF001 (west bank), and 10-BF002 (west bank)] could not be collected due to safety issues associated with in-water sampling under spill conditions.
- The mainstem river at map-unit 10-VR001 was too shallow to properly fish an experimental gill net, so this gear type was replaced with boat electrofishing.
- The unnamed, stream order -99 tributary originally identified during the desktop assessment portion of Study 13 from the National Hydrography Dataset and associated with Vernon riverine map unit 10-VR002 was dry during field sampling. As a result, no electrofish sample was collected from that tributary location.
- The mainstem river at map-unit 10-VR004 was inadvertently sampled along the west bank rather than the east bank as specified in the Revised SSR.

3.2 Summer Sampling

Fish assemblage sampling during the summer period (July-August 2015) followed the location and sampling gears presented in the Revised SSR with the following exceptions:

- The unnamed, stream order 2 tributary originally identified during the desktop assessment portion of Study 13 from the National Hydrography Dataset and associated with Wilder impoundment map unit 10-W105 was not located during field sampling. As a result, no electrofish sample was collected from that site (originally selected due to location within a selected mainstem map-unit).
- The backwater originally identified during the desktop assessment portion of Study 13 and associated with map unit 10-W120 was neither significantly watered nor identifiable at the time of sampling. As a result, no electrofish or trap net sample could be collected from that site (originally selected due to location within a selected mainstem map-unit).
- The mainstem river at map-unit 10-WR034 was sampled along the west bank rather than the east bank as specified in the Revised SSR. This change was made in the field to address safety concerns with wading through deep, fast currents associated with a portion of the rapids at Sumner Falls.
- The unnamed, stream order 2 tributary associated with Bellows Falls map unit 10-B092 was not sampled during the summer period. The location was inadvertently passed over by the field crew.
- Due to the presence of significant amounts of large, woody debris, a suitable location for the beach seine sample could not be located at mainstem map-unit 10-BR020. An electrofish sample was collected at that location.
- The unnamed, stream order -99 tributary originally identified during the desktop assessment portion of Study 13 from the National Hydrography Dataset and associated with Vernon riverine map unit 10-VR002 was dry during field sampling. As a result, no electrofish sample was collected from that tributary location.
- The mainstem river at map-unit 10-VR005 was too shallow to properly fish an experimental gill net so this gear type was replaced with boat electrofishing. .

3.3 Fall Sampling

Fish assemblage sampling during the fall period (September-October 2015) followed the location and sampling gears presented in the Revised SSR with the following exceptions:

- The unnamed, stream order 1 tributary originally identified during the desktop assessment portion of Study 13 from the National

Hydrography Dataset and associated with Wilder impoundment map unit 10-W074 was not located during field sampling. As a result, no electrofish sample was collected from that site (originally selected due to location within a selected mainstem map-unit).

- The backwater originally identified during the desktop assessment portion of Study 13 and associated with map unit 10-W121 was neither significantly watered nor identifiable at the time of sampling. As a result, no electrofish or trap net sample could be collected at that location.
- The unnamed, stream order 1 tributary originally identified during the desktop assessment portion of Study 13 from the National Hydrography Dataset and associated with Wilder impoundment map unit 10-W140 was dry during field sampling. As a result, no electrofish sample was collected from that tributary location.
- The mainstem river at map-unit 10-B001 was too shallow to properly fish an experimental gill net, so this gear type was replaced with boat electrofishing.
- The unnamed, stream order -99 tributary originally identified during the desktop assessment portion of Study 13 from the National Hydrography Dataset and associated with Vernon riverine map unit 10-VR002 was dry during field sampling. As a result, no electrofish sample was collected from that tributary location.
- The mainstem river at map-unit 10-VR004 was too shallow to properly fish an experimental gill net so this gear type was replaced with boat electrofishing.

The final set of map-unit locations sampled as part of Study 10 are illustrated in Figures 3.1-1 through 3.1-6, excluding the two map-units in the Bellows Falls bypassed reach. For those study sites, 10-BF001 extended from Bellows Falls dam to the upstream side of the fish diversion boom and 10-BF002 extended from the downstream side of the fish diversion boom to the bypassed reach confluence with the mainstem river.

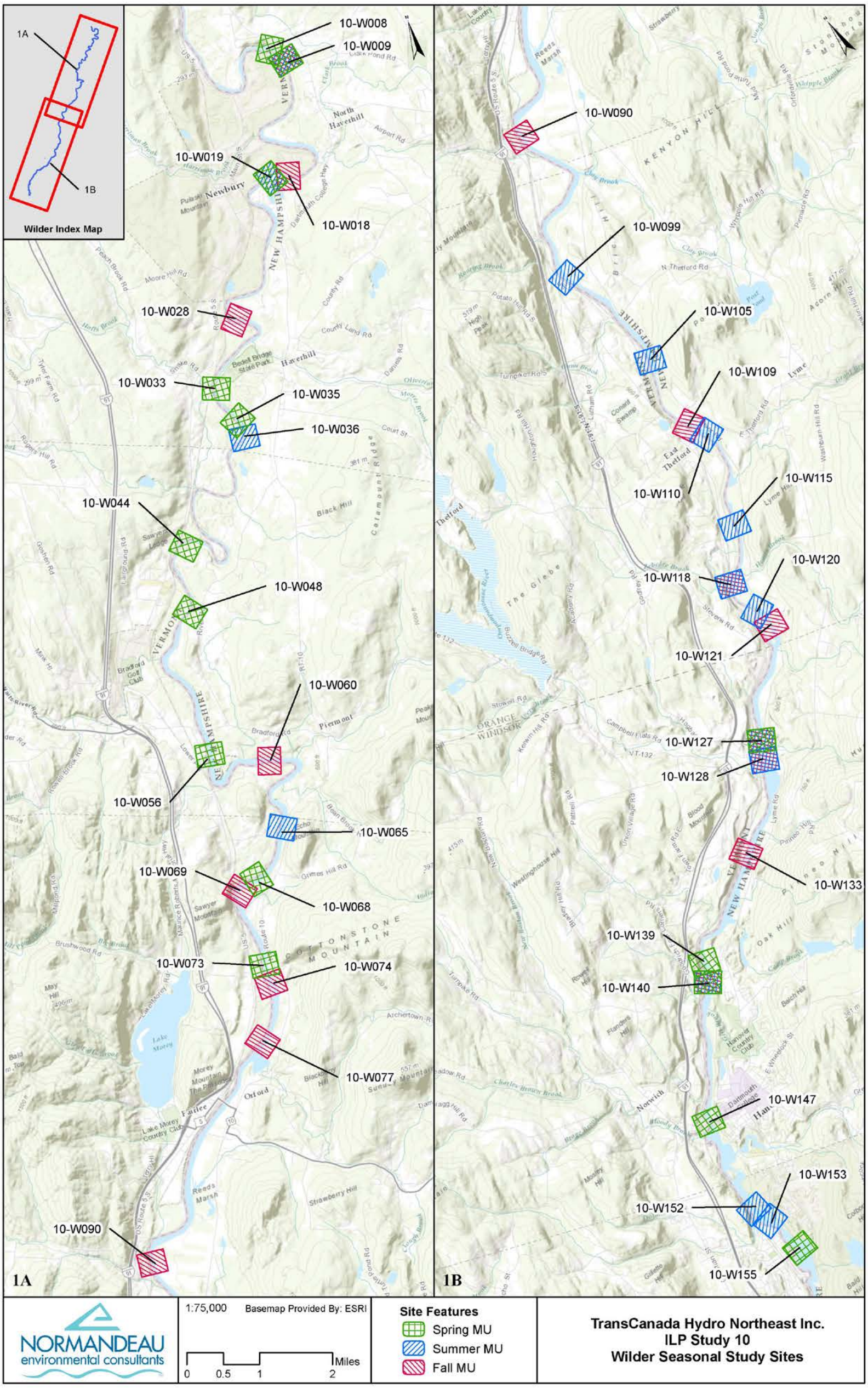

Figure 3.1-1. Map-units sampled within the Wilder impoundment, 2015.

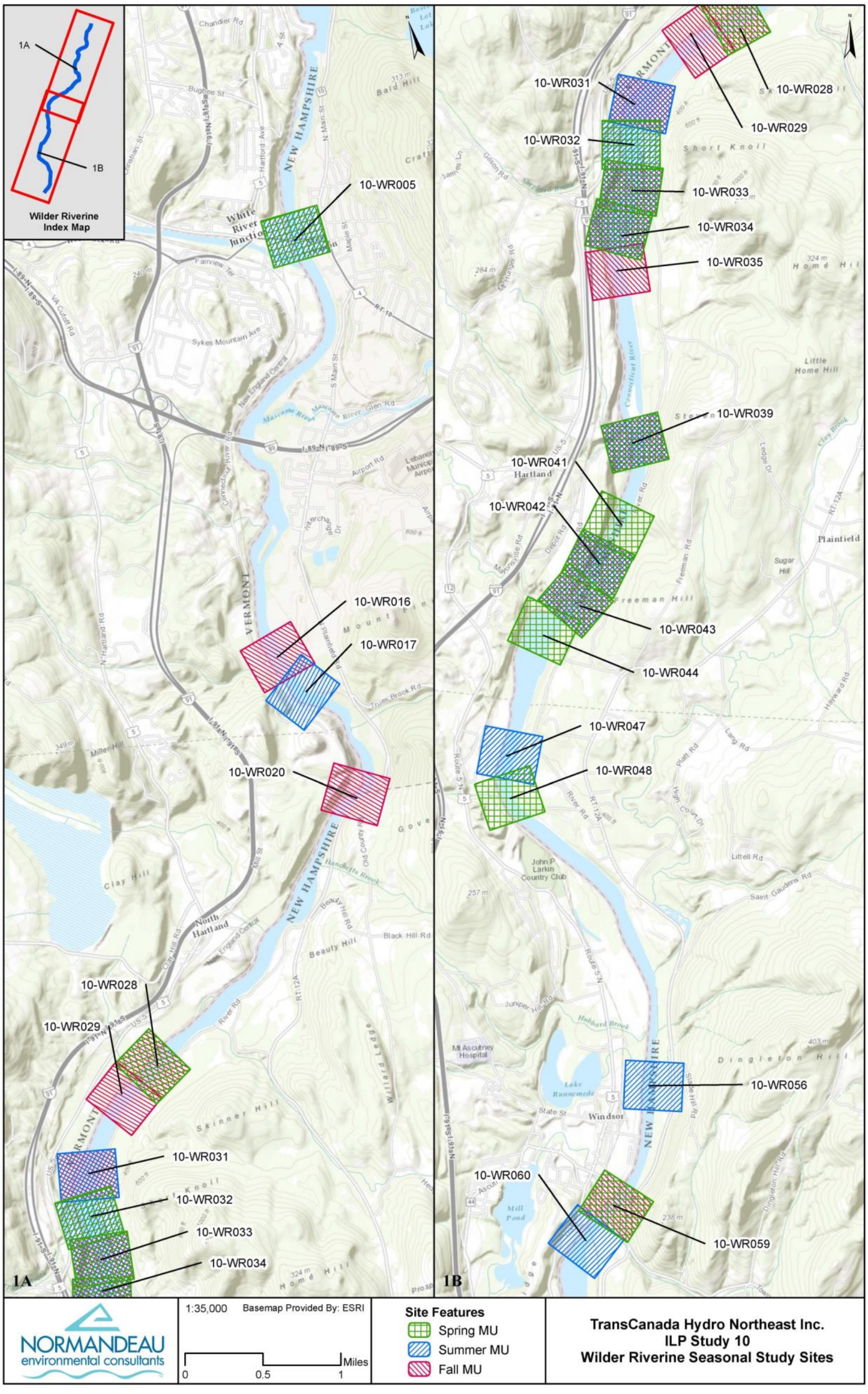

Figure 3.1-2. Map-units sampled within the Wilder riverine reach, 2015.

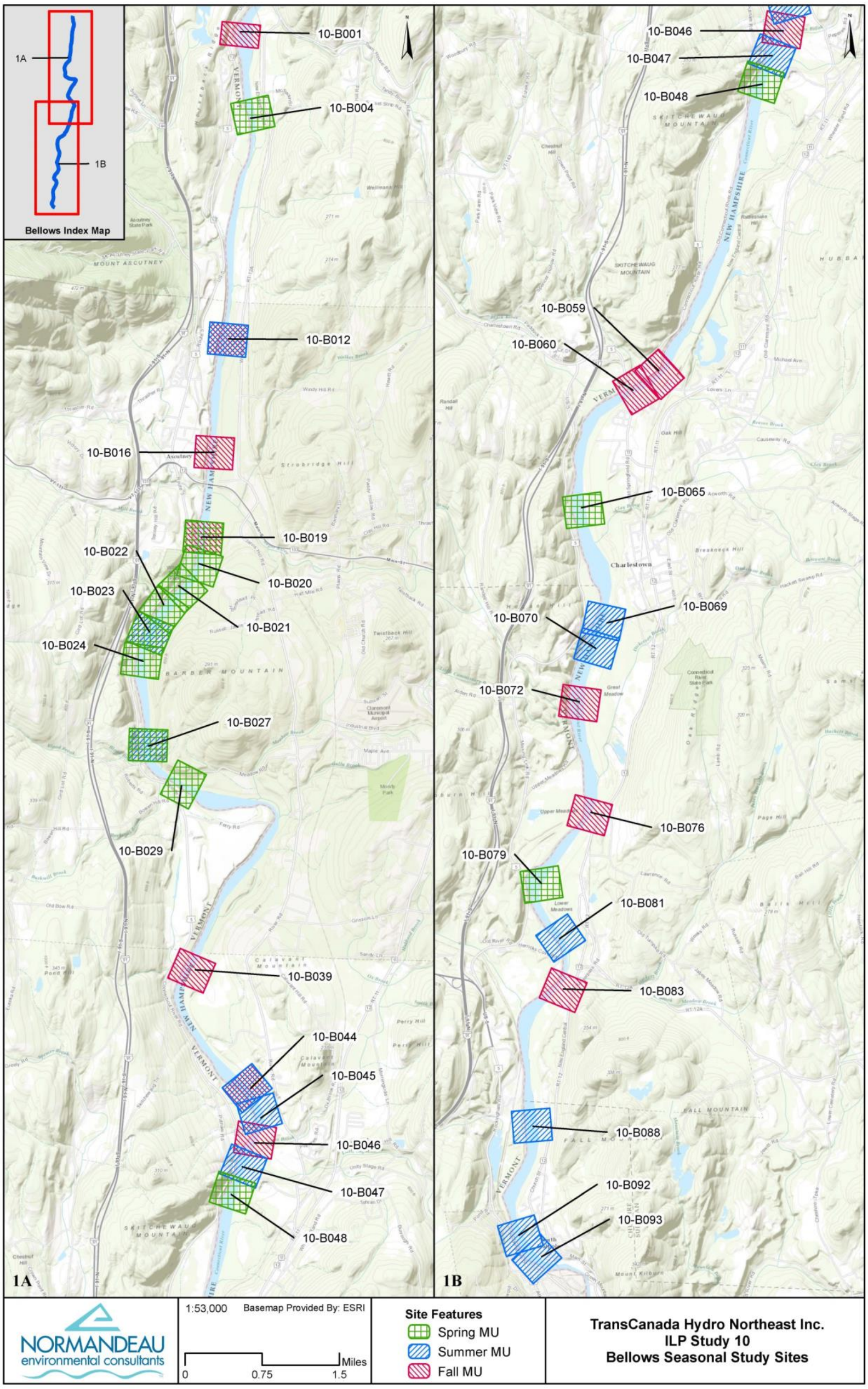

Figure 3.1-3. Map-units sampled within the Bellows Falls impoundment, 2015.

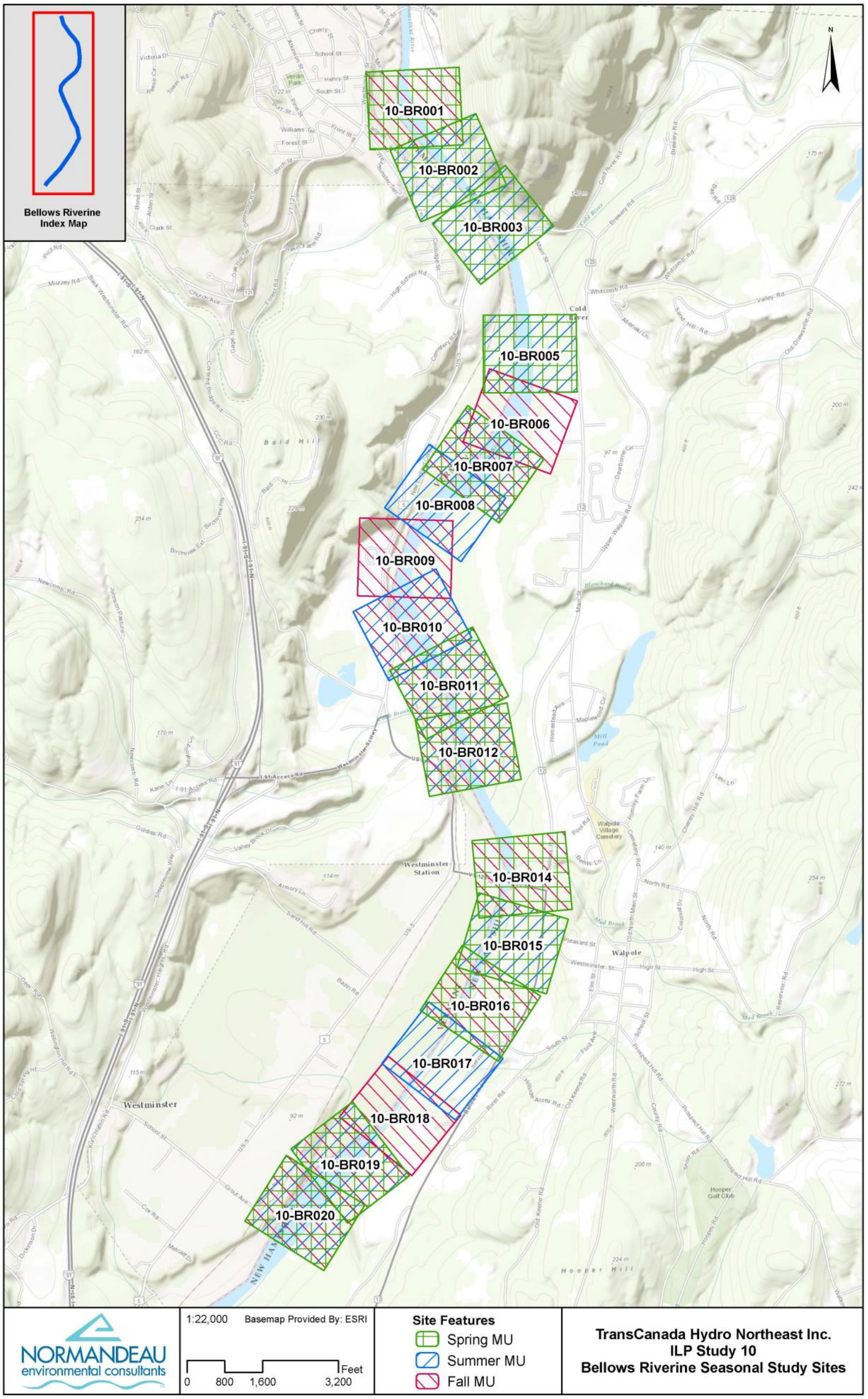

Figure 3.1-4. Map-units sampled within the Bellows Falls riverine reach, 2015.

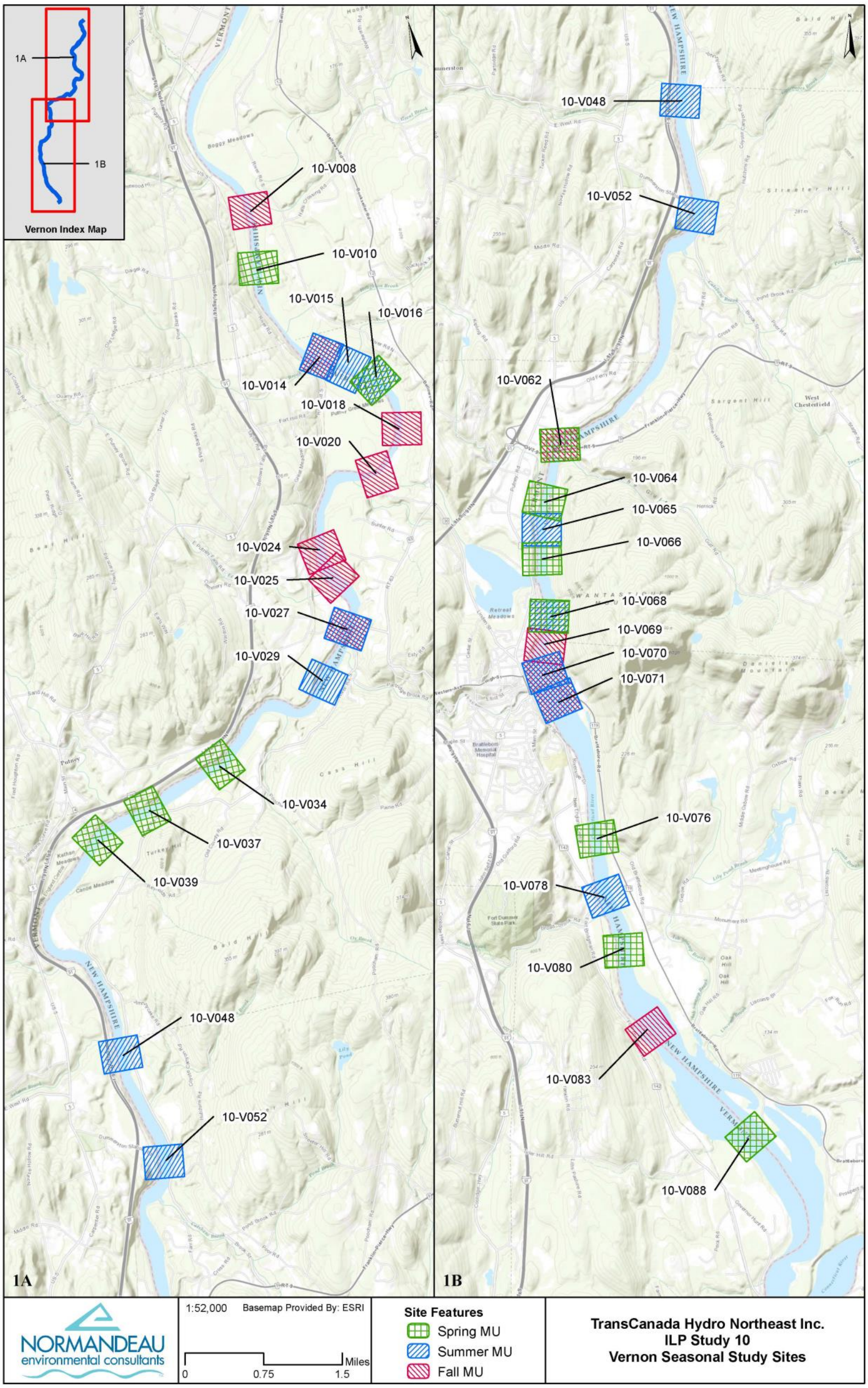

Figure 3.1-5. Map-units sampled within the Vernon impoundment, 2015.

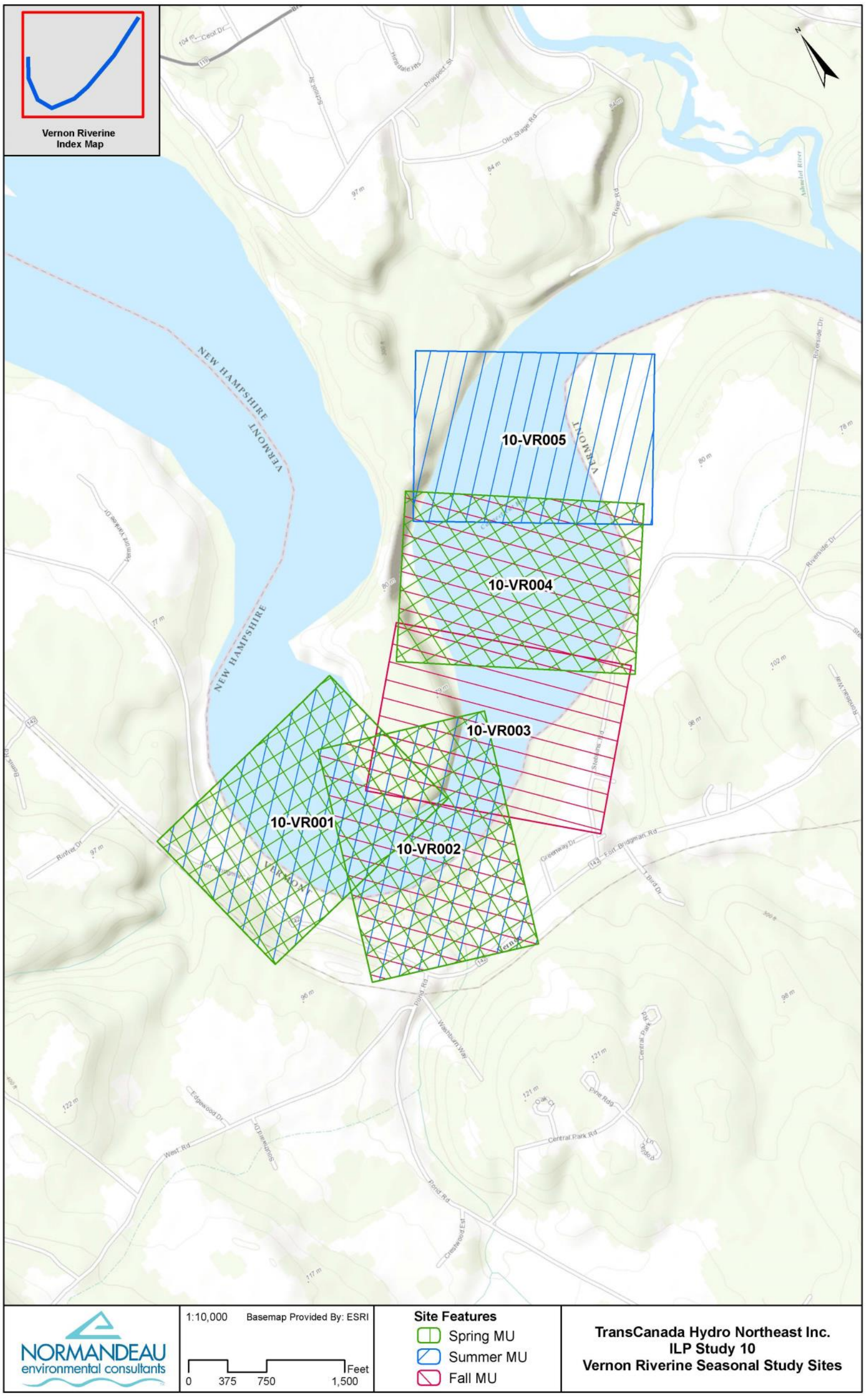

Figure 3.1-6. Map-units sampled within the Vernon riverine reach, 2015.

Table 3.1-1. Summary of map-unit sampling by season, sampling bank, and dominant substrate.

Map-Unit	Spring	Summer	Fall	Sample Bank	Dominant Substrate	Downstream Coordinate (DD NAD83 UTM Z18N)	
						X	Y
Wilder Impoundment							
10 – W008	X			West	Gravel, Cobble	-72.03165	44.10074
10 – W009	X	X		West	Boulder	-72.03090	44.09710
10 – W009			X	East	Boulder	-72.02968	44.09730
10 – W018			X	West	Sand, Silt, Clay	-72.04279	44.07940
10 – W019	X			West	Sand, Silt, Clay	-72.04705	44.07814
10 – W019		X		East	Sand, Silt, Clay	-72.04665	44.07731
10 – W028			X	East	Sand, Silt, Clay	-72.06340	44.05316
10 – W033	X			East	Sand, Silt, Clay	-72.07804	44.03974
10 – W035	X			West	Sand, Silt, Clay	-72.07484	44.03243
10 – W036		X		East	Sand, Silt, Clay	-72.07629	44.02894
10 – W044	X			East	Sand, Silt, Clay	-72.10316	44.01350
10 – W048	X			East	Boulder	-72.10712	44.00023
10 – W056	X			West	Sand, Silt, Clay	-72.11390	43.97159
10 – W060			X	East	Sand, Silt, Clay	-72.09431	43.96848
10 – W065		X		West	Sand, Silt, Clay	-72.10248	43.95374
10 – W068	X			West	Sand, Silt, Clay	-72.11464	43.94748
10 – W069			X	West	Sand, Silt, Clay	-72.11894	43.94448
10 – W073	X			East	Sand, Silt, Clay	-72.11625	43.92824
10 – W074			X	West	Sand, Silt, Clay	-72.11801	43.92432
10 – W077			X	West	Boulder	-72.12734	43.91551
10 – W090			X	East	Sand, Silt, Clay	-72.17208	43.87938
10 – W099		X		West	Sand, Silt, Clay	-72.18689	43.85190
10 - W105		X		East	Sand, Silt, Clay	-72.18341	43.82865
10 - W109			X	East	Sand, Silt, Clay	-72.18331	43.81427
10 - W110		X		West	Sand, Silt, Clay	-72.18332	43.80993
10 - W115		X		West	Sand, Silt, Clay	-72.19477	43.79278
10 - W118		X	X	East	Sand, Silt, Clay	-72.20442	43.78380
10 - W120		X		West	Sand, Silt, Clay	-72.20246	43.77602
10 - W121			X	West	Sand, Silt, Clay	-72.20317	43.77246
10 - W127	X	X		West	Gravel, Cobble	-72.20317	43.77246
10 - W127			X	East	Gravel, Cobble	-72.22416	43.75552
10 - W128		X		East	Gravel, Cobble	-72.22477	43.75130
10 - W128			X	West	Gravel, Cobble	-72.22903	43.75294
10 - W133			X	East	Sand, Silt, Clay	-72.24760	43.73947
10 - W139	X			West	Boulder	-72.27525	43.72817
10 - W140	X	X		West	Gravel, Cobble	-72.27896	43.72538
10 - W140			X	East	Gravel, Cobble	-72.27728	43.72442
10 - W147	X			East	Sand, Silt, Clay	-72.29912	43.70222
10 - W152		X		East	Boulder	-72.30233	43.68327
10 - W153		X		West	Boulder	-72.30273	43.67931

Map-Unit	Spring	Summer	Fall	Sample Bank	Dominant Substrate	Downstream Coordinate (DD NAD83 UTM Z18N)	
						X	Y
10 - W155	X			West	Sand, Silt, Clay	-72.30479	43.67136
Wilder Riverine Reach							
10 – WR005	X	X		East	Sand, Silt, Clay	-72.31301	43.64862
10 – WR016			X	West	Gravel, Cobble	-72.33377	43.61213
10 – WR017		X		West	Gravel, Cobble	-72.33018	43.60876
10 – WR020			X	East	Gravel, Cobble	-72.33237	43.59865
10 – WR028	X		X	East	Sand, Silt, Clay	-72.36760	43.58030
10 – WR029			X	East	Sand, Silt, Clay	-72.37223	43.57832
10 – WR031		X	X	West	Sand, Silt, Clay	-72.38053	43.57268
10 – WR032	X	X		West	Sand, Silt, Clay	-72.38030	43.56852
10 – WR033	X	X	X	West	Boulder	-72.38226	43.56481
10 – WR034	X	X	X	East	Sand, Silt, Clay	-72.38069	43.56049
10 – WR035			X	East	Gravel, Cobble	-72.37981	43.55689
10 – WR039	X		X	East	Gravel, Cobble	-72.37863	43.54102
10 – WR039		X		West	Gravel, Cobble	-72.38066	43.54071
10 – WR041	X			East	Gravel, Cobble	-72.38352	43.53331
10 – WR042	X	X	X	East	Boulder	-72.38608	43.52976
10 – WR043	X		X	West	Boulder	-72.39115	43.52754
10 – WR043		X		East	Boulder	-72.38968	43.52655
10 – WR044	X			West	Gravel, Cobble	-72.39344	43.52378
10 – WR047		X		West	Gravel, Cobble	-72.39913	43.51247
10 – WR048	X			East	Gravel, Cobble	-72.39503	43.50867
10 – WR056		X		West	Gravel, Cobble	-72.38182	43.48118
10 – WR059	X		X	East	Gravel, Cobble	-72.38694	43.47030
10 – WR060		X		East	Gravel, Cobble	-72.39211	43.46780
Bellows Falls Impoundment							
10 – B001			X	West	Gravel, Cobble	-72.39270	43.46463
10 – B004	X			East	Gravel, Cobble	-72.38879	43.45274
10 – B012		X	X	West	Gravel, Cobble	-72.39833	43.42133
10 – B016			X	East	Sand, Silt, Clay	-72.39874	43.40527
10 – B019	X		X	East	Sand, Silt, Clay	-72.40109	43.39335
10 – B020	X			East	Sand, Silt, Clay	-72.40330	43.38944
10 – B021	X			East	Sand, Silt, Clay	-72.40817	43.38678
10 – B022	X			West	Boulder	-72.41267	43.38442
10 – B023	X			East	Boulder	-72.41327	43.38007
10 – B023		X		West	Gravel, Cobble	-72.41509	43.38068
10 – B024	X			East	Gravel, Cobble	-72.41389	43.37626
10 – B027	X			West	Boulder	-72.41468	43.36453
10 – B027		X		East	Sand, Silt, Clay	-72.41286	43.36444
10 – B029	X			East	Sand, Silt, Clay	-72.40410	43.36084
10 – B039			X	West	Sand, Silt, Clay	-72.40968	43.33332
10 – B044		X		East	Sand, Silt, Clay	-72.39422	43.31682
10 – B044			X	West	Boulder	-72.39638	43.31561
10 – B045		X		East	Sand, Silt, Clay	-72.39301	43.31248

Map-Unit	Spring	Summer	Fall	Sample Bank	Dominant Substrate	Downstream Coordinate (DD NAD83 UTM Z18N)	
						X	Y
10 – B046			X	East	Gravel, Cobble	-72.39637	43.30858
10 – B047		X		West	Gravel, Cobble	-72.40041	43.30544
10 – B048	X			West	Gravel, Cobble	-72.40291	43.30179
10 – B059			X	East	Boulder	-72.42352	43.26100
10 – B060			X	East	Boulder	-72.42851	43.25902
10 – B065	X			West	Sand, Silt, Clay	-72.43862	43.24174
10 – B069		X		East	Boulder	-72.43302	43.22600
10 – B070		X		East	Sand, Silt, Clay	-72.43419	43.22195
10 – B072			X	West	Sand, Silt, Clay	-72.44111	43.21502
10 – B076			X	West	Sand, Silt, Clay	-72.44058	43.19954
10 – B079	X			West	Sand, Silt, Clay	-72.44597	43.18956
10 – B081		X		East	Sand, Silt, Clay	-72.44122	43.18276
10 – B083			X	East	Sand, Silt, Clay	-72.44409	43.17435
10 – B088		X		East	Sand, Silt, Clay	-72.44770	43.15568
10 – B092		X		East	Boulder	-72.45105	43.14059
10 – B093		X		East	Boulder	-72.44722	43.13821
Bellows Falls Bypassed Reach							
10 - BF001	X		X	East	Boulder	-72.44020	43.13592
10 - BF001	X	X	X	West	Boulder	-72.44029	43.13593
10 - BF002	X	X		West	Boulder	-72.44230	43.13157
10 - BF002		X	X	East	Boulder	-72.43978	43.13148
Bellows Falls Riverine Reach							
10 - BR001	X			East	Gravel, Cobble	-72.43718	43.12735
10 - BR001			X	West	Gravel, Cobble	-72.44064	43.12729
10 - BR002	X			West	Gravel, Cobble	-72.43682	43.12392
10 - BR002		X		East	Gravel, Cobble	-72.43510	43.12442
10 - BR003	X	X		West	Gravel, Cobble	-72.43323	43.12049
10 - BR005	X	X		East	Gravel, Cobble	-72.43081	43.11288
10 - BR006			X	East	Gravel, Cobble	-72.43324	43.10896
10 - BR007	X	X	X	East	Gravel, Cobble	-72.43701	43.10671
10 - BR008		X		East	Gravel, Cobble	-72.44069	43.10486
10 - BR009			X	East	Gravel, Cobble	-72.44185	43.10125
10 - BR010		X		East	Gravel, Cobble	-72.43928	43.09804
10 - BR010			X	West	Gravel, Cobble	-72.44117	43.09737
10 - BR011	X			West	Sand, Silt, Clay	-72.43888	43.09376
10 - BR011		X	X	East	Sand, Silt, Clay	-72.43712	43.09438
10 - BR012	X			West	Sand, Silt, Clay	-72.43824	43.08999
10 - BR012		X	X	East	Sand, Silt, Clay	-72.43572	43.09028
10 - BR014	X			West	Gravel, Cobble	-72.43532	43.08267
10 - BR014			X	East	Gravel, Cobble	-72.43271	43.08279
10 - BR015	X	X		East	Gravel, Cobble	-72.43414	43.07859
10 - BR016	X		X	West	Gravel, Cobble	-72.43986	43.07623
10 - BR017		X		East	Gravel, Cobble	-72.44128	43.07198
10 - BR018			X	West	Gravel, Cobble	-72.44680	43.07013

Map-Unit	Spring	Summer	Fall	Sample Bank	Dominant Substrate	Downstream Coordinate (DD NAD83 UTM Z18N)	
						X	Y
10 - BR019	X	X	X	East	Gravel, Cobble	-72.44878	43.06566
10 - BR020	X		X	West	Gravel, Cobble	-72.45411	43.06433
10 - BR020		X		East	Gravel, Cobble	-72.45170	43.06315
Vernon Impoundment							
10 – V008			X	West	Gravel, Cobble	-72.46099	43.03728
10 – V010	X			West	Gravel, Cobble	-72.46292	43.02947
10 – V014		X	X	East	Sand, Silt, Clay	-72.45113	43.01659
10 – V015		X		East	Sand, Silt, Clay	-72.44693	43.01388
10 – V016	X			West	Sand, Silt, Clay	-72.44423	43.01022
10 – V016		X		East	Sand, Silt, Clay	-72.44213	43.01100
10 – V018			X	West	Sand, Silt, Clay	-72.44588	43.00295
10 – V020			X	West	Sand, Silt, Clay	-72.45322	43.00054
10 – V024			X	East	Gravel, Cobble	-72.46288	42.98922
10 – V025			X	East	Sand, Silt, Clay	-72.46049	42.98602
10 – V027		X		West	Sand, Silt, Clay	-72.46567	42.97867
10 – V027			X	East	Boulder	-72.46416	42.97791
10 – V029		X		East	Sand, Silt, Clay	-72.47146	42.97183
10 – V034	X			East	Boulder	-72.49580	42.96582
10 – V037	X			East	Sand, Silt, Clay	-72.51147	42.96230
10 – V039	X			East	Sand, Silt, Clay	-72.52111	42.95934
10 – V048		X		West	Gravel, Cobble	-72.52699	42.92991
10 – V052		X		West	Boulder	-72.52537	42.91421
10 – V062	X			East	Boulder	-72.55066	42.88285
10 – V062			X	West	Gravel, Cobble	-72.55255	42.88281
10 – V064	X			East	Gravel, Cobble	-72.55335	42.87507
10 – V065		X		East	Gravel, Cobble	-72.55336	42.87119
10 – V066	X			East	Gravel, Cobble	-72.55310	42.86722
10 – V068	X	X		West	Boulder	-72.55453	42.85931
10 – V069			X	East	Boulder	-72.55159	42.85479
10 – V070		X	X	West	Boulder	-72.55572	42.85107
10 – V071		X	X	East	Boulder	-72.54874	42.84837
10 – V076	X			East	Sand, Silt, Clay	-72.54403	42.82850
10 – V078		X		East	Sand, Silt, Clay	-72.54180	42.82089
10 – V080	X			East	Sand, Silt, Clay	-72.53957	42.81291
10 – V083			X	East	Sand, Silt, Clay	-72.53338	42.80268
10 – V088	X			East	Sand, Silt, Clay	-72.51439	42.78842
Vernon Riverine Reach							
10 - VR001	X			West	Gravel, Cobble	-72.51479	42.76496
10 - VR001		X		East	Gravel, Cobble	-72.51215	42.76531
10 - VR002	X	X	X	West	Sand, Silt, Clay	-72.05842	42.76439
10 - VR003			X	West	Gravel, Cobble	-72.50292	42.76660
10 - VR004	X		X	East	Gravel, Cobble	-72.50406	42.77239
10 - VR005		X		East	Gravel, Cobble	-72.49939	42.77458

4.0 METHODOLOGY

The Revised SSR presented the preliminary sampling gears identified for each map-unit to be sampled. Preselected sampling techniques for the collection of fish assemblage information were determined for each selected sampling unit based on physical access, dominant substrate and anticipated water depth and velocities. In general, sampling within the three impoundments (Wilder, Bellows Falls and Vernon) was to consist of a 500-m shoreline boat electrofish transect as well as a 2-hr experimental gill net set. Fish assemblage sampling within the riverine reaches was to consist of a 500-m shoreline pram or backpack electrofish sample as well as a 100-ft beach seine set. Fish assemblage sampling within the Bellows Falls bypassed reach was to consist of a 500-m shoreline pram or backpack electrofish sample. Where present on the same selected bank within a particular map-unit, tributary or backwater sites were included in this study to be sampled for fish assemblage. Sampling at those locations was to consist of a 500-m pram or backpack electrofish sample (shorter if the project-affected reach was less than 500-m) as well as a 24-hr trap net set in backwater habitats. When sampling in tributaries, the upper extent of the project-affected reach was determined using the best professional judgement of the field crew and relied on visual determination based on indicators such as the presence/absence of terrestrial and aquatic vegetation, sedimentation, and dominant water lines on permanent objects (e.g., large boulders or abutments). All preliminary selections of sampling gear were subject to change based on appropriateness for observed field conditions at a particular map-unit at the time of sampling.

Descriptions for sampling techniques are provided below for boat electrofishing (Section 4.1.1), portable electrofishing (Section 4.1.2), experimental gill net sampling (Section 4.1.3), beach seine sampling (Section 4.1.4) and trap net sampling (Section 4.1.5). Following sample collection, fish catch was processed in the manner outlined in Section 4.1.6. Following collection of biological data, the sampling crew proceeded to a representative point near the middle of the targeted sampling area. Water quality parameters (temperature, dissolved oxygen, pH, conductivity, and turbidity) and water velocity (m/s) were recorded. Water quality parameters were collected using a YSI Model 6920 sonde and velocity measurements were taken using a Marsh-McBierney Flowmate flowmeter.

4.1 Field Sampling

Boat Electrofish Sampling

Boat electrofish sampling was conducted at mainstem river locations with trailer access and appropriate water depth and velocity conditions. Appropriate conditions for boat electrofish sampling generally consisted of a minimum of two feet of water depth for proper outboard operation and velocities in a range that allowed netters ample reaction time to collect stunned fish. Boat electrofish sampling took place during night hours which were defined by the field crews as the time between local sunset and sunrise. Prior to the start of sampling, settings on the electrofishing unit were adjusted by a trained crew member to ensure that approximately 4.0 amps of pulsed DC current was being generated. After recording the start time,

boat electrofish sampling consisted of a single shoreline pass starting at the downstream end of the transect and proceeding upstream. Effort was made by the boat driver to follow the shoreline contour and probe the sampling anodes into habitat areas (i.e., overhanging vegetation, submerged aquatic vegetation, woody debris, etc.). A scap netter located on the bow of the sampling vessel netted and placed all stunned fish into an onboard livewell for processing. In a variance to the RSP, a single scap netter was used; however, this approach was used at all study locations so results within the evaluation and across all study reaches were consistent.

Once the sample reach was finished, the driver recorded the completion time, duration of the sampling effort (i.e., the number of seconds of pedal time as recorded on the Smith Root counter) and average water depth.

Portable Electrofish Sampling

Portable electrofish sampling (i.e., pram or backpack mounted electrofish units) was conducted at mainstem river locations with limited to no trailer access and appropriate water depth and velocity conditions. Appropriate conditions for portable electrofish sampling generally consisted of a maximum of approximately 3-3.5 feet of water depth and velocities in a range that allowed field samplers to safely wade over submerged substrates. This sampling technique was also employed in the smaller tributary reaches. All sampling conducted by portable electrofish sampling occurred during daylight hours. This was done as a safety precaution to protect field crew members either wearing or pulling electrofish equipment over uneven and slippery substrates in areas of swift current. For sampling purposes, daylight hours were defined as the time between local sunrise and sunset. Prior to the start of sampling, settings on the electrofishing unit were adjusted by a trained crew member to ensure that approximately 4.0 amps of pulsed DC current was being generated. Portable electrofish sampling was conducted by anchoring a fine mesh seine at the downstream end of the transect reach. The start time was recorded and then the electrofish unit and two to four biologists moved in a downstream direction towards the seine while actively netting stunned individuals and kicking the substrate to drive additional stunned individuals towards the collection net. Stunned fish were placed in one of several buckets of ambient water located on the pram raft itself or carried by one of the netters. Effort was made by to follow the shoreline contour and probe the sampling anodes into habitat areas (i.e., overhanging vegetation, submerged aquatic vegetation, woody debris, etc.). Once the sample reach was finished, the completion time, duration of the sampling effort (i.e., the number of seconds of pedal time), and average water depth was recorded.

Experimental Gill Net Sampling

Experimental gill net sampling was conducted at mainstem river locations with trailer access and appropriate water depth and velocity conditions. Appropriate conditions required for gill net sampling included at least 8 feet of water depth to permit the net to properly open and water velocities in a range that allowed the net to remain anchored at its deployment location for the duration of the set. Exact gill net locations were determined by the field crew leader and were established at a suitable point within each 500-m map-unit. Gill nets were an experimental design

with foam-core top line, lead-core bottom line and five, 25-foot panels with sequential stretch mesh sizes of 1, 1.5, 2, 2.5, and 3 inches. Nets were 125 feet long and 8 feet deep. The net sets were intended to target fish species that use areas too deep or far from shore to effectively sample by boat electrofishing or other means. Nets were bottom-anchored and deployed perpendicular to the shoreline with the smallest size net mesh oriented towards shore. Care was taken to deploy gill nets in areas where water depths were greater than the net height and capture area was maximized. Once deployed, the set time and date were recorded and the net was allowed to fish undisturbed for a two hour period. At the conclusion of the sample period, the net was pulled onboard, the pull time was recorded, and fish were removed and placed in an on-board livewell.

Beach Seine Sampling

Beach seine sampling was preselected for use at mainstem locations in the riverine reaches. It was also employed at map-units within the three impoundments where water depths did not permit the use of an experimental gill net (i.e., less than 8 feet of depth). Beach seine samples were collected during daylight hours using a 100-ft x 10-ft x 3/8-inch mesh beach seine. The exact sampling location within a 500-m map-unit was determined by the field crew leader and was intended to occur in an area of appropriate bottom substrate (i.e., relatively smooth with no large boulders, woody debris, etc.). Sampling was conducted by anchoring one end of the seine net on the shoreline and extending the second end of the net out and away from the shoreline then back to the starting point in a circular manner. Care was taken to ensure that the lead line maintained contact with the bottom substrate to avoid fish moving under the net. Once both ends were on shore, the net was pulled in hand-over-hand by the lead lines, taking care to maintain contact with the bottom. Catch was transferred to a livewell filled with ambient river water.

Trap Net Sampling

Trap net sampling was preselected for use in backwater areas adjacent to mainstem map-units selected for fish assemblage sampling. The exact sampling location within the backwater was determined by the field crew leader and occurred in an area with appropriate bottom topography. Care was taken to avoid setting trap nets in areas with sudden changes in bottom topography because gear effectiveness can be reduced by setting on steep banks or in deep water; and in areas that could become dewatered due to flow fluctuations over the set period. Trap nets were deployed with the primary lead set perpendicular to the bank, and the wings extended at an approximate 45-degree angle. The wing ends and net cod end were weighted with appropriate anchors and a pull float was secured to the cod end of the net. Trap nets were constructed with 3-ft diameter hoops, a single 60-ft lead, two 30-ft wings, and ¾-inch stretch mesh knotted twine. Nets were set and allowed to fish for an approximate 24-hour period prior to pulling. Field crews recorded the set coordinates for each trap net sample. In addition, the set and pull date and time, and water depth were recorded.

Collection of Bio-characteristic Information

Captured fish were identified to species, enumerated, measured (total length, mm), weighed (nearest gram) and released. In the event that large numbers (i.e., >25

individuals) of small young-of-year (YOY) or cyprinids (collectively defined by total length less than 100 mm) were captured within a particular sample they were grouped, enumerated, batch-weighed, and a representative length and weight measurement from a large and small individual was recorded. Fish were released back into the river following processing.

In the event of identification questions, a voucher specimen was retained for submittal to Normandeau's Bedford New Hampshire laboratory for identification to species. Voucher specimens were placed in an appropriate container and preserved in buffered formalin. An internal and external label was put on the specimen container and contained the sample ID, river reach, sample date, and crew leader initials. Where species identification was obvious to the field crew, no voucher specimens were collected.

4.2 Data Analysis

Data sheets containing all field recorded parameters (e.g., sampling effort, fish catch, water quality, etc.) were collected and data was keypunched and then subjected to a quality control inspection to assure a 1% Average Outgoing Quality Limit (AOQL) according to a lot sampling plan (ASQL, 1993). This procedure ensures that ≥99% of the observations in a data file agree with the original data sheets. The number of observations to be checked, and the number of those that must be within tolerance are presented in Table 4.2-1. If more than the acceptable number of failures is found then 100% of the data set must be inspected.

Table 4.2-1. Lot sampling plan for QC inspection at less than 1% AOQL.

Lot Size* (range of observations recorded)	Sample Size (number of observations QC'd)	Number of Failures	
		Accept if ≤	Reject if ≥
1-32	ALL	0	1
33-500	32	0	1
501-3,200	125	1	2
3,201-10,000	200	2	3
10,001-35,000	315	3	4
35,001-150,000	500	5	6
150,001-500,000	800	7	8
500,001 and over	1,250	10	11

a. Lot size represents the total number of observations for the category being evaluated

As described in the RSP, summary statistics to describe the fish assemblage were calculated on a seasonal basis and examined by river reach and substrate/habitat type. Summary statistics included species richness, species composition, diversity, and relative abundance (i.e., catch-per-unit-of-effort (CPUE)).

Species Richness: Species richness is one of several metrics commonly used by fisheries scientists to evaluate community structure. Species richness is simply a tabulation of the number of species present within a given area at a given time (Kwak and Peterson, 2007). Taxonomic categories higher than species were not

included in species richness calculations if a lower level taxonomic category within the higher category was identified in that segment (e.g., *Lepomis* sp. if *Lepomis macrochirus* was already found to be present). Species richness was calculated (1) by river reach with all seasons and sampling gears combined, (2) seasonally by river reach with all sampling gears combined, (3) seasonally by river reach and sampling gear, and (4) seasonally by river reach and map-unit substrate/habitat type.

Species Composition: Species composition was calculated as the proportional contribution of a single fish taxon to the total catch from a particular river reach, sampling gear, and/or substrate/habitat type. Species composition was calculated (1) by river reach with all seasons and sampling gears combined, (2) seasonally by river reach with all sampling gears combined, (3) seasonally by river reach and sampling gear, and (4) seasonally by river reach and map-unit substrate/habitat type.

Diversity: Diversity indices combine information on the number of species in an assemblage (species richness) and their relative abundance (evenness) (Kwak and Peterson, 2007). Diversity indices are one of many tools available to describe assemblage structure, providing information about rarity and commonness of species in a community. The Shannon Diversity Index (H') is a common diversity index applied at the species level for fish. It is calculated using the formula $H' = -\Sigma p_i \ln(p_i)$, where p_i is the relative abundance of each fish taxon.

Evenness based on Shannon's Index, a measure of equitability in relative abundance among species, was calculated as $E_H = H'/H_{max}$ where $H_{max} = H/\ln S$ with S = to the number of species observed within the sample year. Equitability assumes a value between 0 and 1 with 1 being complete evenness. When describing fish assemblage structure, it is appropriate to report richness, diversity and evenness (Kwak and Peterson, 2007). Diversity and evenness values were calculated (1) seasonally by river reach with all sampling gears combined, (2) seasonally by river reach and sampling gear, and (3) seasonally by river reach and map-unit substrate/habitat type.

Relative Abundance: Relative abundance, the number of fish captured with known sampling effort and indexed as catch per unit of effort (CPUE), was calculated on a species and gear-specific basis. Values were calculated in units appropriate to the method (i.e., per hour for electroshocking, stationary gill net, and trap nets, and per haul for beach seine). CPUE values were standardized to gear-specific units using the following equations:

$$\text{CPUE for taxon } j \text{ in sample } i = (\text{catch}_{ji} / \text{duration}_i) * 60 \text{ min}$$

Where: duration is expressed in minutes

Prior to the calculation of any CPUE values, whether by river reach, season or substrate/habitat type, the data set was "zero filled" for each fish species, such that each species collected in the study was represented in every sample. All zero catch samples (i.e., those with no fish catch of any species) were included in the matrix. CPUE values were calculated for each fish species by season, river reach, sampling gear, and map-unit substrate/habitat type.

Due to the logistics of sampling the approximate 120-miles encompassing the study area, a variety of sampling gears were required to capture fish from varying water depths, velocities, and substrate/habitat types. As all sampling gears are somewhat selective and can bias the true abundance of fish species, a meaningful way to convert relative abundance data from multiple gear types to some common scale that will facilitate a more direct comparison between locations was desired. To address this issue, catch and effort data for frequently used active gear types (i.e., boat electrofish, portable electrofish, and beach seine) were converted to catch-per-unit-area (CPUA) values. CPUA was calculated by gear type as follows:

Boat Electrofish ($CPUA_{BEF}$): $CPUA_{BEF} = \frac{N}{W_{BEF} \, x \, D_{BEF}}$

Where: N = number of fish collected

W_{BEF} = estimated width of the effective electrical field of the shocking area (i.e., 3.0 m) [1]

D_{BEF} = distance covered by the electrofish boat

Portable Electrofish ($CPUA_{PEF}$): $CPUA_{PEF} = \frac{N}{W_{PEF} \, x \, D_{PEF}}$

Where: N = number of fish collected

W_{PEF} = estimated width of the effective electrical field of the shocking area (i.e., 2.4 m for pram, 1.5 m for backpack) [1]

D_{PEF} = distance covered by the electrofish pram or backpack

Beach Seine ($CPUA_{BS}$): $CPUA_{BS} = \frac{N}{(\frac{\pi \, x \, r^2}{2})}$

Where: N = number of fish collected

r = radius of the seine haul (i.e., 4.85 m)

Due to their passive nature of sampling, set gears (i.e., gill net and trap net) were not converted to CPUA values. Relative abundance for catch from those two gear types was expressed as catch per hour (i.e., CPUE). This approach of examining relative abundance among substrate/habitat types and river reaches using data from multiple active gear types scaled to a common sampling area has been conducted previously for benthic fish communities within the Missouri and Lower Yellowstone Rivers (Wildhaber et al., 2012).

CPUA values were calculated for each species by season, river reach, sampling gear (excluding trap netting), and map-unit substrate/habitat type (excluding backwaters where trap netting occurred).

[1] The effective width of electrofish sampling was estimated by experienced equipment operators and relied on observations of stunned individuals as well as the effective reach distance of the netter.

In addition to fish assemblage summary statistics, size distribution of selected fish species was examined. Sampling gears and map-unit habitat types were pooled for this analysis since the combination of multiple gear types should provide a more robust sample of body sizes within a particular season. Length distribution plots were created for each species where greater than 100 individuals were measured within a season. Collected weight and length information for all individuals by reach, sampling gear, and map-unit habitat type is available in Appendix A (filed separately in Excel format).

As described in the RSP, the distribution of seasonal catch among size classes (i.e., YOY, juvenile, adult) was also developed. Criteria used in the determination of adult, juvenile (age 1+), and YOY (age 0+) were adapted from available literature sources, primarily Yoder et al. (2009), and a summary of those values and their origin is provided in Table 4.2-2. All species lists in all tables to this report are sorted alphabetically by family and species within each family as TNC had requested in comments on the USR.

Table 4.2-2. Criteria used to determine adult, juvenile and young of year designations for observed fish species.

Family / Common Name	Criteria for Age Designation		
	Adult	Juvenile	YOY
Anguillidae			
American Eel*	≥500 g	499-11 g	≤10 g
Catostomidae			
Longnose Sucker*	≥1000 g	999-9 g	≤10 g
White Sucker*	≥1000 g	999-9 g	≤10 g
Centrarchidae			
Black Crappie*	≥100 g	99-11 g	≤10 g
Bluegill[b]	≥50 g	49-6 g	≤5 g
Largemouth Bass*	≥150 g	149-11 g	≤10 g
Pumpkinseed*	≥50 g	49-6 g	≤5 g
Rock Bass*	≥80 g	79-6 g	≤5 g
Smallmouth Bass*	≥150 g	149-11 g	≤10 g
Clupeidae			
American Shad*	≥100 g	99-11 g	≤10 g
Cottidae			
Slimy Sculpin*	≥20 g	19-3 g	≤2 g
Cyprinidae			
Blacknose Dace[a]	≥45 mm	44-26 mm	≤25 mm
Blacknose Shiner[a]	≥55 mm	54-36 mm	≤35 mm
Bluntnose Minnow[a]	≥60 mm	59-41 mm	≤40 mm
Bridle Shiner[a]	≥40 mm	39-23 mm	≤22 mm
Common Carp*	≥1000 g	999-51 g	≤50 g
Common Shiner*	≥10 g	9-2 g	≤1 g

Family / Common Name	Criteria for Age Designation		
	Adult	**Juvenile**	**YOY**
Creek Chub[a]	≥115 mm	114-51 mm	≤50 mm
Cutlips Minnow[b]	≥110 mm	-	-
Eastern Silvery Minnow[a]	≥85 mm	84-51 mm	≤50 mm
Fallfish*	≥50 g	49-4 g	≤3 g
Fathead Minnow[b]	≥50 mm	-	<50 mm
Finescale Dace[c]	≥45 mm	44-26 mm	≤25 mm
Golden Shiner*	≥100 g	99-11 g	≤10 g
Lake Chub*	≥10 g	9-2 g	≤1 g
Longnose Dace[a]	≥75 mm	74-41 mm	≤40 mm
Mimic Shiner[a]	≥60 mm	59-31 mm	≤30 mm
Rosyface Shiner[a]	≥70 mm	69-36 mm	≤35 mm
Spottail Shiner[a]	≥90 mm	89-51 mm	≤50 mm
Esocidae			
Chain Pickerel*	≥80 g	79-11 g	≤10 g
Northern Pike*	≥500 g	499-11 g	≤10 g
Fundulidae			
Banded Killifish[a]	≥64 mm	63-51 mm	≤50 mm
Gadidae			
Burbot*	≥100 g	99-11 g	≤10 g
Ictaluridae			
Brown bullhead*	≥100 g	99-11 g	≤10 g
Channel Catfish[d]	≥100 g	99-11 g	≤10 g
Yellow Bullhead[d]	≥100 g	99-11 g	≤10 g
Moronidae			
White Perch*	≥100 g	99-11 g	≤10 g
Percidae			
Yellow Perch*	≥50 g	49-6 g	≤5 g
Walleye[e]	≥425 mm	424-151 mm	≤150 mm
Tessellated Darter[f]	≥53 mm	52-35 mm	≤34 mm

Family / Common Name	Criteria for Age Designation		
	Adult	**Juvenile**	**YOY**
Petromyzontidae			
Sea Lamprey	≥610 mm	609-49 mm	≤50 mm
Salmonidae			
Brook Trout*	≥100 g	99-11 g	≤10 g
Brown Trout*	≥100 g	99-11 g	≤10 g

* Source = Yoder et al. (2009)

a - used Pumpkinseed as a surrogate
b - Source = Carlander (1969)
c - Source = Scott and Crossman (1973)
d - used Blacknose Dace as a surrogate
e - used brown bullhead as a surrogate
f - Source = Jenkins and Burkhead (1993)

5.0 RESULTS AND DISCUSSION

When all river reaches are considered, a total of 204 mainstem map-units, 28 tributaries and three backwater areas were sampled using a variety of fishing gear types during the period from May through October, 2015. A total of 11,551 fish representing 14 families and 43 species were collected when all seasons, locations, and sampling gears are considered (Table 5.0-1, Section 5.4). Overall, Spottail Shiner (22.8%), Fallfish (12.1%), and Smallmouth Bass (12.0%) were the most abundant species collected. Tessellated Darter (9.4%), Yellow Perch (8.8%), and Rock Bass (7.0%) were the only other fish species representing greater than 5% each of the total number of individuals sampled.

Throughout the sections below and in the Appendices to this report, tables and figures incorporate the following abbreviations:

River Reach:

WI = Wilder impoundment

WR = Wilder riverine reach

BFI = Bellows Falls impoundment

BFB = Bellows Falls bypassed reach

BFR = Bellows Falls riverine reach

VI = Vernon impoundment

VR = Vernon riverine reach

Sampling Gear:

BEF = Boat electrofish

PEF = Portable electrofish

GN = Gill net

BS = Beach seine

TN = Trap net

Substrate/Habitat Type:

SSC = Sand-silt-clay

GC = Gravel-cobble

BLD = Boulder

TRB = Tributary

BW = Backwater

Table 5.0-1. Total catch (N) and percent composition (%) for species, across river reaches for all sampling gears pooled.

Family / Common Name	REACH														ALL	
	WI		WR		BFI		BFB		BFR		VI		VR			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Anguillidae																
American Eel	1	<0.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	0.6	3	<0.1
Catostomidae																
Longnose Sucker	0	0.0	26	1.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	26	0.2
White Sucker	88	4.1	163	6.9	74	2.8	8	3.9	52	3.0	62	3.0	31	8.7	478	4.1
Centrarchidae																
Black Crappie	0	0.0	0	0.0	16	0.6	1	0.5	0	0.0	20	1.0	2	0.6	39	0.3
Bluegill	20	0.9	5	0.2	25	0.9	0	0.0	19	1.1	154	7.4	49	13.7	272	2.4
Largemouth Bass	50	2.3	3	0.1	37	1.4	1	0.5	24	1.4	87	4.2	1	0.3	203	1.8
Pumpkinseed	10	0.5	0	0.0	40	1.5	0	0.0	3	0.2	38	1.8	1	0.3	92	0.8
Rock Bass	261	12.2	186	7.8	154	5.8	3	1.5	99	5.7	80	3.8	26	7.3	809	7.0
Smallmouth Bass	145	6.8	395	16.6	238	9.0	43	21.0	379	21.9	79	3.8	107	30.0	1386	12.0
Clupeidae																
American Shad	0	0.0	0	0.0	0	0.0	0	0.0	41	2.4	16	0.8	22	6.2	79	0.7
Cottidae																
Slimy Sculpin	7	0.3	73	3.1	1	<0.1	0	0.0	1	0.1	13	0.6	18	5.0	113	1.0
Cyprinidae																
Blacknose Dace	2	0.1	25	1.1	118	4.4	0	0.0	32	1.8	1	<0.1	0	0.0	178	1.5
Blacknose Shiner	50	2.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	50	0.4
Bluntnose Minnow	9	0.4	3	0.1	0	0.0	0	0.0	1	0.1	0	0.0	0	0.0	13	0.1
Bridle Shiner	9	0.4	0	0.0	4	0.2	0	0.0	0	0.0	0	0.0	0	0.0	13	0.1
Common Carp	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	4	0.2	2	0.6	6	0.1
Common Shiner	5	0.2	131	5.5	1	<0.1	1	0.5	134	7.7	0	0.0	0	0.0	272	2.4
Creek Chub	21	1.0	31	1.3	33	1.2	0	0.0	19	1.1	5	0.2	0	0.0	109	0.9
Cutlips Minnow	0	0.0	1	<0.1	1	<0.1	0	0.0	0	0.0	0	0.0	0	0.0	2	<0.1
Eastern Silvery Minnow	3	0.1	0	0.0	0	0.0	1	0.5	25	1.4	34	1.6	0	0.0	63	0.5
Fallfish	358	16.7	375	15.8	200	7.5	2	1.0	254	14.7	192	9.2	12	3.4	1393	12.1
Fathead Minnow	0	0.0	2	0.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	<0.1
Finescale Dace	0	0.0	2	0.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	<0.1
Golden Shiner	95	4.4	2	0.1	102	3.8	0	0.0	22	1.3	96	4.6	1	0.3	318	2.8
Lake Chub	0	0.0	1	<0.1	0	0.0	0	0.0	3	0.2	0	0.0	0	0.0	4	<0.1
Longnose Dace	2	0.1	32	1.3	16	0.6	127	62.0	30	1.7	0	0.0	0	0.0	207	1.8
Mimic Shiner	0	0.0	0	0.0	0	0.0	0	0.0	4	0.2	0	0.0	0	0.0	4	<0.1

Family / Common Name	REACH														ALL	
	WI		WR		BFI		BFB		BFR		VI		VR			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Rosyface Shiner	0	0.0	313	13.2	20	0.9	0	0.0	34	2.0	1	<0.1	1	0.3	369	3.2
Spottail Shiner	302	14.1	174	7.3	1163	43.8	0	0.0	216	12.5	755	36.3	22	6.2	2632	22.8
Esocidae																
Chain Pickerel	6	0.3	0	0.0	5	0.2	0	0.0	1	0.1	1	<0.1	0	0.0	13	0.1
Northern Pike	28	1.3	0	0.0	12	0.5	0	0.0	1	0.1	12	0.6	3	0.8	56	0.5
Fundulidae																
Banded Killifish	3	0.1	1	<0.1	0	0.0	1	0.5	7	0.4	1	<0.1	6	1.7	19	0.2
Gadidae																
Burbot	0	0.0	0	0.0	0	0.0	0	0.0	3	0.2	0	0.0	0	0.0	3	<0.1
Ictaluridae																
Brown bullhead	1	<0.1	0	0.0	11	0.4	2	1.0	3	0.2	2	0.1	0	0.0	19	0.2
Channel Catfish	0	0.0	0	0.0	1	<0.1	0	0.0	2	0.1	2	0.1	9	2.5	14	0.1
Yellow Bullhead	0	0.0	0	0.0	1	<0.1	0	0.0	6	0.3	0	0.0	0	0.0	7	0.1
Moronidae																
White Perch	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	7	0.3	0	0.0	7	0.1
Percidae																
Tessellated Darter	231	10.8	397	16.7	50	1.9	15	7.3	282	16.3	114	5.5	2	0.6	1091	9.4
Walleye	68	3.2	0	0.0	10	0.4	0	0.0	0	0.0	4	0.2	3	0.8	85	0.7
Yellow Perch	371	17.3	8	0.3	316	11.9	0	0.0	20	1.2	273	13.1	29	8.1	1017	8.8
Petromyzontidae																
Sea Lamprey	0	0.0	15	0.6	8	0.3	0	0.0	13	0.8	23	1.1	3	0.8	62	0.5
Salmonidae																
Brook Trout	0	0.0	7	0.3	0	0.0	0	0.0	0	0.0	5	0.2	5	1.4	17	0.1
Brown Trout	0	0.0	2	0.1	1	<0.1	0	0.0	1	0.1	0	0.0	0	0.0	4	<0.1
Total Individuals	**2146**		**2373**		**2658**		**205**		**1731**		**2081**		**357**		**11551**	
Total Families	**9**		**8**		**9**		**6**		**12**		**12**		**12**		**14**	
Taxa Richness	**26**		**26**		**28**		**12**		**31**		**28**		**23**		**43**	

5.1 Spring Fish Assemblage Sampling

5.1.1 Sampling Effort

Sampling effort for the spring (May-June) is presented in Table 5.1-1. When each of the seven geographic reaches is considered, a total of 42 boat electrofish samples, 34 portable electrofish samples, 40 gill net samples and 23 beach seine samples were conducted during the two month period.

Spring fish assemblage data was collected from 66 of the 69 mainstem locations specified in the Revised SSR. Stations 10-BF-001 (east bank), 10-BF-001 (west bank) and 10-BF-002 (west bank) in the Bellows Falls bypassed reach had been randomly selected for sampling during the spring period but due to high flow events resulting in spill conditions at Bellows Falls dam and associated safety concerns, these stations could not be sampled during their targeted spring time period (latter part of June, 2015). Two of the 11 tributary locations identified in the Revised SSR were not sampled due to a lack of water at the time of sampling (10-VR002, stream order -99) or the area originally identified from the National Hydrography Dataset could not be located within the 500-m map-unit in the field (10-W035, stream order 2).

A summary of field sampling effort (by season and gear type) is provided in Appendix B (filed separately in Excel format).

Table 5.1-1. Number of fish assemblage sample locations (by river reach) and number of completed samples (by gear type) for spring sampling (May-June 2015).

River Reach	No. Sample Locations (Study Design: Revised SSR)			No. Sample Locations where sampling occurred			# Collected Samples				
	Main-stem	Trib.	Back-water	Main-stem	Trib.	Back-water	Boat Efish	Portable Efish	Gill Net	Trap Net	Seine
Wilder impoundment	15	1	1	15	0	1	15	1	15	0	0
Wilder riverine	12	2	0	12	2	0	0	14	0	0	9
Bellows Falls impoundment	12	1	0	12	1	0	12	1	11	0	1
Bellows Falls bypassed reach[a]	3	0	0	0	0	0	0	0	0	0	0
Bellows Falls riverine	12	3	0	12	3	0	0	15	0	0	12
Vernon impoundment	12	1	0	12	1	0	12	1	12	0	0
Vernon riverine	3	3	0	3	2	0	3	2	2	0	1
Total	**69**	**11**	**1**	**66**	**9**	**1**	**42**	**34**	**40**	**0**	**23**

a. No spring sampling was conducted in the Bellows Falls bypassed reach due to persistent high flows resulting in spill.

5.1.2 Species Richness and Composition

A total of 3,936 fish representing 11 families and 35 species were collected during spring (May-June 2015) when all river reaches and sampling gears are considered (Table 5.1-2). Overall, Spottail Shiner (30.6%), Rock Bass (9.8%), and Tessellated Darter (8.8%) were the most abundant species collected during the spring. When examined by river reach, the most frequently collected fish species were Yellow Perch (Wilder impoundment), Rosyface Shiner (Wilder riverine), Spottail Shiner (Bellows Falls impoundment, Bellows Falls riverine, and Vernon impoundment), and Smallmouth Bass (Vernon riverine).

Table 5.1-3 presents the total catch and percent composition of fish catch by sampling gear during the spring. For all river reaches combined, 2,273 individuals representing 9 families and 24 species were captured by boat electrofish, 1,072 individuals representing 8 families and 26 species were captured by portable electrofish, 16 individuals representing 5 families and 5 species were captured by gillnet and 575 individuals representing 5 families and 8 species were captured by beach seine. When examined by gear type, the most frequently collected fish species were Spottail Shiner (boat electrofish and beach seine) and Tessellated Darter (portable electrofish). Fish catch in the gillnets during the spring sampling period was limited with only Fallfish, White Sucker, Channel Catfish, Rock Bass and Yellow Perch present in the catch.

Table 5.1-4 presents the total catch and percent composition of fish catch by habitat type during the spring. For all river reaches combined, 1,632 individuals representing 7 families and 24 species were captured in areas of sand-silt-clay substrate, 1,486 individuals representing 10 families and 25 species were captured in areas of gravel-cobble substrate, 507 individuals representing 7 families and 15 species were captured in areas of boulder habitat and 311 individuals representing 7 families and 21 species were captured in the project-affected portions of sampled tributaries. A single backwater sample was collected from the Wilder impoundment during the spring but did not produce any fish catch. When examined by habitat, Spottail Shiner was the most frequently collected fish species in areas of sand-silt-clay, gravel-cobble, and boulder habitats. Slimy Sculpin were the most frequently collected fish species in the project-affected portions of sampled tributaries.

Section 5.4 includes graphical representations of percent composition for all sampling seasons combined, and Appendix J provides additional graphical representations for spring sampling by gear types combined and separately.

Table 5.1-2. Total catch (N) and percent composition (%) during spring (April-May 2015), by river reach for all sampling gears pooled.

Family / Common Name	REACH[a]														ALL	
	WI		WR		BFI		BFB		BFR		VI		VR			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Anguillidae																
American Eel	0	0.0	0	0.0	0	0.0	n/a	-	0	0.0	0	0.0	0	0.0	0	0.0
Catostomidae																
Longnose Sucker	0	0.0	26	2.4	0	0.0	n/a	-	0	0.0	0	0.0	0	0.0	26	0.7
White Sucker	19	2.7	28	2.6	9	1.2	n/a	-	24	4.9	11	1.4	7	6.4	98	2.5
Centrarchidae																
Black Crappie	0	0.0	0	0.0	2	0.3	n/a	-	0	0.0	2	0.3	0	0.0	4	0.1
Bluegill	1	0.1	2	0.2	1	0.1	n/a	-	4	0.8	20	2.6	16	14.7	44	1.1
Largemouth Bass	0	0.0	0	0.0	4	0.5	n/a	-	18	3.7	1	0.1	1	0.9	24	0.6
Pumpkinseed	0	0.0	0	0.0	5	0.6	n/a	-	3	0.6	17	2.2	1	0.9	26	0.7
Rock Bass	121	17.0	141	13.0	32	4.1	n/a	-	35	7.1	38	5.0	18	16.5	385	9.8
Smallmouth Bass	69	9.7	34	3.1	32	4.1	n/a	-	41	8.3	29	3.8	33	30.3	238	6.0
Clupeidae																
American Shad	0	0.0	0	0.0	0	0.0	n/a	-	0	0.0	0	0.0	3	2.8	3	0.1
Cottidae																
Slimy Sculpin	0	0.0	71	6.6	0	0.0	n/a	-	1	0.2	0	0.0	9	8.3	81	2.1
Cyprinidae																
Blacknose Dace	0	0.0	12	1.1	0	0.0	n/a	-	31	6.3	1	0.1	0	0.0	44	1.1
Blacknose Shiner	0	0.0	0	0.0	0	0.0	n/a	-	0	0.0	0	0.0	0	0.0	0	0.0
Bluntnose Minnow	0	0.0	0	0.0	0	0.0	n/a	-	1	0.2	0	0.0	0	0.0	1	0.0
Bridle Shiner	1	0.1	0	0.0	0	0.0	n/a	-	0	0.0	0	0.0	0	0.0	1	0.0
Common Carp	0	0.0	0	0.0	0	0.0	n/a	-	0	0.0	0	0.0	0	0.0	0	0.0
Common Shiner	0	0.0	130	12.0	0	0.0	n/a	-	3	0.6	0	0.0	0	0.0	133	3.4
Creek Chub	3	0.4	10	0.9	6	0.8	n/a	-	15	3.0	0	0.0	0	0.0	34	0.9

Family / Common Name	REACH[a]														ALL	
	WI		WR		BFI		BFB		BFR		VI		VR			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Cutlips Minnow	0	0.0	0	0.0	0	0.0	n/a	-	0	0.0	0	0.0	0	0.0	0	0.0
Eastern Silvery Minnow	3	0.4	0	0.0	0	0.0	n/a	-	0	0.0	0	0.0	0	0.0	3	0.1
Fallfish	109	15.3	86	7.9	54	7.0	n/a	-	18	3.7	67	8.7	1	0.9	335	8.5
Fathead Minnow	0	0.0	0	0.0	0	0.0	n/a	-	0	0.0	0	0.0	0	0.0	0	0.0
Finescale Dace	0	0.0	0	0.0	0	0.0	n/a	-	0	0.0	0	0.0	0	0.0	0	0.0
Golden Shiner	1	0.1	1	0.1	5	0.6	n/a	-	2	0.4	1	0.1	0	0.0	10	0.3
Lake Chub	0	0.0	1	0.1	0	0.0	n/a	-	3	0.6	0	0.0	0	0.0	4	0.1
Longnose Dace	0	0.0	3	0.3	0	0.0	n/a	-	25	5.1	0	0.0	0	0.0	28	0.7
Mimic Shiner	0	0.0	0	0.0	0	0.0	n/a	-	4	0.8	0	0.0	0	0.0	4	0.1
Rosyface Shiner	0	0.0	308	28.5	2	0.3	n/a	-	29	5.9	0	0.0	0	0.0	339	8.6
Spottail Shiner	49	6.9	127	11.7	504	65.1	n/a	-	139	28.2	384	50.1	1	0.9	1204	30.6
Esocidae																
Chain Pickerel	1	0.1	0	0.0	1	0.1	n/a	-	0	0.0	0	0.0	0	0.0	2	0.1
Northern Pike	12	1.7	0	0.0	2	0.3	n/a	-	1	0.2	5	0.7	1	0.9	21	0.5
Fundulidae																
Banded Killifish	0	0.0	1	0.1	0	0.0	n/a	-	4	0.8	1	0.1	0	0.0	6	0.2
Gadidae																
Burbot	0	0.0	0	0.0	0	0.0	n/a	-	0	0.0	0	0.0	0	0.0	0	0.0
Ictaluridae																
Brown bullhead	0	0.0	0	0.0	2	0.3	n/a	-	0	0.0	1	0.1	0	0.0	3	0.1
Channel Catfish	0	0.0	0	0.0	0	0.0	n/a	-	0	0.0	0	0.0	1	0.9	1	0.0
Yellow Bullhead	0	0.0	0	0.0	1	0.1	n/a	-	0	0.0	0	0.0	0	0.0	1	0.0
Moronidae																
White Perch	0	0.0	0	0.0	0	0.0	n/a	-	0	0.0	0	0.0	0	0.0	0	0.0
Percidae																
Tessellated Darter	112	15.7	88	8.1	21	2.7	n/a	-	73	14.8	52	6.8	0	0.0	346	8.8

Family / Common Name	REACH[a]														ALL	
	WI		WR		BFI		BFB		BFR		VI		VR			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Walleye	56	7.9	0	0.0	1	0.1	n/a	-	0	0.0	1	0.1	1	0.9	59	1.5
Yellow Perch	155	21.8	3	0.3	83	10.7	n/a	-	6	1.2	114	14.9	10	9.2	371	9.4
Petromyzontidae																
Sea Lamprey	0	0.0	1	0.1	7	0.9	n/a	-	13	2.6	16	2.1	1	0.9	38	1.0
Salmonidae																
Brook Trout	0	0.0	7	0.6	0	0.0	n/a	-	0	0.0	5	0.7	5	4.6	17	0.4
Brown Trout	0	0.0	2	0.2	0	0.0	n/a	-	0	0.0	0	0.0	0	0.0	2	0.1
Total Individuals	**712**		**1082**		**774**		**n/a**		**493**		**766**		**109**		**3936**	
Total Families	**5**		**8**		**7**		**n/a**		**8**		**9**		**10**		**11**	
Taxa Richness	**15**		**21**		**20**		**n/a**		**23**		**19**		**16**		**35**	

Table 5.1-3. Total catch (N) and percent composition (%) during spring (April-May 2015) by sampling gear.

Family / Common Name	Sampling Gear							
	BEF		PEF		GN		BS	
	N	%	N	%	N	%	N	%
Anguillidae								
American Eel	0	0.0	0	0.0	0	0.0	0	0.0
Catostomidae								
Longnose Sucker	0	0.0	26	2.4	0	0.0	0	0.0
White Sucker	40	1.8	48	4.5	3	18.8	7	1.2
Centrarchidae								
Black Crappie	4	0.2	0	0.0	0	0.0	0	0.0
Bluegill	36	1.6	8	0.7	0	0.0	0	0.0
Largemouth Bass	4	0.2	20	1.9	0	0.0	0	0.0
Pumpkinseed	21	0.9	5	0.5	0	0.0	0	0.0
Rock Bass	205	9.0	176	16.4	4	25.0	0	0.0
Smallmouth Bass	163	7.2	74	6.9	0	0.0	1	0.2
Clupeidae								
American Shad	3	0.1	0	0.0	0	0.0	0	0.0
Cottidae								
Slimy Sculpin	0	0.0	81	7.6	0	0.0	0	0.0
Cyprinidae								
Blacknose Dace	0	0.0	44	4.1	0	0.0	0	0.0
Blacknose Shiner	0	0.0	0	0.0	0	0.0	0	0.0
Bluntnose Minnow	0	0.0	1	0.1	0	0.0	0	0.0
Bridle Shiner	1	0.0	0	0.0	0	0.0	0	0.0
Common Carp	0	0.0	0	0.0	0	0.0	0	0.0
Common Shiner	0	0.0	133	12.4	0	0.0	0	0.0
Creek Chub	9	0.4	25	2.3	0	0.0	0	0.0
Cutlips Minnow	0	0.0	0	0.0	0	0.0	0	0.0
Eastern Silvery Minnow	3	0.1	0	0.0	0	0.0	0	0.0
Fallfish	226	9.9	33	3.1	4	25.0	72	12.5
Fathead Minnow	0	0.0	0	0.0	0	0.0	0	0.0
Finescale Dace	0	0.0	0	0.0	0	0.0	0	0.0
Golden Shiner	3	0.1	6	0.6	0	0.0	1	0.2
Lake Chub	0	0.0	4	0.4	0	0.0	0	0.0
Longnose Dace	0	0.0	28	2.6	0	0.0	0	0.0
Mimic Shiner	0	0.0	4	0.4	0	0.0	0	0.0
Rosyface Shiner	2	0.1	7	0.7	0	0.0	330	57.4
Spottail Shiner	936	41.2	106	9.9	0	0.0	162	28.2

Family / Common Name	Sampling Gear							
	BEF		PEF		GN		BS	
	N	%	N	%	N	%	N	%
Esocidae								
Chain Pickerel	2	0.1	0	0.0	0	0.0	0	0.0
Northern Pike	20	0.9	0	0.0	0	0.0	1	0.2
Fundilidae								
Banded Killifish	1	0.0	5	0.5	0	0.0	0	0.0
Gadidae								
Burbot	0	0.0	0	0.0	0	0.0	0	0.0
Ictaluridae								
Brown Bullhead	3	0.1	0	0.0	0	0.0	0	0.0
Channel Catfish	0	0.0	0	0.0	1	6.3	0	0.0
Yellow Bullhead	1	0.0	0	0.0	0	0.0	0	0.0
Moronidae								
White Perch	0	0.0	0	0.0	0	0.0	0	0.0
Percidae								
Tessellated Darter	158	7.0	187	17.4	0	0.0	1	0.2
Walleye	58	2.6	1	0.1	0	0.0	0	0.0
Yellow Perch	355	15.6	12	1.1	4	25.0	0	0.0
Petromyzontidae								
Sea Lamprey	19	0.8	19	1.8	0	0.0	0	0.0
Salmonidae								
Brook Trout	0	0.0	17	1.6	0	0.0	0	0.0
Brown Trout	0	0.0	2	0.2	0	0.0	0	0.0
Total Individuals	**2273**		**1072**		**16**		**575**	
Total Families	**9**		**8**		**5**		**5**	
Taxa Richness	**24**		**26**		**5**		**8**	

Table 5.1-4. Total catch (N) and percent composition (%) during spring (April-May 2015) by substrate/habitat type.

Family / Common Name	Substrate / Habitat Type							
	SSC		CG		BLD		TRB	
	N	%	N	%	N	%	N	%
Anguillidae								
American Eel	0	0.0	0	0.0	0	0.0	0	0.0
Catostomidae								
Longnose Sucker	0	0.0	0	0.0	0	0.0	26	8.4
White Sucker	29	1.8	25	1.7	3	0.6	41	13.2
Centrarchidae								
Black Crappie	4	0.2	0	0.0	0	0.0	0	0.0
Bluegill	24	1.5	14	0.9	3	0.6	3	1.0
Largemouth Bass	7	0.4	7	0.5	0	0.0	10	3.2
Pumpkinseed	18	1.1	3	0.2	3	0.6	2	0.6
Rock Bass	122	7.5	145	9.8	117	23.1	1	0.3
Smallmouth Bass	79	4.8	99	6.7	60	11.8	0	0.0
Clupeidae								
American Shad	0	0.0	3	0.2	0	0.0	0	0.0
Cottidae								
Slimy Sculpin	0	0.0	0	0.0	0	0.0	81	26.0
Cyprinidae								
Blacknose Dace	4	0.2	2	0.1	0	0.0	38	12.2
Blacknose Shiner	0	0.0	0	0.0	0	0.0	0	0.0
Bluntnose Minnow	0	0.0	0	0.0	0	0.0	1	0.3
Bridle Shiner	1	0.1	0	0.0	0	0.0	0	0.0
Common Carp	0	0.0	0	0.0	0	0.0	0	0.0
Common Shiner	1	0.1	131	8.8	0	0.0	1	0.3
Creek Chub	11	0.7	13	0.9	5	1.0	5	1.6
Cutlips Minnow	0	0.0	0	0.0	0	0.0	0	0.0
Eastern Silvery Minnow	0	0.0	3	0.2	0	0.0	0	0.0
Fallfish	148	9.1	147	9.9	39	7.7	1	0.3
Fathead Minnow	0	0.0	0	0.0	0	0.0	0	0.0
Finescale Dace	0	0.0	0	0.0	0	0.0	0	0.0
Golden Shiner	2	0.1	4	0.3	0	0.0	4	1.3
Lake Chub	0	0.0	3	0.2	1	0.2	0	0.0
Longnose Dace	1	0.1	2	0.1	0	0.0	25	8.0
Mimic Shiner	0	0.0	0	0.0	0	0.0	4	1.3
Rosyface Shiner	30	1.8	309	20.8	0	0.0	0	0.0
Spottail Shiner	677	41.5	364	24.5	156	30.8	7	2.3
Esocidae								
Chain Pickerel	2	0.1	0	0.0	0	0.0	0	0.0
Northern Pike	14	0.9	3	0.2	4	0.8	0	0.0
Fundilidae								
Banded Killifish	0	0.0	5	0.3	1	0.2	0	0.0
Gadidae								
Burbot	0	0.0	0	0.0	0	0.0	0	0.0
Ictaluridae								
Brown Bullhead	3	0.2	0	0.0	0	0.0	0	0.0
Channel Catfish	0	0.0	1	0.1	0	0.0	0	0.0
Yellow Bullhead	1	0.1	0	0.0	0	0.0	0	0.0
Moronidae								
White Perch	0	0.0	0	0.0	0	0.0	0	0.0

Family / Common Name	Substrate/Habitat Type							
	SSC		CG		BLD		TRB	
	N	%	N	%	N	%	N	%
Percidae								
Tessellated Darter	133	8.1	136	9.2	43	8.5	34	10.9
Walleye	28	1.7	18	1.2	12	2.4	1	0.3
Yellow Perch	285	17.5	26	1.7	56	11.0	4	1.3
Petromyzontidae								
Sea Lamprey	8	0.5	21	1.4	4	0.8	5	1.6
Salmonidae								
Brook Trout	0	0.0	0	0.0	0	0.0	17	5.5
Brown Trout	0	0.0	2	0.1	0	0.0	0	0.0
Total Individuals	**1632**		**1486**		**507**		**311**	
Total Families	**7**		**10**		**7**		**7**	
Taxa Richness	**24**		**25**		**15**		**21**	

5.1.3 Diversity

Table 5.1-5 presents a summary of species richness, Shannon diversity, and evenness values for the spring fish assemblage as described by the catch of all sampling gears within each river reach. During the spring, fish community diversity and evenness were highest in samples collected within the Bellows Falls riverine reach. Diversity and evenness were lowest within the Bellows Falls impoundment. Lower values in the Bellows Falls impoundment were likely a function of the high proportional contribution of Spottail Shiner to the fish collections at that location. Section 5.4 includes graphical representations of species richness, diversity, and evenness in various combinations of sampling season, river reach, sampling gear, and substrate/habitat type.

Table 5.1-5. Species richness, diversity, and evenness of the fish community by river reach for the spring (May-June 2015) sampling for all sampling gears combined.

River Reach	Richness	Diversity	Evenness
Wilder impoundment	15	2.07	0.76
Wilder riverine	21	2.21	0.73
Bellows Falls impoundment	20	1.39	0.46
Bellows Falls bypassed reach[a]	n/a	n/a	n/a
Bellows Falls riverine	23	2.44	0.78
Vernon impoundment	19	1.75	0.60
Vernon riverine	16	2.13	0.77
All Reaches	35	2.41	0.68

a. No spring sampling was conducted in the Bellows Falls bypassed reach due to persistent high flows resulting in spill.

When examined by sampling gear, diversity within the observed fish assemblage was highest for the boat and portable electrofish methods (Table 5.1-6).

Table 5.1-6. Species richness, diversity, and evenness of the fish community by river reach and sampling gear for the spring (May-June 2015) sampling.

Gear	Metric	Reach[a]							ALL
		WI	WR	BFI	BFB[b]	BFR	VI	VR	
BEF	Richness	15	-	18	-	-	17	11	24
	Diversity	2.07	-	1.31	-	-	1.63	1.79	1.93
	Evenness	0.76	-	0.45	-	-	0.58	0.74	0.61
PEF	Richness	-	21	6	-	22	6	4	26
	Diversity	-	2.25	1.67	-	2.42	1.13	1.03	2.60
	Evenness	-	0.74	0.93	-	0.78	0.63	0.75	0.80
GN	Richness	2	-	3	-	-	3	1	5
	Diversity	0.69	-	1.08	-	-	0.95	0.00	1.53
	Evenness	1.00	-	0.99	-	-	0.86	0.00	0.95
BS	Richness	-	5	1	-	6	-	1	8
	Diversity	-	0.94	0.00	-	1.11	-	0.00	1.03
	Evenness	-	0.59	0.00	-	0.62	-	0.00	0.50
TN	Richness	-	-	-	-	-	-	-	-
	Diversity	-	-	-	-	-	-	-	-
	Evenness	-	-	-	-	-	-	-	-

a. A dash indicates gear type was not fished within a particular river reach.
b. No spring sampling was conducted in the Bellows Falls bypassed reach due to persistent high flows resulting in spill.

Table 5.1-7 presents a summary of species richness, Shannon diversity, and evenness values for the spring fish assemblage by habitat type and riverine reach as described by the catch of all sampling gears. Community diversity was highest within tributary and gravel-cobble habitat types. Evenness was highest within the tributary habitat type and lowest within the sand-silt-clay habitat type, likely influenced by the high proportional contribution of Spottail Shiner within all samples collected over that habitat type.

Table 5.1-7. Species richness, diversity, and evenness of the fish community by river reach and habitat type for the spring (May-June 2015) sampling.

Substrate / Habitat	Metric	Reach[a]							ALL
		WI	WR	BFI	BFB[b]	BFR	VI	VR	
SSC	Richness	13	10	17	-	15	16	9	24
	Diversity	1.96	1.71	1.39	-	1.75	1.48	1.80	1.96
	Evenness	0.76	0.74	0.49	-	0.65	0.53	0.82	0.62
GC	Richness	12	16	9	-	18	9	9	25
	Diversity	2.23	1.82	1.15	-	2.11	1.41	1.70	2.23

Substrate / Habitat	Metric	Reach[a]							ALL
		WI	WR	BFI	BFB[b]	BFR	VI	VR	
	Evenness	0.90	0.66	0.52	-	0.73	0.64	0.77	0.69
BLD	Richness	9	7	8	-	-	11	-	15
	Diversity	1.81	1.33	1.01	-	-	1.98	-	1.93
	Evenness	0.82	0.68	0.49	-	-	0.83	-	0.71
TRB	Richness	-	7	6	-	13	6	4	21
	Diversity	-	1.37	1.67	-	1.97	1.13	1.03	2.35
	Evenness	-	0.70	0.93	-	0.77	0.63	0.75	0.77
BW	Richness	-	-	-	-	-	-	-	-
	Diversity	-	-	-	-	-	-	-	-
	Evenness	-	-	-	-	-	-	-	-

a. A dash indicates habitat type was not fished within a particular river reach.
b. No spring sampling was conducted in the Bellows Falls bypassed reach due to persistent high flows resulting in spill.

5.1.4 Relative Abundance

Spring CPUE values for each of the 43 species observed are presented in tabular format by species, river reach, sampling gear, and substrate/habitat type in Appendix C, and in Appendix H in graphical format.

To facilitate a more direct comparison among active sampling gears, CPUA values were generated for all fish species during the spring and were scaled to the number of individuals per $100m^2$. The exclusion of passive sampling gears from the evaluation of CPUA values observed for the spring sampling was not expected to have a significant impact as total catch from gill net sampling generated a total of catch of only 16 individuals (0.4% of the total spring catch). Spottail Shiner, Rock Bass, Yellow Perch, Tessellated Darter, Rosyface Shiner, Fallfish, Smallmouth Bass, and Common Shiner comprised approximately 85% of the total catch (all river reaches and active sampling gears, combined) during the spring sampling. CPUA values for those eight species are presented in Figures 5.1-1 through 5.1-8 and for all species in Appendix D in tabular format, and in Appendix I in graphical format.

When visually observed by habitat type and river reach, spring CPUA for Spottail Shiner was patchy with the highest mean spring CPUA values recorded in gravel-cobble habitat in the Wilder riverine reach and in sand-silt-clay habitat in the Bellows Falls riverine reach (Figure 5.1-1). The highest mean spring CPUA values for Rock Bass occurred in boulder habitat in the Wilder impoundment and riverine reaches as well as in gravel-cobble habitat in the Wilder riverine reach (Figure 5.1-2). Mean spring CPUA values for Yellow Perch were highest in the impoundments, particularly in areas with sand-silt-clay and boulder habitat (Figure 5.1-3). Tessellated Darter mean spring CPUA values tended to higher in the upstream reaches (Wilder impoundment and riverine) than in downstream reaches (Figure 5.1-4). Within the Wilder impoundment and Wilder riverine reach, the mean CPUA values for Tessellated Darter appeared comparable among mainstem habitat types. Relative abundance for Tessellated Darter was also high in tributary areas sampled within the Bellows Falls riverine reach and Vernon impoundment. The distribution

of Rosyface Shiner was limited to the Wilder riverine reach, Bellows Falls impoundment and Bellows Falls riverine reach (Figure 5.1-5). Mean spring CPUA was highest in gravel-cobble habitat in Wilder riverine and sand-silt-clay habitat in Bellows Falls riverine reach. Fallfish were present to some degree over the majority of sampled mainstem habitat types within each river reach (Figure 5.1-6). Mean spring CPUA values were highest for Fallfish in gravel-cobble habitat within the Wilder and Bellows Falls riverine reaches. With the exception of tributary habitat, Smallmouth Bass were present within all habitat types sampled in each of the six river reaches during the spring (Figure 5.1-7). Spring CPUA for Common Shiner was limited to gravel-cobble habitat within the Wilder riverine reach and tributary, gravel-cobble and sand-silt-clay habitat in the Bellows Falls riverine reach (Figure 5.1-8).

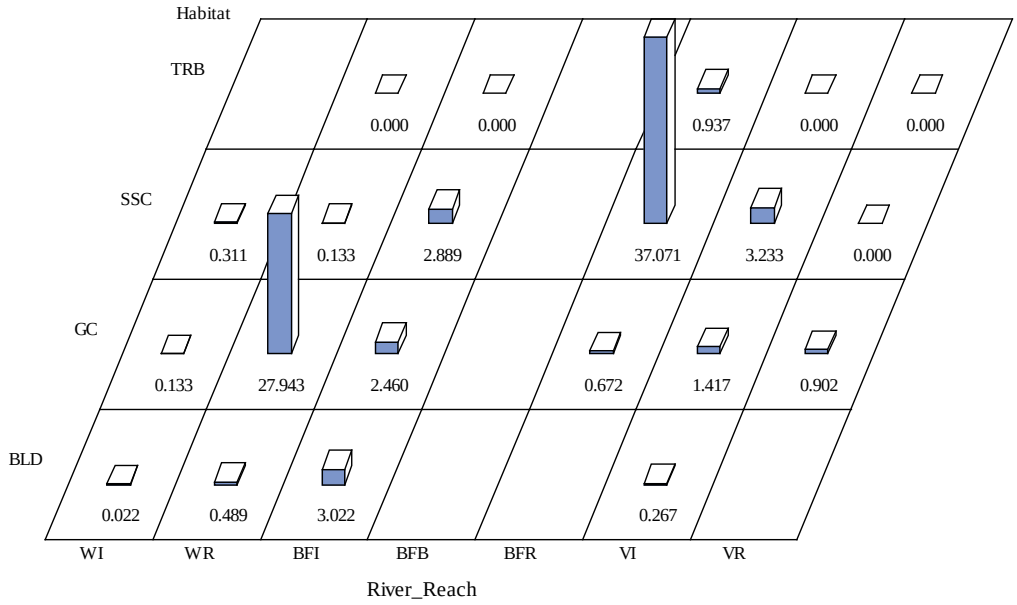

Figure 5.1-1. Mean CPUA values (# individuals/100 m^2) for Spottail Shiner by river reach and substrate/habitat type for the spring (May-June 2015) sampling.

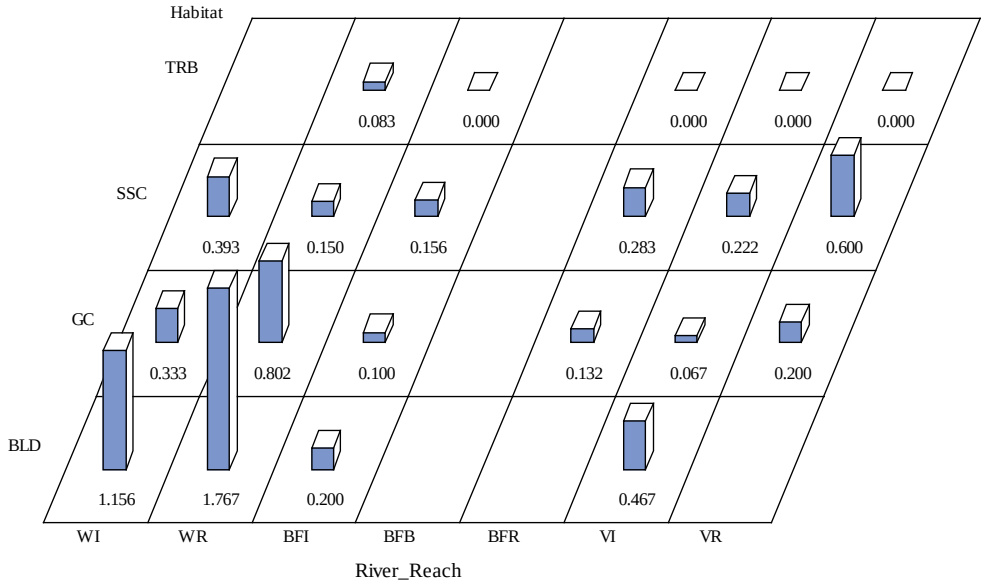

Figure 5.1-2. Mean CPUA values (# individuals/100 m^2) for Rock Bass by river reach and substrate/habitat type for the spring (May-June 2015) sampling.

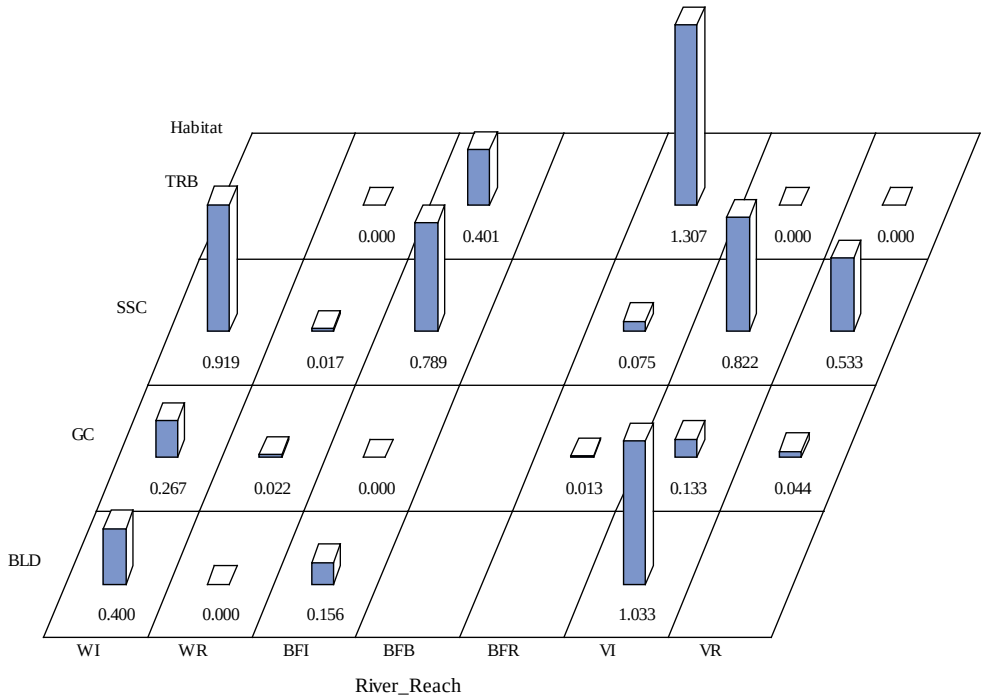

Figure 5.1-3. Mean CPUA values (# individuals/100 m^2) for Yellow Perch by river reach and substrate/habitat type for the spring (May-June 2015) sampling.

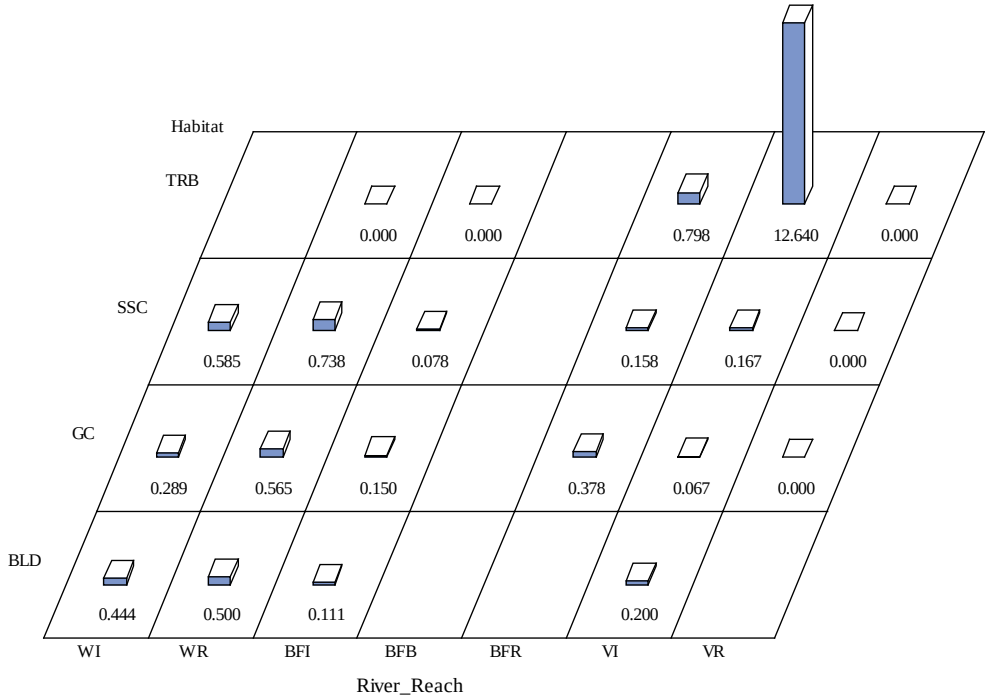

Figure 5.1-4. Mean CPUA values (# individuals/100 m^2) for Tessellated Darter by river reach and substrate/habitat type for the spring (May-June 2015) sampling.

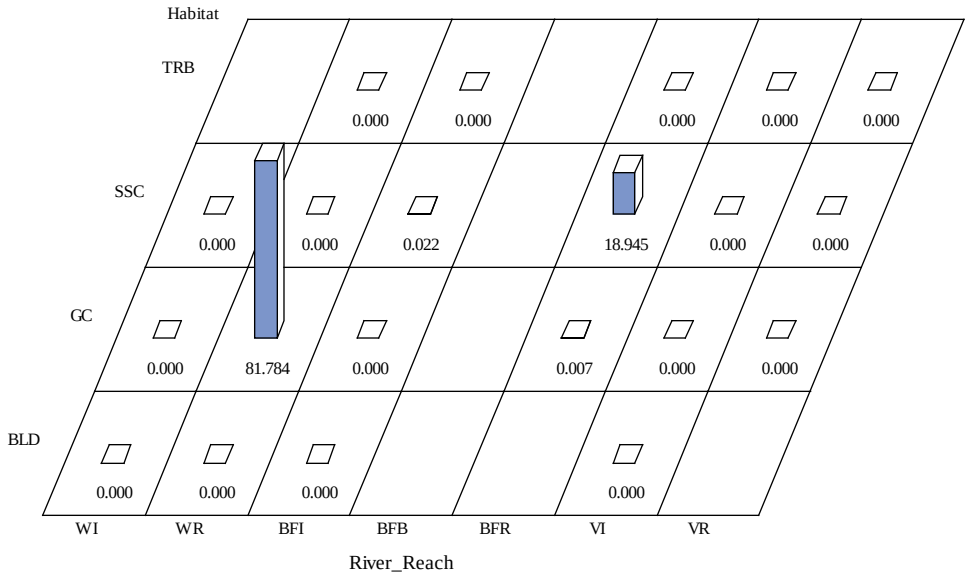

Figure 5.1-5. Mean CPUA values (# individuals/100 m^2) for Rosyface Shiner by river reach and substrate/habitat type for the spring (May-June 2015) sampling.

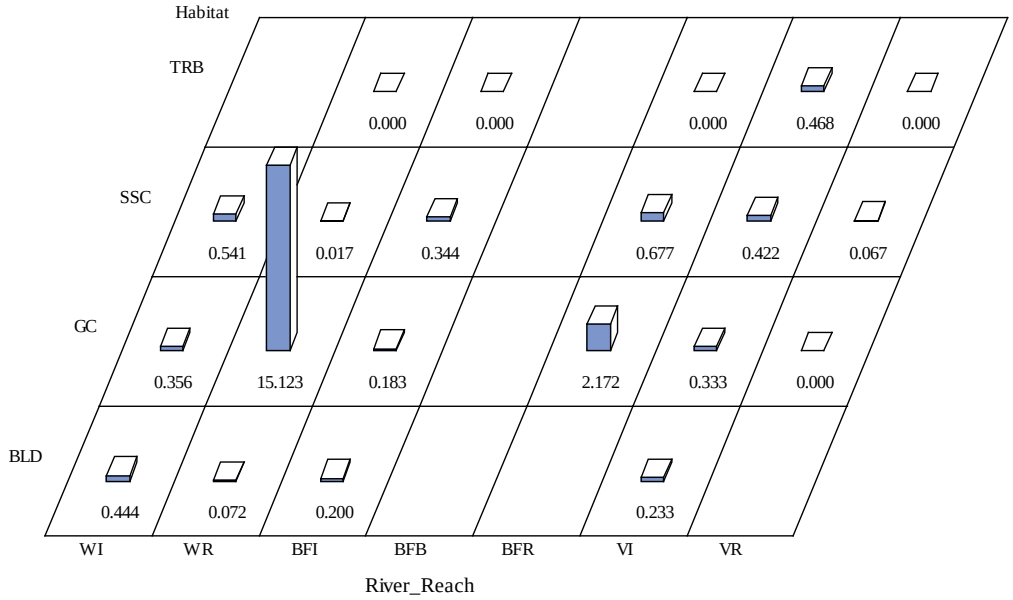

Figure 5.1-6. Mean CPUA values (# individuals/100 m^2) for Fallfish by river reach and substrate/habitat type for the spring (May-June 2015) sampling.

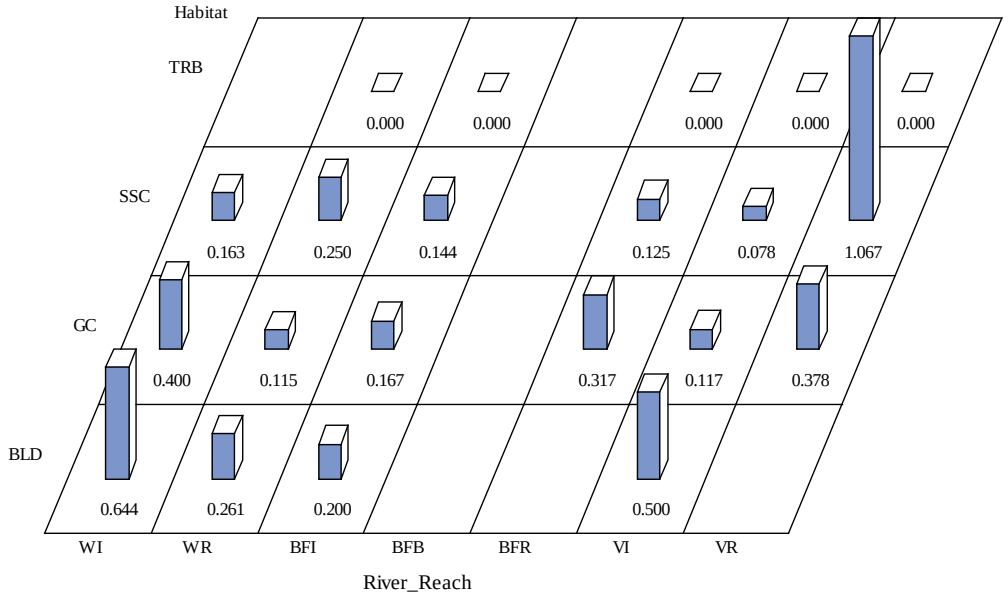

Figure 5.1-7. Mean CPUA values (# individuals/100 m^2) for Smallmouth Bass by river reach and substrate/habitat type for the spring (May-June 2015) sampling.

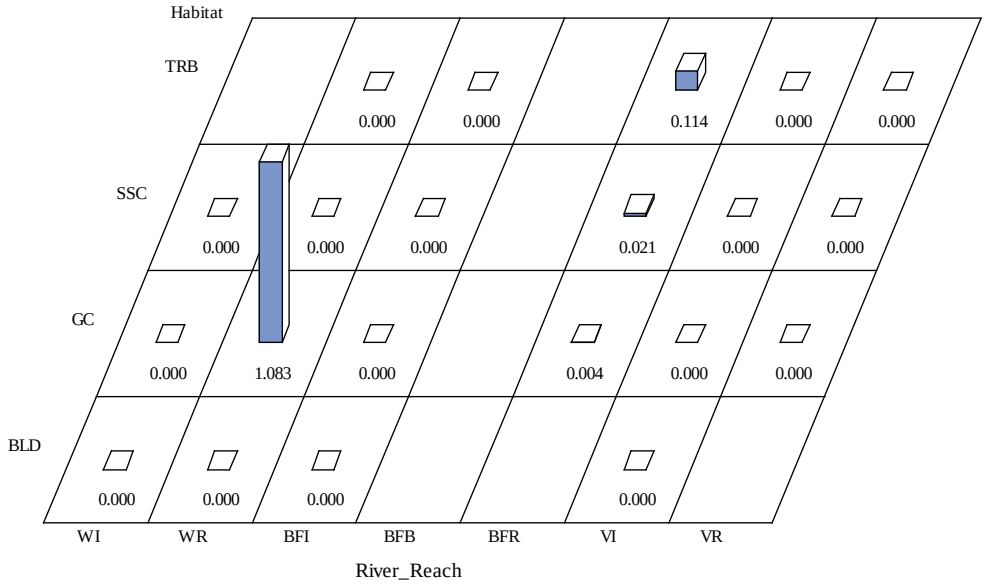

Figure 5.1-8. Mean CPUA values (# individuals/100 m^2) for Common Shiner by river reach and substrate/habitat type for the spring (May-June 2015) sampling.

5.1.5 Size Distributions

Length frequency distributions for six of the most frequently captured fish species during the spring sampling (Rock Bass, Yellow Perch, Tessellated Darter, Spottail Shiner, Fallfish, and Smallmouth Bass) are presented in Figures 5.1-9 through 5.1-14. A full listing of all available fish length information by species, river reach, sampling gear and map-unit habitat type is provided in Appendix A. The observed range of recorded body lengths presented in Figures 5.1-9 through 5.1-14 are within the bounds of those reported for each of the six fish species in Vermont (Langdon et al., 2006).

Table 5.1-8 presents the distribution of catch among the YOY, juvenile and adult age classes (as defined using criteria presented in Table 4.2-3) for species within each of the six river reaches sampled during the spring. The majority of catch during the spring period constituted juvenile fish (43%) with the remainder representing YOY (30%) and adult (27%) individuals. Based on the timing of sampling and the observed range of measured body lengths, YOY individuals captured during the spring period are in all likelihood individuals that were spawned during Spring 2014 but did not achieve the weight or length criteria to be classified as juveniles (see Table 4.2-2) based on literature reported values.

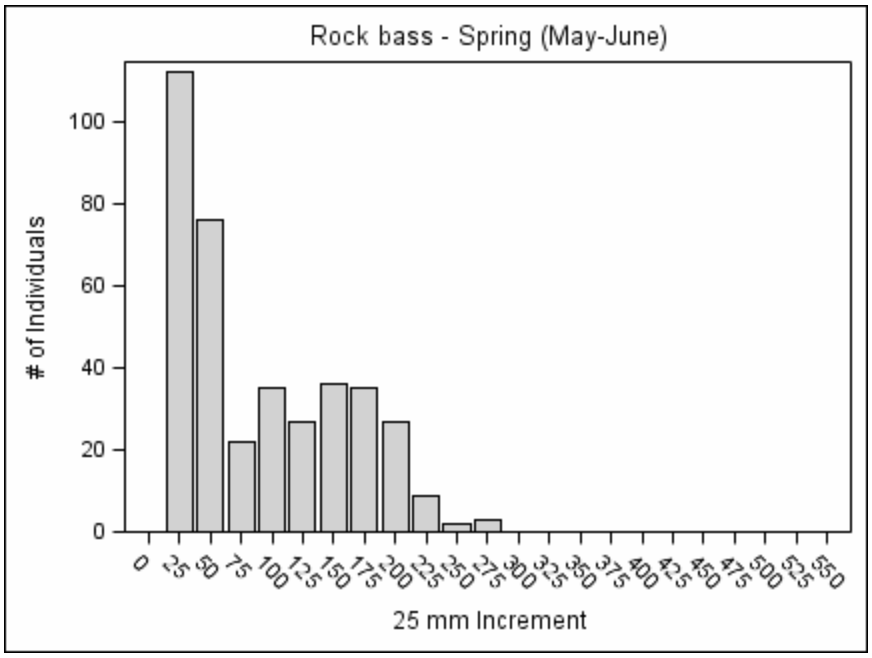

Figure 5.1-9. Length frequency distribution for Rock Bass captured throughout the study area during May-June 2015.

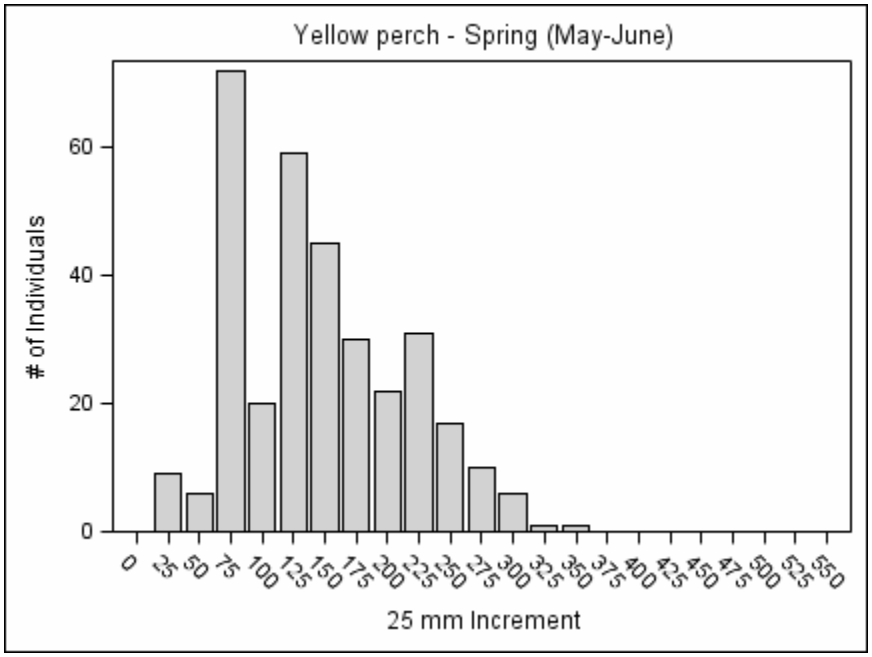

Figure 5.1-10. Length frequency distribution for Yellow Perch captured throughout the study area during May-June 2015.

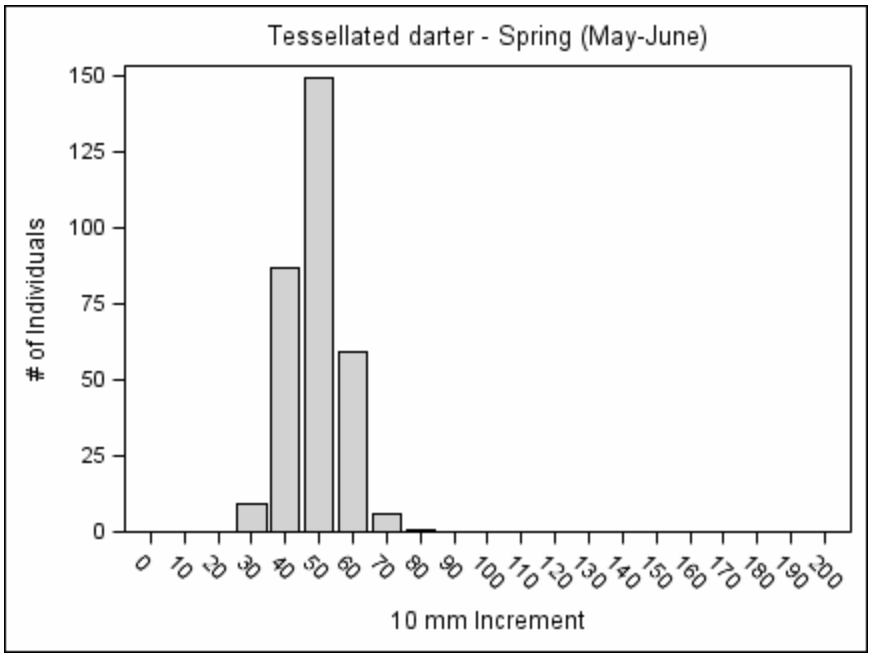

Figure 5.1-11. Length frequency distribution for Tessellated Darter captured throughout the study area during May-June 2015.

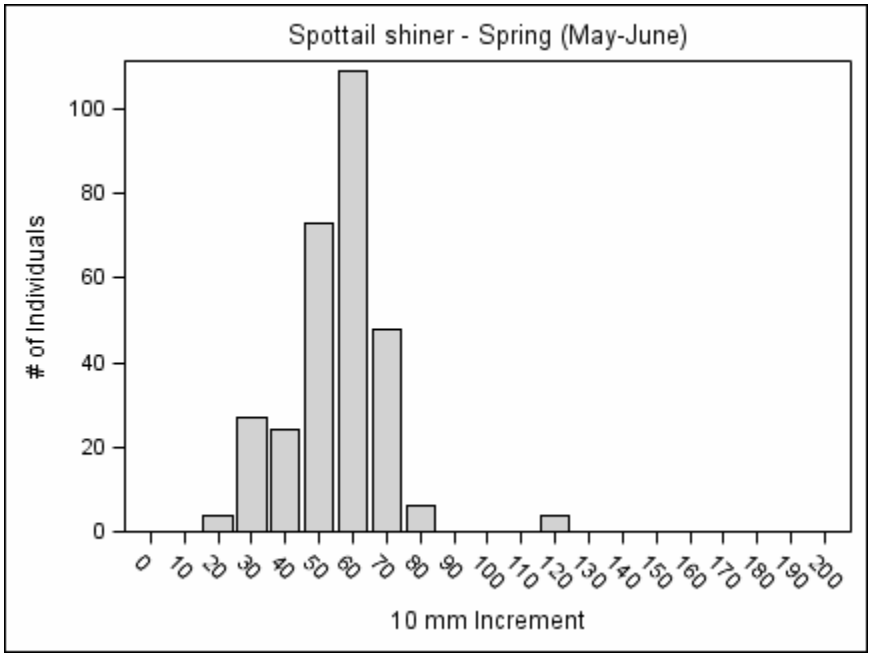

Figure 5.1-12. Length frequency distribution for Spottail Shiner captured throughout the study area during May-June 2015.

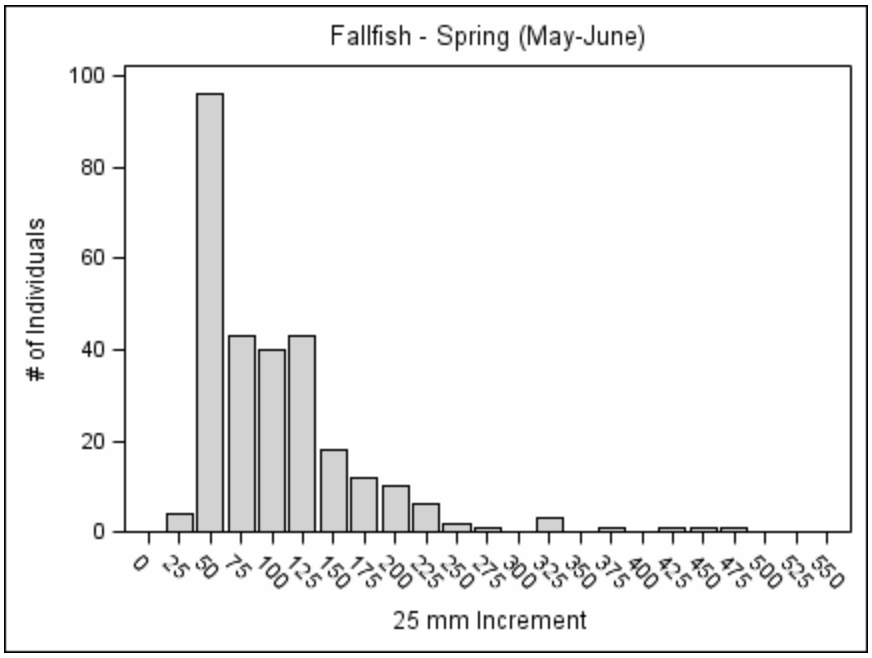

Figure 5.1-13. Length frequency distribution for Fallfish captured throughout the study area during May-June 2015.

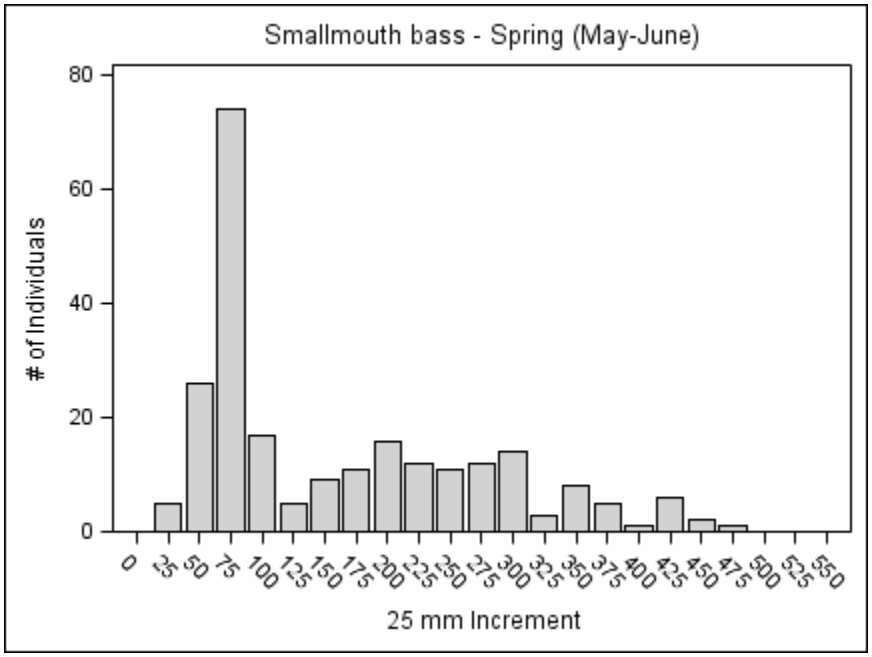

Figure 5.1-14. Length frequency distribution for Smallmouth Bass captured throughout the study area during May-June 2015.

Table 5.1.8. Life stage (YOY, juvenile, and adult) percentages for each fish species recorded during the spring sampling (May-June 2015) by river reach.

Family / Common Name	Life Stage	REACH[a]													
		WI		WR		BFI		BFB		BFR		VI		VR	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Catostomidae															
Longnose Sucker	Juvenile			1	3.8			n/a	n/a						
	YOY			25	96.2			n/a	n/a						
	Total			26	100.0			n/a	n/a						
White Sucker	Adult	11	57.9			4	44.4	n/a	n/a			3	27.3	3	42.9
	Juvenile	5	26.3	2	7.1	3	33.3	n/a	n/a	8	33.3	4	36.4	4	57.1
	YOY	3	15.8	26	92.9	2	22.2	n/a	n/a	16	66.7	4	36.4		
	Total	19	100.0	28	100.0	9	100.0	n/a	n/a	24	100.0	11	100.0	7	100.0
Centrarchidae															
Black Crappie	Adult					2	100.0	n/a	n/a			2	100.0		
	Total					2	100.0	n/a	n/a			2	100.0		
Bluegill	Adult	1	100.0	2	100.0	1	100.0	n/a	n/a	3	75.0	15	75.0	15	93.8
	Juvenile							n/a	n/a			5	25.0	1	6.3
	YOY							n/a	n/a	1	25.0				
	Total	1	100.0	2	100.0	1	100.0	n/a	n/a	4	100.0	20	100.0	16	100.0
Largemouth Bass	Adult					2	50.0	n/a	n/a			1	100.0	1	100.0
	YOY					2	50.0	n/a	n/a	18	100.0				
	Total					4	100.0	n/a	n/a	18	100.0	1	100.0	1	100.0
Pumpkinseed	Adult					5	100.0	n/a	n/a	1	33.3	8	47.1	1	100.0
	Juvenile							n/a	n/a	1	33.3	5	29.4		
	YOY							n/a	n/a	1	33.3	4	23.5		
	Total					5	100.0	n/a	n/a	3	100.0	17	100.0	1	100.0

Family / Common Name	Life Stage	REACH[a]													
		WI		WR		BFI		BFB		BFR		VI		VR	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Rock Bass	Adult	51	42.5	2	1.4	24	75.0	n/a	n/a	7	20.0	5	13.2	13	72.2
	Juvenile	56	46.7			7	21.9	n/a	n/a	7	20.0	26	68.4	5	27.8
	YOY	13	10.8	139	98.6	1	3.1	n/a	n/a	21	60.0	7	18.4		
	Total	120	100.0	141	100.0	32	100.0	n/a	n/a	35	100.0	38	100.0	18	100.0
Smallmouth Bass	Adult	26	37.7	1	2.9	21	65.6	n/a	n/a	1	2.4	11	37.9	14	42.4
	Juvenile	30	43.5	9	26.5	2	6.3	n/a	n/a	8	19.5	5	17.2	12	36.4
	YOY	13	18.8	24	70.6	9	28.1	n/a	n/a	32	78.0	13	44.8	7	21.2
	Total	69	100.0	34	100.0	32	100.0	n/a	n/a	41	100.0	29	100.0	33	100.0
Clupeidae															
American Shad	Adult							n/a	n/a					3	100.0
	Total							n/a	n/a					3	100.0
Cottidae															
Slimy Sculpin	Juvenile			14	35.9			n/a	n/a	1	100.0			4	44.4
	YOY			25	64.1			n/a	n/a					5	55.6
	Total			39	100.0			n/a	n/a	1	100.0			9	100.0
Cyprinidae															
Blacknose Dace	Juvenile			9	75.0			n/a	n/a	23	74.2				
	YOY			3	25.0			n/a	n/a	8	25.8	1	100.0		
	Total			12	100.0			n/a	n/a	31	100.0	1	100.0		
Bluntnose Minnow	Juvenile							n/a	n/a	1	100.0				
	Total							n/a	n/a	1	100.0				
Bridle Shiner	Juvenile	1	100.0					n/a	n/a						
	Total	1	100.0					n/a	n/a						
Common Shiner	Juvenile			1	3.4			n/a	n/a	1	33.3				
	YOY			28	96.6			n/a	n/a	2	66.7				
	Total			29	100.0			n/a	n/a	3	100.0				

Family / Common Name	Life Stage	REACH[a]													
		WI		WR		BFI		BFB		BFR		VI		VR	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Creek Chub	Adult	1	33.3					n/a	n/a						
	Juvenile	2	66.7	5	50.0	6	100.0	n/a	n/a	4	26.7				
	YOY			5	50.0			n/a	n/a	11	73.3				
	Total	3	100.0	10	100.0	6	100.0	n/a	n/a	15	100.0				
Eastern Silvery Minnow	Juvenile	3	100.0					n/a	n/a						
	Total	3	100.0					n/a	n/a						
Fallfish	Adult	18	16.5	1	3.0	13	24.1	n/a	n/a			12	17.9	1	100.0
	Juvenile	52	47.7	5	15.2	24	44.4	n/a	n/a	16	88.9	42	62.7		
	YOY	39	35.8	27	81.8	17	31.5	n/a	n/a	2	11.1	13	19.4		
	Total	109	100.0	33	100.0	54	100.0	n/a	n/a	18	100.0	67	100.0	1	100.0
Golden Shiner	Juvenile					1	20.0	n/a	n/a	1	50.0	1	100.0		
	YOY	1	100.0	1	100.0	4	80.0	n/a	n/a	1	50.0				
	Total	1	100.0	1	100.0	5	100.0	n/a	n/a	2	100.0	1	100.0		
Lake Chub	YOY			1	100.0			n/a	n/a	3	100.0				
	Total			1	100.0			n/a	n/a	3	100.0				
Longnose Dace	Adult			3	100.0			n/a	n/a	25	100.0				
	Total			3	100.0			n/a	n/a	25	100.0				
Mimic Shiner	Adult							n/a	n/a	2	50.0				
	Juvenile							n/a	n/a	2	50.0				
	Total							n/a	n/a	4	100.0				
Rosyface Shiner	Adult			1	12.5			n/a	n/a	18	69.2				
	Juvenile			7	87.5	2	100.0	n/a	n/a	8	30.8				
	Total			8	100.0	2	100.0	n/a	n/a	26	100.0				

Family / Common Name	Life Stage	REACH[a]													
		WI		WR		BFI		BFB		BFR		VI		VR	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Spottail Shiner	Adult							n/a	n/a			4	7.8		
	Juvenile	47	95.9	8	30.8	56	84.8	n/a	n/a	77	75.5	44	86.3	1	100.0
	YOY	2	4.1	18	69.2	10	15.2	n/a	n/a	25	24.5	3	5.9		
	Total	49	100.0	26	100.0	66	100.0	n/a	n/a	102	100.0	51	100.0	1	100.0
Esocidae															
Chain Pickerel	Adult	1	100.0			1	100.0	n/a	n/a						
	Total	1	100.0			1	100.0	n/a	n/a						
Northern Pike	Adult	3	25.0			2	100.0	n/a	n/a			1	20.0	1	100.0
	Juvenile	9	75.0					n/a	n/a	1	100.0	4	80.0		
	Total	12	100.0			2	100.0	n/a	n/a	1	100.0	5	100.0	1	100.0
Fundulidae															
Banded Killifish	Adult							n/a	n/a	1	25.0				
	Juvenile							n/a	n/a	2	50.0				
	YOY			1	100.0			n/a	n/a	1	25.0	1	100.0		
	Total			1	100.0			n/a	n/a	4	100.0	1	100.0		
Ictaluridae															
Brown Bullhead	Adult					2	100.0	n/a	n/a			1	100.0		
	Total					2	100.0	n/a	n/a			1	100.0		
Channel Catfish	Adult							n/a	n/a					1	100.0
	Total							n/a	n/a					1	100.0
Yellow Bullhead	Adult					1	100.0	n/a	n/a						
	Total					1	100.0	n/a	n/a						
Percidae															
Tessellated Darter	Adult	12	15.6	79	89.8	12	57.1	n/a	n/a	45	61.6	21	40.4		
	Juvenile	65	84.4	9	10.2	9	42.9	n/a	n/a	28	38.4	31	59.6		
	Total	77	100.0	88	100.0	21	100.0	n/a	n/a	73	100.0	52	100.0		

Family / Common Name	Life Stage	REACH[a]													
		WI		WR		BFI		BFB		BFR		VI		VR	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Walleye	Adult	1	1.8					n/a	n/a						
	Juvenile	24	42.9					n/a	n/a			1	100.0	1	100.0
	YOY	31	55.4			1	100.0	n/a	n/a						
	Total	56	100.0			1	100.0	n/a	n/a			1	100.0	1	100.0
Yellow Perch	Adult	42	37.2			46	55.4	n/a	n/a			31	27.2	10	100.0
	Juvenile	66	58.4	1	33.3	26	31.3	n/a	n/a			64	56.1		
	YOY	5	4.4	2	66.7	11	13.3	n/a	n/a	6	100.0	19	16.7		
	Total	113	100.0	3	100.0	83	100.0	n/a	n/a	6	100.0	114	100.0	10	100.0
Petromyzontidae															
Sea Lamprey	Juvenile			1	100.0	7	100.0	n/a	n/a	13	100.0	16	100.0	1	100.0
	Total			1	100.0	7	100.0	n/a	n/a	13	100.0	16	100.0	1	100.0
Salmonidae															
Brook Trout	Juvenile			1	14.3			n/a	n/a			2	40.0		
	YOY			6	85.7			n/a	n/a			3	60.0	5	100.0
	Total			7	100.0			n/a	n/a			5	100.0	5	100.0
Brown Trout	YOY			2	100.0			n/a	n/a						
	Total			2	100.0			n/a	n/a						

5.2 Summer Fish Assemblage Sampling

5.2.1 Sampling Effort

Sampling effort for the summer (July-August) is presented in Table 5.2-1. When each of the seven geographic reaches is considered, a total of 43 boat electrofish samples, 36 portable electrofish samples, 41 gill net samples, 24 beach seine samples, and one trap net sample were conducted during the two month period.

Summer fish assemblage data was collected at all 69 mainstem locations specified in the Revised SSR, 10 of the 13 tributary locations and 1 of the 2 backwater locations. Two of the 13 tributary locations and 1 of the 2 backwater locations identified in the Revised SSR were not sampled due to a lack of water at the time of sampling (10-W120, backwater; 10-VR002, stream order -99) or the area originally identified from the National Hydrography Dataset could not be located within the 500-m map-unit in the field. One tributary location (10-B092, stream order 2) was inadvertently missed by the field crew during sampling (10-W105; stream order 2).

A summary of field sampling effort (by season and gear type) is provided in Appendix B.

Table 5.2-1. Number of fish assemblage sample locations (by river reach) and number of completed samples (by gear type) for summer sampling (July-August 2015).

River Reach	No. Sample Locations (Study Design: Revised SSR)			No. Sample Locations where Sampling Occurred			# Collected Samples				
	Main-stem	Trib.	Back-water	Main-stem	Trib.	Back-water	Boat Efish	Portable Efish	Gill Net	Trap Net	Seine
Wilder impoundment	15	2	1	15	1	0	15	1	15	0	0
Wilder riverine	12	2	0	12	2	0	0	14	0	0	12
Bellows Falls impoundment	12	2	1	12	1	1	12	1	12	1	0
Bellows Falls bypassed reach	3	0	0	3	0	0	0	3	0	0	0
Bellows Falls riverine	12	2	0	12	2	0	0	14	0	0	11
Vernon impoundment	12	3	0	12	3	0	13	2	12	0	0
Vernon riverine	3	2	0	3	1	0	3	1	2	0	1
Total	**69**	**13**	**2**	**69**	**10**	**1**	**43**	**36**	**41**	**1**	**24**

5.2.2 Species Richness and Composition

A total of 3,776 fish representing 13 families and 36 species were collected during summer (July-August 2015) when all river reaches and sampling gears are considered (Table 5.2-2). Overall, Spottail Shiner (18.8%), Fallfish (16.4%), and Smallmouth Bass (12.7%) were the most abundant species collected during the summer. When examined by river reach, the most frequently collected fish species were Fallfish (Wilder impoundment, Wilder riverine), Yellow Perch (Bellows Falls impoundment), Longnose Dace (Bellows Falls bypassed reach), Smallmouth Bass (Bellows Falls riverine, Vernon riverine), and Spottail Shiner (Vernon impoundment).

Table 5.2-3 presents the total catch and percent composition of fish catch by sampling gear during the summer. For all river reaches combined, 2,151 individuals representing 8 families and 22 species were captured by boat electrofish, 1,472 individuals representing 11 families and 26 species were captured by portable electrofish, 38 individuals representing 6 families and 9 species were captured by gillnet, 9 individuals representing 3 families and 4 species were captured by trap net, and 106 individuals representing 5 families and 7 species were captured by beach seine. When examined by gear type, the most frequently collected fish species were Spottail Shiner (boat electrofish), Tessellated Darter (portable electrofish), White Sucker (gillnet), and Fallfish (beach seine). Fish catch in the trap nets during the summer sampling period was limited with only Yellow Perch, Rock Bass, Channel Catfish, and Brown Bullhead present in the catch.

Table 5.2-4 presents the total catch and percent composition of fish catch by substrate/habitat type during the summer. For all river reaches combined, 1,567 individuals representing 9 families and 26 species were captured in areas of sand-silt-clay substrate, 1,189 individuals representing 11 families and 28 species were captured in areas of gravel-cobble substrate, 764 individuals representing 7 families and 23 species were captured in areas of boulder, 247 individuals representing 8 families and 17 species were captured in the project-affected portions of sampled tributaries and 9 individuals representing 3 families and 4 species were captured in the sampled backwaters. When examined by substrate/habitat, Spottail Shiner was the most frequently collected fish species in areas of sand-silt-clay, Fallfish was the most frequently collected species in areas of gravel-cobble and the project-affected portion of tributaries, Yellow Perch was the most frequently collected fish species in areas of boulder, and Rock Bass were the most frequently collected fish species in the sampled backwaters.

Section 5.4 includes graphical representations of percent composition for all sampling seasons combined, and Appendix J provides additional graphical representations for spring sampling by gear types combined and separately.

Table 5.2-2. Total catch (N) and percent composition (%) during summer (July-August 2015) by river reach with all sampling gears pooled.

Family / Common Name	REACH														ALL	
	WI		WR		BFI		BFB		BFR		VI		VR			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Anguillidae																
American Eel	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Catostomidae																
Longnose Sucker	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
White Sucker	33	4.4	120	14.4	15	2.5	7	6.5	8	1.6	38	4.2	9	8.3	230	6.1
Centrarchidae																
Black Crappie	0	0.0	0	0.0	7	1.2	0	0.0	0	0.0	3	0.3	2	1.9	12	0.3
Bluegill	4	0.5	1	0.1	22	3.7	0	0.0	9	1.8	87	9.7	29	26.9	152	4.0
Largemouth Bass	9	1.2	3	0.4	23	3.9	1	0.9	2	0.4	49	5.5	0	0.0	87	2.3
Pumpkinseed	1	0.1	0	0.0	20	3.4	0	0.0	0	0.0	13	1.4	0	0.0	34	0.9
Rock Bass	84	11.2	23	2.8	41	6.9	0	0.0	24	4.9	33	3.7	4	3.7	209	5.5
Smallmouth Bass	38	5.1	107	12.8	72	12.1	17	15.9	190	38.9	23	2.6	33	30.6	480	12.7
Clupeidae																
American Shad	0	0.0	0	0.0	0	0.0	0	0.0	31	6.3	0	0.0	2	1.9	33	0.9
Cottidae																
Slimy Sculpin	7	0.9	0	0.0	0	0.0	0	0.0	0	0.0	13	1.4	4	3.7	24	0.6
Cyprinidae																
Blacknose Dace	2	0.3	6	0.7	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	9	0.2
Blacknose Shiner	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Bluntnose Minnow	0	0.0	3	0.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	0.1
Bridle Shiner	7	0.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	7	0.2
Common Carp	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.1	1	0.9	2	0.1
Common Shiner	4	0.5	1	0.1	0	0.0	1	0.9	12	2.5	0	0.0	0	0.0	18	0.5

Family / Common Name	REACH														ALL	
	WI		WR		BFI		BFB		BFR		VI		VR			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Creek Chub	6	0.8	20	2.4	0	0.0	0	0.0	0	0.0	3	0.3	0	0.0	29	0.8
Cutlips Minnow	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Eastern Silvery Minnow	0	0.0	0	0.0	0	0.0	1	0.9	3	0.6	0	0.0	0	0.0	4	0.1
Fallfish	167	22.4	265	31.7	23	3.9	1	0.9	72	14.7	91	10.1	1	0.9	620	16.4
Fathead Minnow	0	0.0	2	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	0.1
Finescale Dace	0	0.0	2	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	0.1
Golden Shiner	36	4.8	1	0.1	17	2.9	0	0.0	3	0.6	9	1.0	1	0.9	67	1.8
Lake Chub	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Longnose Dace	2	0.3	10	1.2	0	0.0	73	68.2	4	0.8	0	0.0	0	0.0	89	2.4
Mimic Shiner	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Rosyface Shiner	0	0.0	5	0.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	5	0.1
Spottail Shiner	159	21.3	39	4.7	150	25.3	0	0.0	51	10.4	343	38.2	4	3.7	746	19.8
Esocidae																
Chain Pickerel	2	0.3	0	0.0	3	0.5	0	0.0	0	0.0	1	0.1	0	0.0	6	0.2
Northern Pike	6	0.8	0	0.0	4	0.7	0	0.0	0	0.0	5	0.6	1	0.9	16	0.4
Fundulidae																
Banded Killifish	2	0.3	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	3	0.1
Gadidae																
Burbot	0	0.0	0	0.0	0	0.0	0	0.0	3	0.6	0	0.0	0	0.0	3	0.1
Ictaluridae																
Brown Bullhead	0	0.0	0	0.0	8	1.3	1	0.9	0	0.0	0	0.0	0	0.0	9	0.2
Channel Catfish	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	1	0.1	5	4.6	7	0.2
Yellow Bullhead	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Moronidae																
White Perch	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	4	0.4	0	0.0	4	0.1
Percidae																
Tessellated Darter	39	5.2	216	25.9	18	3.0	5	4.7	63	12.9	60	6.7	0	0.0	401	10.6

Family / Common Name	REACH														ALL	
	WI		WR		BFI		BFB		BFR		VI		VR			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Walleye	6	0.8	0	0.0	4	0.7	0	0.0	0	0.0	2	0.2	2	1.9	14	0.4
Yellow Perch	133	17.8	5	0.6	165	27.8	0	0.0	11	2.2	111	12.4	8	7.4	433	11.5
Petromyzontidae																
Sea Lamprey	0	0.0	6	0.7	0	0.0	0	0.0	0	0.0	7	0.8	2	1.9	15	0.4
Salmonidae																
Brook Trout	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Brown Trout	0	0.0	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0	0	0.0	1	0.0
Total Individuals	**747**		**835**		**593**		**107**		**489**		**897**		**108**		**3776**	
Total Families	**7**		**5**		**6**		**5**		**8**		**9**		**9**		**13**	
Taxa Richness	**21**		**19**		**17**		**9**		**18**		**21**		**16**		**36**	

Table 5.2-3. Total catch (N) and percent composition (%) during summer (July-August 2015) by sampling gear.

	Sampling Gear									
	BEF		PEF		GN		TN		BS	
	N	%	N	%	N	%	N	%	N	%
Anguillidae										
American Eel	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Catostomidae										
Longnose Sucker	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
White Sucker	66	3.1	149	10.1	12	31.6	0	0.0	3	2.8
Centrarchidae										
Black Crappie	12	0.6	0	0.0	0	0.0	0	0.0	0	0.0
Bluegill	142	6.6	10	0.7	0	0.0	0	0.0	0	0.0
Largemouth Bass	80	3.7	7	0.5	0	0.0	0	0.0	0	0.0
Pumpkinseed	34	1.6	0	0.0	0	0.0	0	0.0	0	0.0
Rock Bass	151	7.0	46	3.1	8	21.1	3	33.3	1	0.9
Smallmouth Bass	161	7.5	301	20.4	1	2.6	0	0.0	17	16.0
Clupeidae										
American Shad	2	0.1	1	0.1	0	0.0	0	0.0	30	28.3
Cottidae										
Slimy Sculpin	0	0.0	24	1.6	0	0.0	0	0.0	0	0.0
Cyprinidae										
Blacknose Dace	0	0.0	9	0.6	0	0.0	0	0.0	0	0.0
Blacknose Shiner	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Bluntnose Minnow	0	0.0	3	0.2	0	0.0	0	0.0	0	0.0
Bridle Shiner	7	0.3	0	0.0	0	0.0	0	0.0	0	0.0
Common Carp	1	0.0	0	0.0	1	2.6	0	0.0	0	0.0
Common Shiner	4	0.2	2	0.1	0	0.0	0	0.0	12	11.3
Creek Chub	8	0.4	21	1.4	0	0.0	0	0.0	0	0.0
Cutlips Minnow	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Eastern Silvery Minnow	0	0.0	4	0.3	0	0.0	0	0.0	0	0.0
Fallfish	267	12.4	310	21.1	3	7.9	0	0.0	40	37.7
Fathead Minnow	0	0.0	2	0.1	0	0.0	0	0.0	0	0.0
Finescale Dace	0	0.0	2	0.1	0	0.0	0	0.0	0	0.0
Golden Shiner	63	2.9	4	0.3	0	0.0	0	0.0	0	0.0
Lake Chub	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Longnose Dace	0	0.0	89	6.0	0	0.0	0	0.0	0	0.0
Mimic Shiner	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Rosyface Shiner	0	0.0	5	0.3	0	0.0	0	0.0	0	0.0
Spottail Shiner	635	29.5	111	7.5	0	0.0	0	0.0	0	0.0

	Sampling Gear									
	BEF		PEF		GN		TN		BS	
	N	%	N	%	N	%	N	%	N	%
Esocidae										
Chain Pickerel	6	0.3	0	0.0	0	0.0	0	0.0	0	0.0
Northern Pike	16	0.7	0	0.0	0	0.0	0	0.0	0	0.0
Fundulidae										
Banded Killifish	0	0.0	3	0.2	0	0.0	0	0.0	0	0.0
Gadidae										
Burbot	0	0.0	3	0.2	0	0.0	0	0.0	0	0.0
Ictaluridae										
Brown Bullhead	7	0.3	1	0.1	0	0.0	1	11.1	0	0.0
Channel Catfish	0	0.0	0	0.0	6	15.8	1	11.1	0	0.0
Yellow Bullhead	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Moronidae										
White Perch	0	0.0	0	0.0	4	10.5	0	0.0	0	0.0
Percidae										
Tessellated Darter	62	2.9	339	23.0	0	0.0	0	0.0	0	0.0
Walleye	13	0.6	0	0.0	1	2.6	0	0.0	0	0.0
Yellow Perch	411	19.1	13	0.9	2	5.3	4	44.4	3	2.8
Petromyzontidae										
Sea Lamprey	3	0.1	12	0.8	0	0.0	0	0.0	0	0.0
Salmonidae										
Brook Trout	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Brown Trout	0	0.0	1	0.1	0	0.0	0	0.0	0	0.0
Total Individuals	**2151**		**1472**		**38**		**9**		**106**	
Total Families	**8**		**11**		**6**		**3**		**5**	
Taxa Richness	**22**		**26**		**9**		**4**		**7**	

Table 5.2-4. Total catch (N) and percent composition (%) during summer (July-August 2015) by substrate/habitat type.

	Substrate / Habitat Type									
	SSC		CG		BLD		TRB		BW	
	N	%	N	%	N	%	N	%	N	%
Anguillidae										
American Eel	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Catostomidae										
Longnose Sucker	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
White Sucker	55	3.5	109	9.2	43	5.6	23	9.3	0	0.0
Centrarchidae										
Black Crappie	6	0.4	3	0.3	3	0.4	0	0.0	0	0.0
Bluegill	49	3.1	44	3.7	59	7.7	0	0.0	0	0.0
Largemouth Bass	52	3.3	13	1.1	21	2.7	1	0.4	0	0.0
Pumpkinseed	17	1.1	2	0.2	15	2.0	0	0.0	0	0.0
Rock Bass	91	5.8	53	4.5	53	6.9	9	3.6	3	33.3
Smallmouth Bass	115	7.3	262	22.0	96	12.6	7	2.8	0	0.0
Clupeidae										
American Shad	30	1.9	3	0.3	0	0.0	0	0.0	0	0.0
Cottidae										
Slimy Sculpin	0	0.0	0	0.0	0	0.0	24	9.7	0	0.0
Cyprinidae										
Blacknose Dace	1	0.1	1	0.1	4	0.5	3	1.2	0	0.0
Blacknose Shiner	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Bluntnose Minnow	0	0.0	0	0.0	1	0.1	2	0.8	0	0.0
Bridle Shiner	1	0.1	6	0.5	0	0.0	0	0.0	0	0.0
Common Carp	1	0.1	0	0.0	1	0.1	0	0.0	0	0.0
Common Shiner	5	0.3	12	1.0	1	0.1	0	0.0	0	0.0
Creek Chub	5	0.3	21	1.8	2	0.3	1	0.4	0	0.0
Cutlips Minnow	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Eastern Silvery Minnow	0	0.0	3	0.3	1	0.1	0	0.0	0	0.0
Fallfish	202	12.9	273	23.0	76	9.9	69	27.9	0	0.0
Fathead Minnow	0	0.0	2	0.2	0	0.0	0	0.0	0	0.0
Finescale Dace	0	0.0	0	0.0	0	0.0	2	0.8	0	0.0
Golden Shiner	53	3.4	6	0.5	8	1.0	0	0.0	0	0.0
Lake Chub	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Longnose Dace	1	0.1	9	0.8	77	10.1	2	0.8	0	0.0
Mimic Shiner	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Rosyface Shiner	0	0.0	1	0.1	0	0.0	4	1.6	0	0.0
Spottail Shiner	537	34.3	125	10.5	53	6.9	31	12.6	0	0.0
Esocidae										
Chain Pickerel	6	0.4	0	0.0	0	0.0	0	0.0	0	0.0
Northern Pike	9	0.6	4	0.3	3	0.4	0	0.0	0	0.0
Fundilidae										
Banded Killifish	0	0.0	1	0.1	0	0.0	2	0.8	0	0.0
Gadidae										
Burbot	0	0.0	3	0.3	0	0.0	0	0.0	0	0.0
Ictaluridae										
Brown Bullhead	6	0.4	0	0.0	2	0.3	0	0.0	1	11.1
Channel Catfish	2	0.1	4	0.3	0	0.0	0	0.0	1	11.1
Yellow Bullhead	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Moronidae										
White Perch	3	0.2	1	0.1	0	0.0	0	0.0	0	0.0

	Substrate / Habitat Type									
	SSC		CG		BLD		TRB		BW	
	N	%	N	%	N	%	N	%	N	%
Percidae										
Tessellated Darter	83	5.3	143	12.0	115	15.1	60	24.3	0	0.0
Walleye	8	0.5	3	0.3	3	0.4	0	0.0	0	0.0
Yellow Perch	224	14.3	80	6.7	125	16.4	0	0.0	4	44.4
Petromyzontidae										
Sea Lamprey	5	0.3	2	0.2	2	0.3	6	2.4	0	0.0
Salmonidae										
Brook Trout	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Brown Trout	0	0.0	0	0.0	0	0.0	1	0.4	0	0.0
Total Individuals	**1567**		**1189**		**764**		**247**		**9**	
Total Families	**9**		**11**		**7**		**8**		**3**	
Taxa Richness	**26**		**28**		**23**		**17**		**4**	

5.2.3 Diversity

Table 5.2-5 presents a summary of species richness, Shannon diversity, and evenness values for the summer fish assemblage as described by the catch from all sampling gears within each river reach. During the summer, fish community diversity was highest in samples collected within the Wilder impoundment and lowest within the Bellows Falls bypassed reach. Community evenness was highest within the Wilder impoundment, Bellows Falls impoundment, and Vernon riverine reaches and lowest within the Bellows Falls bypassed reach. Lower values in the Bellows Falls bypassed reach were likely a function of the high proportional contribution of Longnose Dace to the fish collections as well as reduced habitat diversity at that location relative to other river reaches. Section 5.4 includes graphical representations of species richness, diversity, and evenness in various combinations of sampling season, river reach, sampling gear, and substrate/habitat type.

Table 5.2-5. Species richness, diversity, and evenness of the fish community by river reach for the summer (July-August 2015) sampling for all gears combined.

River Reach	Richness	Diversity	Evenness
Wilder impoundment	21	2.19	0.72
Wilder riverine	19	1.87	0.63
Bellows Falls impoundment	17	2.15	0.76
Bellows Falls bypassed reach	9	1.09	0.50
Bellows Falls riverine	18	2.02	0.70
Vernon impoundment	21	2.11	0.69
Vernon riverine	16	2.09	0.75
All Reaches	36	2.49	0.69

When examined by sampling gear, diversity within the observed fish assemblage was highest for the boat and portable electrofish methods (Table 5.2-6).

Table 5.2-6. Species richness, diversity, and evenness of the fish community by river reach and sampling gear for the summer (July-August 2015) sampling.

Gear	Metric	Reach[a]							ALL
		WI	WR	BFI	BFB	BFR	VI	VR	
BEF	Richness	17	-	16	-	-	17	13	22
	Diversity	2.07	-	2.14	-	-	1.93	1.88	1.93
	Evenness	0.73	-	0.77	-	-	0.68	0.73	0.63
PEF	Richness	6	19	-	9	17	8	2	26
	Diversity	1.47	1.90	-	1.09	1.85	1.47	0.64	2.60
	Evenness	0.82	0.64	-	0.50	0.65	0.71	0.92	0.80
GN	Richness	2	-	1	-	-	8	1	9
	Diversity	0.69	-	0.00	-	-	1.89	0.00	1.53
	Evenness	0.99	-	0.00	-	-	0.91	0.00	0.69
BS	Richness	-	3	-	-	6	-	1	7
	Diversity	-	0.52	-	-	1.39	-	0.00	1.03
	Evenness	-		-	-	0.77	-	0.00	0.53
TN	Richness	-	-	4	-	-	-	-	4
	Diversity	-	-	1.21	-	-	-	-	1.21
	Evenness	-	-	0.88	-	-	-	-	0.88

a. A dash indicates gear type was not fished within a particular river reach.

Table 5.2-7 presents a summary of species richness, Shannon diversity, and evenness values for the summer fish assemblage by substrate/habitat type and riverine reach as described by the catch of all sampling gears. Community diversity was highest within boulder and gravel-cobble substrates and lowest within sampled tributaries. Evenness was highest within the backwater and boulder types and lowest within sand-silt-clay and gravel-cobble substrates. The lower values of evenness were likely influenced by the high proportional contribution of Spottail Shiner within samples collected over sand-silt-clay and by the high proportional contribution of Creek Chub and Bluegill within samples collected over gravel-cobble.

Table 5.2-7. Species richness, diversity, and evenness of the fish community by river reach and substrate/habitat type for the fall (July - August 2015) sampling.

Substrate / Habitat	Metric	Reach[a]							ALL
		WI	WR	BFI	BFB	BFR	VI	VR	
SSC	Richness	17	11	16	-	7	18	10	26
	Diversity	2.03	1.66	2.02	-	1.14	1.65	1.92	2.21
	Evenness	0.72	0.69	0.73	-	0.59	0.57	0.83	0.68
GC	Richness	13	15	5	-	16	16	12	28
	Diversity	2.02	1.76	1.41	-	1.88	2.31	1.81	2.31
	Evenness	0.79	0.65	0.88	-	0.68	0.83	0.73	0.69
BLD	Richness	10	10	15	9	-	15	-	23

Substrate / Habitat	Metric	Reach[a]							ALL
		WI	WR	BFI	BFB	BFR	VI	VR	
	Diversity	1.75	1.26	2.10	1.09	-	2.06	-	2.43
	Evenness	0.76	0.55	0.78	0.50	-	0.76	-	0.77
TRB	Richness	6	9	-	-	3	9	2	17
	Diversity	1.47	1.49	-	-	1.10	1.55	0.64	2.06
	Evenness	0.82	0.68	-	-	1.00	0.71	0.92	0.73
BW	Richness	-	-	4	-	-	-	-	4
	Diversity	-	-	1.21	-	-	-	-	1.21
	Evenness	-	-	0.87	-	-	-	-	0.87

a. A dash indicates substrate/habitat type was not fished within a particular river reach.

5.2.4 Relative Abundance

Summer CPUE values for each of the 43 species observed are presented in tabular format by species, river reach, sampling gear, and substrate/habitat type in Appendix C, and in Appendix H in graphical format.

To facilitate a more direct comparison among active sampling gears, CPUA values were generated for all fish species during the summer and were scaled to the number of individuals per $100m^2$. The exclusion of passive sampling gears from the evaluation of CPUA values observed for the summer sampling was not expected to have a significant impact as total catch from gill net and trap net sampling (combined) generated a total of catch of only 47 individuals (1.2% of the total summer catch).Spottail Shiner, Fallfish, Smallmouth Bass, Yellow Perch, Tessellated Darter, White Sucker, Rock Bass, and Bluegill comprised approximately 85% of the total catch (all river reaches and active sampling gears, combined) during the summer sampling. CPUA values for those eight species are presented in Figures 5.2-1 through 5.2-8 and for all species in and for all species in Appendix D in tabular format, and in Appendix I in graphical format.

When visually observed by substrate/habitat type and river reach, Spottail Shiner were present to some degree over the majority of sampled mainstem substrate/habitat types within each river reach (Figure 5.2-1). Summer CPUA values for Spottail Shiner were highest in sand-silt-clay in the three impoundments as well as in tributaries in the Wilder riverine reach and Vernon impoundment. Fallfish were present to some degree over the majority of sampled mainstem substrate/habitat types within each river reach (Figure 5.2-2). Mean summer CPUA values were highest for Fallfish in tributaries, gravel-cobble, and boulder within the Wilder riverine reach and in sand-silt-clay and gravel-cobble within the Bellows Falls riverine reach. Smallmouth Bass were present within all mainstem substrate/habitat types sampled in each of the seven river reaches during the summer (Figure 5.2-3). Mean summer CPUA values were highest for Smallmouth Bass in gravel-cobble within the Bellows Falls and Vernon riverine reaches. Mean summer CPUA values for Yellow Perch were highest in the impoundments and the species was observed in all substrate/habitat types with the exception of tributaries (Figure 5.2-4). With the exception of tributary habitat within the Vernon impoundment, Tessellated Darter mean summer CPUA values tended to be higher

in the upstream reaches (Wilder impoundment and riverine) than in downstream reaches (Figure 5.2-5). White Sucker were present to some degree over the majority of sampled mainstem substrate/habitat types within each river reach (Figure 5.2-6). Relative abundance for White Sucker was highest in tributary habitat in the majority of sampled reaches. Rock Bass were present within all mainstem substrate/habitat types and were present in each river reach with the exception of the Bellows Falls bypassed reach (Figure 5.2-7). Bluegill mean summer CPUA values tended to be higher in the downstream reaches (Vernon impoundment and riverine) than upstream (Figure 5.2-8). Within the Vernon impoundment and the Vernon riverine reach, the mean summer CPUA values for Bluegill appeared comparable among mainstem habitat types. Bluegill were absent from tributary habitat during the summer sampling.

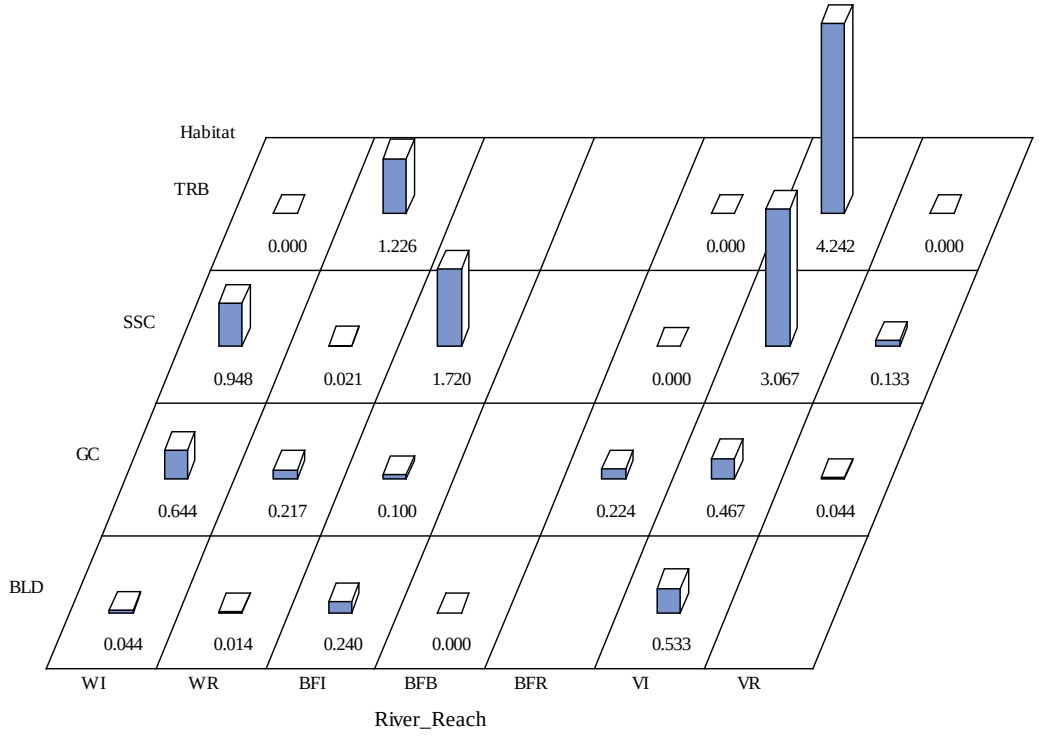

Figure 5.2-1. Mean CPUA values (# individuals/100 m^2) for Spottail Shiner by river reach and substrate/habitat type for the summer (July-August 2015) sampling.

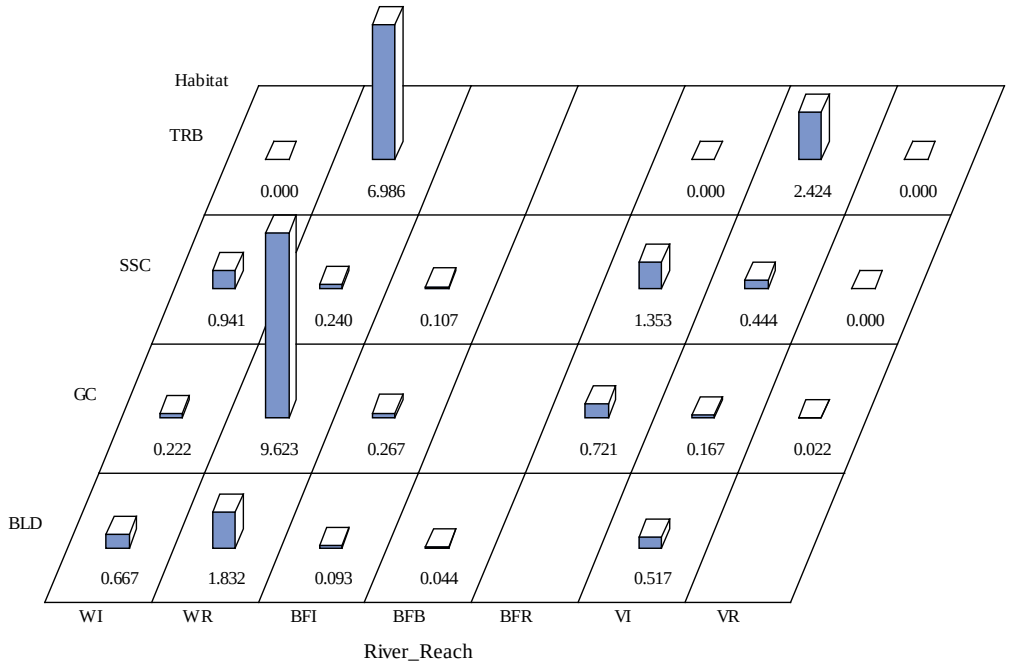

Figure 5.2-2. Mean CPUA values (# individuals/100 m^2) for Fallfish by river reach and substrate/habitat type for the summer (July-August 2015) sampling.

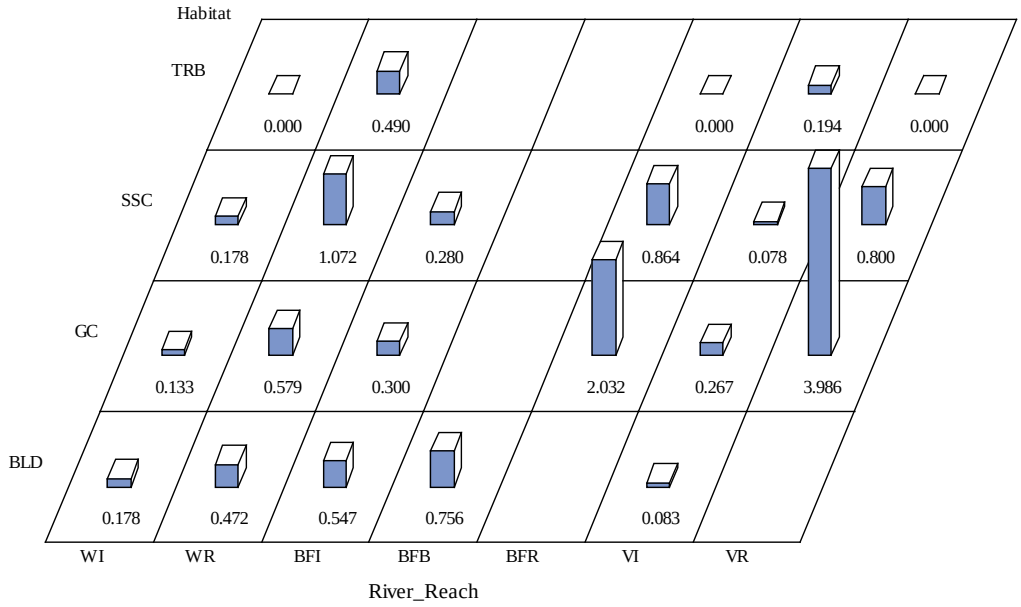

Figure 5.2-3. Mean CPUA values (# individuals/100 m^2) for Smallmouth Bass by river reach and substrate/habitat type for the summer (July-August 2015) sampling.

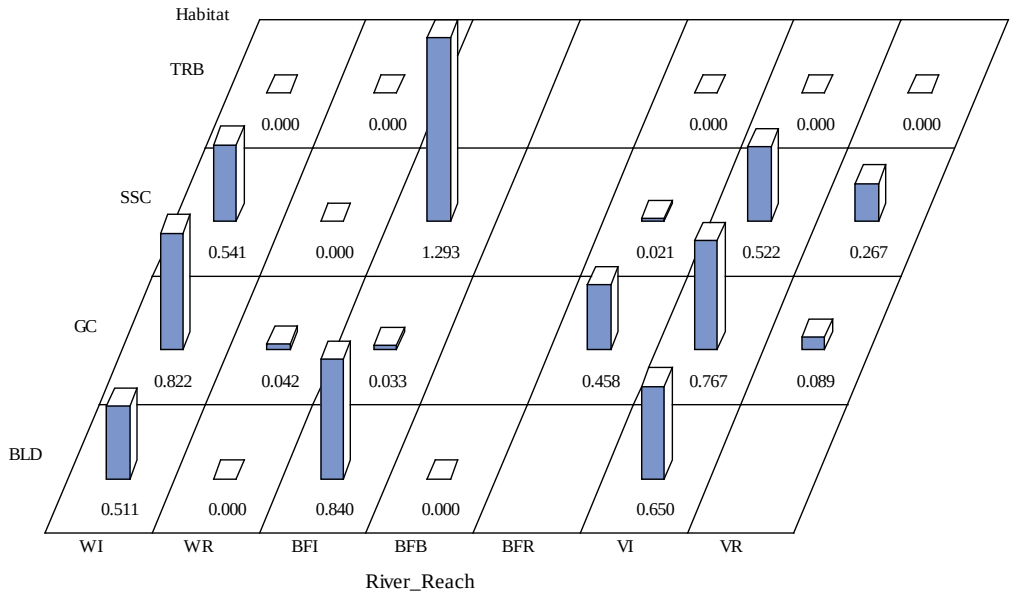

Figure 5.2-4. Mean CPUA values (# individuals/100 m^2) for Yellow Perch by river reach and substrate/habitat type for the summer (July-August 2015) sampling.

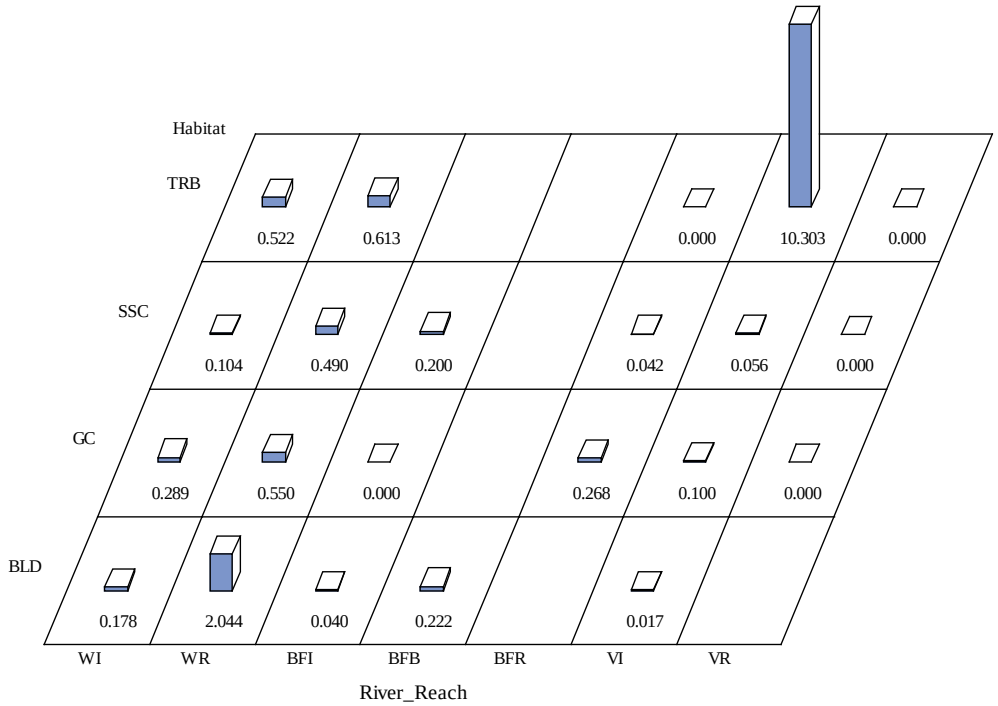

Figure 5.2-5. Mean CPUA values (# individuals/100 m^2) for Tessellated Darter by river reach and substrate/habitat type for the summer (July-August 2015) sampling.

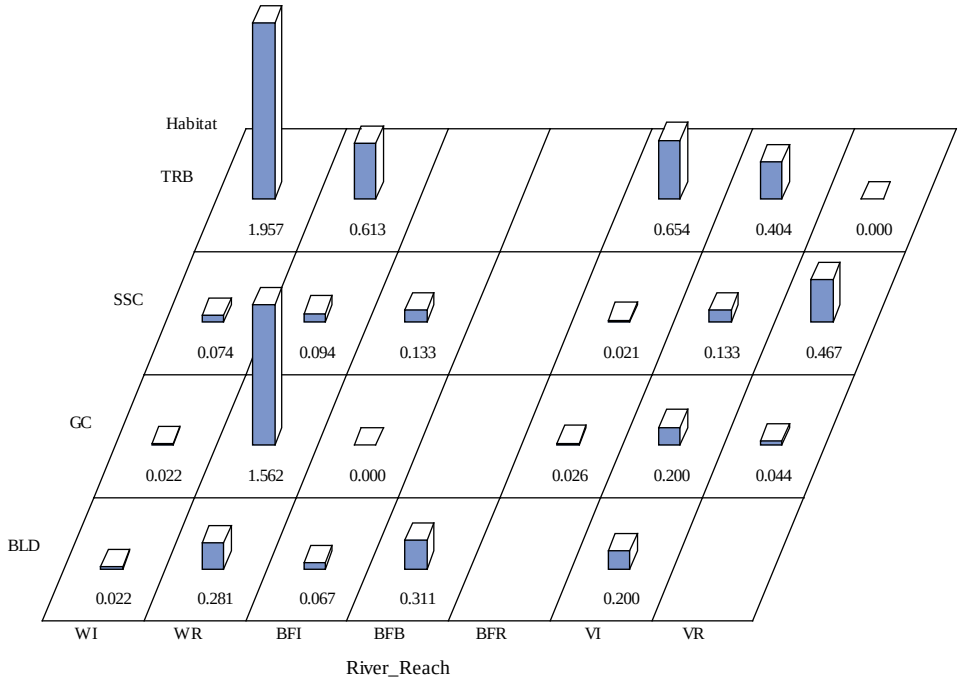

Figure 5.2-6. Mean CPUA values (# individuals/100 m^2) for White Sucker by river reach and substrate/habitat type for the summer (July-August 2015) sampling.

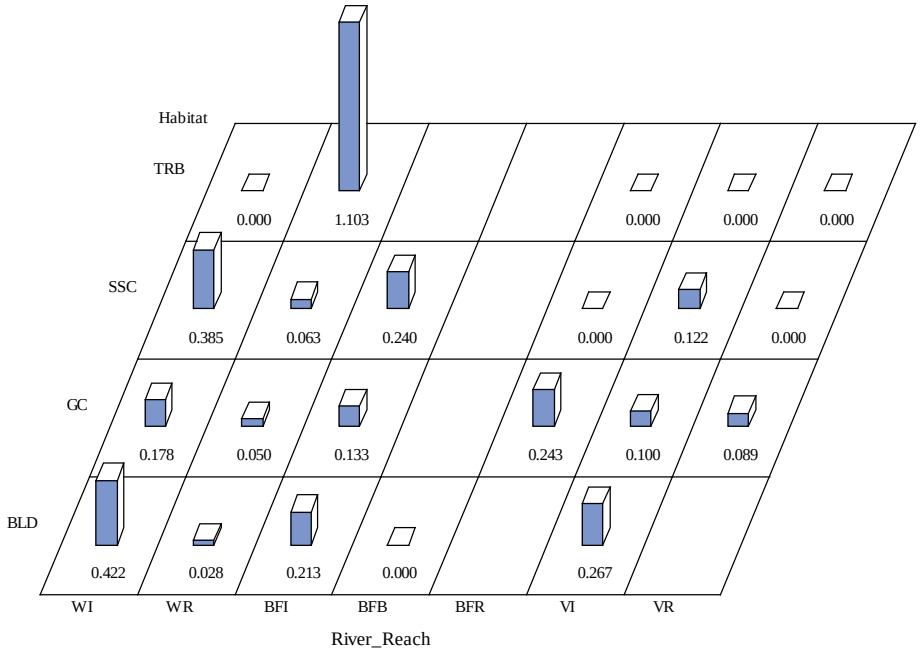

Figure 5.2-7. Mean CPUA values (# individuals/100 m^2) for Rock Bass by river reach and substrate/habitat type for the summer (July-August 2015) sampling.

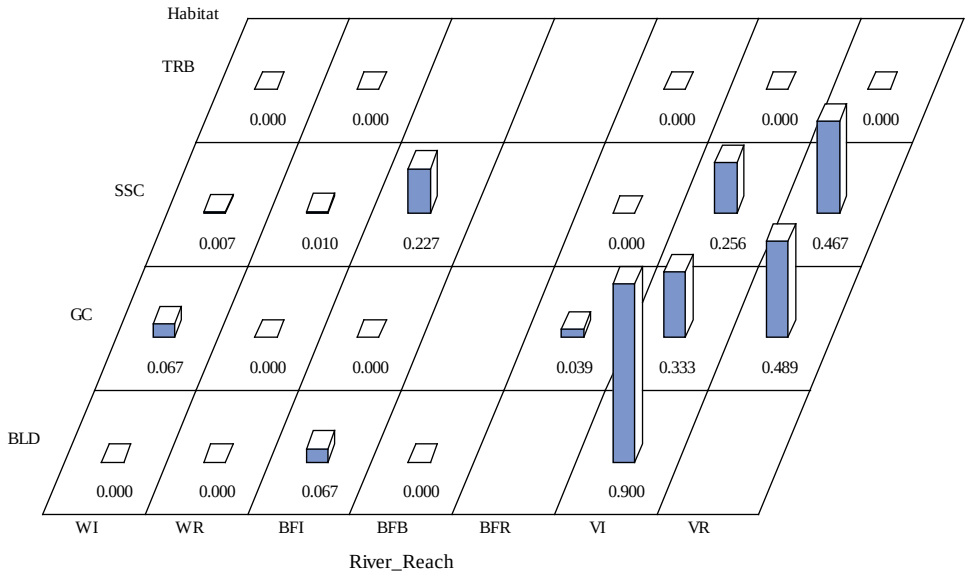

Figure 5.2-8. Mean CPUA values (# individuals/100 m^2) for Bluegill by river reach and substrate/habitat type for the summer (July-August 2015) sampling.

5.2.5 Size Distributions

Length frequency distributions for eight of the most frequently captured fish species during the summer sampling (Yellow Perch, Smallmouth Bass, Fallfish, Tessellated Darter, Spottail Shiner, Rock Bass, White Sucker, and Bluegill) are presented in Figures 5.2-9 through 5.2-16. A full listing of all available fish length information by species, river reach, sampling gear and map-unit substrate/habitat type is provided in Appendix A. The observed range of recorded body lengths presented in Figures 5.2-9 through 5.2-16 are within the bounds of those reported for each of the eight fish species in Vermont (Langdon et al., 2006).

Table 5.2-8 presents the distribution of catch among the YOY, juvenile and adult age classes (as defined using criteria presented in Table 4.2-3) for species within each of the seven river reaches sampled during the summer. The majority of catch during the summer was comprised of young fish (33% YOY and 37% juvenile). Adult fish constituted the remainder of the catch (30%). Based on the observed range of measured lengths, YOY individuals spawned during the spring of 2015 began to recruit to sampling gears during July and August.

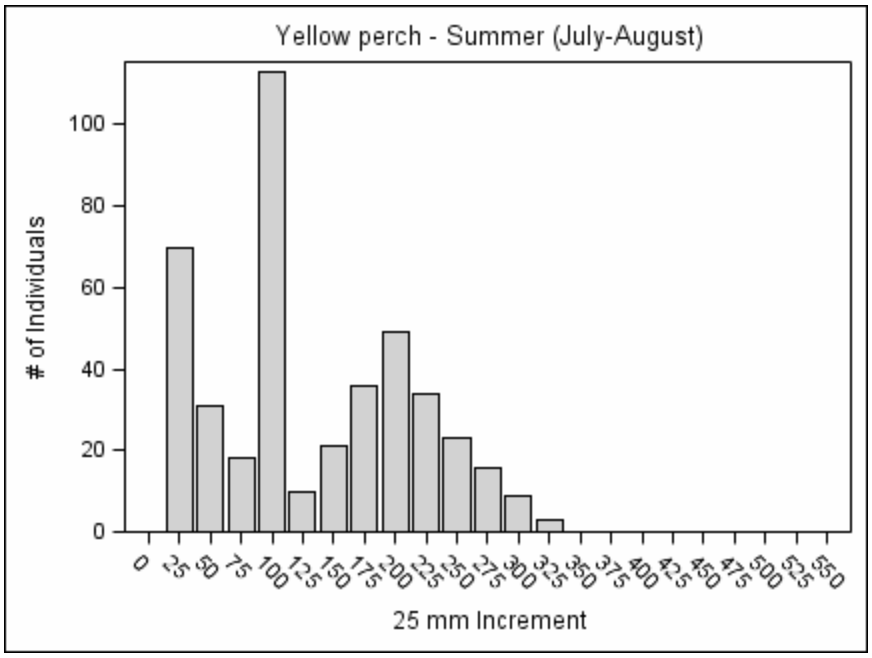

Figure 5.2-9. Length frequency distribution for Yellow Perch captured throughout the study area during July-August 2015.

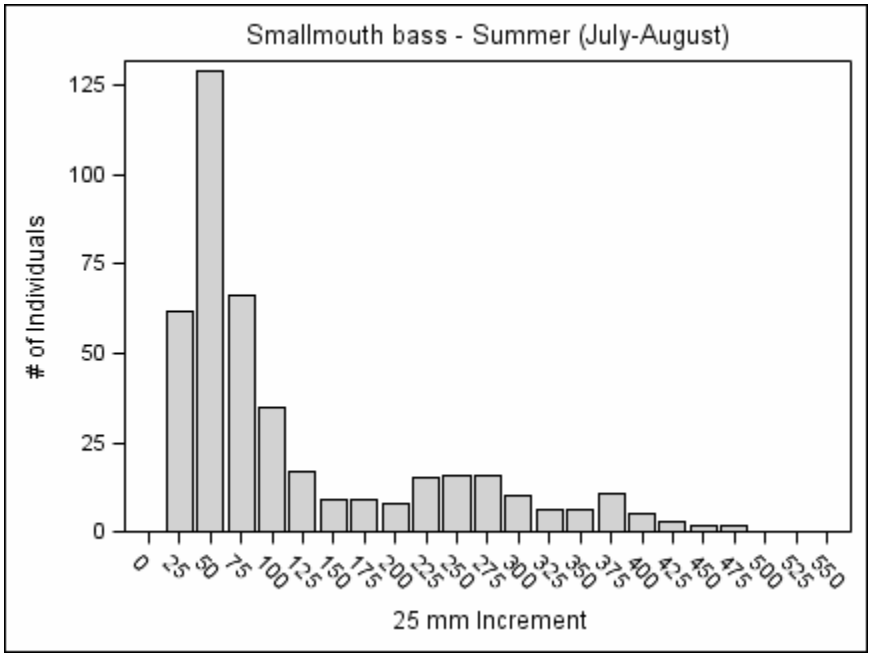

Figure 5.2-10. Length frequency distribution for Smallmouth Bass captured throughout the study area during July-August 2015.

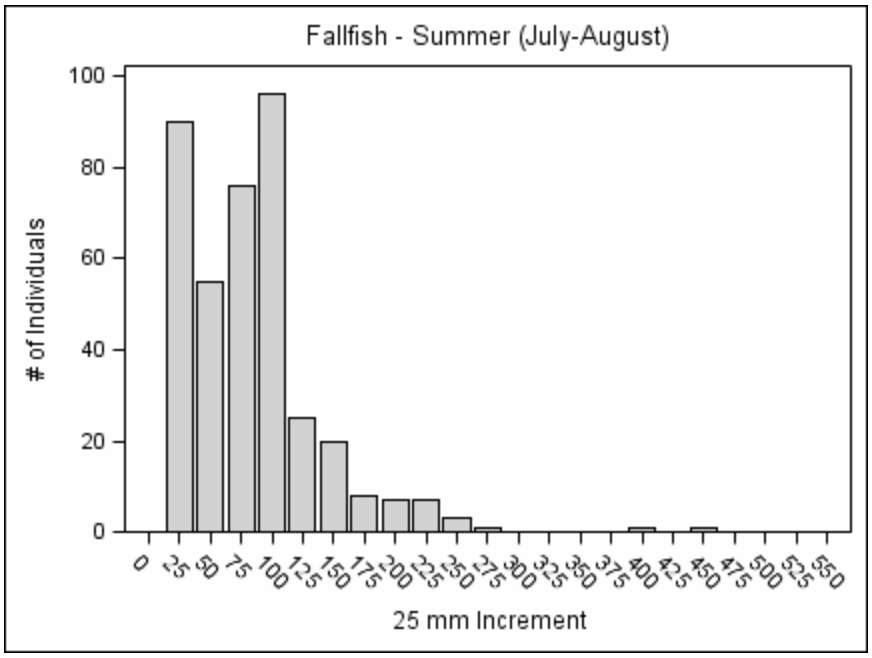

Figure 5.2-11. Length frequency distribution for Fallfish captured throughout the study area July-August 2015.

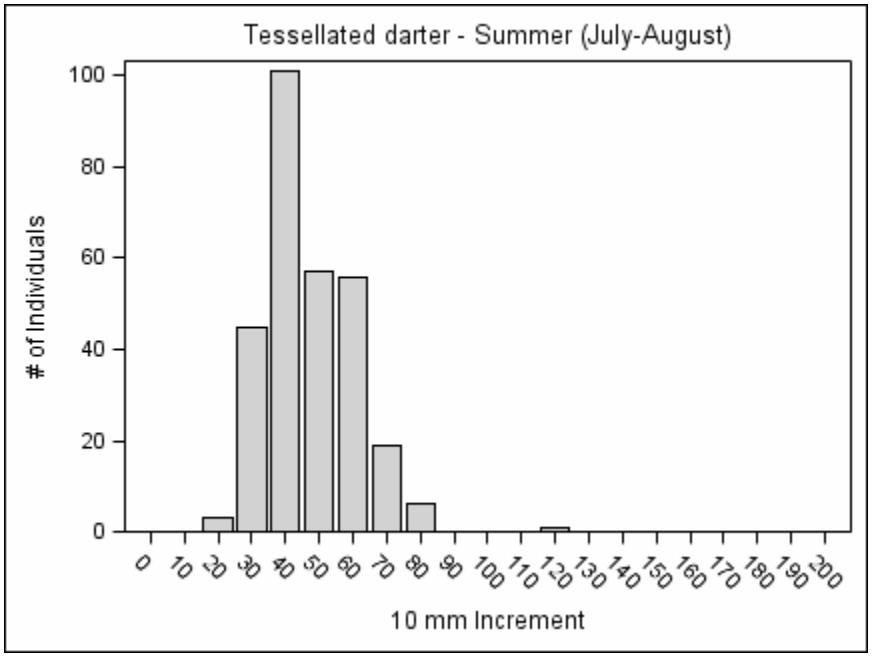

Figure 5.2-12. Length frequency distribution for Tessellated Darter captured throughout the study area during July-August 2015.

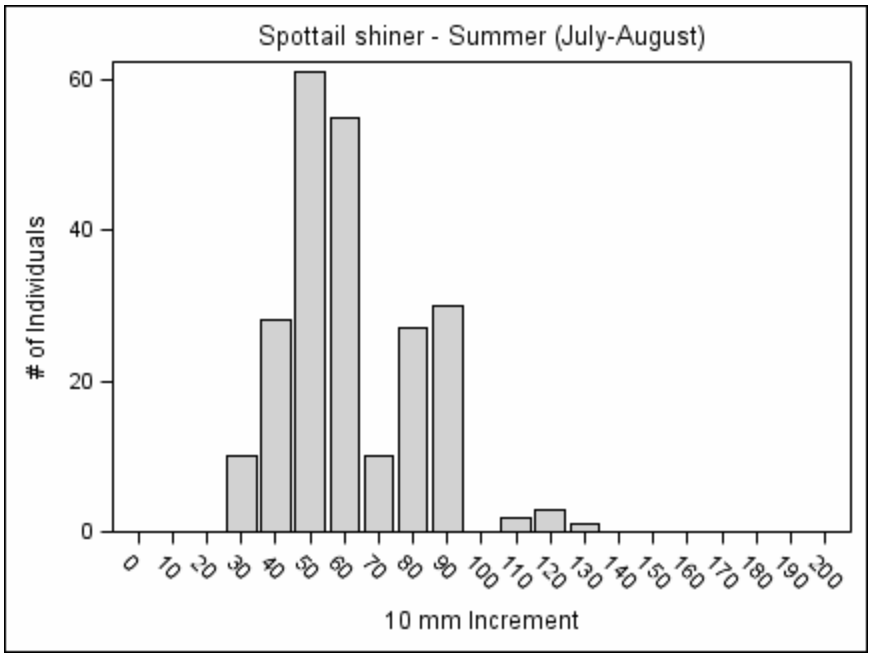

Figure 5.2-13. Length frequency distribution for Spottail Shiner captured throughout the study area during July-August 2015.

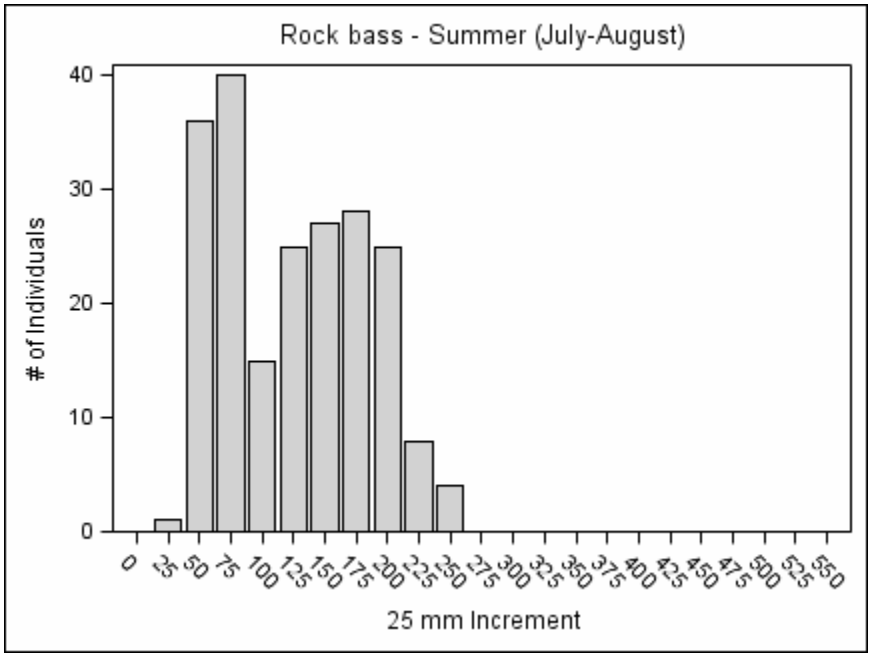

Figure 5.2-14. Length frequency distribution for Rock Bass captured throughout the study area during July-August 2015.

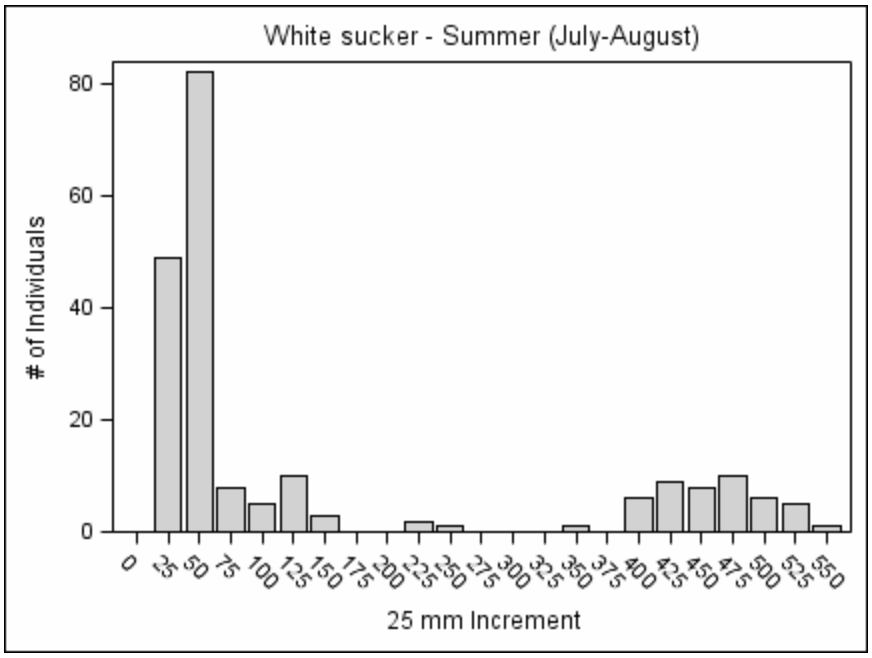

Figure 5.2-15. Length frequency distribution for White Sucker captured throughout the study area during July-August 2015.

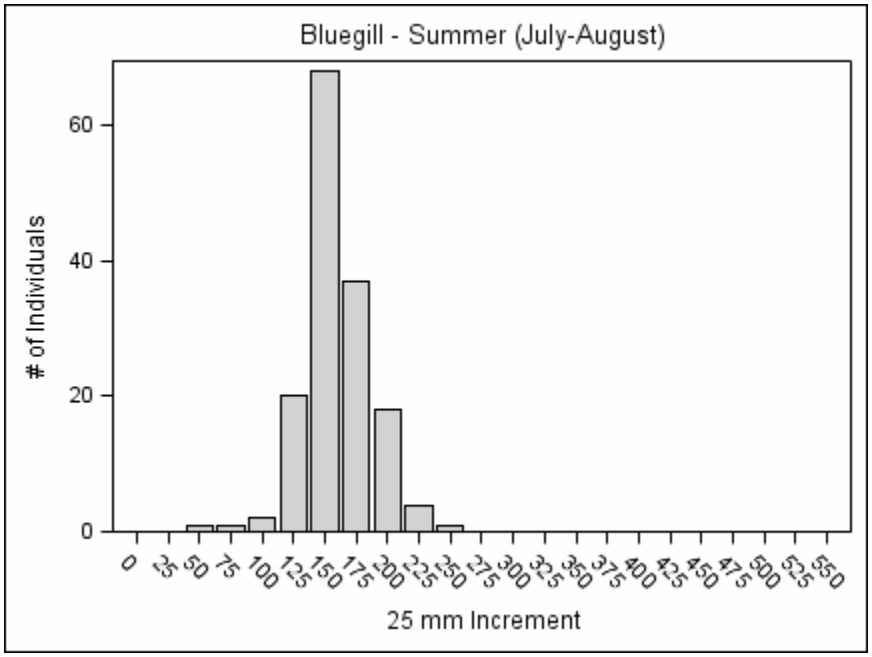

Figure 5.2-16. Length frequency distribution for Bluegill captured throughout the study area during July-August 2015.

Table 5.2.8. Life stage (YOY, juvenile, and adult) percentages for each fish species recorded during the summer sampling (July-August 2015) by river reach.

Family / Common Name	Life Stage	REACH[a]													
		WI		WR		BFI		BFB		BFR		VI		VR	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Catostomidae															
White Sucker	Adult	11	33.3			2	13.3					16	42.1	6	66.7
	Juvenile	4	12.1	4	4.2	5	33.3					16	42.1	3	33.3
	YOY	18	54.5	92	95.8	8	53.3	7	100.0	8	100.0	6	15.8		
	Total	33	100.0	96	100.0	15	100.0	7	100.0	8	100.0	38	100.0	9	100.0
Centrarchidae															
Black Crappie	Adult					5	71.4					2	66.7	2	100.0
	Juvenile					1	14.3					1	33.3		
	YOY					1	14.3								
	Total					7	100.0					3	100.0	2	100.0
Bluegill	Adult	4	100.0			22	100.0			9	100.0	83	95.4	29	100.0
	Juvenile			1	100.0							4	4.6		
	Total	4	100.0	1	100.0	22	100.0			9	100.0	87	100.0	29	100.0
Largemouth Bass	Adult					4	17.4					7	14.3		
	Juvenile			1	33.3	1	4.3			1	50.0	3	6.1		
	YOY	9	100.0	2	66.7	18	78.3	1	100.0	1	50.0	39	79.6		
	Total	9	100.0	3	100.0	23	100.0	1	100.0	2	100.0	49	100.0		
Pumpkinseed	Adult					19	95.0					10	76.9		
	Juvenile					1	5.0					3	23.1		
	YOY	1	100.0												
	Total	1	100.0			20	100.0					13	100.0		
Rock Bass	Adult	45	53.6	1	4.3	22	53.7			4	16.7	13	39.4	3	75.0
	Juvenile	28	33.3	14	60.9	19	46.3			20	83.3	18	54.5	1	25.0
	YOY	11	13.1	8	34.8							2	6.1		
	Total	84	100.0	23	100.0	41	100.0			24	100.0	33	100.0	4	100.0
Smallmouth Bass	Adult	22	57.9	2	1.9	39	54.2			2	1.5	11	47.8	13	39.4
	Juvenile	14	36.8	8	7.5	20	27.8	4	23.5	16	11.7	10	43.5	18	54.5
	YOY	2	5.3	97	90.7	13	18.1	13	76.5	119	86.9	2	8.7	2	6.1
	Total	38	100.0	107	100.0	72	100.0	17	100.0	137	100.0	23	100.0	33	100.0
Clupeidae															
American Shad	YOY									7	100.0			2	100.0
	Total									7	100.0			2	100.0

Family / Common Name	Life Stage	REACH[a]													
		WI		WR		BFI		BFB		BFR		VI		VR	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Cottidae															
Slimy Sculpin	Juvenile	4	57.1											1	25.0
	YOY	3	42.9									13	100.0	3	75.0
	Total	7	100.0									13	100.0	4	100.0
Cyprinidae															
Blacknose Dace	Juvenile	1	50.0	4	66.7										
	YOY	1	50.0	2	33.3					1	100.0				
	Total	2	100.0	6	100.0					1	100.0				
Bluntnose Minnow	Adult			2	66.7										
	Juvenile			1	33.3										
	Total			3	100.0										
Bridle Shiner	Adult	3	42.9												
	Juvenile	4	57.1												
	Total	7	100.0												
Common Carp	Adult											1	100.0	1	100.0
	Total											1	100.0	1	100.0
Common Shiner	Juvenile	4	100.0	1	100.0			1	100.0	12	100.0				
	Total	4	100.0	1	100.0			1	100.0	12	100.0				
Creek Chub	Adult											1	33.3		
	Juvenile	6	100.0	3	15.0							1	33.3		
	YOY			17	85.0							1	33.3		
	Total	6	100.0	20	100.0							3	100.0		
Eastern Silvery Minnow	Juvenile							1	100.0	3	100.0				
	Total							1	100.0	3	100.0				
Fallfish	Adult	10	10.4			5	21.7					15	16.5	1	100.0
	Juvenile	82	85.4	55	38.2	18	78.3			2	5.9	59	64.8		
	YOY	4	4.2	89	61.8			1	100.0	32	94.1	17	18.7		
	Total	96	100.0	144	100.0	23	100.0	1	100.0	34	100.0	91	100.0	1	100.0
Fathead Minnow	YOY			2	100.0										
	Total			2	100.0										
Finescale Dace	Adult			1	100.0										
	Total			1	100.0										
Golden Shiner	Adult											1	11.1		
	Juvenile	4	11.1			8	47.1								
	YOY	32	88.9	1	100.0	9	52.9			3	100.0	8	88.9	1	100.0
	Total	36	100.0	1	100.0	17	100.0			3	100.0	9	100.0	1	100.0

Family / Common Name	Life Stage	REACH[a]													
		WI		WR		BFI		BFB		BFR		VI		VR	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Longnose Dace	Adult	2	100.0	5	50.0			3	75.0	4	100.0				
	Juvenile			5	50.0			1	25.0						
	Total	2	100.0	10	100.0			4	100.0	4	100.0				
Rosyface Shiner	Juvenile			3	100.0										
	Total			3	100.0										
Spottail Shiner	Adult					3	5.8					32	50.8	1	25.0
	Juvenile	47	85.5	25	64.1	37	71.2			7	50.0	31	49.2	2	50.0
	YOY	8	14.5	14	35.9	12	23.1			7	50.0			1	25.0
	Total	55	100.0	39	100.0	52	100.0			14	100.0	63	100.0	4	100.0
Esocidae															
Chain Pickerel	Adult					1	33.3								
	Juvenile	2	100.0			1	33.3					1	100.0		
	YOY					1	33.3								
	Total	2	100.0			3	100.0					1	100.0		
Northern Pike	Adult	3	50.0			4	100.0					4	80.0		
	Juvenile	3	50.0									1	20.0	1	100.0
	Total	6	100.0			4	100.0					5	100.0	1	100.0
Fundulidae															
Banded Killifish	Adult									1	100.0				
	Juvenile	2	100.0												
	Total	2	100.0							1	100.0				
Gadidae															
Burbot	Juvenile									2	66.7				
	YOY									1	33.3				
	Total									3	100.0				
Ictaluridae															
Brown Bullhead	Adult					8	100.0								
	YOY							1	100.0						
	Total					8	100.0	1	100.0						
Channel Catfish	Adult											1	100.0	5	100.0
	Juvenile					1	100.0								
	Total					1	100.0					1	100.0	5	100.0
Moronidae															
White Perch	Adult											4	100.0		
	Total											4	100.0		

Family / Common Name	Life Stage	REACH[a]													
		WI		WR		BFI		BFB		BFR		VI		VR	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Percidae															
Tessellated Darter	Adult	27	69.2	39	27.9	11	61.1	4	80.0	33	52.4	7	30.4		
	Juvenile	9	23.1	92	65.7	6	33.3	1	20.0	28	44.4	10	43.5		
	YOY	3	7.7	9	6.4	1	5.6			2	3.2	6	26.1		
	Total	39	100.0	140	100.0	18	100.0	5	100.0	63	100.0	23	100.0		
Walleye	Adult											2	100.0		
	Juvenile	6	100.0			3	75.0							2	100.0
	YOY					1	25.0								
	Total	6	100.0			4	100.0					2	100.0	2	100.0
Yellow Perch	Adult	53	39.8			79	47.9			2	18.2	38	34.2	7	87.5
	Juvenile	40	30.1			57	34.5			4	36.4	50	45.0	1	12.5
	YOY	40	30.1	5	100.0	29	17.6			5	45.5	23	20.7		
	Total	133	100.0	5	100.0	165	100.0			11	100.0	111	100.0	8	100.0
Petromyzontidae															
Sea Lamprey	Juvenile			6	100.0							7	100.0	2	100.0
	Total			6	100.0							7	100.0	2	100.0
Salmonidae															
Brown Trout	YOY									1	100.0				
	Total									1	100.0				

5.3 Fall Fish Assemblage Sampling

5.3.1 Sampling Effort

Sampling effort for the fall (September-October) is presented in Table 5.3-1. When each of the seven geographic reaches is considered, a total of 43 boat electrofish samples, 35 portable electrofish samples, 40 gill net samples, 1 trap net sample, and 26 beach seine samples were conducted during the two month period.

Fall fish assemblage data was collected at all 69 mainstem locations specified in the Revised SSR, 9 of the 12 tributary locations and 1 of the 2 backwater locations. Three of the 12 tributary locations and 1 of the 2 backwater locations identified in the Revised SSR were not sampled due to a lack of water at the time of sampling (10-W121, backwater; 10-W140, stream order 1; 10-VR002, stream order -99) or the area originally identified from the National Hydrography Dataset could not be located within the 500-m map-unit in the field (10-W074, stream order 1).

A summary of field sampling effort (by season and gear type) is provided in Appendix B.

Table 5.3-1. Number of fish assemblage sample locations (by river reach) and number of completed samples (by gear type) for fall sampling (September-October 2015).

River Reach	No. Sample Locations (Study Design: Revised SSR)			No. Sample Locations where Sampling Occurred			# Collected Samples				
	Main-stem	Trib.	Back-water	Main-stem	Trib.	Back-water	Boat Efish	Portable Efish	Gill Net	Trap Net	Seine
Wilder impoundment	15	4	2	15	2	1	15	2	15	1	0
Wilder riverine	12	1	0	12	1	0	0	13	0	0	12
Bellows Falls impoundment	12	2	0	12	2	0	12	2	11	0	1
Bellows Falls bypassed reach	3	0	0	3	0	0	0	3	0	0	0
Bellows Falls riverine	12	1	0	12	1	0	0	13	0	0	12
Vernon impoundment	12	2	0	12	2	0	13	1	12	0	0
Vernon riverine	3	2	0	3	1	0	3	1	2	0	1
Total	**69**	**12**	**2**	**69**	**9**	**1**	**43**	**35**	**40**	**1**	**26**

5.3.2 Species Richness and Composition

A total of 3,839 fish representing 13 families and 36 species were collected during fall (September-October 2015) when all river reaches and sampling gears are considered (Table 5.3-2). Overall, Spottail Shiner (17.8%), Smallmouth Bass (17.4%), and Fallfish (11.4%) were the most abundant species collected during the fall. When examined by river reach, the most frequently collected fish species were Spottail Shiner (Wilder impoundment, Bellows Falls impoundment), Smallmouth Bass (Wilder riverine, Vernon riverine), Longnose Dace (Bellows Falls bypassed reach), Fallfish (Bellows Falls riverine), and Golden Shiner (Vernon impoundment).

Table 5.3-3 presents the total catch and percent composition of fish catch by sampling gear during the fall. For all river reaches combined, 2,011 individuals representing 9 families and 27 species were captured by boat electrofish, 1,729 individuals representing 10 families and 28 species were captured by portable electrofish, 42 individuals representing 7 families and 9 species were captured by gillnet, 10 individuals representing 2 families and 5 species were captured by trap net, and 47 individuals representing 4 families and 8 species were captured by beach seine. When examined by gear type, the most frequently collected fish species were Spottail Shiner (boat electrofish) Smallmouth Bass (portable electrofish), White Sucker (gill net), and Fallfish (beach seine). Fish catch in the trap nets during the fall sampling period was limited to Largemouth Bass, Rock Bass, Pumpkinseed, Bluegill, and Walleye.

Table 5.3-4 presents the total catch and percent composition of fish catch by substrate/habitat type during the fall. For all river reaches combined, 1,480 individuals representing 11 families and 30 species were captured in areas of sand-silt-clay substrate, 1,201 individuals representing 10 families and 30 species were captured in areas of gravel-cobble substrate, 635 individuals representing 7 families and 23 species were captured in areas of boulder, 513 individuals representing 8 families and 19 species were captured in the project-affected portions of sampled tributaries and 10 individuals representing 2 families and 5 species were captured in the sampled backwaters. When examined by substrate/habitat, Spottail Shiner was the most frequently collected fish species in areas of sand-silt-clay as well as boulder, and Smallmouth Bass was the most commonly collected fish species in areas of gravel-cobble. Blacknose Dace were the most frequently collected fish species in the project-affected portions of sampled tributaries and Largemouth Bass was the most commonly collected fish species in backwater habitat.

Section 5.4 includes graphical representations of percent composition for all sampling seasons combined, and Appendix J provides additional graphical representations for spring sampling by gear types combined and separately.

Table 5.3-2. Total catch (N) and percent composition (%) during fall (September-October 2015) by river reach with all sampling gears pooled.

Family / Common Name	REACH														ALL	
	WI		WR		BFI		BFB		BFR		VI		VR			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Anguillidae																
American Eel	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	1.4	3	0.1
Catostomidae																
Longnose Sucker	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
White Sucker	36	5.2	15	3.3	50	3.9	1	1.0	20	2.7	13	3.1	15	10.7	150	3.9
Centrarchidae																
Black Crappie	0	0.0	0	0.0	7	0.5	1	1.0	0	0.0	15	3.6	0	0.0	23	0.6
Bluegill	15	2.2	2	0.4	2	0.2	0	0.0	6	0.8	47	11.2	4	2.9	76	2.0
Largemouth Bass	41	6.0	0	0.0	10	0.8	0	0.0	4	0.5	37	8.9	0	0.0	92	2.4
Pumpkinseed	9	1.3	0	0.0	15	1.2	0	0.0	0	0.0	8	1.9	0	0.0	32	0.8
Rock Bass	56	8.2	22	4.8	81	6.3	3	3.1	40	5.3	9	2.2	4	2.9	215	5.6
Smallmouth Bass	38	5.5	254	55.7	134	10.4	26	26.5	148	19.8	27	6.5	41	29.3	668	17.4
Clupeidae																
American Shad	0	0.0	0	0.0	0	0.0	0	0.0	10	1.3	16	3.8	17	12.1	43	1.1
Cottidae																
Slimy Sculpin	0	0.0	2	0.4	1	0.1	0	0.0	0	0.0	0	0.0	5	3.6	8	0.2
Cyprinidae																
Blacknose Dace	0	0.0	7	1.5	118	9.1	0	0.0	0	0.0	0	0.0	0	0.0	125	3.3
Blacknose Shiner	50	7.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	50	1.3
Bluntnose Minnow	9	1.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	9	0.2
Bridle Shiner	1	0.1	0	0.0	4	0.3	0	0.0	0	0.0	0	0.0	0	0.0	5	0.1
Common Carp	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	0.7	1	0.7	4	0.1
Common Shiner	1	0.1	0	0.0	1	0.1	0	0.0	119	15.9	0	0.0	0	0.0	121	3.2
Creek Chub	12	1.7	1	0.2	27	2.1	0	0.0	4	0.5	2	0.5	0	0.0	46	1.2

Family / Common Name	REACH														ALL	
	WI		WR		BFI		BFB		BFR		VI		VR			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Cutlips Minnow	0	0.0	1	0.2	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0	2	0.1
Eastern Silvery Minnow	0	0.0	0	0.0	0	0.0	0	0.0	22	2.9	34	8.1	0	0.0	56	1.5
Fallfish	82	11.9	24	5.3	123	9.5	1	1.0	164	21.9	34	8.1	10	7.1	438	11.4
Fathead Minnow	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Finescale Dace	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Golden Shiner	58	8.4	0	0.0	80	6.2	0	0.0	17	2.3	86	20.6	0	0.0	241	6.3
Lake Chub	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Longnose Dace	0	0.0	19	4.2	16	1.2	54	55.1	1	0.1	0	0.0	0	0.0	90	2.3
Mimic Shiner	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Rosyface Shiner	0	0.0	0	0.0	18	1.4	0	0.0	5	0.7	1	0.2	1	0.7	25	0.7
Spottail Shiner	94	13.7	8	1.8	509	39.4	0	0.0	26	3.5	28	6.7	17	12.1	682	17.8
Esocidae																
Chain Pickerel	3	0.4	0	0.0	1	0.1	0	0.0	1	0.1	0	0.0	0	0.0	5	0.1
Northern Pike	10	1.5	0	0.0	6	0.5	0	0.0	0	0.0	2	0.5	1	0.7	19	0.5
Fundulidae																
Banded Killifish	1	0.1	0	0.0	0	0.0	1	1.0	2	0.3	0	0.0	6	4.3	10	0.3
Gadidae																
Burbot	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Ictaluridae																
Brown Bullhead	1	0.1	0	0.0	1	0.1	1	1.0	3	0.4	1	0.2	0	0.0	7	0.2
Channel Catfish	0	0.0	0	0.0	0	0.0	0	0.0	2	0.3	1	0.2	3	2.1	6	0.2
Yellow Bullhead	0	0.0	0	0.0	0	0.0	0	0.0	6	0.8	0	0.0	0	0.0	6	0.2
Moronidae																
White Perch	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	0.7	0	0.0	3	0.1
Percidae																
Tessellated Darter	80	11.6	93	20.4	11	0.9	10	10.2	146	19.5	2	0.5	2	1.4	344	9.0
Walleye	6	0.9	0	0.0	5	0.4	0	0.0	0	0.0	1	0.2	0	0.0	12	0.3

Family / Common Name	REACH														ALL	
	WI		WR		BFI		BFB		BFR		VI		VR			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Yellow Perch	83	12.1	0	0.0	68	5.3	0	0.0	3	0.4	48	11.5	11	7.9	213	5.5
Petromyzontidae																
Sea Lamprey	0	0.0	8	1.8	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0	9	0.2
Salmonidae																
Brook Trout	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Brown Trout	0	0.0	0	0.0	1	0.1	0	0.0	0	0.0	0	0.0	0	0.0	1	0.0
Total Individuals	**687**		**456**		**1291**		**98**		**749**		**418**		**140**		**3839**	
Total Families	**8**		**6**		**9**		**6**		**8**		**8**		**10**		**13**	
Taxa Richness	**22**		**13**		**26**		**9**		**21**		**22**		**16**		**36**	

Table 5.3-3. Total catch (N) and percent composition (%) during fall (September-October 2015) by sampling gear.

Family / Common Name	Sampling Gear									
	BEF		PEF		GN		TN		BS	
	N	%	N	%	N	%	N	%	N	%
Anguillidae										
American Eel	3	0.1	0	0.0	0	0.0	0.0	0.0	0	0.0
Catostomidae										
Longnose Sucker	0	0.0	0	0.0	0	0.0	0.0	0.0	0	0.0
White Sucker	43	2.1	89	5.1	18	42.9	0.0	0.0	0	0.0
Centrarchidae										
Black Crappie	22	1.1	1	0.1	0	0.0	0.0	0.0	0	0.0
Bluegill	54	2.7	21	1.2	0	0.0	1.0	10.0	0	0.0
Largemouth Bass	72	3.6	16	0.9	0	0.0	4.0	40.0	0	0.0
Pumpkinseed	30	1.5	0	0.0	0	0.0	2.0	20.0	0	0.0
Rock Bass	135	6.7	71	4.1	6	14.3	2.0	20.0	1	2.1
Smallmouth Bass	217	10.8	438	25.3	2	4.8	0.0	0.0	11	23.4
Clupeidae										
American Shad	33	1.6	0	0.0	0	0.0	0.0	0.0	10	21.3
Cottidae										
Slimy Sculpin	0	0.0	8	0.5	0	0.0	0.0	0.0	0	0.0
Cyprinidae										
Blacknose Dace	0	0.0	125	7.2	0	0.0	0.0	0.0	0	0.0
Blacknose Shiner	1	0.0	49	2.8	0	0.0	0.0	0.0	0	0.0
Bluntnose Minnow	0	0.0	9	0.5	0	0.0	0.0	0.0	0	0.0
Bridle Shiner	5	0.2	0	0.0	0	0.0	0.0	0.0	0	0.0
Common Carp	4	0.2	0	0.0	0	0.0	0.0	0.0	0	0.0
Common Shiner	2	0.1	119	6.9	0	0.0	0.0	0.0	0	0.0
Creek Chub	16	0.8	30	1.7	0	0.0	0.0	0.0	0	0.0
Cutlips Minnow	1	0.0	1	0.1	0	0.0	0.0	0.0	0	0.0
Eastern Silvery Minnow	34	1.7	21	1.2	0	0.0	0.0	0.0	1	2.1
Fallfish	161	8.0	253	14.6	6	14.3	0.0	0.0	18	38.3
Fathead Minnow	0	0.0	0	0.0	0	0.0	0.0	0.0	0	0.0
Finescale Dace	0	0.0	0	0.0	0	0.0	0.0	0.0	0	0.0
Golden Shiner	219	10.9	22	1.3	0	0.0	0.0	0.0	0	0.0
Lake Chub	0	0.0	0	0.0	0	0.0	0.0	0.0	0	0.0
Longnose Dace	0	0.0	90	5.2	0	0.0	0.0	0.0	0	0.0
Mimic Shiner	0	0.0	0	0.0	0	0.0	0.0	0.0	0	0.0
Rosyface Shiner	20	1.0	5	0.3	0	0.0	0.0	0.0	0	0.0
Spottail Shiner	645	32.1	35	2.0	0	0.0	0.0	0.0	2	4.3

Family / Common Name	Sampling Gear									
	BEF		PEF		GN		TN		BS	
	N	%	N	%	N	%	N	%	N	%
Esocidae										
Chain Pickerel	4	0.2	1	0.1	0	0.0	0.0	0.0	0	0.0
Northern Pike	18	0.9	0	0.0	1	2.4	0.0	0.0	0	0.0
Fundulidae										
Banded Killifish	1	0.0	9	0.5	0	0.0	0.0	0.0	0	0.0
Gadidae										
Burbot	0	0.0	0	0.0	0	0.0	0.0	0.0	0	0.0
Ictaluridae										
Brown Bullhead	2	0.1	4	0.2	1	2.4	0.0	0.0	0	0.0
Channel Catfish	0	0.0	2	0.1	4	9.5	0.0	0.0	0	0.0
Yellow Bullhead	0	0.0	6	0.3	0	0.0	0.0	0.0	0	0.0
Moronidae										
White Perch	0	0.0	0	0.0	3	7.1	0.0	0.0	0	0.0
Percidae										
Tessellated Darter	61	3.0	280	16.2	0	0.0	0.0	0.0	3	6.4
Walleye	10	0.5	0	0.0	1	2.4	1.0	10.0	0	0.0
Yellow Perch	198	9.8	14	0.8	0	0.0	0.0	0.0	1	2.1
Petromyzontidae										
Sea Lamprey	0	0.0	9	0.5	0	0.0	0.0	0.0	0	0.0
Salmonidae										
Brook Trout	0	0.0	0	0.0	0	0.0	0.0	0.0	0	0.0
Brown Trout	0	0.0	1	0.1	0	0.0	0.0	0.0	0	0.0
Total Individuals	**2011**		**1729**		**42**		**10**		**47**	
Total Families	**9**		**10**		**7**		**2**		**4**	
Taxa Richness	**27**		**28**		**9**		**5**		**8**	

Table 5.3-4. Total catch (N) and percent composition (%) during fall (September-October 2015) by substrate/habitat type.

Family / Common Name	Substrate / Habitat Type									
	SSC		CG		BLD		TRB		BW	
	N	%	N	%	N	%	N	%	N	%
Anguillidae										
American Eel	2	0.1	1	0.1	0	0.0	0	0.0	0	0.0
Catostomidae										
Longnose Sucker	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
White Sucker	45	3.0	34	2.8	10	1.6	61	11.9	0	0.0
Centrarchidae										
Black Crappie	15	1.0	2	0.2	6	0.9	0	0.0	0	0.0
Bluegill	19	1.3	22	1.8	19	3.0	15	2.9	1	10.0
Largemouth Bass	49	3.3	14	1.2	13	2.0	12	2.3	4	40.0
Pumpkinseed	23	1.6	1	0.1	6	0.9	0	0.0	2	20.0
Rock Bass	78	5.3	69	5.7	59	9.3	7	1.4	2	20.0
Smallmouth Bass	162	10.9	325	27.1	159	25.0	22	4.3	0	0.0
Clupeidae										
American Shad	23	1.6	17	1.4	3	0.5	0	0.0	0	0.0
Cottidae										
Slimy Sculpin	0	0.0	0	0.0	0	0.0	8	1.6	0	0.0
Cyprinidae										
Blacknose Dace	0	0.0	2	0.2	0	0.0	123	24.0	0	0.0
Blacknose Shiner	1	0.1	0	0.0	0	0.0	49	9.6	0	0.0
Bluntnose Minnow	0	0.0	0	0.0	0	0.0	9	1.8	0	0.0
Bridle Shiner	5	0.3	0	0.0	0	0.0	0	0.0	0	0.0
Common Carp	1	0.1	3	0.2	0	0.0	0	0.0	0	0.0
Common Shiner	1	0.1	119	9.9	1	0.2	0	0.0	0	0.0
Creek Chub	14	0.9	1	0.1	2	0.3	29	5.7	0	0.0
Cutlips Minnow	0	0.0	1	0.1	1	0.2	0	0.0	0	0.0
Eastern Silvery Minnow	27	1.8	28	2.3	1	0.2	0	0.0	0	0.0
Fallfish	134	9.1	187	15.6	34	5.4	83	16.2	0	0.0
Fathead Minnow	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Finescale Dace	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Golden Shiner	206	13.9	27	2.2	3	0.5	5	1.0	0	0.0
Lake Chub	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Longnose Dace	0	0.0	10	0.8	54	8.5	26	5.1	0	0.0
Mimic Shiner	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Rosyface Shiner	7	0.5	13	1.1	5	0.8	0	0.0	0	0.0
Spottail Shiner	368	24.9	130	10.8	183	28.8	1	0.2	0	0.0
Esocidae										
Chain Pickerel	4	0.3	1	0.1	0	0.0	0	0.0	0	0.0
Northern Pike	17	1.1	2	0.2	0	0.0	0	0.0	0	0.0
Fundilidae										
Banded Killifish	1	0.1	1	0.1	1	0.2	7	1.4	0	0.0
Gadidae										
Burbot	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Ictaluridae										
Brown Bullhead	3	0.2	3	0.2	1	0.2	0	0.0	0	0.0
Channel Catfish	3	0.2	2	0.2	1	0.2	0	0.0	0	0.0
Yellow Bullhead	3	0.2	3	0.2	0	0.0	0	0.0	0	0.0
Moronidae										
White Perch	3	0.2	0	0.0	0	0.0	0	0.0	0	0.0

Family / Common Name	Substrate/Habitat Type									
	SSC		CG		BLD		TRB		BW	
	N	%	N	%	N	%	N	%	N	%
Percidae										
Tessellated Darter	108	7.3	148	12.3	45	7.1	43	8.4	0	0.0
Walleye	9	0.6	1	0.1	1	0.2	0	0.0	1	10.0
Yellow Perch	148	10.0	27	2.2	27	4.3	11	2.1	0	0.0
Petromyzontidae										
Sea Lamprey	1	0.1	7	0.6	0	0.0	1	0.2	0	0.0
Salmonidae										
Brook Trout	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Brown Trout	0	0.0	0	0.0	0	0.0	1	0.2	0	0.0
Total Individuals	**1480**		**1201**		**635**		**513**		**10**	
Total Families	**11**		**10**		**7**		**8**		**2**	
Taxa Richness	**30**		**30**		**23**		**19**		**5**	

5.3.3 Diversity

Table 5.3-5 presents a summary of species richness, Shannon diversity, and evenness values for the fall fish assemblage as described by the catch from all sampling gears within each river reach. During the fall, fish community diversity and evenness was highest in samples collected within the Wilder impoundment. Diversity was lowest within the Bellows Falls bypassed reach. Community evenness was lowest within the Wilder riverine and Bellows Falls bypassed reaches. Lower values at those locations were likely a function of the high proportional contribution of Smallmouth Bass and Tessellated Darter in the Wilder riverine reach, and Longnose Dace and Smallmouth Bass in the Bellows Falls bypassed reach as well as reduced habitat diversity there relative to other river reaches. Section 5.4 includes graphical representations of species richness, diversity, and evenness in various combinations of sampling season, river reach, sampling gear, and substrate/habitat type.

Table 5.3-5. Species richness, diversity, and evenness of the fish community by river reach for the fall (September-October 2015) sampling for all gears combined).

River Reach	Richness	Diversity	Evenness
Wilder impoundment	21	2.56	0.84
Wilder riverine	19	1.48	0.50
Bellows Falls impoundment	17	2.13	0.75
Bellows Falls bypassed reach	9	1.25	0.57
Bellows Falls riverine	18	2.19	0.76
Vernon impoundment	21	2.52	0.83
Vernon riverine	16	2.27	0.82
All Reaches	36	2.68	0.75

When examined by sampling gear, diversity within the observed fish assemblage for the fall sampling was highest for the boat and portable electrofish methods (Table 5.3-6).

Table 5.3-6. Species richness, diversity, and evenness of the fish community by river reach and sampling gear for the fall (September-October 2015) sampling.

Gear	Metric	Reach[a]							ALL
		WI	WR	BFI	BFB	BFR	VI	VR	
BEF	Richness	21	-	21	-	-	19	13	27
	Diversity	2.34	-	1.76	-	-	2.46	1.94	2.33
	Evenness	0.77	-	0.58	-	-	0.83	0.76	0.71
PEF	Richness	10	13	9	9	20	3	4	28
	Diversity	2.02	1.46	1.48	1.25	2.15	0.94	1.12	2.43
	Evenness	0.88	0.57	0.67	0.57	0.72	0.85	0.81	0.73
GN	Richness	4	-	5	-	-	6	3	9
	Diversity	1.07	-	1.49	-	-	1.67	0.94	1.74
	Evenness	0.77	-	0.93	-	-		0.85	0.79
BS	Richness	-	3	-	-	5	-	3	8
	Diversity	-	1.07	-	-	1.32	-	0.80	1.59
	Evenness	-	0.97	-	-	0.82	-	0.73	0.77
TN	Richness	5	-	-	-	-	-	-	5
	Diversity	1.47	-	-	-	-	-	-	1.47
	Evenness	0.91	-	-	-	-	-	-	0.91

a. A dash indicates gear type was not fished within a particular river reach.

Table 5.3-7 presents a summary of species richness, Shannon diversity, and evenness values for the fall fish assemblage by substrate/habitat type and riverine reach as described by the catch of all sampling gears. Community diversity was highest within sand-silt-clay, gravel-cobble, and the project-affected reaches of sampled tributaries and lowest within sampled backwater habitat. Evenness was highest within the backwater and tributary habitat types and lowest within the sand-silt-clay, gravel-cobble, and boulder substrate types. The lower values of evenness were likely influenced by the high proportional contribution of Spottail Shiner within samples collected over sand-silt-clay and boulder and by the high proportional contribution of Smallmouth Bass within samples collected over gravel-cobble.

Table 5.3-7. Species richness, diversity, and evenness of the fish community by river reach and substrate/habitat type for the fall (September-October 2015) sampling.

Substrate / Habitat	Metric	Reach[a]							ALL
		WI	WR	BFI	BFB	BFR	VI	VR	
SSC	Richness	21	6	19	-	10	19	9	30
	Diversity	2.39	1.20	1.90	-	1.57	2.35	1.98	2.45
	Evenness	0.79	0.67	0.65	-	0.68	0.80	0.90	0.72
GC	Richness	8	9	11	-	20	15	13	30
	Diversity	1.74	1.35	1.35	-	2.16	2.38	1.87	2.35
	Evenness	0.84	0.61	0.56	-	0.72	0.88	0.73	0.69

Substrate / Habitat	Metric	Reach[a]							ALL
		WI	WR	BFI	BFB	BFR	VI	VR	
BLD	Richness	9	7	14	9	-	14	-	23
	Diversity	1.78	0.95	1.43	1.25	-	2.33	-	2.13
	Evenness	0.81	0.49	0.54	0.57	-	0.88	-	0.68
TRB	Richness	10	8	9	-	2	4	4	19
	Diversity	2.02	1.88	1.48	-	0.56	1.16	1.12	2.38
	Evenness	0.88	0.90	0.67	-	0.81	0.84	0.81	0.81
BW	Richness	5	-	-	-	-	-	-	5
	Diversity	1.47	-	-	-	-	-	-	1.47
	Evenness	0.91	-	-	-	-	-	-	0.91

a. A dash indicates substrate/habitat type was not fished within a particular river reach.

5.3.4 Relative Abundance

Fall Summer CPUE values for each of the 43 species observed are presented in tabular format by species, river reach, sampling gear, and substrate/habitat type in Appendix C, and in Appendix H in graphical format.

To facilitate a more direct comparison among active sampling gears, CPUA values were generated for all fish species during the fall and were scaled to the number of individuals per $100m^2$. The exclusion of passive sampling gears from the evaluation of CPUA values observed for the fall sampling was not expected to have a significant impact as total catch from gill net and trap net sampling (combined) generated a total of catch of only 52 individuals (1.2% of the total fall catch). Spottail Shiner, Smallmouth Bass, Fallfish, Tessellated Darter, Golden Shiner, Rock Bass, Yellow Perch, White Sucker, and Blacknose Dace comprised approximately 80% of the total catch (all river reaches and active sampling gears, combined) during the fall sampling. CPUA values for those nine species are presented in Figures 5.3-1 through 5.3-9 and for all species in Appendix D in tabular format, and in Appendix I in graphical format.

When visually observed by substrate/habitat type and river reach, Spottail Shiner were present to some degree over the majority of sampled mainstem substrate/habitat types within each river reach (Figure 5.3-1). Fall CPUA values for Spottail Shiner were highest in sand-silt-clay and boulder in the Bellows Falls impoundment and gravel-cobble in the Vernon riverine reach. With the exception of tributary habitat in four of the reaches, Smallmouth Bass were present within all mainstem substrate/habitat types sampled in each of the seven river reaches during the fall (Figure 5.3-2). Mean fall CPUA numbers were highest in the Bellows Falls bypassed reach, and the Wilder, Bellows Falls, and Vernon riverine reaches. Fallfish were present to some degree over the majority of sampled mainstem substrate/habitat types within each river reach (Figure 5.3-3). Mean fall CPUA values were highest for Fallfish in gravel-cobble within the Wilder, Bellows Falls, and Vernon riverine reaches; and in tributary habitat within the Bellows Falls impoundment. Tessellated Darter were collected in each of the seven river reaches

sampled during fall with the mean fall CPUA values highest within tributary habitat in the Wilder impoundment and riverine reach and the Bellows Falls riverine reach (Figure 5.3-4). Golden Shiner were most abundant (as indicated by mean CPUA values) in areas of sand-silt-clay within the three impoundments and tributary habitat within the Vernon impoundment (Figure 5.3-5). Rock Bass were present within all mainstem substrate/habitat types and were present in each of the seven river reaches during the fall sampling (Figure 5.3-6). Mean fall CPUA values for Yellow Perch were highest in the three impoundments and the Vernon riverine reach (Figure 5.3-7). Although somewhat limited in tributary habitat, the species was observed in all mainstem substrate/habitat types. White Sucker were present to some degree within each of the seven river reaches during the fall (Figure 5.3-8). Mean fall CPUA values were highest for White Sucker in tributary habitat within the three impoundments and the Wilder riverine reach. Mainstem observations of Blacknose Dace were limited to the Wilder riverine reach (Figure 5.3-9). The highest mean fall CPUA values for Blacknose Dace were from tributary habitat in the Wilder riverine reach and Bellows Falls impoundment.

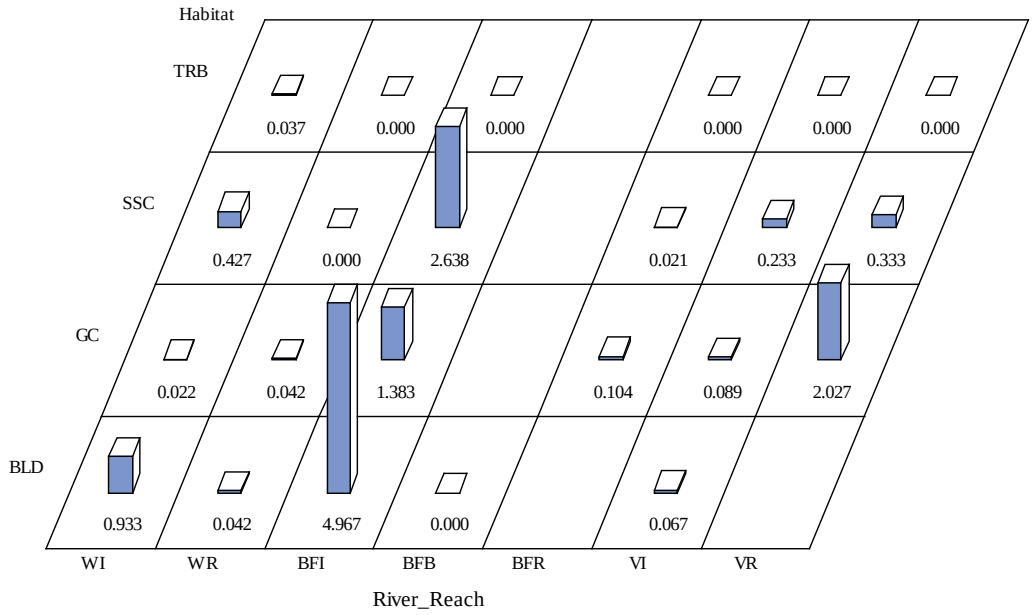

Figure 5.3-1. Mean CPUA values (# individuals/100 m^2) for Spottail Shiner by river reach and substrate/habitat type for the fall (September-October 2015) sampling.

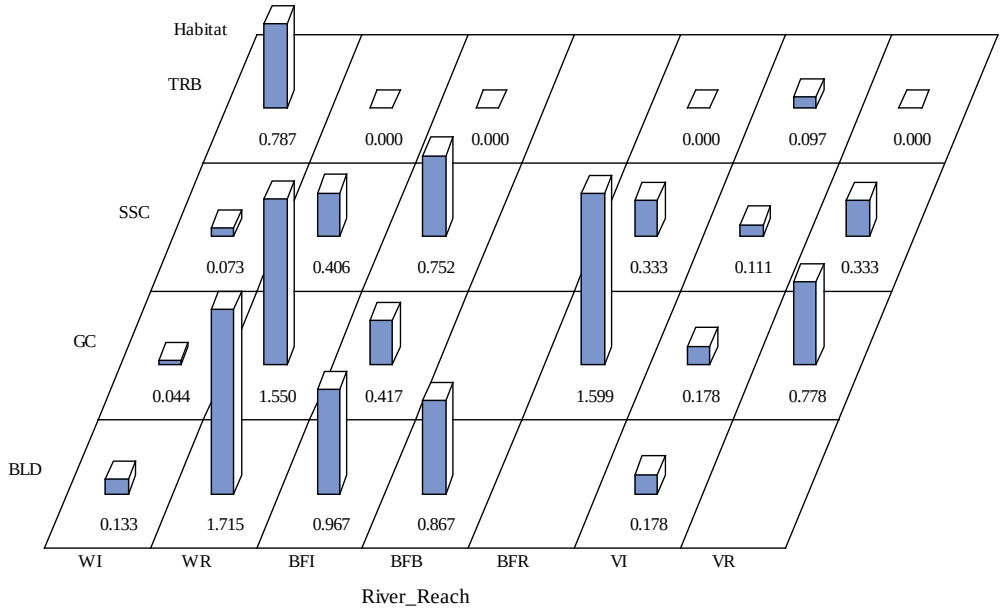

Figure 5.3-2. Mean CPUA values (# individuals/100 m^2) for Smallmouth Bass by river reach and substrate/habitat type for the fall (September-October 2015) sampling.

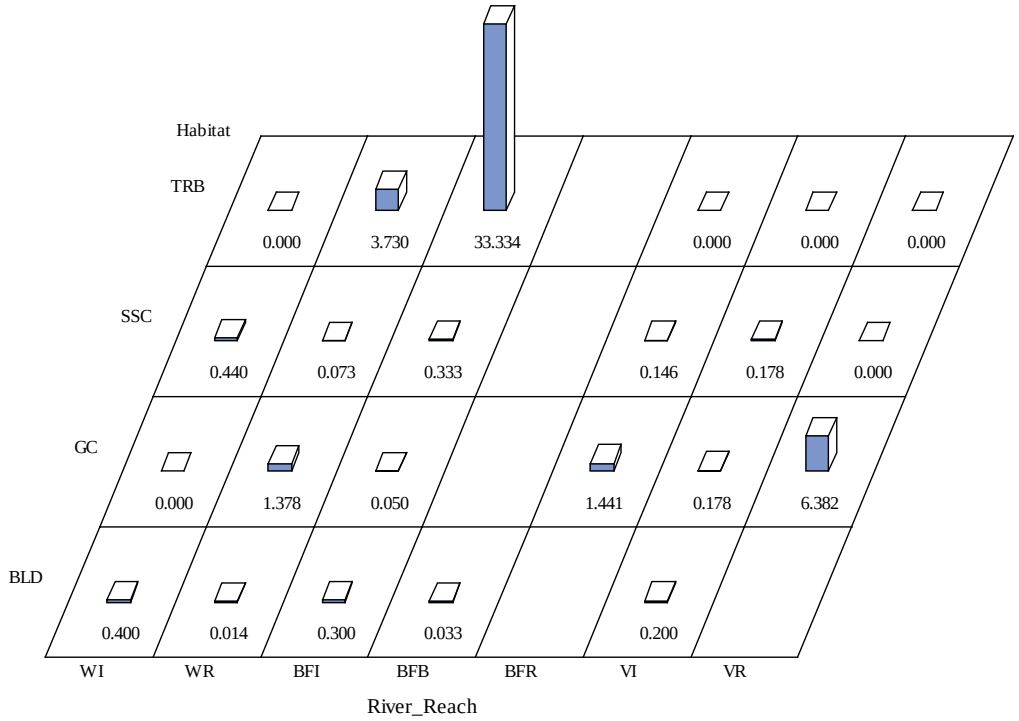

Figure 5.3-3. Mean CPUA values (# individuals/100 m^2) for Fallfish by river reach and substrate/habitat type for the fall (September-October 2015) sampling.

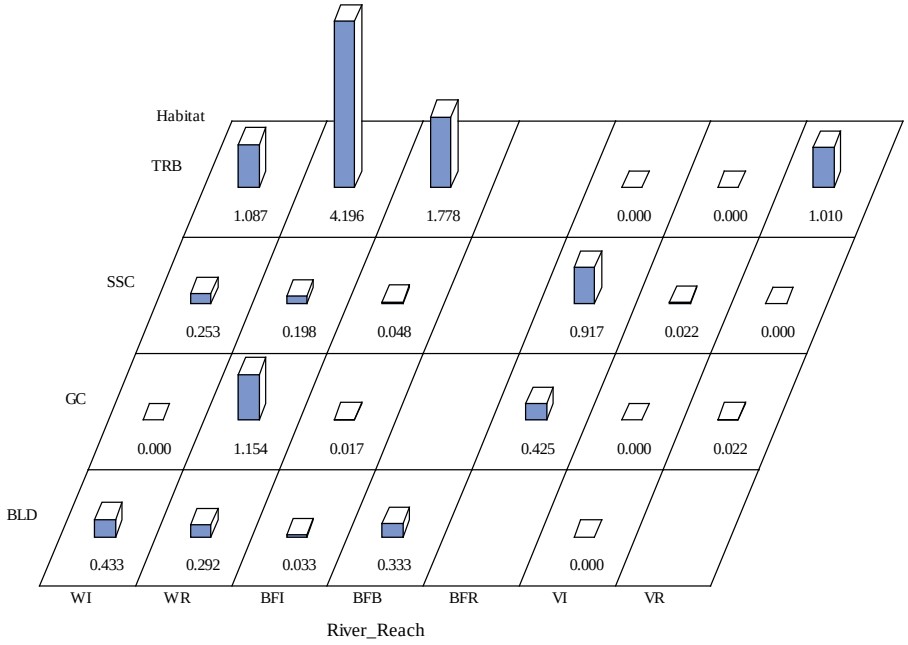

Figure 5.3-4. Mean CPUA values (# individuals/100 m^2) for Tessellated Darter by river reach and substrate/habitat type for the fall (September-October 2015) sampling.

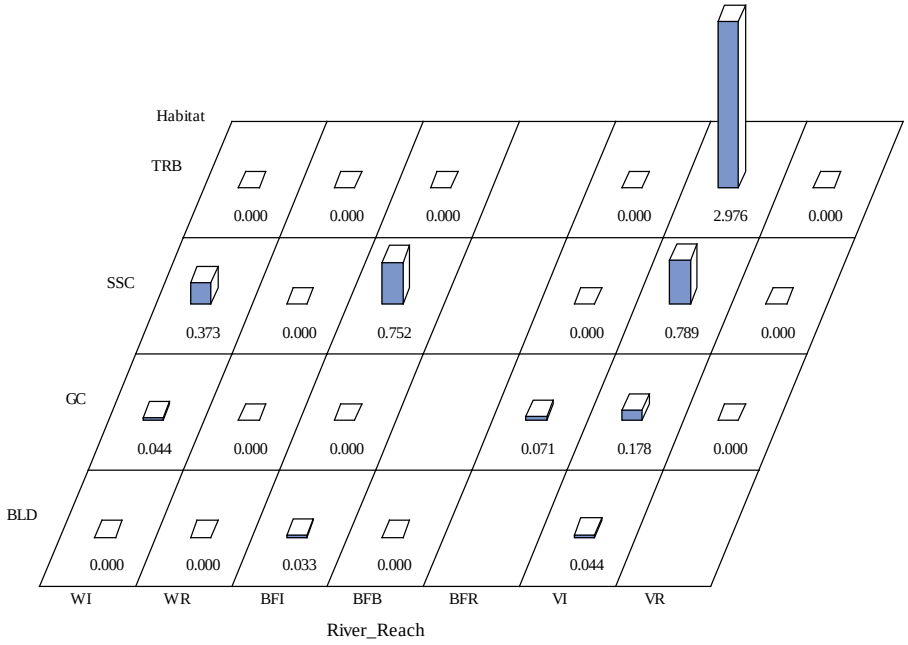

Figure 5.3-5. Mean CPUA values (# individuals/100 m^2) for Golden Shiner by river reach and substrate/habitat type for the fall (September-October 2015) sampling.

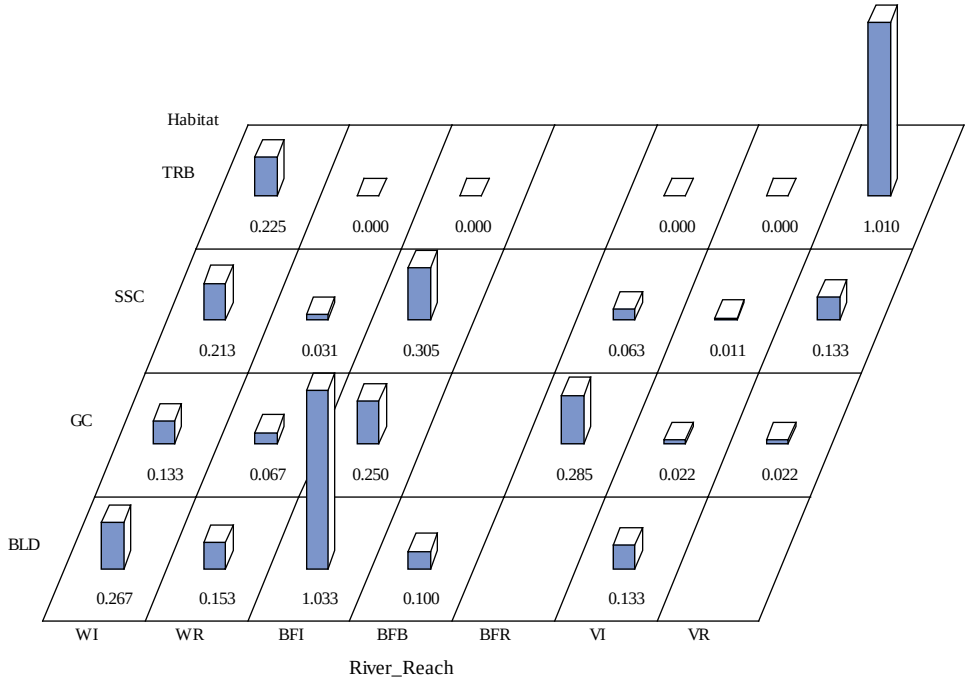

Figure 5.3-6. Mean CPUA values (# individuals/100 m^2) for Rock Bass by river reach and substrate/habitat type for the fall (September-October 2015) sampling.

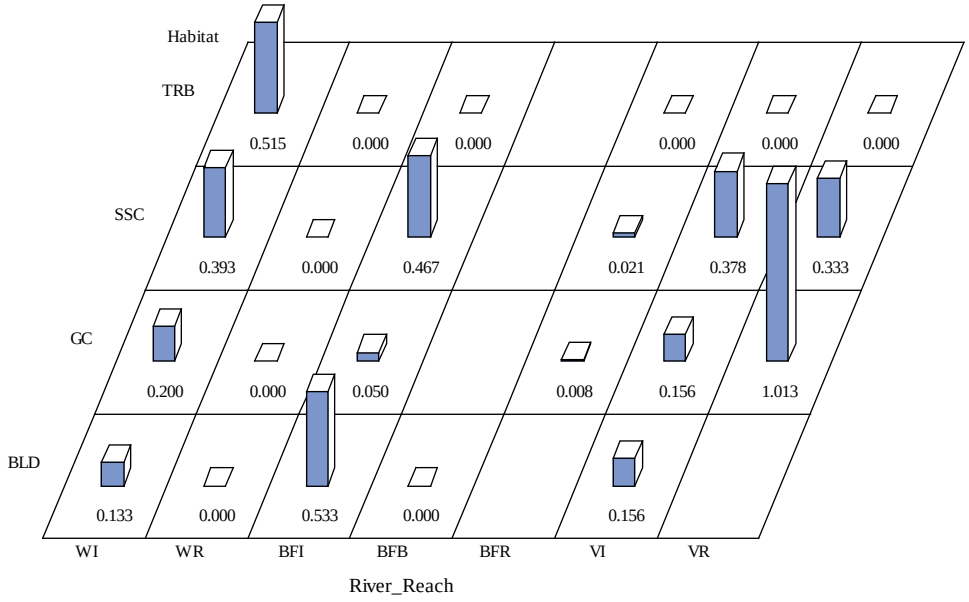

Figure 5.3-7. Mean CPUA values (# individuals/100 m^2) for Yellow Perch by river reach and substrate/habitat type for the fall (September-October 2015) sampling.

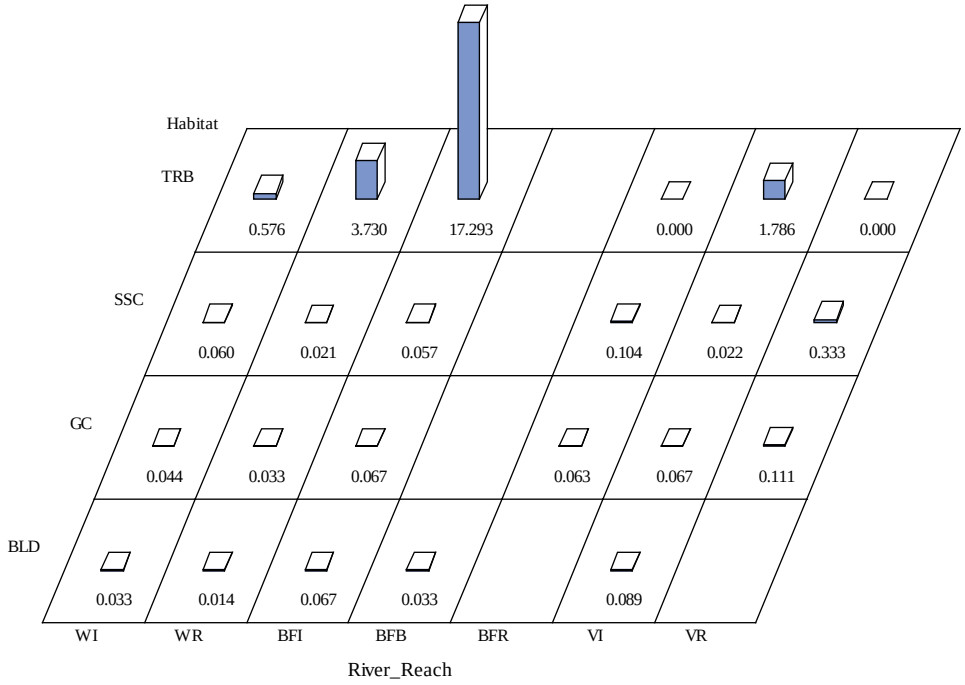

Figure 5.3-8. Mean CPUA values (# individuals/100 m^2) for White Sucker by river reach and substrate/habitat type for the fall (September-October 2015) sampling.

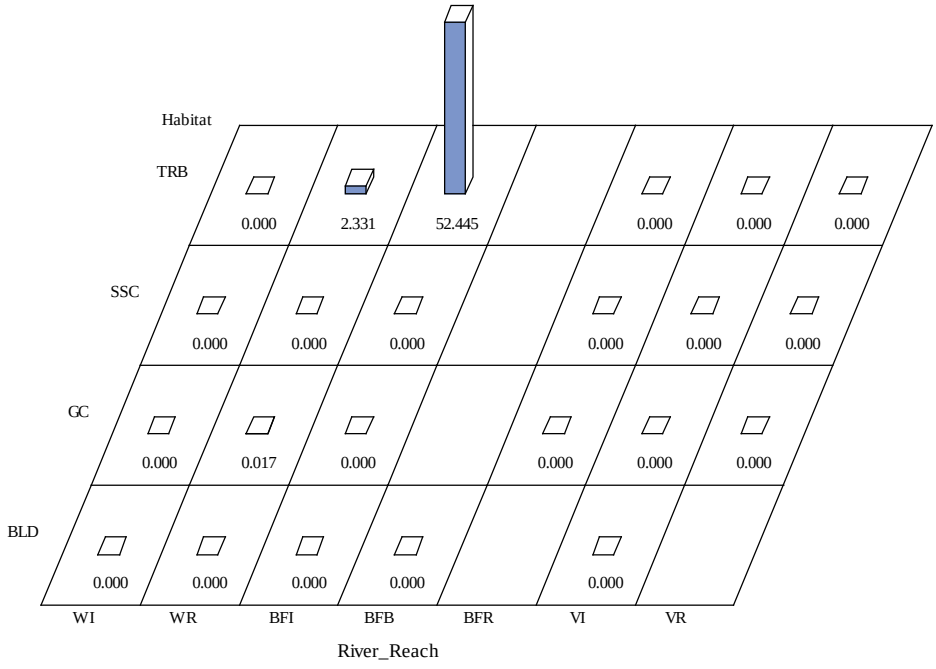

Figure 5.3-9. Mean CPUA values (# individuals/100 m^2) for Blacknose Dace by river reach and substrate/habitat type for the fall (September-October 2015) sampling.

5.3.5 Size Distributions

Length frequency distributions for seven of the most frequently captured fish species during the fall sampling (Smallmouth Bass, Tessellated Darter, Fallfish, Rock Bass, Spottail Shiner, Yellow Perch, and White Sucker) are presented in Figures 5.3-10 through 5.3-16. A full listing of all available fish length information by species, river reach, sampling gear and map-unit substrate/habitat type is provided in Appendix A. The observed range of recorded body lengths presented in Figures 5.3-1 through 5.3-7 are within the bounds of those reported for each of the seven fish species in Vermont (Langdon et al., 2006).

Table 5.3-8 presents the distribution of catch among the YOY, juvenile and adult age classes (as defined using criteria presented in Table 4.2-3) for species within each of the seven river reaches sampled during the fall. The majority of catch during the fall was comprised of young fish (37% YOY and 37% juvenile). Adult fish constituted the remainder of the catch (26%).

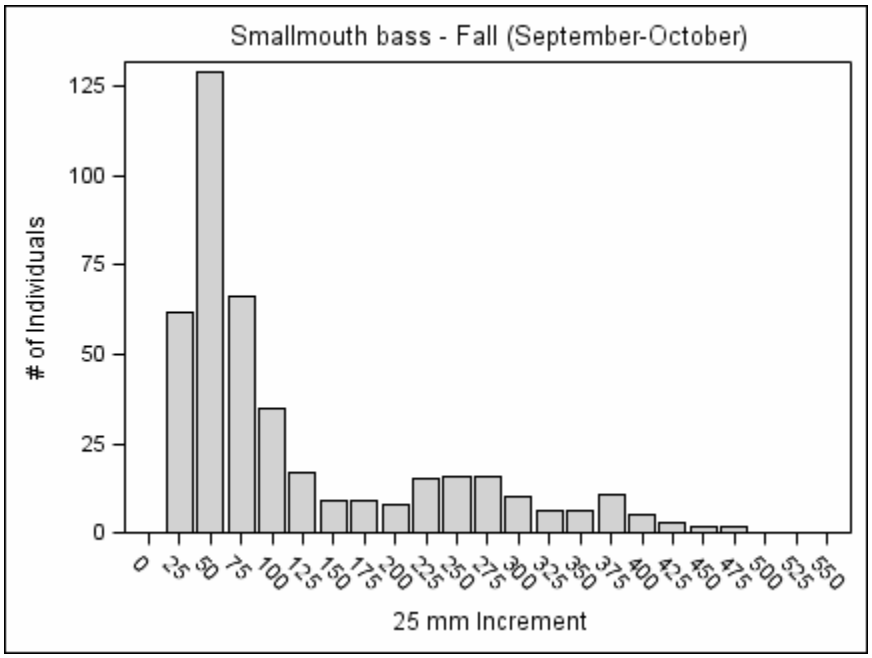

Figure 5.3-10. Length frequency distribution for Smallmouth Bass captured throughout the study area during September-October 2015.

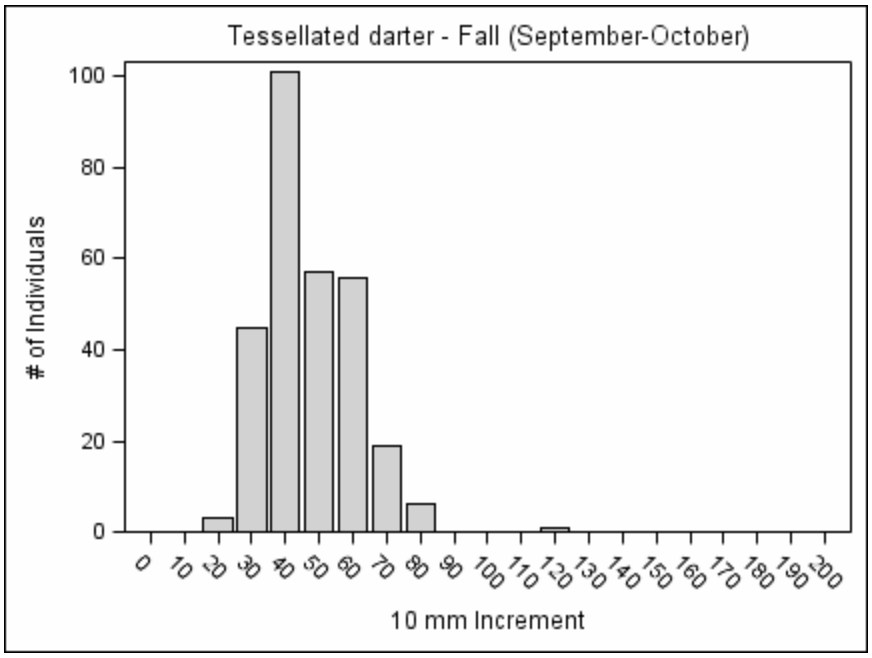

Figure 5.3-11. Length frequency distribution for Tessellated Darter captured throughout the study area during September-October 2015.

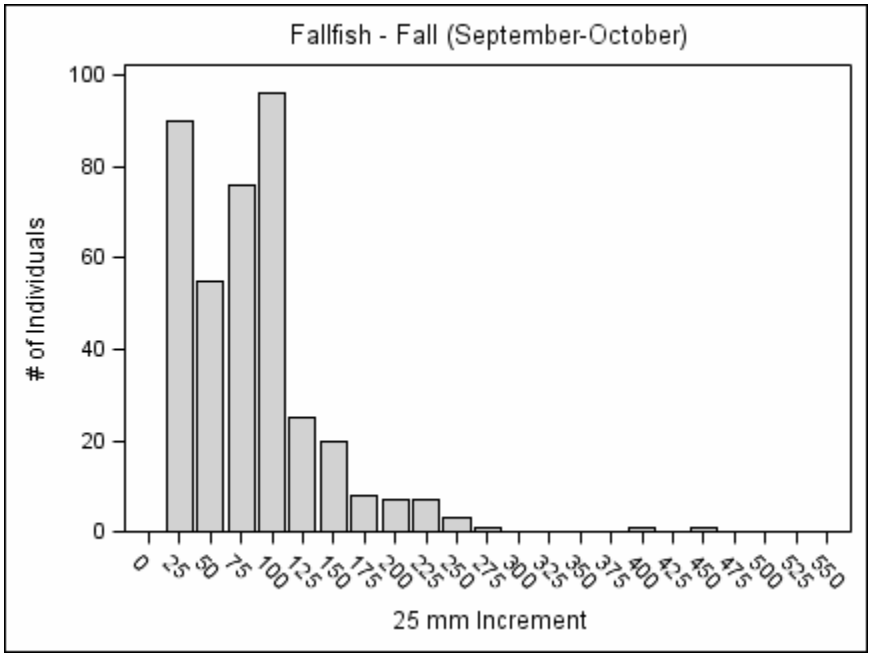

Figure 5.3-12. Length frequency distribution for Fallfish captured throughout the study area during September-October 2015.

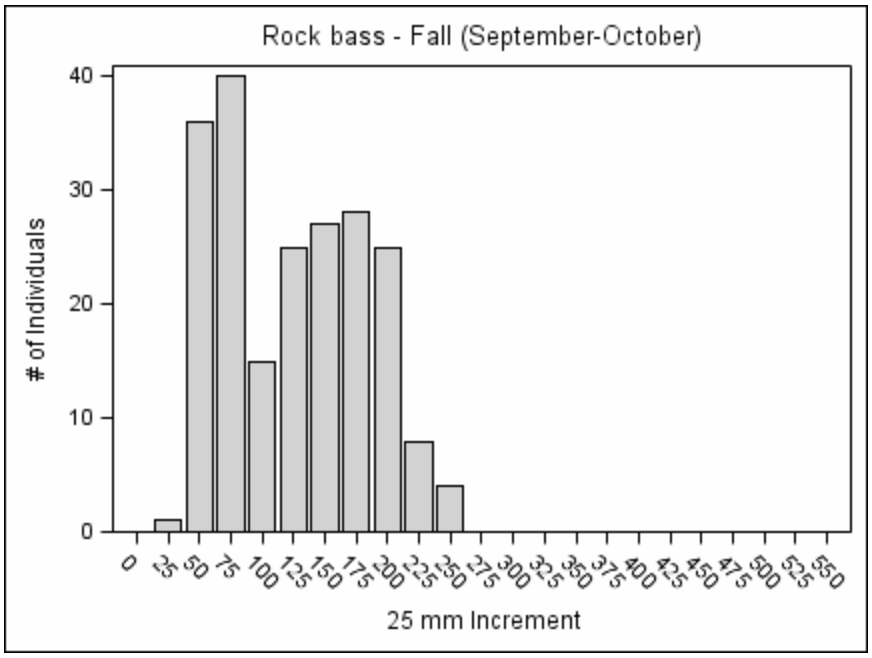

Figure 5.3-13. Length frequency distribution for Rock Bass captured throughout the study area during September-October 2015.

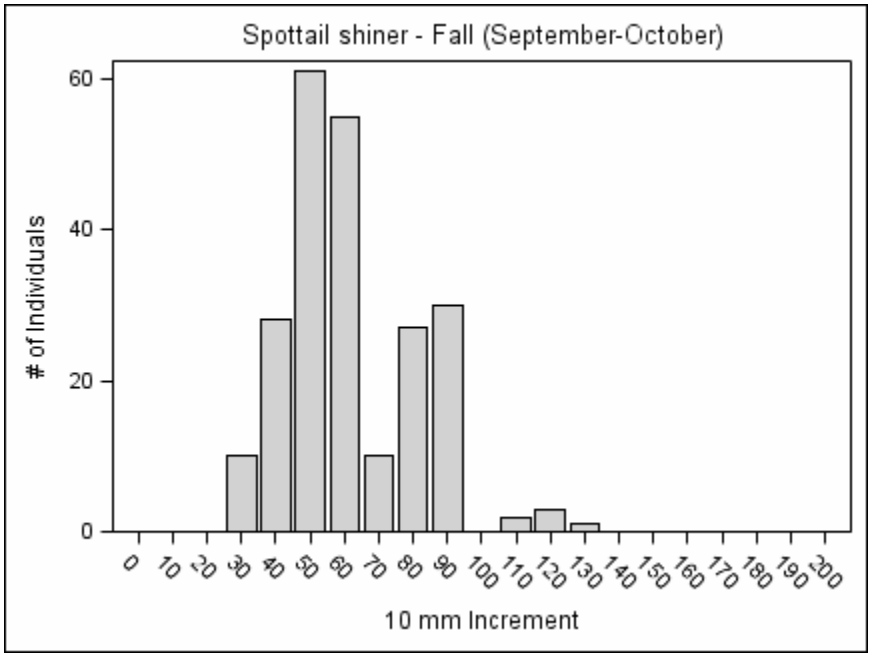

Figure 5.3-14. Length frequency distribution for Spottail Shiner captured throughout the study area during September-October 2015.

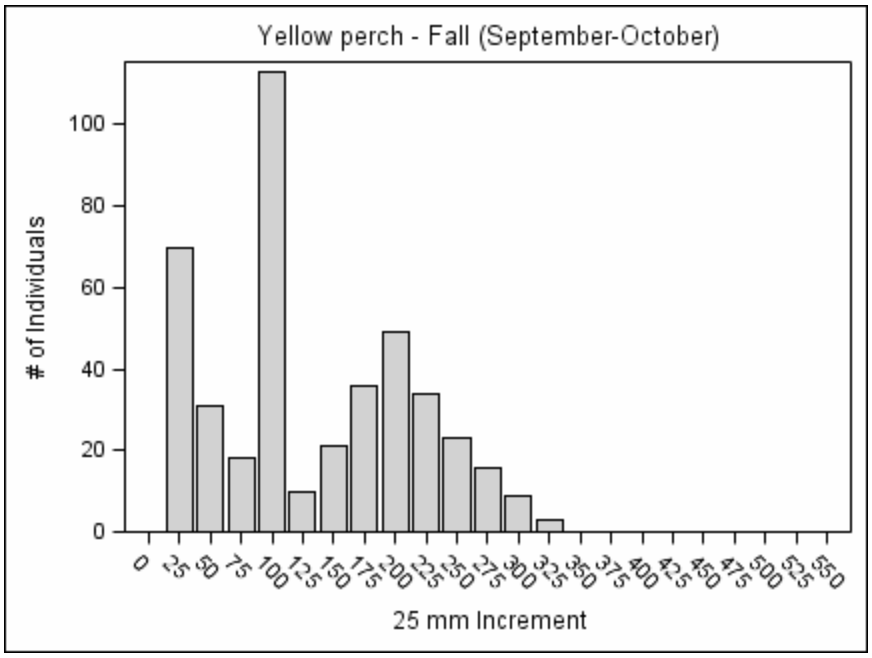

Figure 5.3-15. Length frequency distribution for Yellow Perch captured throughout the study area during September-October 2015.

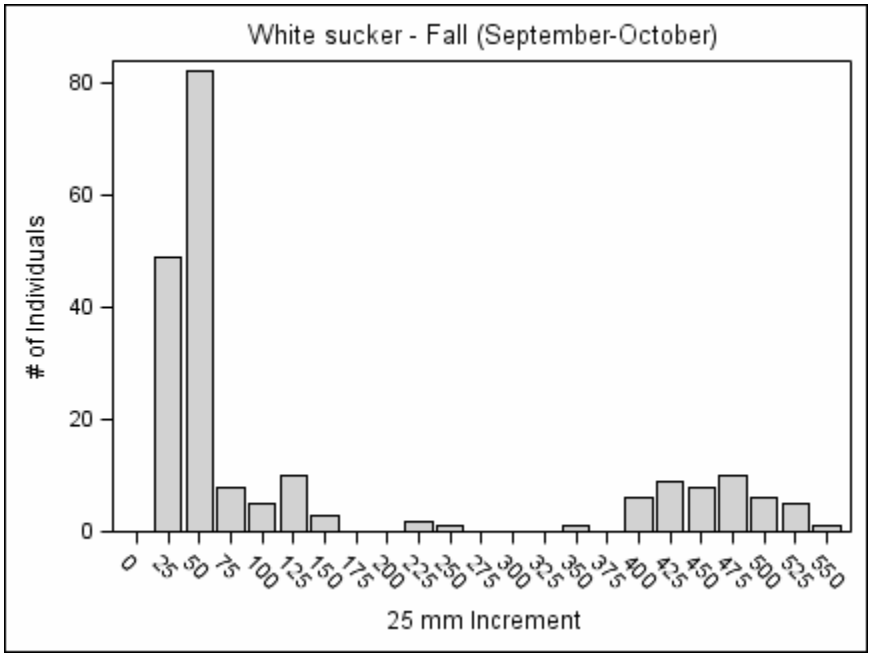

Figure 5.3-16. Length frequency distribution for White Sucker captured throughout the study area during September-October 2015.

Table 5.3.8. Life stage (YOY, juvenile, and adult) percentages for each fish species recorded during the fall sampling (September-October 2015) by river reach.

Family / Common Name	Life Stage	REACH[a]													
		WI		WR		BFI		BFB		BFR		VI		VR	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Anguillidae															
American Eel	Adult	1	100.0											1	50.0
	Juvenile													1	50.0
	Total	1	100.0											2	100.0
Catostomidae															
White Sucker	Adult	9	25.0			3	12.5					4	30.8	7	46.7
	Juvenile	9	25.0			4	16.7			4	21.1	5	38.5	8	53.3
	YOY	18	50.0	15	100.0	17	70.8	1	100.0	15	78.9	4	30.8		
	Total	36	100.0	15	100.0	24	100.0	1	100.0	19	100.0	13	100.0	15	100.0
Centrarchidae															
Black Crappie	Adult											14	93.3		
	Juvenile							1	100.0						
	YOY					7	100.0					1	6.7		
	Total					7	100.0	1	100.0			15	100.0		
Bluegill	Adult	1	6.7			1	50.0					43	91.5	4	100.0
	Juvenile	1	6.7									4	8.5		
	YOY	13	86.7	2	100.0	1	50.0			6	100.0				
	Total	15	100.0	2	100.0	2	100.0			6	100.0	47	100.0	4	100.0
Largemouth Bass	Adult					1	10.0					11	29.7		
	Juvenile	12	29.3			5	50.0			1	25.0	16	43.2		
	YOY	29	70.7			4	40.0			3	75.0	10	27.0		
	Total	41	100.0			10	100.0			4	100.0	37	100.0		

Family / Common Name	Life Stage	REACH[a]													
		WI		WR		BFI		BFB		BFR		VI		VR	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Pumpkinseed	Adult	3	33.3			6	40.0					7	87.5		
	Juvenile	4	44.4									1	12.5		
	YOY	2	22.2			9	60.0								
	Total	9	100.0			15	100.0					8	100.0		
Rock Bass	Adult	17	30.4			35	43.2			2	5.0	5	55.6	2	50.0
	Juvenile	31	55.4	17	77.3	36	44.4			12	30.0	4	44.4	2	50.0
	YOY	8	14.3	5	22.7	10	12.3	3	100.0	26	65.0				
	Total	56	100.0	22	100.0	81	100.0	3	100.0	40	100.0	9	100.0	4	100.0
Smallmouth Bass	Adult	11	28.9	1	0.8	26	19.4			1	0.8	10	37.0	10	24.4
	Juvenile	3	7.9	10	8.4	56	41.8	7	26.9	31	26.3	8	29.6	18	43.9
	YOY	24	63.2	108	90.8	52	38.8	19	73.1	86	72.9	9	33.3	13	31.7
	Total	38	100.0	119	100.0	134	100.0	26	100.0	118	100.0	27	100.0	41	100.0
Clupeidae															
American Shad	YOY									10	100.0	16	100.0	17	100.0
	Total									10	100.0	16	100.0	17	100.0
Cottidae															
Slimy Sculpin	Juvenile			1	50.0									1	20.0
	YOY			1	50.0	1	100.0							4	80.0
	Total			2	100.0	1	100.0							5	100.0
Cyprinidae															
Blacknose Dace	Juvenile			4	57.1	2	50.0								
	YOY			3	42.9	2	50.0								
	Total			7	100.0	4	100.0								
Blacknose Shiner	Juvenile	2	66.7												
	YOY	1	33.3												
	Total	3	100.0												

Family / Common Name	Life Stage	REACH[a]													
		WI		WR		BFI		BFB		BFR		VI		VR	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Bluntnose Minnow	Adult	4	100.0												
	Total	4	100.0												
Bridle Shiner	Adult					4	100.0								
	Total					4	100.0								
Common Carp	Adult											3	100.0	1	100.0
	Total											3	100.0	1	100.0
Common Shiner	Juvenile	1	100.0			1	100.0			16	88.9				
	YOY									2	11.1				
	Total	1	100.0			1	100.0			18	100.0				
Creek Chub	Juvenile	4	33.3	1	100.0	10	37.0			4	100.0	2	100.0		
	YOY	8	66.7			17	63.0								
	Total	12	100.0	1	100.0	27	100.0			4	100.0	2	100.0		
Cutlips Minnow	Adult			1	100.0										
	Total			1	100.0										
Eastern Silvery Minnow	Adult											1	2.9		
	Juvenile									22	100.0	33	97.1		
	Total									22	100.0	34	100.0		
Fallfish	Adult	8	9.8			3	5.6					6	17.6	1	10.0
	Juvenile	33	40.2	1	4.2	27	50.0			6	9.5	23	67.6	5	50.0
	YOY	41	50.0	23	95.8	24	44.4	1	100.0	57	90.5	5	14.7	4	40.0
	Total	82	100.0	24	100.0	54	100.0	1	100.0	63	100.0	34	100.0	10	100.0
Golden Shiner	Adult											2	4.7		
	Juvenile	10	33.3			5	62.5			1	6.3	14	32.6		
	YOY	20	66.7			3	37.5			15	93.8	27	62.8		
	Total	30	100.0			8	100.0			16	100.0	43	100.0		

Family / Common Name	Life Stage	REACH[a]													
		WI		WR		BFI		BFB		BFR		VI		VR	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Longnose dace	Adult			17	89.5	8	50.0	54	100.0	1	100.0				
	Juvenile			2	10.5	8	50.0								
	Total			19	100.0	16	100.0	54	100.0	1	100.0				
Rosyface Shiner	Adult					6	33.3			1	20.0	1	100.0		
	Juvenile					11	61.1			4	80.0			1	100.0
	YOY					1	5.6								
	Total					18	100.0			5	100.0	1	100.0	1	100.0
Spottail Shiner	Adult					12	11.0					17	60.7	6	35.3
	Juvenile	23	82.1	5	62.5	88	80.7			15	88.2	11	39.3	11	64.7
	YOY	5	17.9	3	37.5	9	8.3			2	11.8				
	Total	28	100.0	8	100.0	109	100.0			17	100.0	28	100.0	17	100.0
Esocidae															
Chain Pickerel	Adult					1	100.0			1	100.0				
	Juvenile	3	100.0												
	Total	3	100.0			1	100.0			1	100.0				
Northern Pike	Adult	5	50.0			2	33.3					2	100.0	1	100.0
	Juvenile	5	50.0			4	66.7								
	Total	10	100.0			6	100.0					2	100.0	1	100.0
Fundulidae															
Banded Killifish	Adult									1	50.0				
	Juvenile							1	100.0	1	50.0			3	50.0
	YOY	1	100.0											3	50.0
	Total	1	100.0					1	100.0	2	100.0			6	100.0
Ictaluridae															
Brown Bullhead	Adult	1	100.0			1	100.0					1	100.0		
	YOY							1	100.0	3	100.0				
	Total	1	100.0			1	100.0	1	100.0	3	100.0	1	100.0		

Family / Common Name	Life Stage	REACH[a]													
		WI		WR		BFI		BFB		BFR		VI		VR	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Channel Catfish	Adult											1	100.0	3	100.0
	YOY									2	100.0				
	Total									2	100.0	1	100.0	3	100.0
Yellow Bullhead	Juvenile									1	16.7				
	YOY									5	83.3				
	Total									6	100.0				
Moronidae															
White Perch	Adult											3	100.0		
	Total											3	100.0		
Percidae															
Tessellated Darter	Adult	18	32.7	63	67.7	4	36.4	6	60.0	95	65.1	1	50.0	1	50.0
	Juvenile	32	58.2	30	32.3	7	63.6	4	40.0	51	34.9	1	50.0	1	50.0
	YOY	5	9.1												
	Total	55	100.0	93	100.0	11	100.0	10	100.0	146	100.0	2	100.0	2	100.0
Walleye	Adult	2	33.3			1	20.0								
	Juvenile	3	50.0			1	20.0					1	100.0		
	YOY	1	16.7			3	60.0								
	Total	6	100.0			5	100.0					1	100.0		
Yellow Perch	Adult	10	12.0			8	22.2					12	25.0	7	63.6
	Juvenile	22	26.5			17	47.2			2	66.7	21	43.8	4	36.4
	YOY	51	61.4			11	30.6			1	33.3	15	31.3		
	Total	83	100.0			36	100.0			3	100.0	48	100.0	11	100.0
Petromyzontidae															
Sea Lamprey	Juvenile			8	100.0	1	100.0								
	Total			8	100.0	1	100.0								

Family / Common Name	Life Stage	REACH[a]													
		WI		WR		BFI		BFB		BFR		VI		VR	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Salmonidae															
Brown Trout	YOY					1	100.0								
	Total					1	100.0								

5.4 Summary of Sampling – All Seasons and Reaches

In response to stakeholder comments on the initial study report and related requests for graphical data presentation, the figures that follow provide graphical representations of:

- family and species composition by river reach for all seasons and sampling gears combined (Figures 5.4-1 – 5.4-3), and by river reach (Figures 5.4-4 – 5.4-10);
- species richness, community diversity, and community evenness by river reach and season for all gear types and substrate/habitat types combined (Figures 5.4-11 – 5.4-13);
- species richness, community diversity, and community evenness by sampling gear and season for all river reaches and substrate/habitat types combined (Figures 5.4-14 – 5.4-16); and
- species richness, community diversity, and community evenness by substrate/habitat type and season for all river reaches and sampling gears combined (Figures 5.4-17 – 5.4-19).

Appendix H provides graphical representations of mean CPUE values by gear type for each species, season, and study reach. It should be noted that CPUE units in Appendix H are fish per hour for boat electrofishing (BEF), portable electrofishing (PEF), and gill netting (GN) gear types; and fish per haul for beach seine (BS) gear type.

Appendix I provides graphical representations of mean CPUA values by season for each species, river reach, and substrate/habitat type.

Appendix J provides graphical representation of percent composition values in various combinations of river reach, season, gear type, and substrate/habitat type.

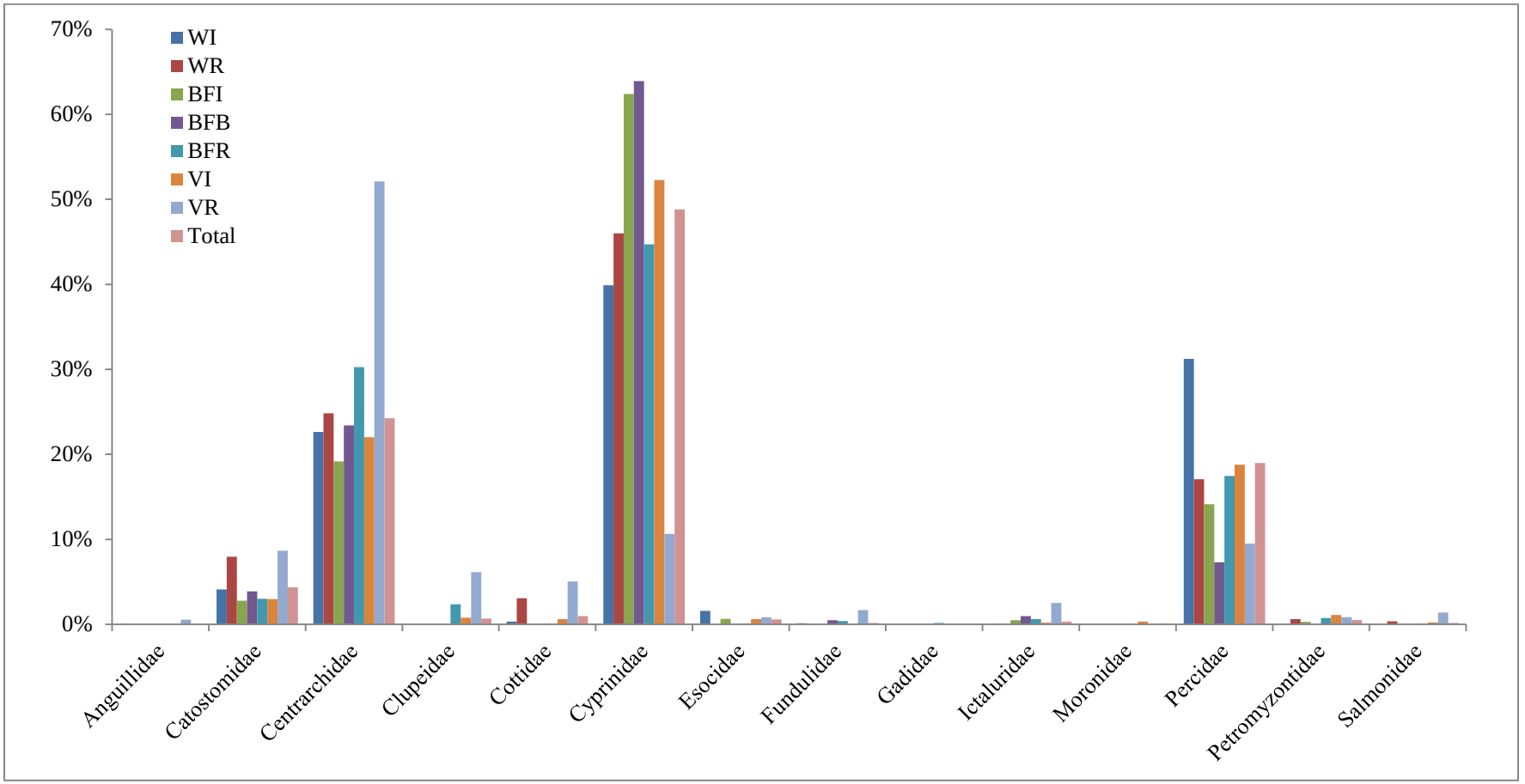

Figure 5.4-1. Percent composition (%) by taxonomic family and river reach for all seasons and sampling gears combined.

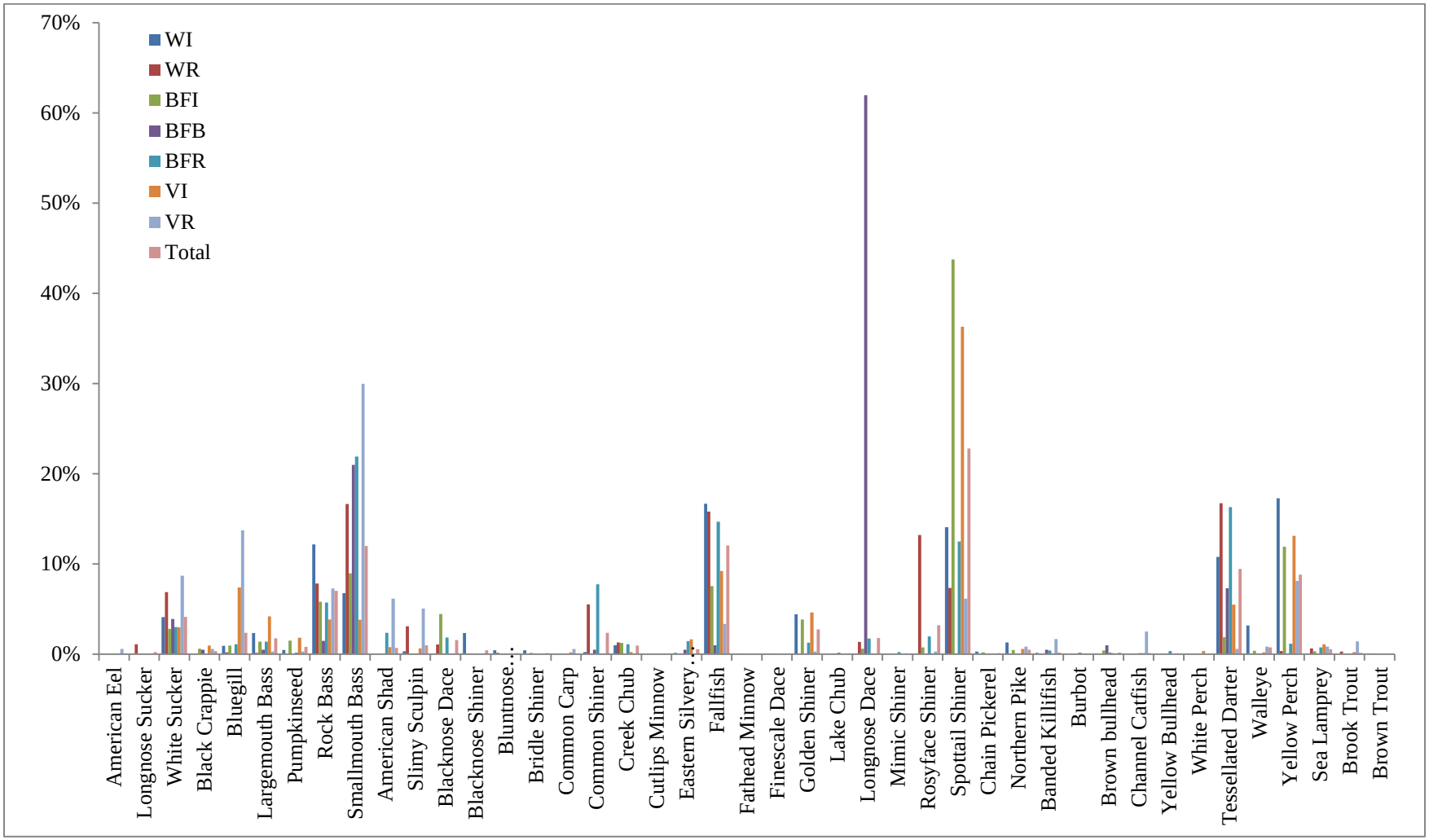

Figure 5.4-2. Percent composition (%) by species and river reach for all seasons and sampling gears combined.

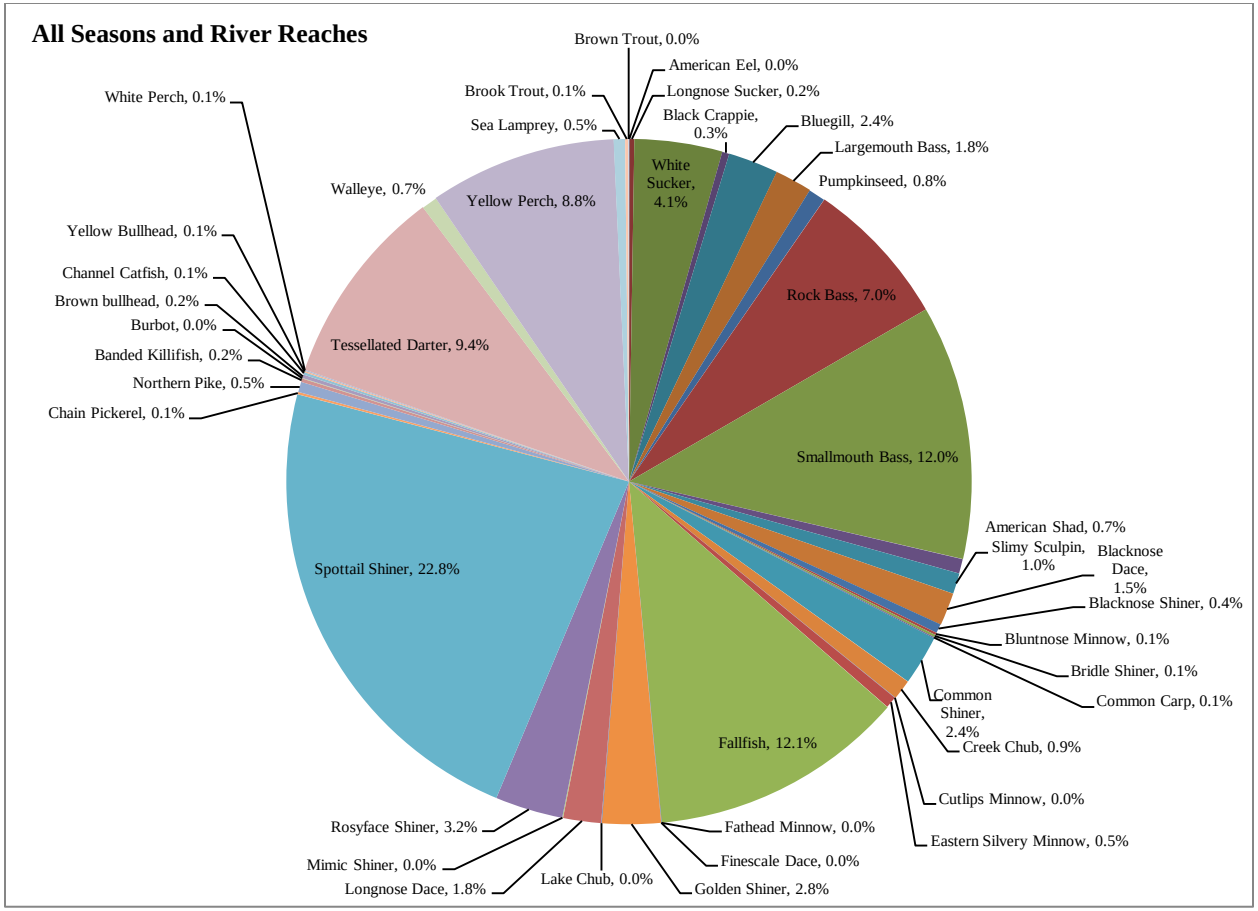

Figure 5.4-3. Percent composition (%) by species for all seasons, sampling gears, and river reaches combined.

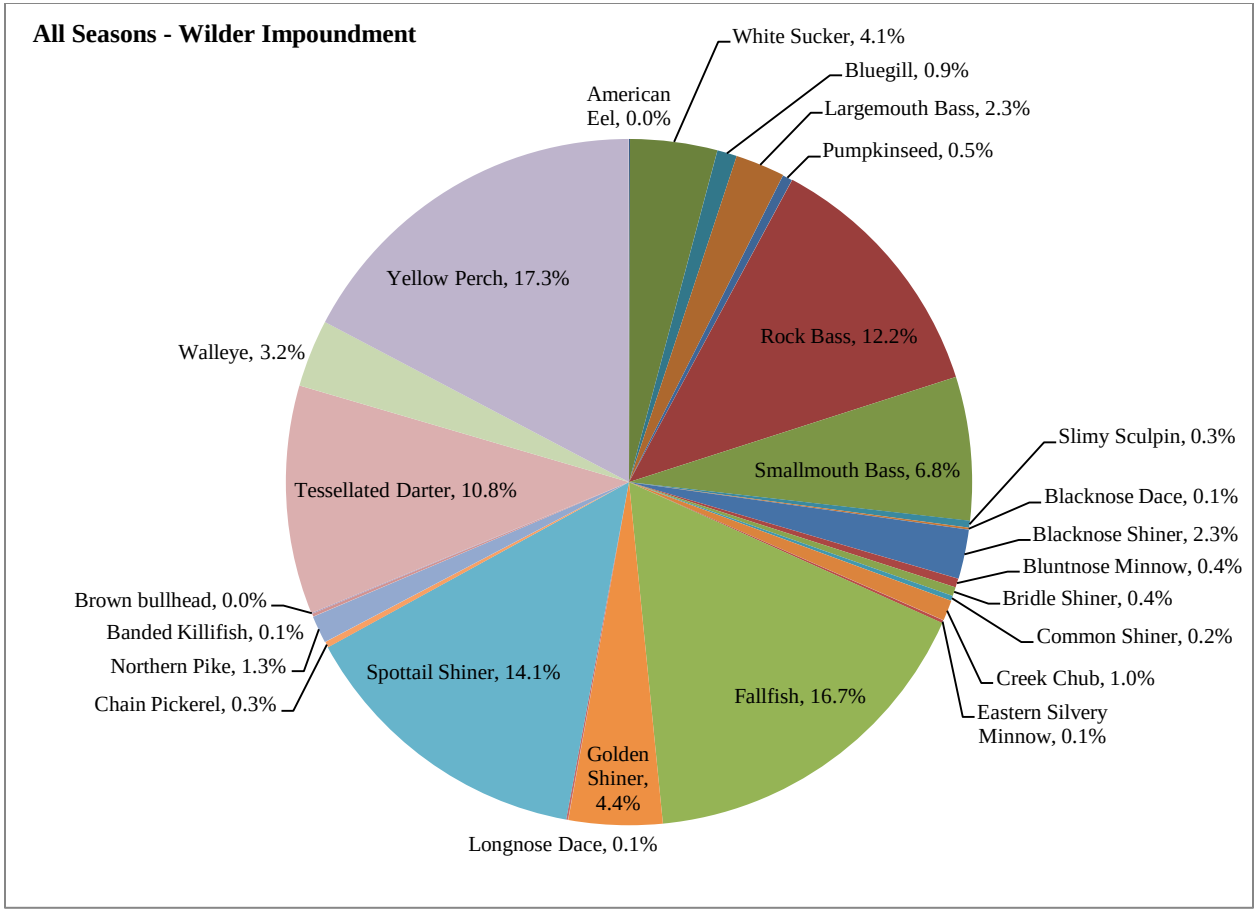

Figure 5.4-4. Percent composition (%) by species for all seasons and sampling gears within the Wilder impoundment reach.

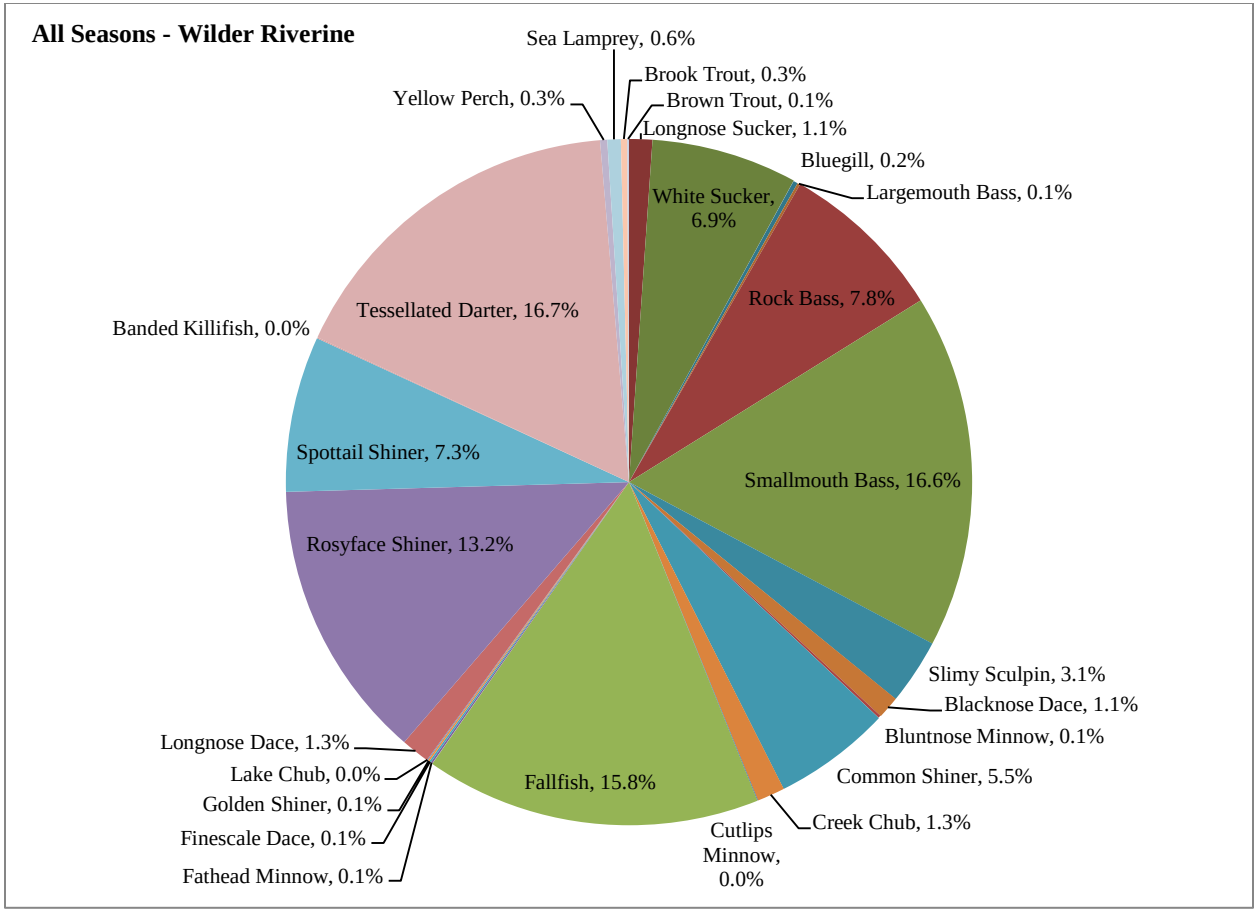

Figure 5.4-5. Percent composition (%) by species for all seasons and sampling gears within the Wilder riverine reach.

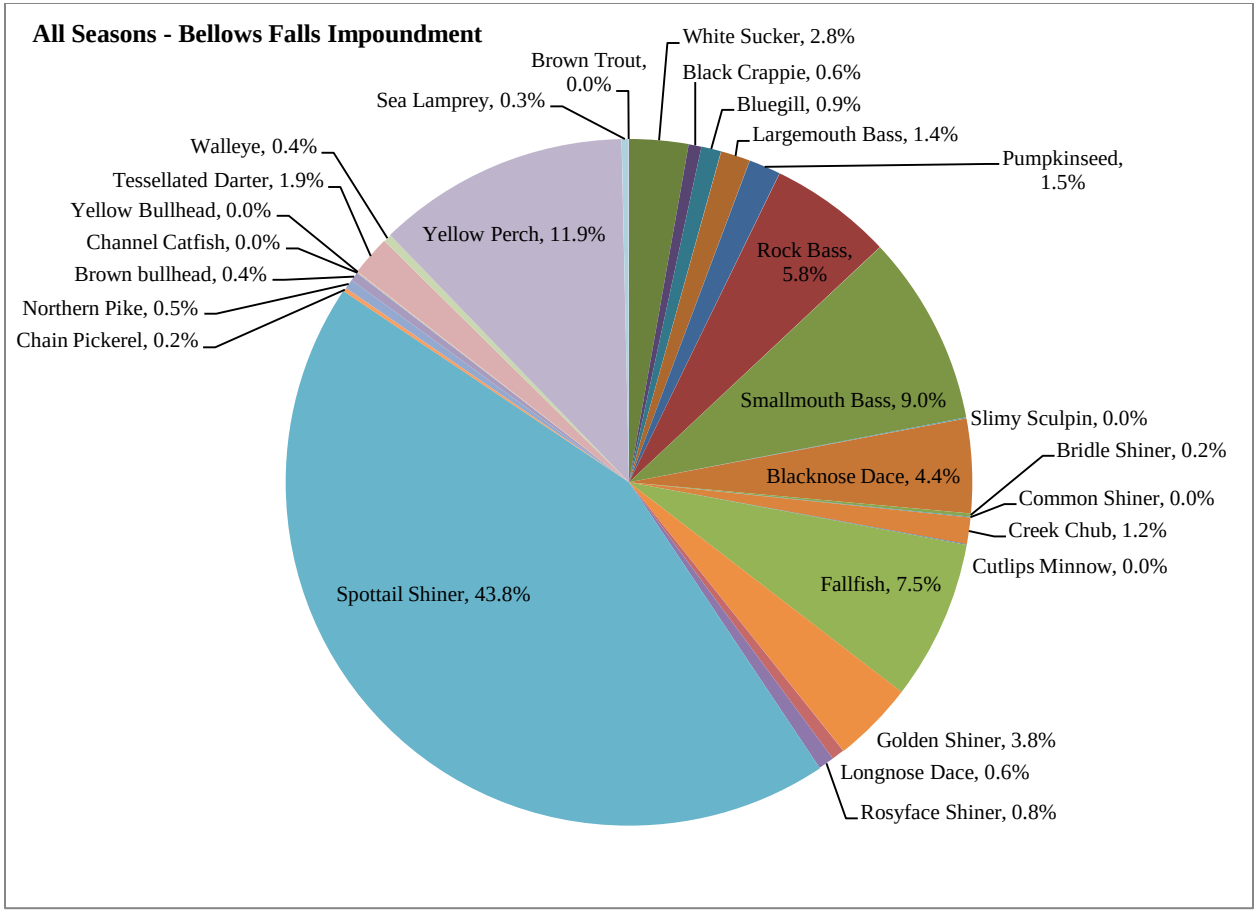

Figure 5.4-6. Percent composition (%) by species for all seasons and sampling gears within the Bellows Falls impoundment reach.

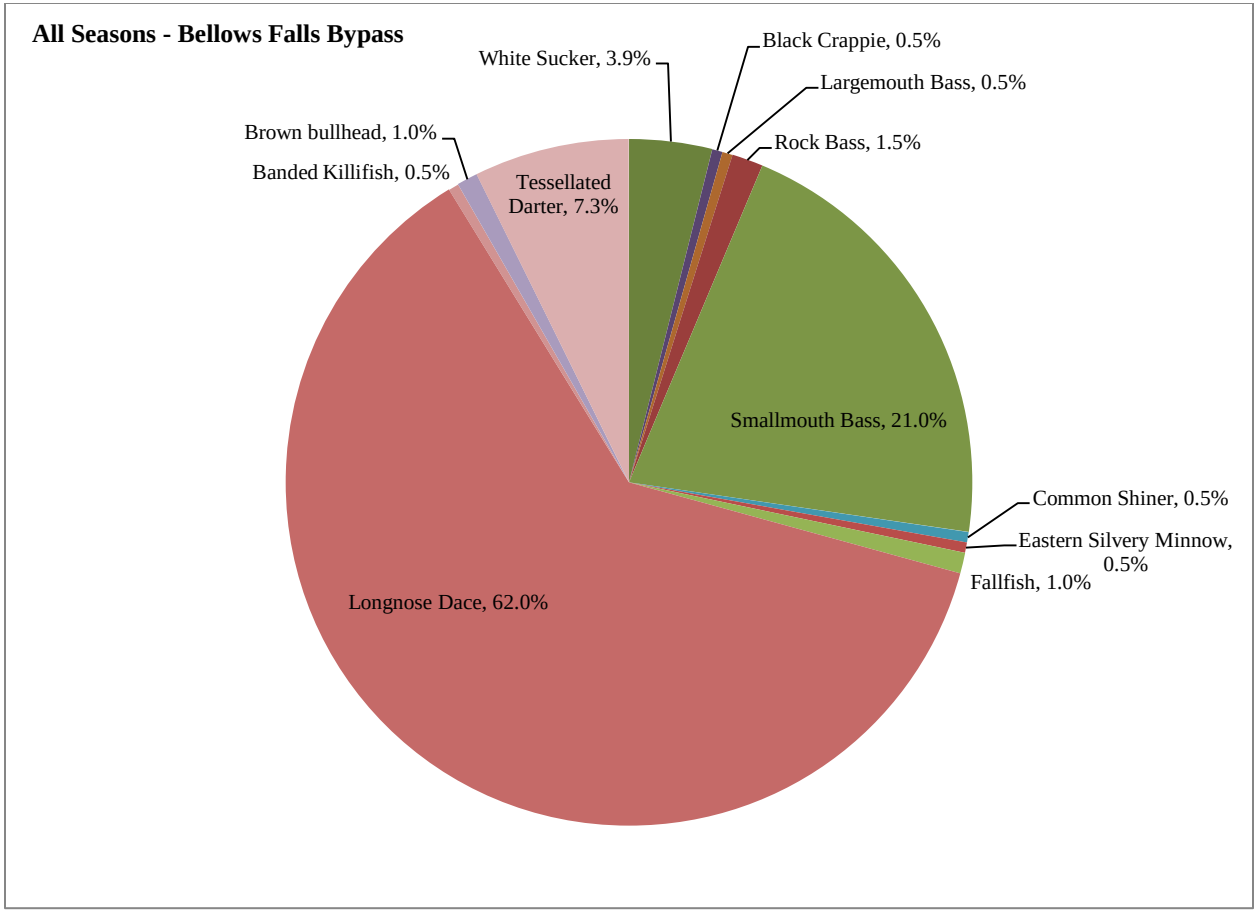

Figure 5.4-7. Percent composition (%) by species for all seasons and sampling gears within the Bellows Falls bypassed reach.

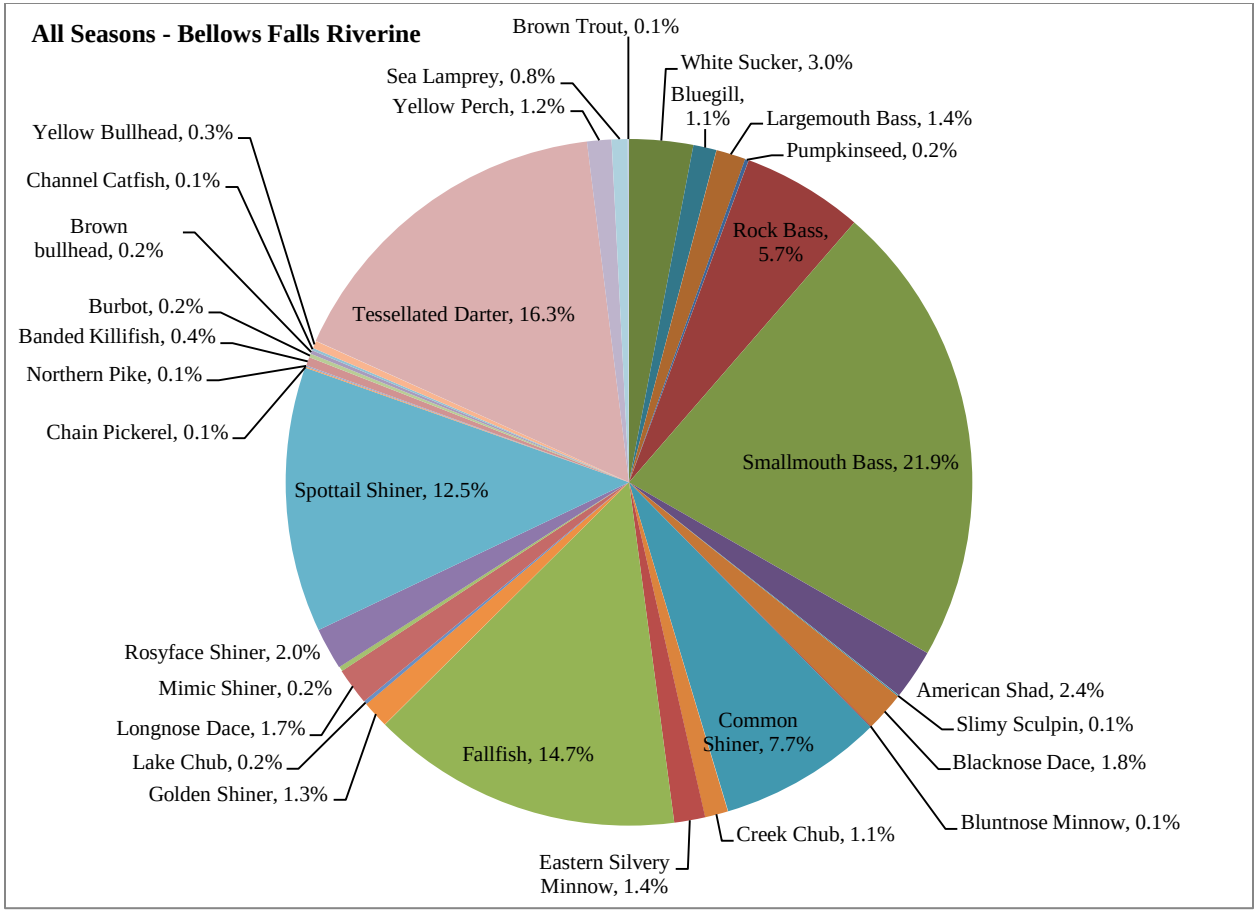

Figure 5.4-8. Percent composition (%) by species for all seasons and sampling gears within the Bellows Falls riverine reach.

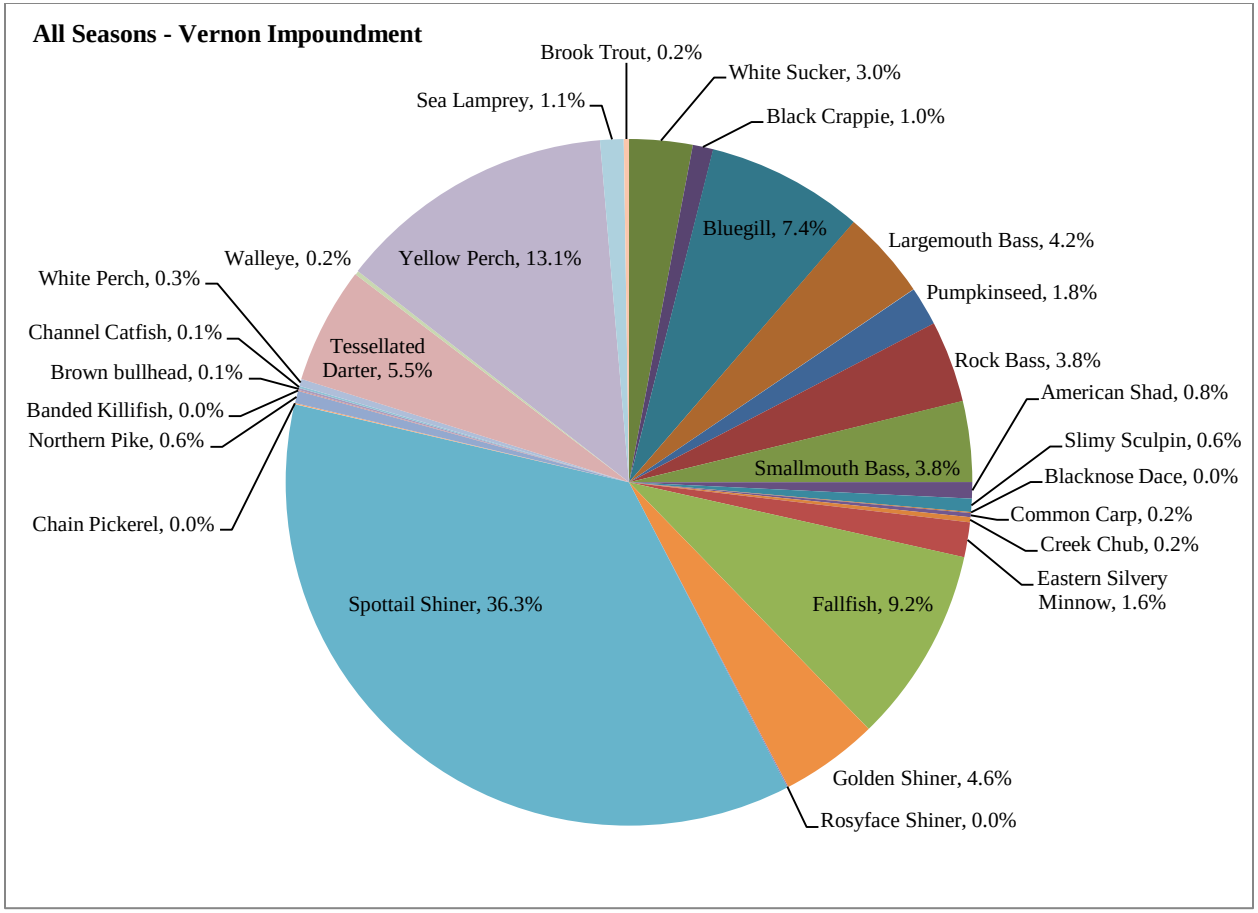

Figure 5.4-9. Percent composition (%) by species for all seasons and sampling gears within the Vernon impoundment reach.

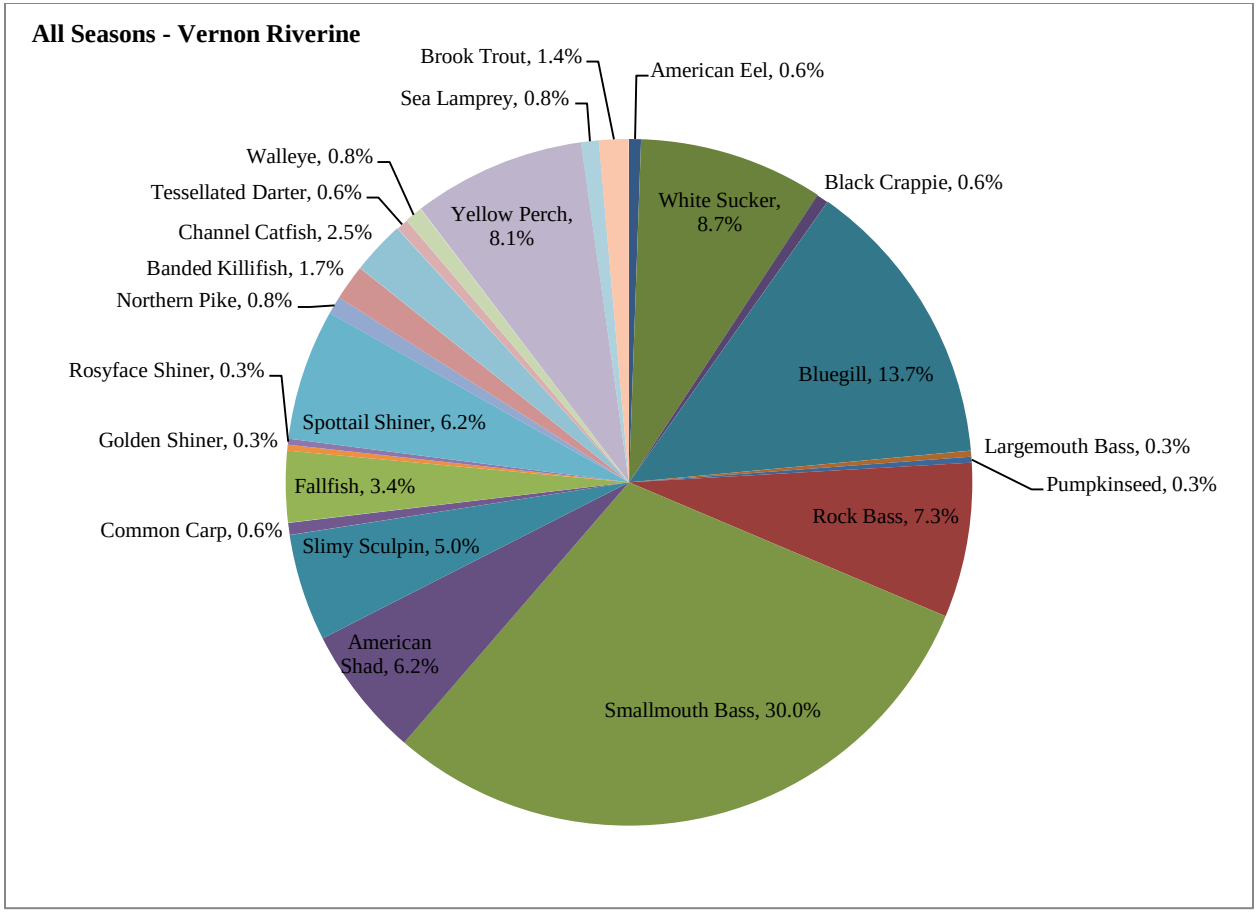

Figure 5.4-10. Percent composition (%) by species for all seasons and sampling gears within the Vernon Riverine reach.

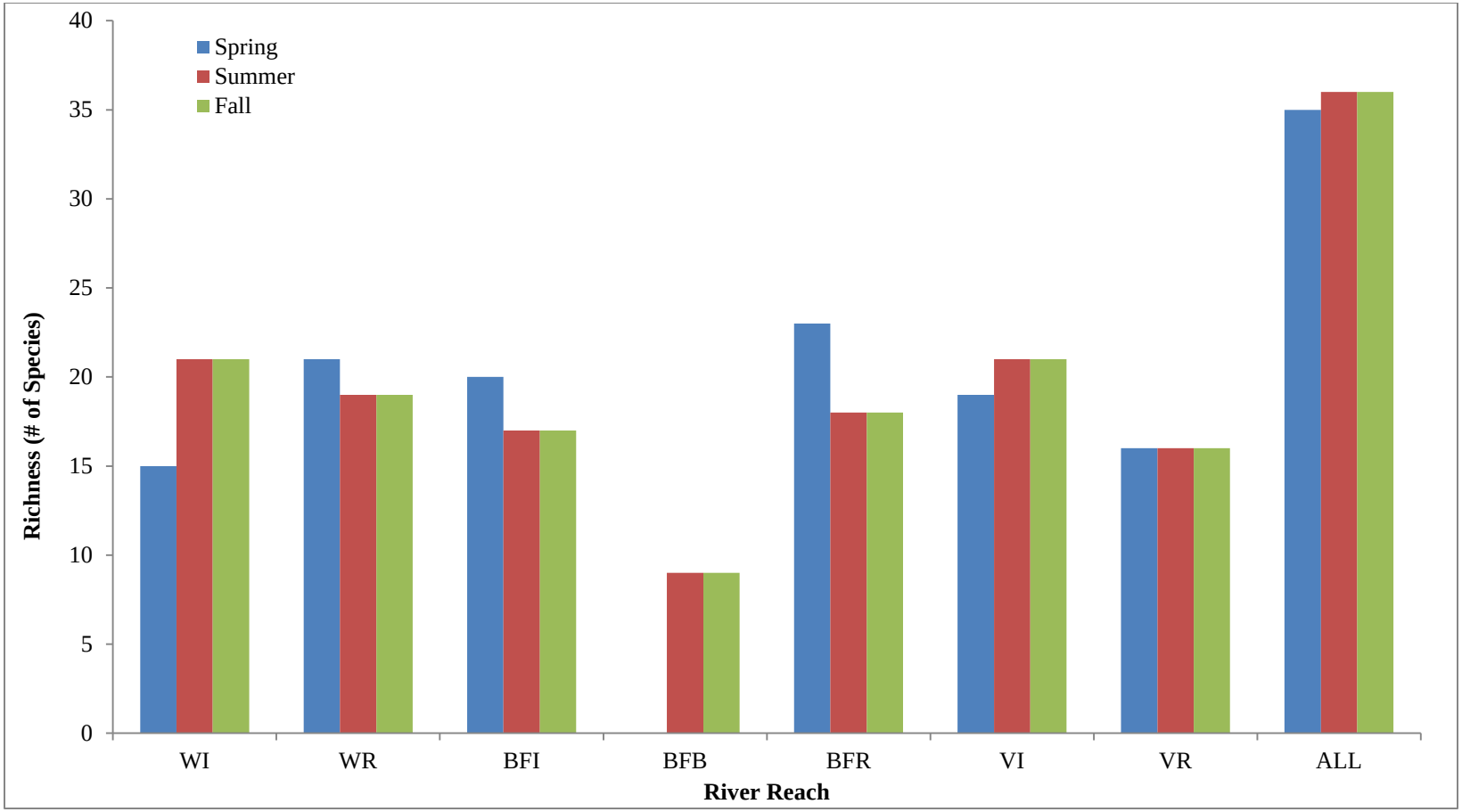

Figure 5.4-11. Species richness of the fish community by river reach, and season (all gears and substrate/habitat types combined, note no spring sampling was conducted in the Bellows Falls bypassed reach) .

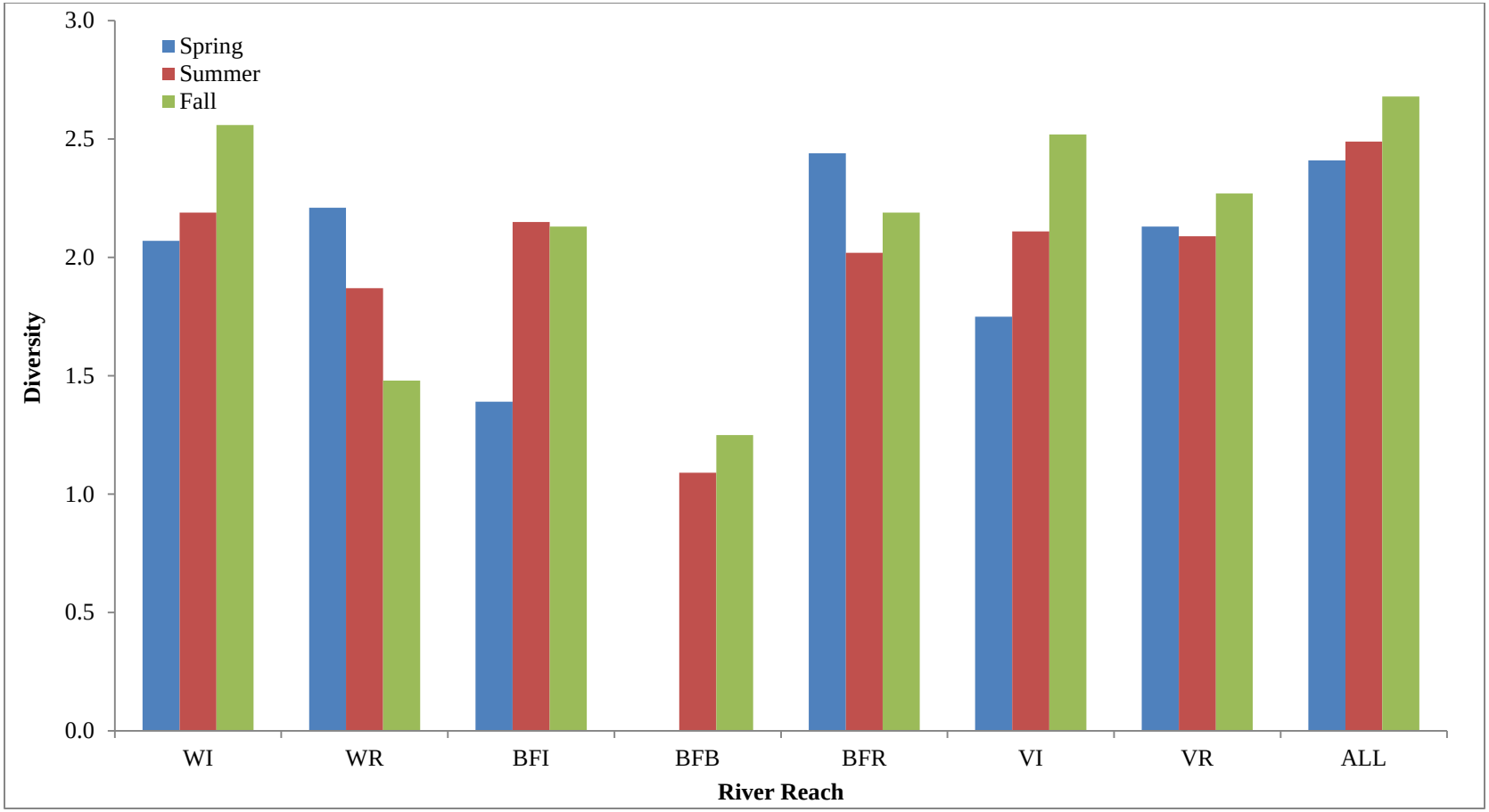

Figure 5.4-12. Community diversity by river reach, and season (all gears and substrate/habitat types combined, note no spring sampling was conducted in the Bellows Falls bypassed reach).

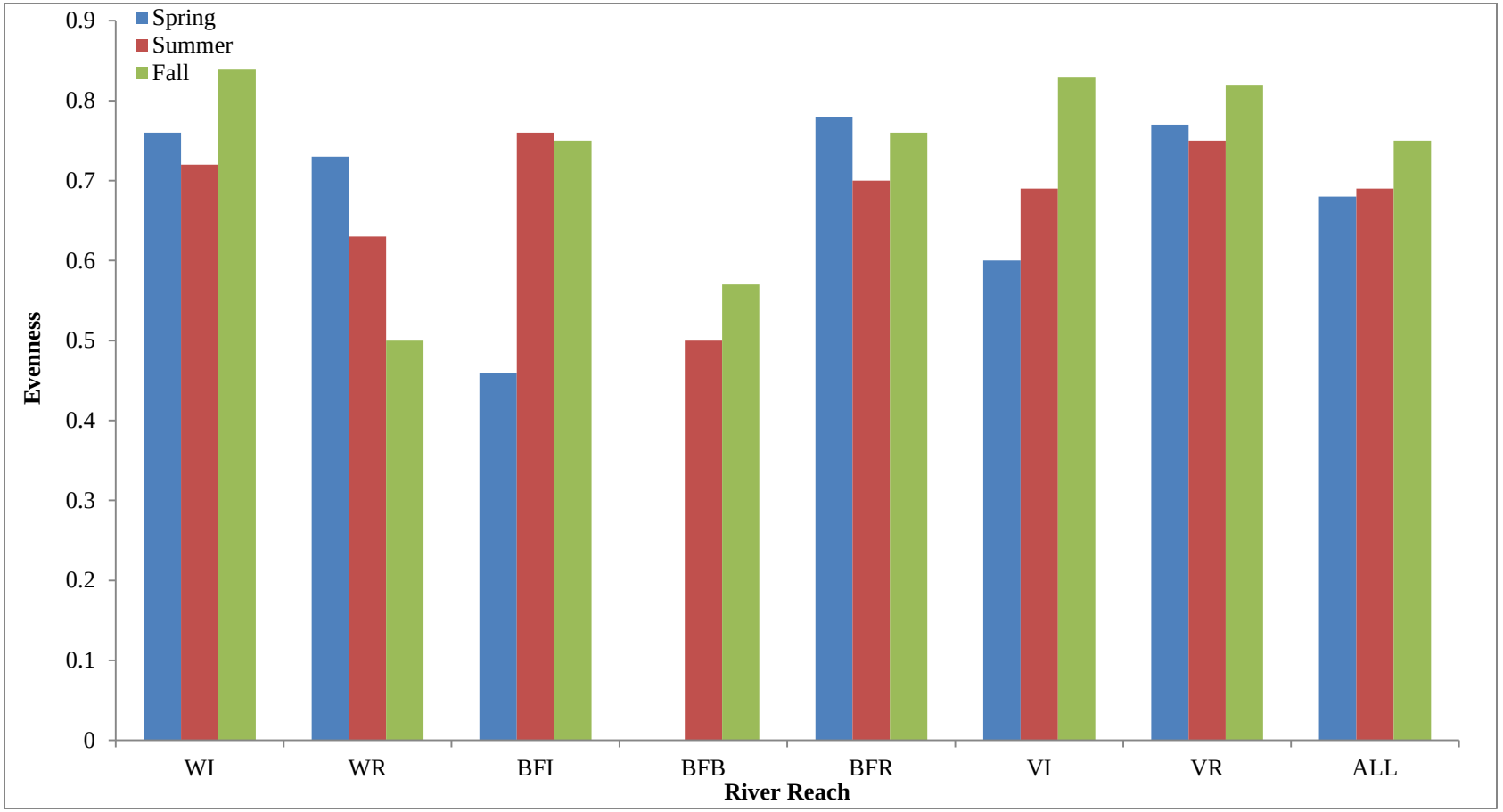

Figure 5.4-13. Community evenness by river reach and season (all gears and substrate/habitat types combined, note no spring sampling was conducted in the Bellows Falls bypassed reach).

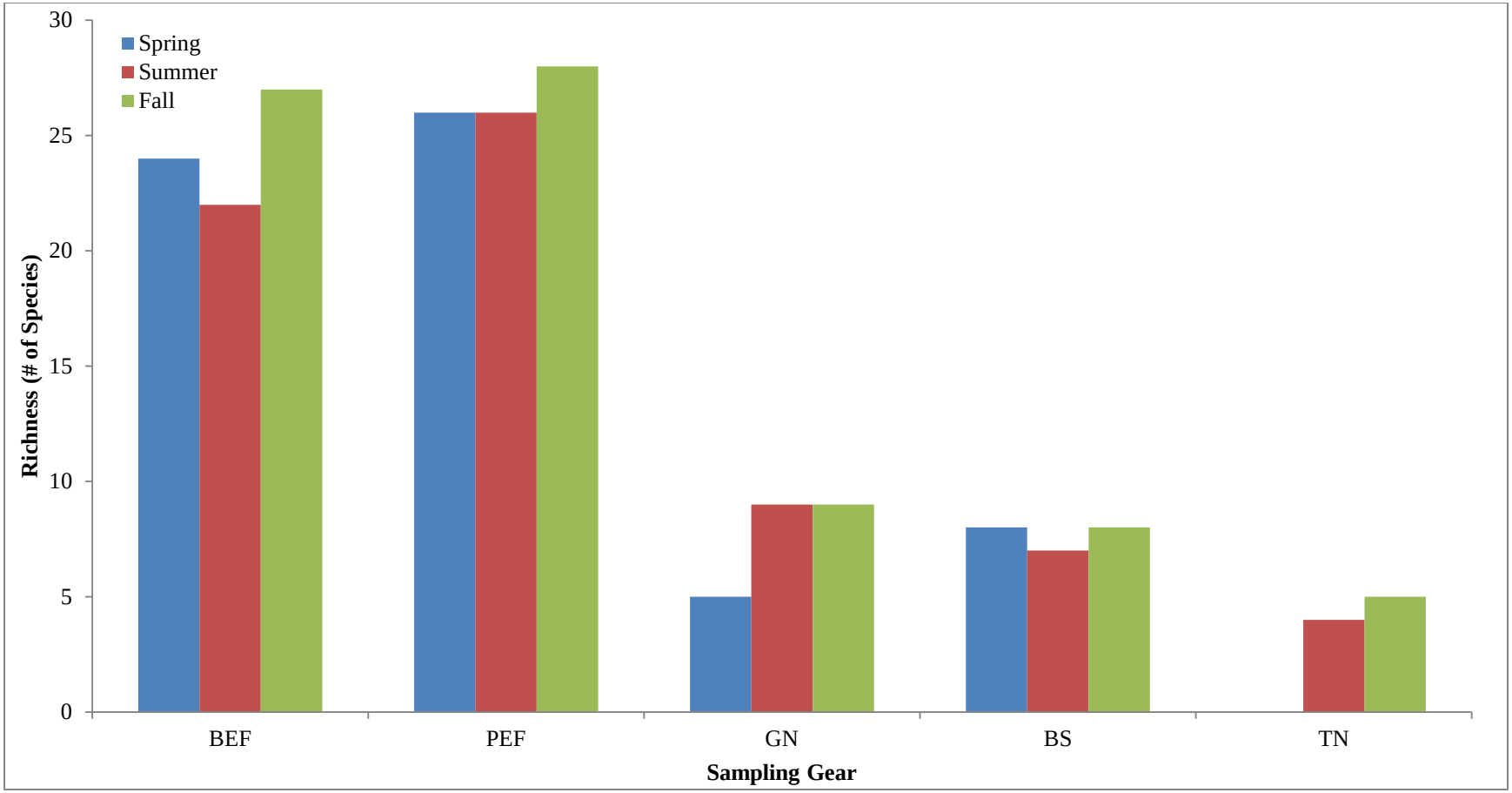

Figure 5.4-14. Species richness by sampling gear and season (all river reaches and substrate/habitat types combined).

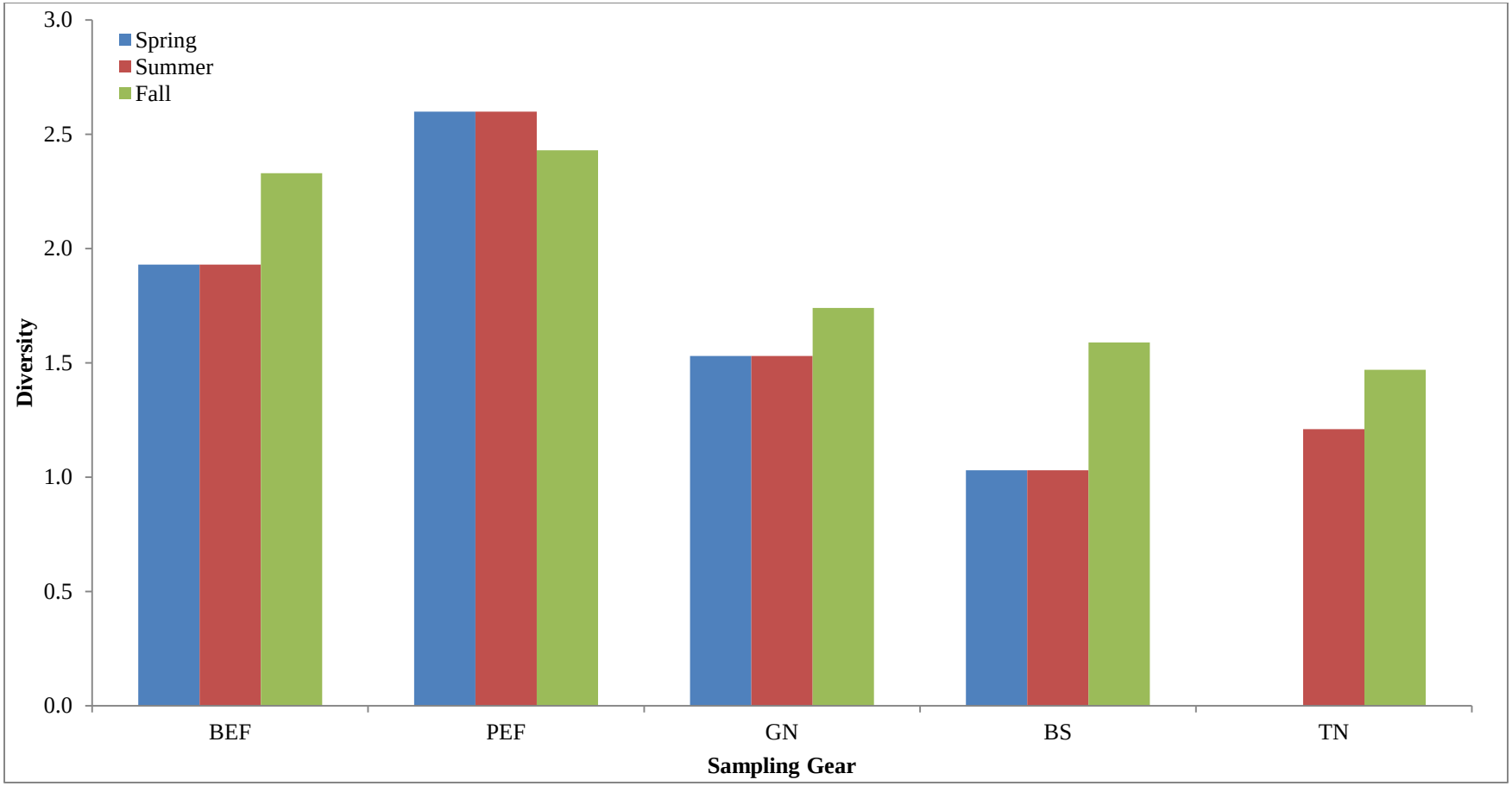

Figure 5.4-15. Community diversity by sampling gear and season (all river reaches and substrate/habitat types combined).

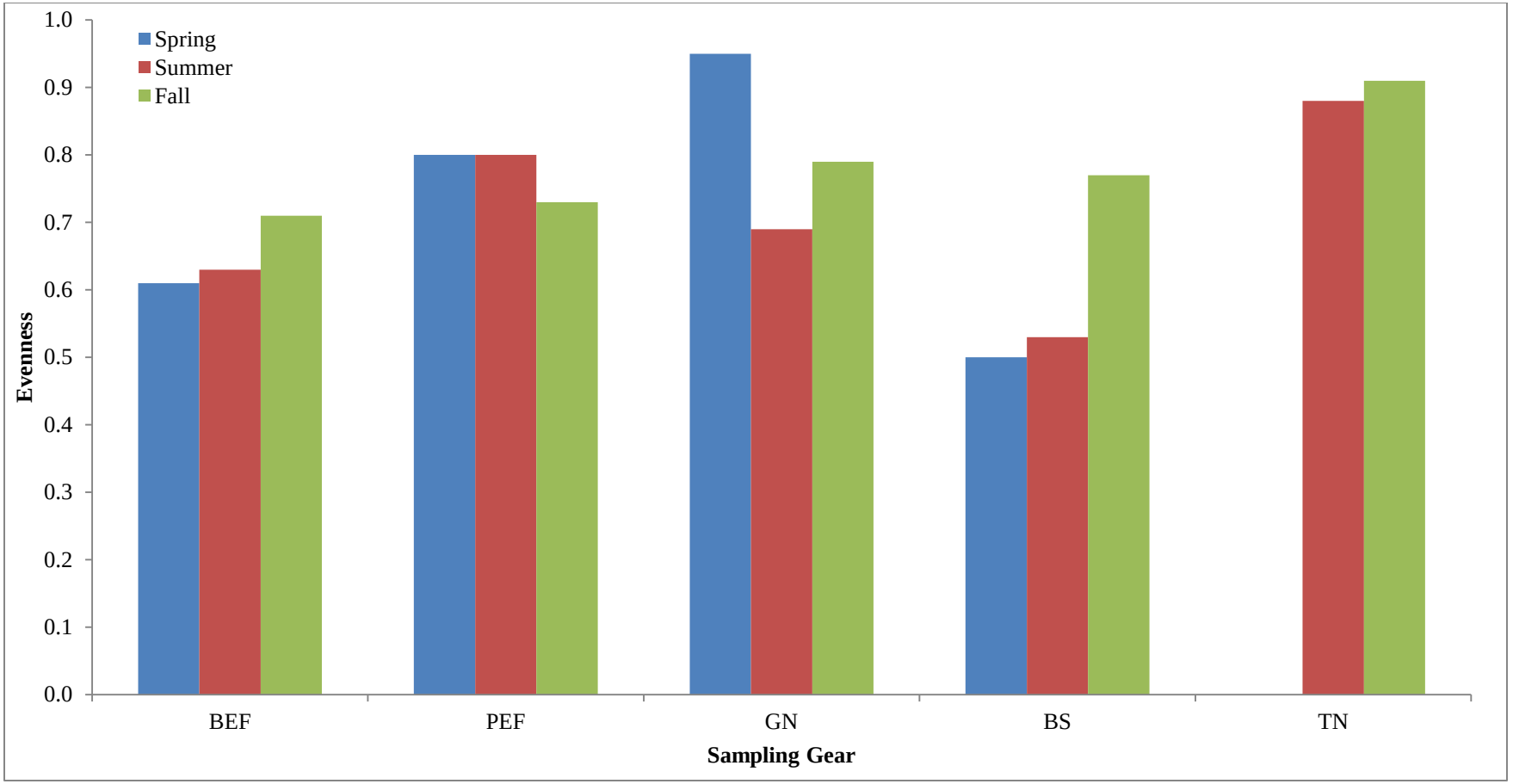

Figure 5.4-16. Community evenness by sampling gear and season (all river reaches and substrate/habitat types combined).

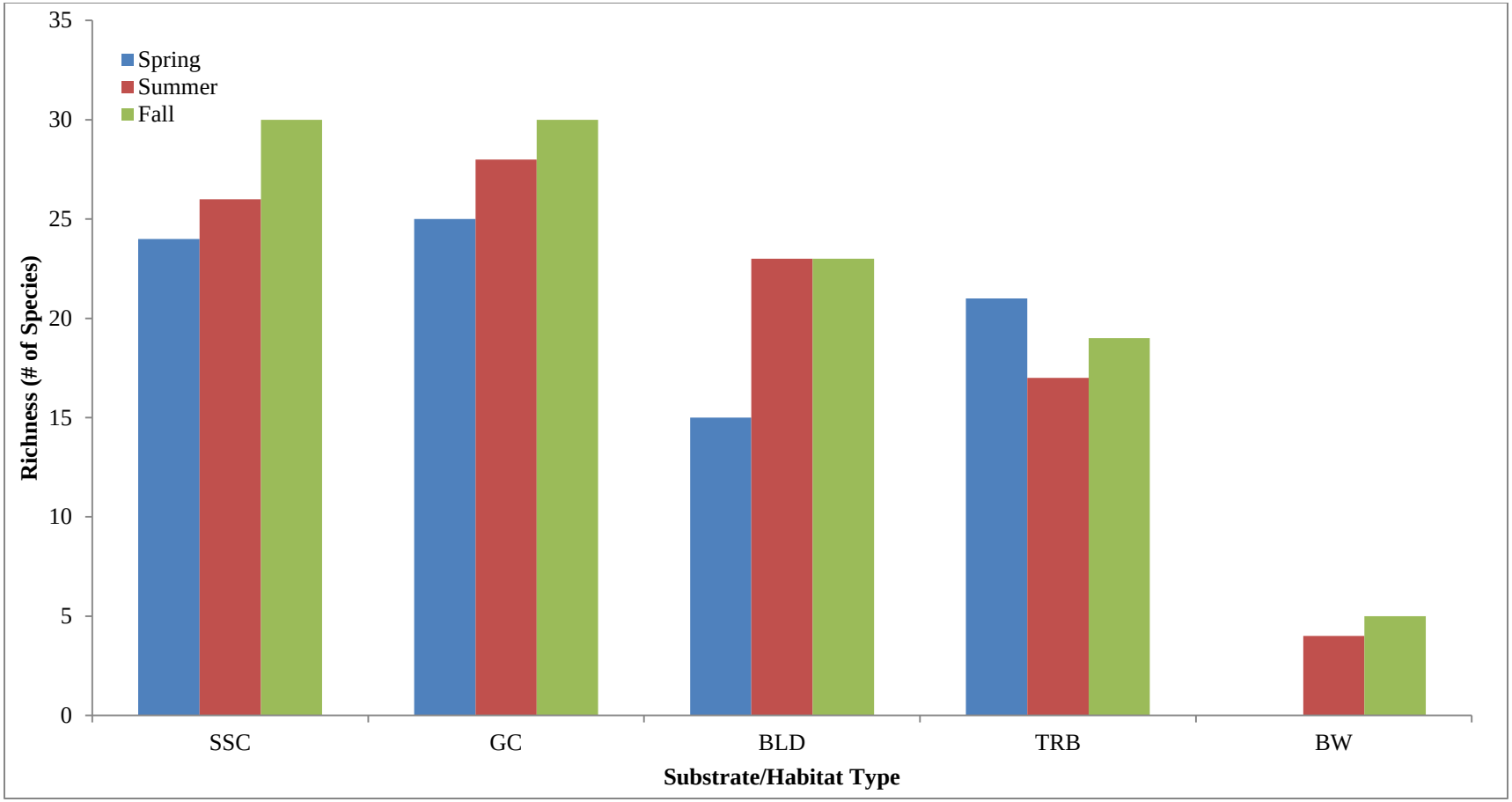

Figure 5.4-17. Species richness by substrate/habitat type and season (all river reaches and sampling gears combined).

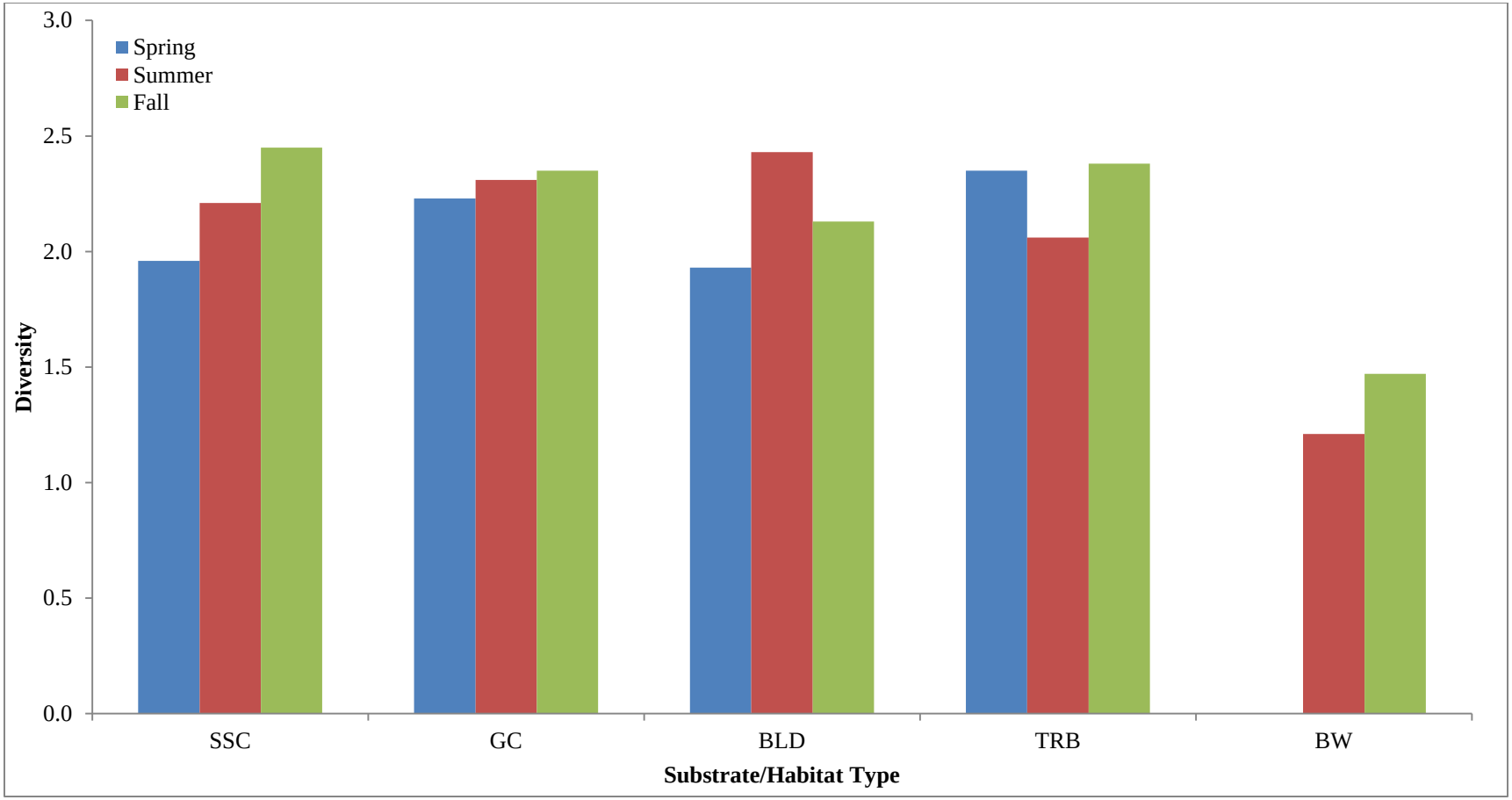

Figure 5.4-18. Community diversity by substrate/habitat type and season (all river reaches and sampling gears combined).

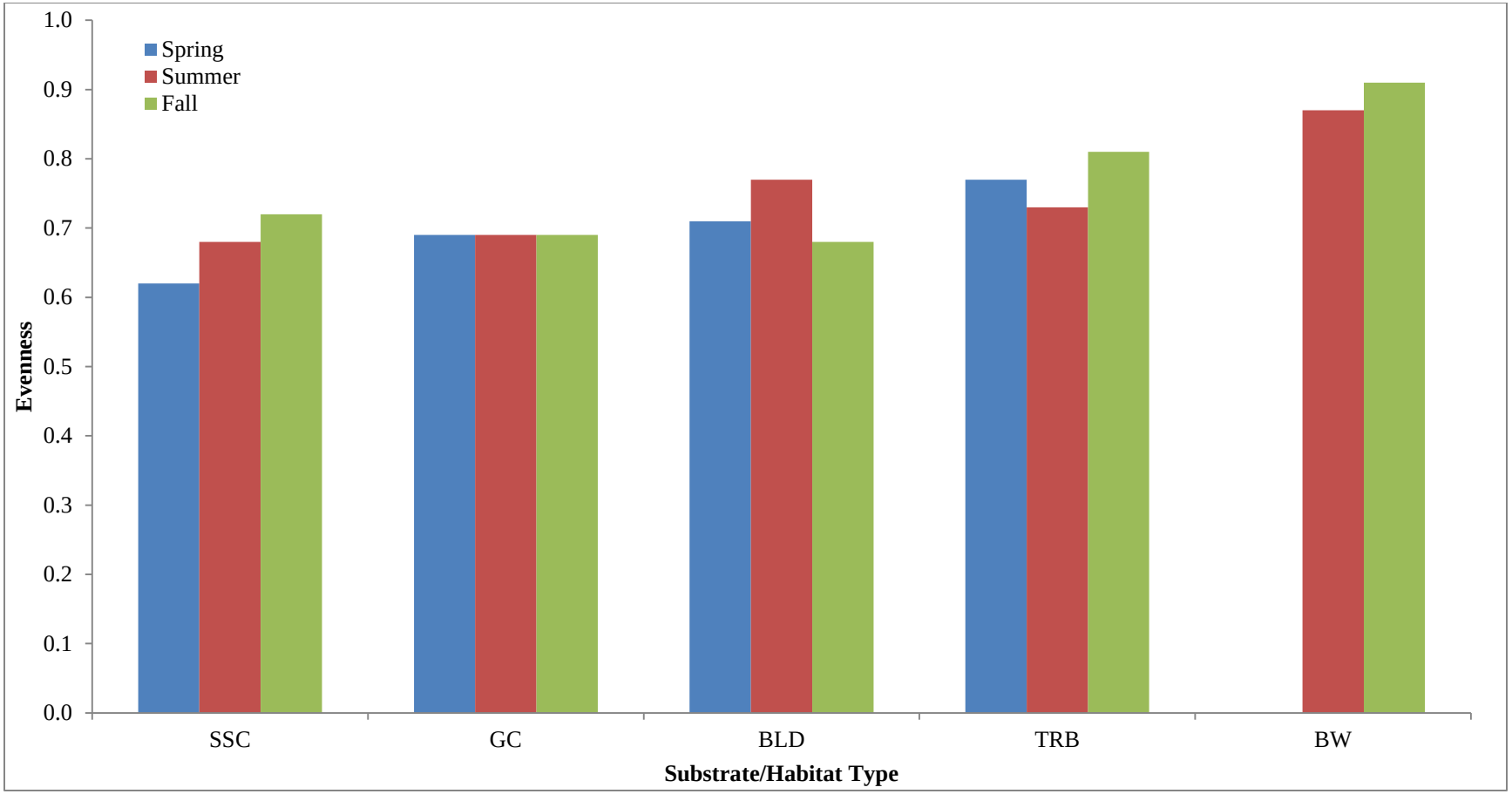

Figure 5.4-19. Community evenness by substrate/habitat type and season (all river reaches and sampling gears combined).

5.5 Native vs. Introduced Fish Species

The Fishes of New Hampshire (Scarola, 1987) reports a total of 58 freshwater fish species are known to have occurred within state waters. Scarola (1987) indicates 42 of those 58 have been identified from the Connecticut River, 31 of the 42 species which are native. Of the 42 species identified by Scarola (1987) as occurring in the Connecticut River, 34 were observed as part of Study 10 sampling. Species identified by Scarola as occurring in the Connecticut River drainage but not observed during Study 10 are species with more northern distributions (i.e., Lake Trout, Northern Red Belly Dace, and Round Whitefish), are no longer functional in the reach (i.e., Atlantic Salmon), or were just not collected (Banded Sunfish, Creek Chubsucker, Rainbow Trout and Redbreast Sunfish).

A more recent publication, The Fishes of Vermont (Langdon et al., 2006) reports a total of 92 freshwater fish species known to have occurred within Vermont waters. Of that total, 77 are reported to be native to Vermont within one of the four major drainage basins (Champlain, St. Lawrence, Hudson, and Connecticut). Table 5.5-1 presents the list of species observed during this study (n=43) and their designation as non-native or native as indicated by Langdon et al. (2006). For each species native to Vermont, the river drainages comprising their "native Vermont range" are indicated.

Of the 43 species observed during this study, six are non-native to Vermont state waters (Brown Trout, Common Carp, White Perch, Black Crappie, Largemouth Bass, and Bluegill). Of the remaining 37 fish species, the Connecticut River watershed is part of the native Vermont range for 23 of them. The majority of the 14 fish species observed during this study and not native to the Connecticut River watershed are listed by Langdon et al. (2006) as native to the Champlain watershed. There were no species observed as part of Study 10 sampling that were not mentioned in either Scarola (1987) or Langdon et al. (2006) as being present within one of the two states.

Fish species considered native to the Connecticut River watershed comprised 71.1% of the study catch. Species native to the Vermont/New Hampshire but not the Connecticut River watershed comprised 24.3% of the catch. Smallmouth Bass, Rock Bass, and Rosyface Shiner comprised the majority of the species native to Vermont but not the Connecticut River drainage. Both Smallmouth Bass and Rock Bass were found throughout the study area whereas the peak observed abundance of Rosyface Shiner was localized to the Wilder riverine reach. The remaining 4.6% of the catch was comprised of non-native fish species. Bluegill and Largemouth Bass were the two most frequently observed non-native fish species. In general, the relative abundance of both species increased with increasing distance downstream within the study area.

Table 5.5-1. Native status within Vermont of fish species observed during Study 10 as summarized from Langdon et al. (2006).

Family / Common Name	Introduced	Native to Vermont	Native Drainage			
			Champlain	Hudson	St Lawrence	Connecticut
Anguillidae						
American Eel		X	X	X	X	X
Catostomidae						
Longnose Sucker		X	X	X	X	X
White Sucker		X	X	X	X	X
Centrarchidae						
Black Crappie	X					
Bluegill	X					
Largemouth Bass	X					
Pumpkinseed		X	X	X	X	X
Rock Bass		X	X			
Smallmouth Bass		X	X			
Clupeidae						
American Shad		X				X
Cottidae						
Slimy Sculpin		X	X	X	X	X
Cyprinidae						
Blacknose Dace		X	X	X	X	X
Blacknose Shiner		X	X			
Bluntnose Minnow		X	X			
Bridle Shiner		X	X		X	
Common Carp	X					
Common Shiner		X	X	X	X	X
Creek Chub		X	X	X	X	X
Cutlips Minnow		X	X	X		
Eastern Silvery Minnow		X	X			X
Fallfish		X	X	X	X	X
Fathead Minnow		X	X			
Finescale Dace		X	X			
Golden Shiner		X	X	X	X	X

Family / Common Name	Introduced	Native to Vermont	Native Drainage			
			Champlain	Hudson	St Lawrence	Connecticut
Lake Chub		X	X	X	X	X
Longnose Dace		X	X	X	X	X
Mimic Shiner		X	X		X	
Rosyface Shiner		X	X			
Spottail Shiner		X	X			X
Esocidae						
Chain Pickerel		X	X	X	X	X
Northern Pike		X	X			
Fundulidae						
Banded Killifish		X	X		X	X
Gadidae						
Burbot		X	X		X	X
Ictaluridae						
Brown bullhead		X	X	X	X	X
Channel Catfish		X	X			
Yellow Bullhead		X	X			
Moronidae						
White Perch	X					
Percidae						
Tessellated Darter		X	X	X	X	X
Walleye		X	X			
Yellow Perch		X	X	X	X	X
Petromyzontidae						
Sea Lamprey		X	X			X
Salmonidae						
Brook Trout		X	X	X	X	X
Brown Trout	X					
Total	**6**	**37**	**36**	**18**	**21**	**23**

5.6 Environmental Variables

Monthly precipitation data is collected by TransCanada at the projects (Table 5.6-1). The Study 10 study season (May – October) and the calendar year through October were both drier than the 10-year average. However, the month of June was wetter than the 10-year average at Wilder and Bellows Falls and drier than

normal at Vernon. Numerous rain events resulted in periods of spill throughout the month at all 3 projects. August was also slightly wetter at Bellows Falls than the 10-year average, but slightly drier than normal at Wilder and Vernon. September was wetter than the 10-year average at all 3 projects. A single rain event resulted in spill at all 3 projects from September 30 continuing into the first few days of October. Bellows Falls also spilled briefly on September 15.

Table 5.6-1. Monthly precipitation at Wilder, Bellows Falls, and Vernon: 2015 and 10-year average.

WILDER	May	Jun.	Jul.	Aug.	Sep.	Oct.
2015	2.69	8.05	2.53	3.48	6.71	2.22
2015 YTD	9.05	17.10	19.63	23.11	29.82	32.04
10 Yr Avg.	3.27	3.98	4.98	3.63	3.68	4.86
10 Yr Avg. YTD	13.07	17.05	22.04	25.67	29.34	34.20
% 10YR AVE MOS	0.82	2.02	0.51	0.96	1.82	0.46
% 10YR AVE YTD	0.69	1.00	0.89	0.90	1.02	0.94
BELLOWS FALLS	**May**	**Jun.**	**Jul.**	**Aug.**	**Sep.**	**Oct.**
2015	1.87	5.96	2.23	3.69	6.67	1.83
2015 YTD	8.58	14.54	16.77	20.46	27.13	28.96
10 Yr Avg.	3.16	4.35	4.48	3.36	3.3	4.78
10 Yr Avg. YTD	13.11	17.46	21.93	25.30	28.6	33.38
% 10YR AVE MOS	0.59	1.37	0.50	1.10	2.02	0.38
% 10YR AVE YTD	0.65	0.83	0.76	0.81	0.95	0.87
VERNON	**May**	**Jun.**	**Jul.**	**Aug.**	**Sep.**	**Oct.**
2015	1.04	3.88	1.93	3.90	6.62	2.22
2015 YTD	8.97	12.85	14.78	18.68	25.3	27.52
10 Yr Avg.	3.68	5.50	4.22	4.16	3.60	6.01
10 Yr Avg. YTD	15.86	21.36	25.58	29.73	33.33	39.34
% 10YR AVE MOS	0.28	0.71	0.46	0.94	1.84	0.37
% 10YR AVE YTD	0.57	0.60	0.58	0.63	0.76	0.70

Water quality parameters were collected at each study site and included temperature (°C), pH (standard units, su), conductivity (µS/cm), turbidity (NTU), DO (mg/l), and DO saturation (%). All measurements were taken with handheld field meters and data represent instantaneous readings. The study included collection and reporting of limited grab samples of water quality data from 1 or 2 visits to each of the study sites. As a result, the data should not be used to characterize general site conditions or trends. Study 6 (Water Quality Monitoring) data will provide the best data on overall water quality within the project-affected area.

Both New Hampshire and Vermont have numeric water quality standards for pH and DO, but only narrative criteria for the other parameters measured. Results of water

quality sampling are summarized below. Appendix E (filed separately in Excel format) presents water quality sampling data from each study site on each sampling date. Velocity data was also collected at sampling sites throughout the study and is included in Appendix E.

Temperature in the mainstem of the river ranged from 12.5 to 26.4°C, and from 10.4 to 25.8°C in the tributaries and backwaters over the course of the study. This range is typical of temperatures expected during the May – October study season with cooler temperatures in spring and fall and warmer temperatures during the summer and/or low flow periods. At mainstem sites, pH ranged from 5.5 to 8.1 su with approximately 15% of measurements at mainstem sites below the New Hampshire and Vermont state standards of 6.5 su for Class B waters. In one sampling instance (Site 10-WR031 in the Wilder riverine reach) pH was higher than the New Hampshire standard of 8.0 su, but not higher than the Vermont standard of 8.5 su. In the tributaries and backwaters, pH ranged from 5.8 to 8.4 su with approximately 28% of measurements below both state standards (6.5 su). Four of the seven low pH measurements were taken in the Vernon impoundment, and two in the Vernon riverine reach. In three sampling instances in the Wilder riverine reach and Bellows Falls impoundment tributary sites, pH was higher than the New Hampshire standard of 8.0 su but less than the Vermont standard of 8.5 su. There were no apparent trends in pH measurements overall.

Conductivity measurements ranged from 62 to 169 µS/cm at mainstem sites with 17% of conductivity measurements less than 100 µS/cm; 83% between 100 and 200 µS/cm; and none greater than 200 µS/cm. Sites 10-VR003 and 10-VR004 in the Vernon riverine reach had the highest conductivity readings but no other general trends were apparent. In the tributary and backwater sites, conductivity ranged from 75 to 541 µS/cm with 7% of measurements less than 100 µS/cm; 62% between 100 and 200 µS/cm; and 31% greater than 200 µS/cm. Site 10-BR014 (Mad Brook) had by far the highest measurement (541 µS/cm) but a mainstem sample taken within the same map-unit on the same day was much lower at 154 µS/cm.

Turbidity measurements in the mainstem of the river ranged from 0 to 17.6 NTU, with 95% of all measurements less than 10 NTU. Turbidity measurements in the tributaries and backwaters ranged from 0 to 20.2 NTU, with 80% less than 10 NTU. Repeated problems with turbidity meter calibration resulted in negative turbidity values in 38% of all samples (identified as “bad data” in Appendix E).

Overall, dissolved oxygen measurements were within New Hampshire and Vermont Class B water quality standards with two instances of measurements outside of one or both state standards. No DO (mg/l) measurements were lower than New Hampshire’s 5.0 mg/l instantaneous standard, and in only one sampling instance on the mainstem (Site BR-002 in the Bellows Falls riverine reach) and one instance in the tributary and backwater sites (Site BR-017 a stream order 2 tributary in the Bellows Falls riverine reach) was the reading lower than Vermont’s 6.0 mg/l standard. In both instances, DO (% saturation) was also below the Vermont standard of 70% for cold water habitat. New Hampshire’s 75% DO saturation standard is a daily average numerical standard, while the data collected in this

study was instantaneous, so the New Hampshire DO % saturation standard is not applicable for this study.

5.7 Project Operations

The temporal distribution of sampling events relative to project operations (in terms of total discharge) is presented in Figures 5.7-1 through 5.7-3 for Wilder, 5.7-4 through 5.7-6 for Bellows Falls and Figures 5.7-7 through 5.7-9. In each graph, project maximum nominal generation (in cfs) is shown on the horizontal line and equates to 10,700 cfs at Wilder, 11,400 cfs at Bellows Falls, and 17,100 cfs at Vernon. Sampling dates are indicated by the small circles at the bottom of each graph. The graphs illustrate that some sampling occurred during periods of high river flow and discharges above project generating capacity, but that many sampling events occurred during periods when the projects operated without spill.

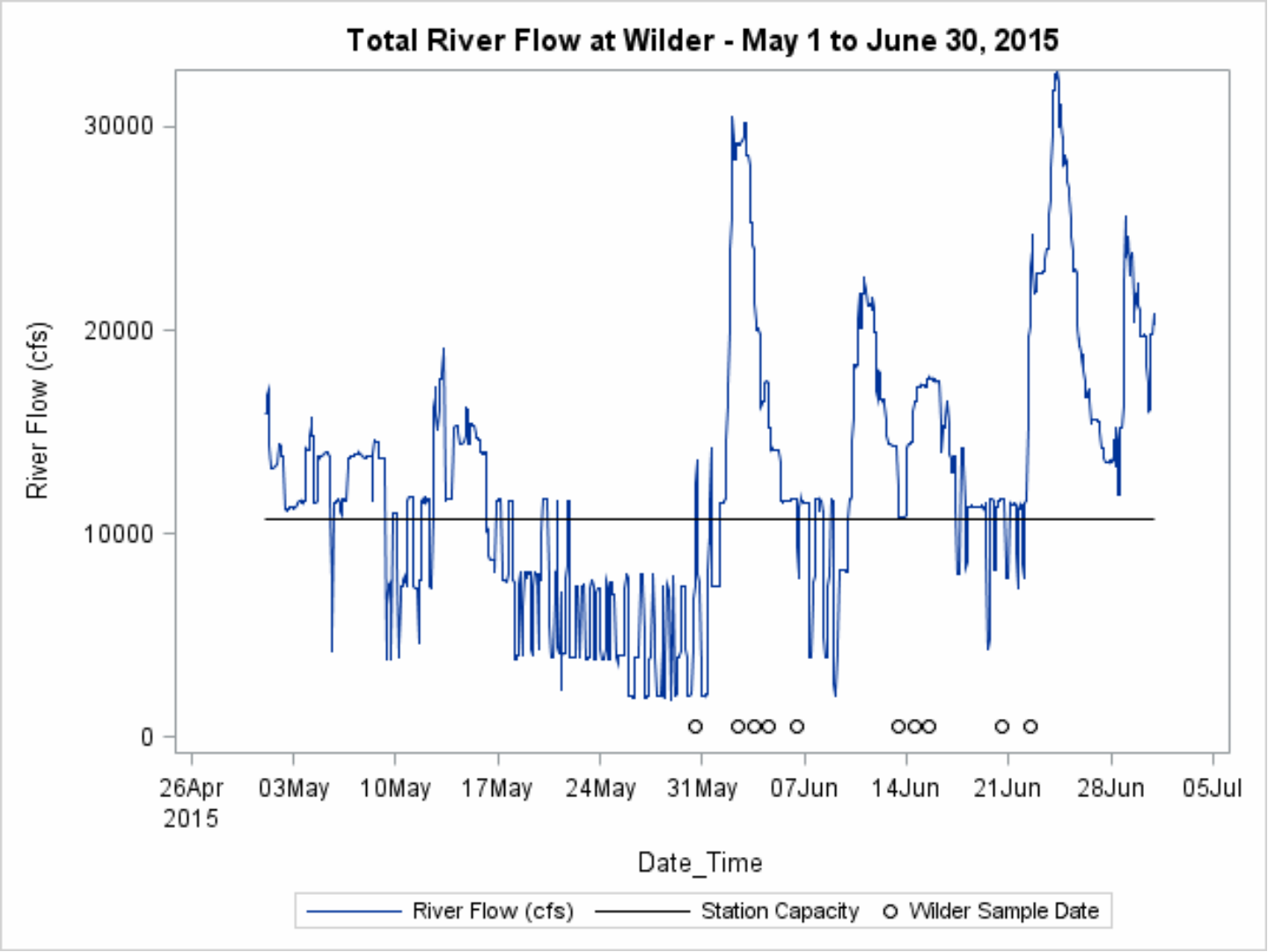

Figure 5.7-1. Total river flow at Wilder dam for the period May1-June 30, 2015.

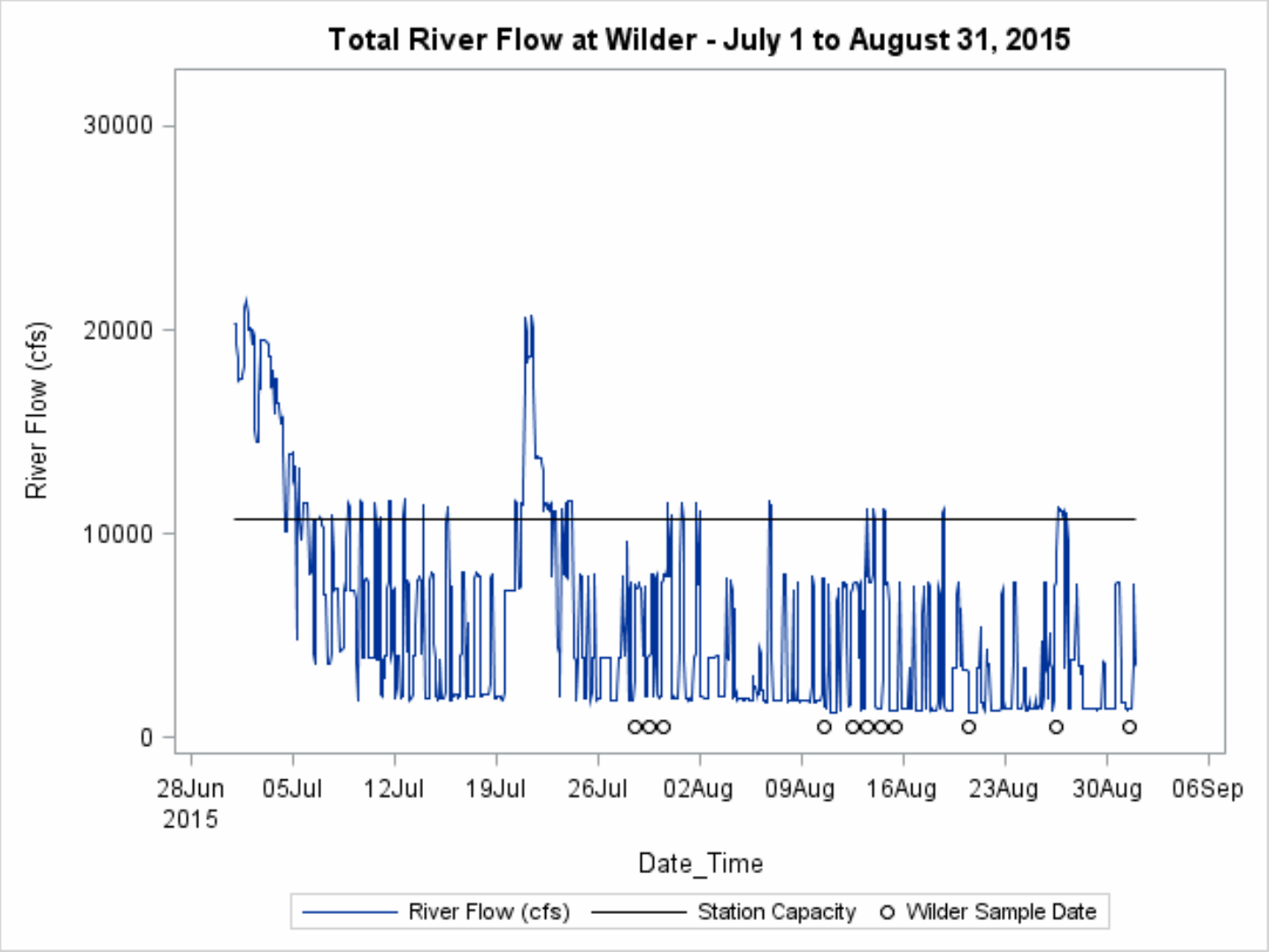

Figure 5.7-2. Total river flow at Wilder dam for the period July1-August 31, 2015.

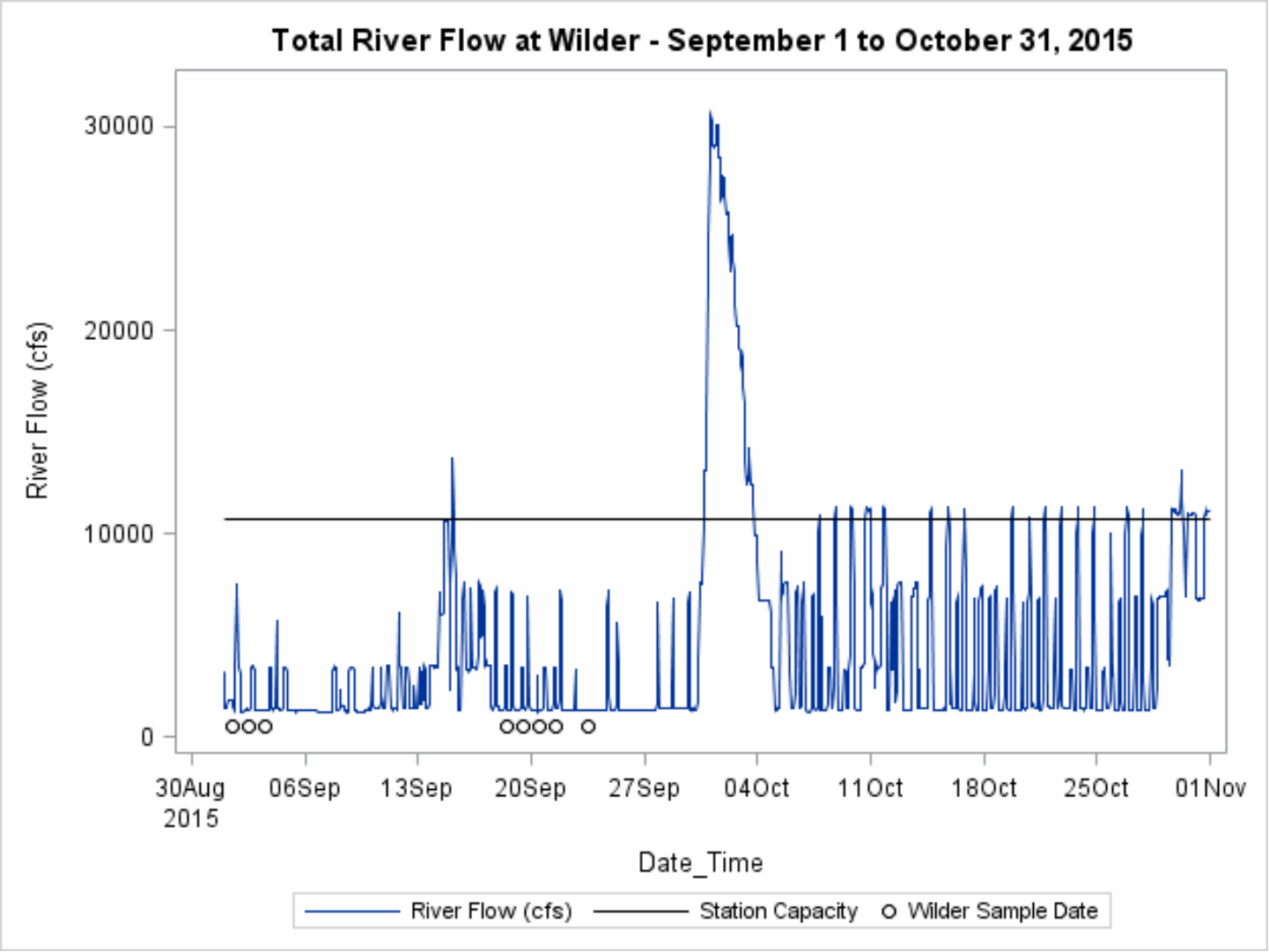

Figure 5.7-3. Total river flow at Wilder dam for the period September 1-October 31, 2015.

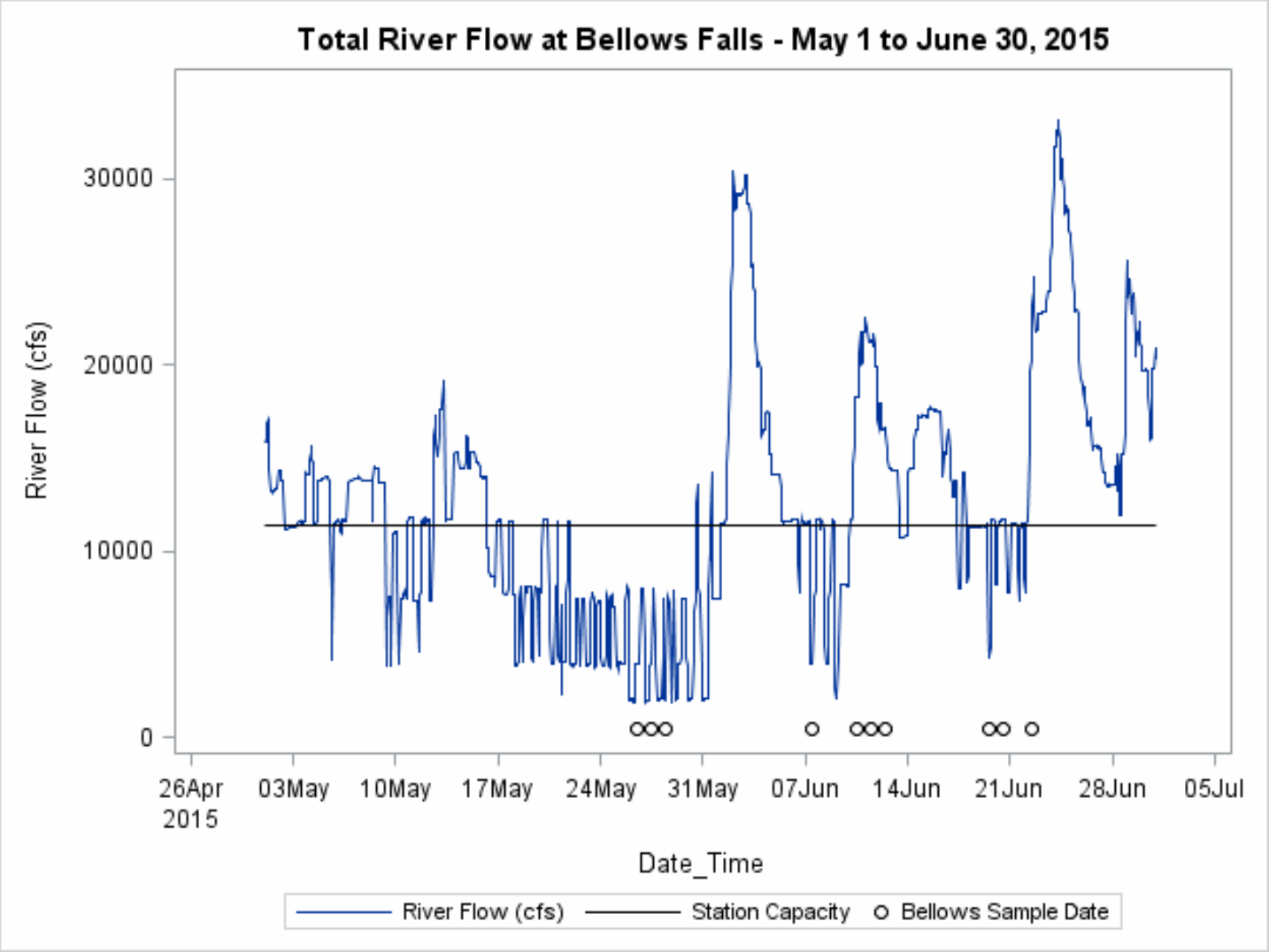

Figure 5.7-4. Total river flow at Bellows Falls dam for the period May1-June 30, 2015.

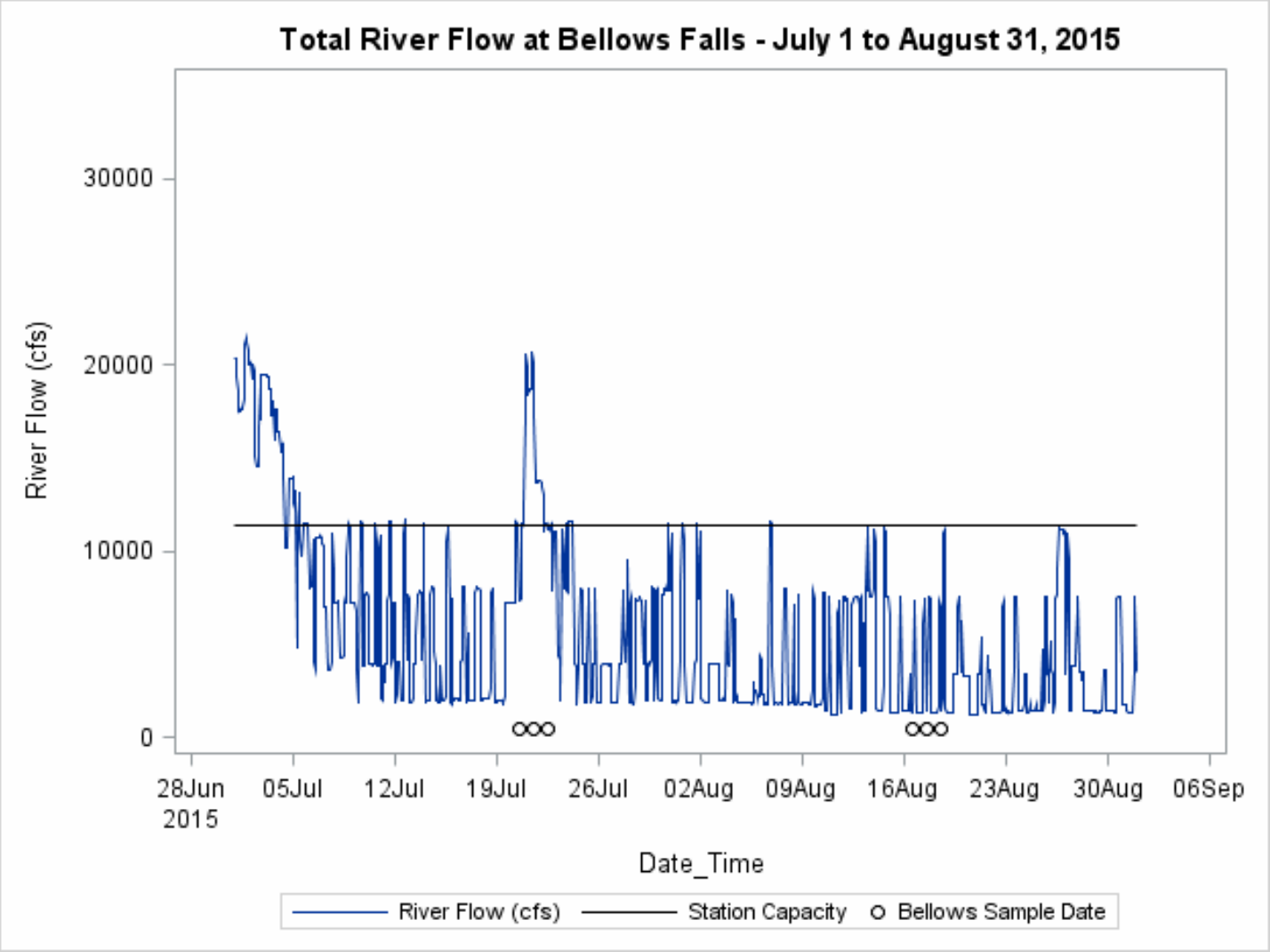

Figure 5.7-5. Total river flow at Bellows Falls dam for the period July1-August 31, 2015.

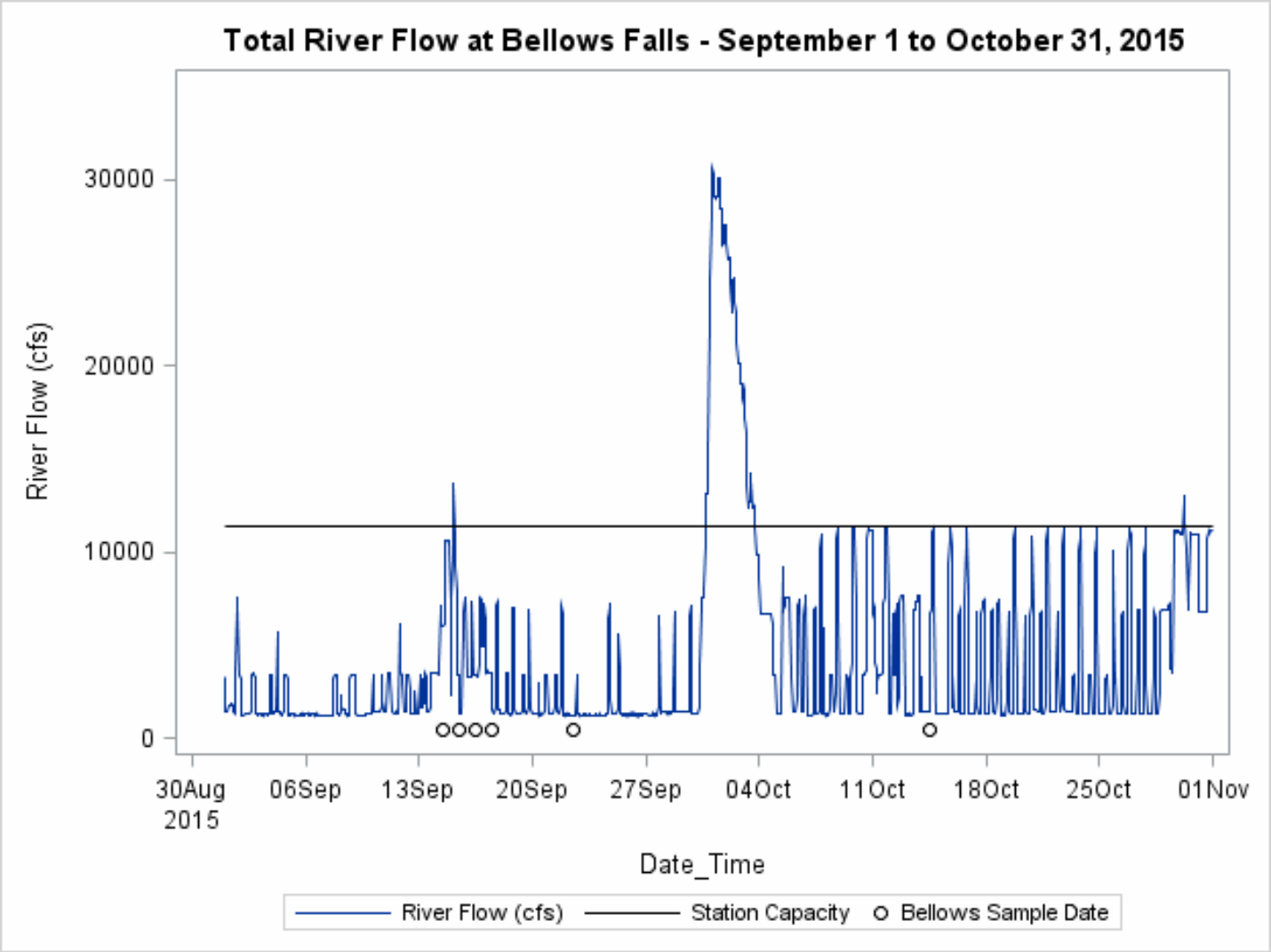

Figure 5.7-6. Total river flow at Bellows Falls dam for the period September 1-October 31, 2015.

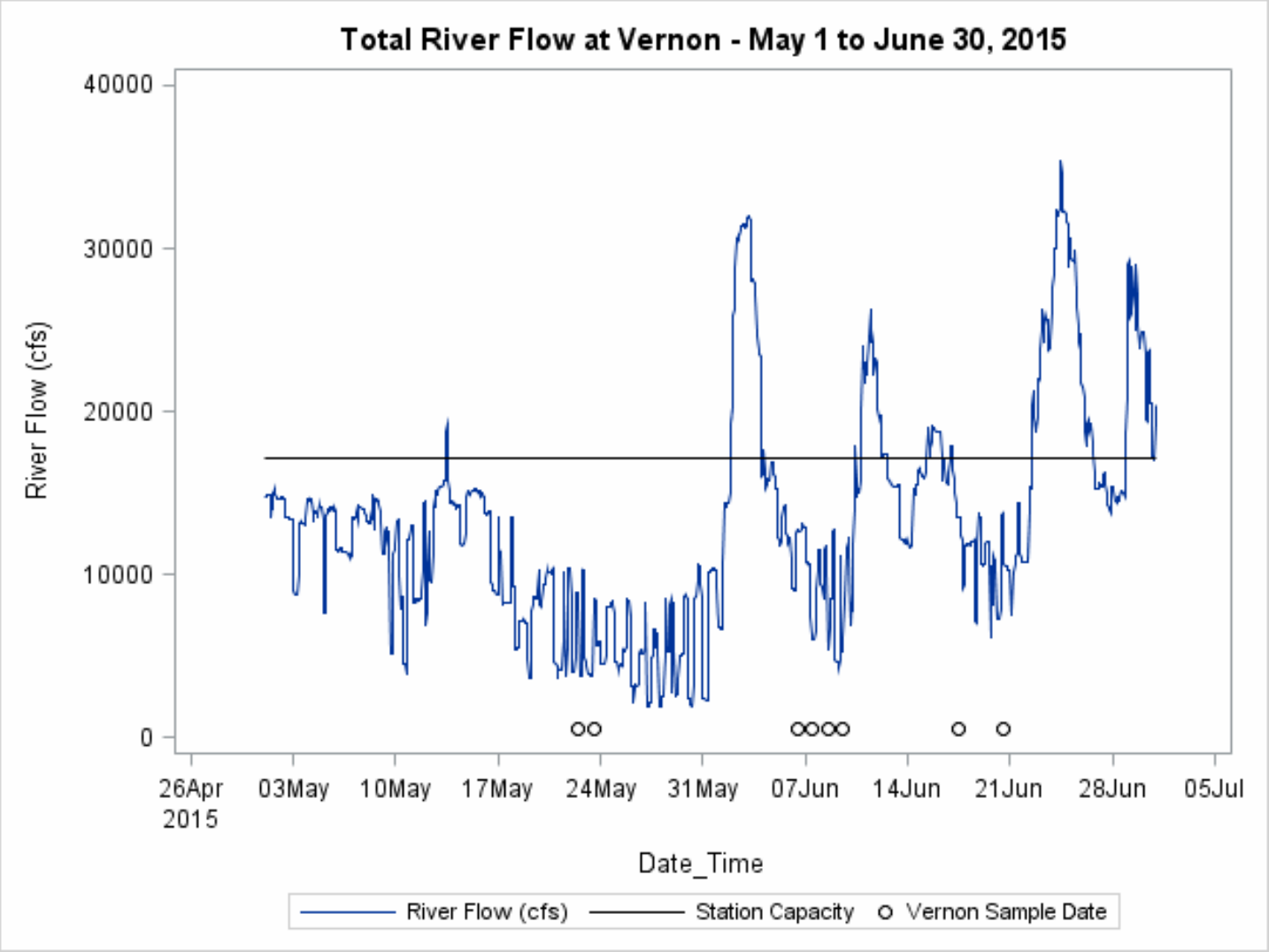

Figure 5.7-7. Total river flow at Vernon dam for the period May1-June 30, 2015.

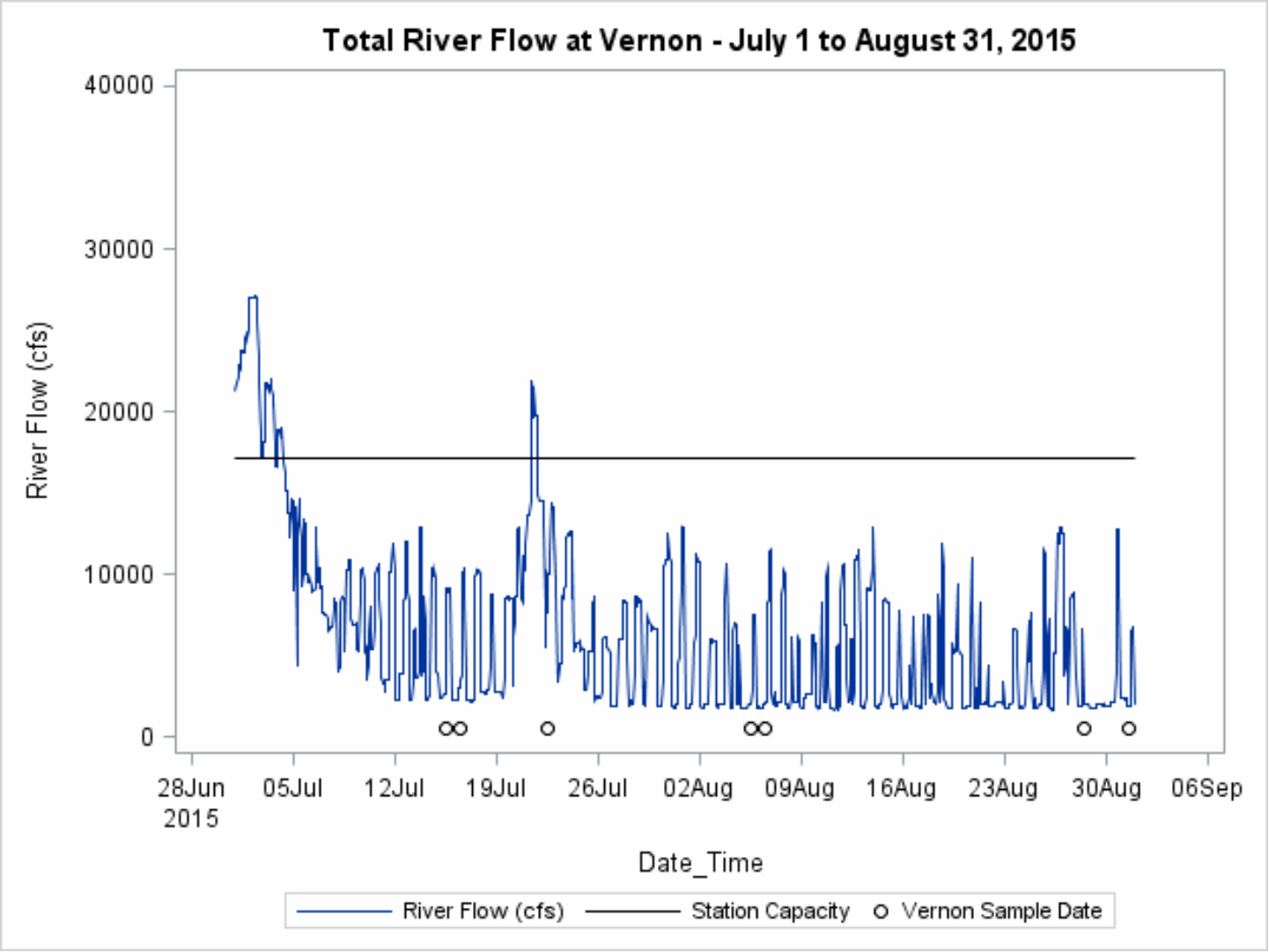

Figure 5.7-8. Total river flow at Vernon dam for the period July1-August 31, 2015.

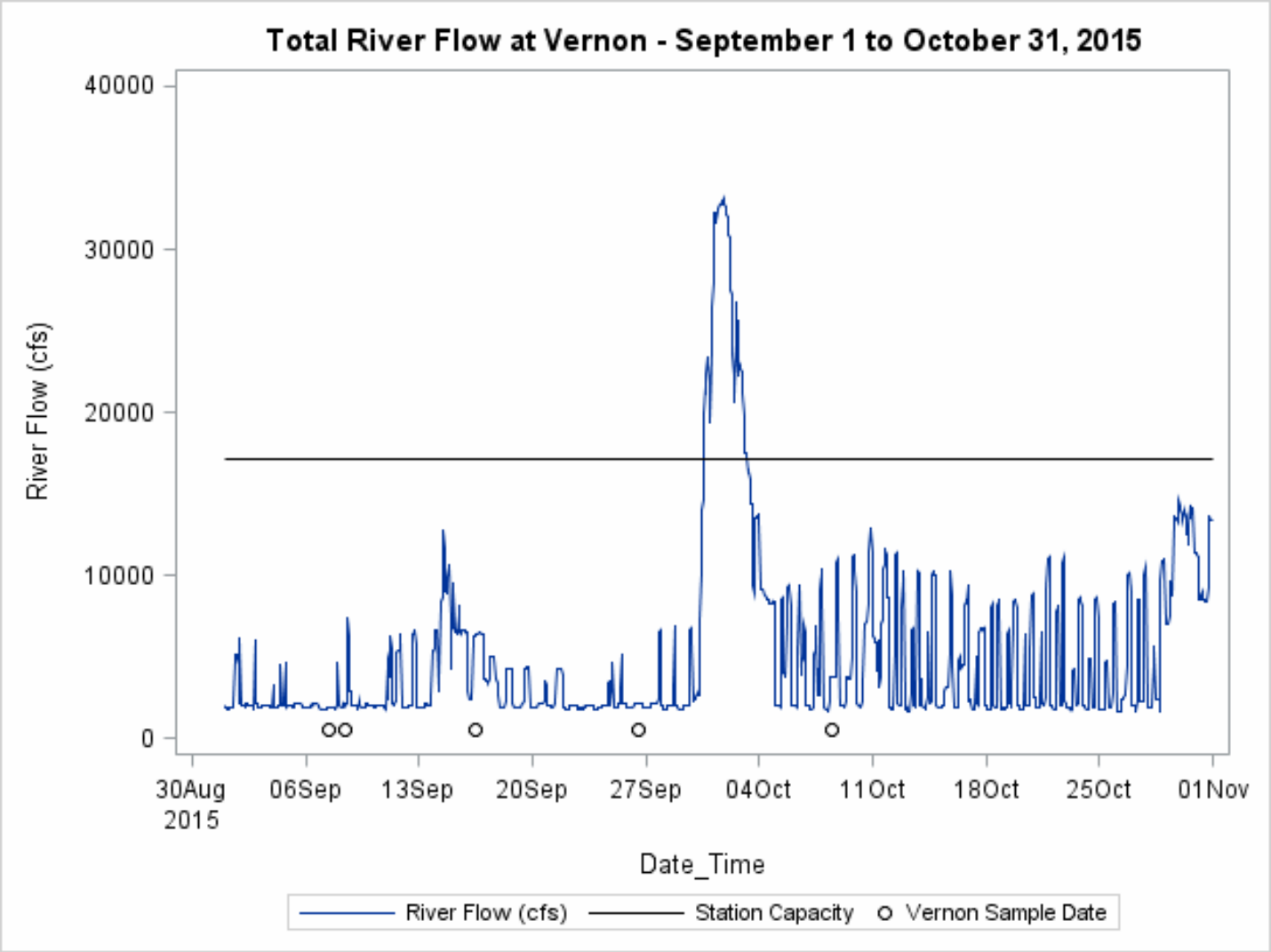

Figure 5.7-9. Total river flow at Vernon dam for the period September 1-October 31, 2015.

6.0 STUDY CONCLUSIONS

Field efforts associated with Study 10 documented the occurrence, distribution, and relative abundance of fish species present within the Wilder, Bellows Falls, and Vernon project-affected areas. A suite of sampling gears (boat electrofish, portable electrofish, experimental gill net, beach seine and trap net) were used to effectively sample available substrate/habitat types (i.e., sand-silt-clay, gravel-cobble, boulder, tributary and backwater) on a seasonal basis. A total of 429 samples were collected between May 22 and October 14, 2015 resulting in 11,551 fish representing 14 families and 43 species.

Table 6.0-1 provides a summary of total catch and dominant fish species within the three impoundments. Although species richness was comparable among the impoundments, family richness was slightly higher in the Vernon impoundment than was observed upstream. Considering the five most abundant species collected in each impoundment, Yellow Perch, Spottail Shiner, and Fallfish were represented in all three impoundments (all gears, substrates/habitats, and seasons combined). Rock Bass were represented in the Wilder and Bellows Falls impoundments, Bluegill in the Vernon impoundment, and Tessellated Darter in the Wilder and Vernon impoundments.

Table 6.0-1. Summary of total catch and dominant fish species among the three impoundments.

	Impoundment		
	Wilder	**Bellows Falls**	**Vernon**
# Fish	2146	2658	2081
# Families	9	9	12
# Species	26	28	28
#1 Abundance	Yellow Perch	Spottail Shiner	Spottail Shiner
#2 Abundance	Fallfish	Yellow Perch	Yellow Perch
#3 Abundance	Spottail Shiner	Smallmouth Bass	Fallfish
#4 Abundance	Rock Bass	Fallfish	Bluegill
#5 Abundance	Tessellated Darter	Rock Bass	Tessellated Darter

A summary of total catch and dominant fish species within the riverine reaches downstream of each dam is presented in Table 6.0-2. It should be noted that the spatial scope of the Vernon riverine reach (approximately 1.5 miles) is significantly shorter than reaches downstream of either Wilder (approximately 17.7 miles) or Bellows Falls dams (approximately 6 miles). Species and family richness was higher within the Bellows Falls riverine reach than in the Wilder riverine reach. Although the values for family richness between Bellows Falls and Vernon riverine reaches were the same, species richness was lower in the Vernon riverine reach. This is likely a function of reach length. Of the five most abundant species in each of the three riverine reaches, only Smallmouth Bass was observed in each reach. Tessellated Darter and Fallfish were among the most abundant species in the Wilder and Bellows Falls impoundments. Similar to the Vernon impoundment, Bluegill and

Yellow Perch were among the most abundant fish species observed in the Vernon riverine reach.

Table 6.0-2. Summary of total catch and dominant fish species among the three riverine reaches.

	Riverine Reach		
	Wilder	**Bellows Falls**	**Vernon**
# Fish	2373	1731	357
# Families	8	12	12
# Species	26	31	23
#1 Abundance	Tessellated Darter	Smallmouth Bass	Smallmouth Bass
#2 Abundance	Smallmouth Bass	Tessellated Darter	Bluegill
#3 Abundance	Fallfish	Fallfish	White Sucker
#4 Abundance	Rosyface Shiner	Spottail Shiner	Yellow Perch
#5 Abundance	Rock Bass	Common Shiner	Rock Bass

Prior to 2015, large-scale fish assemblage evaluations within the Study 10 study area were limited to sampling associated with operation of Vermont Yankee (VY) and a fish assemblage assessment conducted during 2008 (Yoder et al., 2009). Fish community sampling associated with the operation of VY is limited spatially to the lower portion of the Vernon impoundment ("Vernon Pool") and riverine reach but spans over many years. Yoder et al. (2009) conducted fish community sampling over a wide spatial area from the Wilder impoundment downstream through the Vernon riverine reach but samples from the area were limited temporally to single samples collected during August, September, or October, 2008.

In December 2014 VY was shut down for decommissioning and the associated thermal discharge discontinued. Electrofish sampling associated with the operation of VY occurred during May, June, September, and October of 1991 through 2014 at a standard set of six stations in the lower Vernon impoundment and at four stations downstream of Vernon dam unless excessively high or low water levels rendered sampling dangerous or ineffective (Normandeau, 2015c). Samples were collected in the evening beginning approximately one-half hour after sunset.

Appendix F (filed separately in Excel format) includes two tables reproduced from the report entitled "Ecological Studies of the Connecticut River Vernon, Vermont – Report 44" (Normandeau, 2015c). They provide a summary of the number and percent of fish species collected during electrofish sampling in the Connecticut River upstream and downstream of Vernon dam for the period 1991-2014. At sampling locations located in the lower portion of Vernon impoundment (Table F-1), a total of 30,175 fish representing 29 species were collected during the 23 years of sampling. Of that total, 22 of the same species were collected during sampling for Study 10. American Eel, Atlantic Salmon, Common Shiner, Gizzard Shad, Mimic Shiner, Redbreast Sunfish, and Yellow Bullhead were collected from the lower Vernon impoundment during VY electrofish sampling but were not observed during Study 10. The majority of those species are represented by a limited number of individuals and only the Yellow Bullhead has been collected since 2011. Five species: Slimy Sculpin, Brook Trout, Creek Chub, Blacknose Dace, and Rosyface

Shiner were present in the Study 10 catch from the Vernon impoundment but were not collected during VY sampling. Most of these species were limited in abundance and associated with tributary habitat sampled as part of Study 10.

At VY sampling locations in the upper portion of the Vernon riverine reach (Table F-2), a total of 10,297 fish representing 35 fish species were collected during the 23 years of sampling. Of that total, 22 species were also collected during sampling for Study 10. Two fish species: Slimy Sculpin and Rosyface Shiner were present in the Study 10 catch from the Vernon riverine reach but had not been previously observed in catches during VY sampling. Slimy Sculpin were present in tributary habitat not sampled by VY and the Rosyface Shiner was a single individual. Of the 13 species observed during VY sampling but not detected during Study 10, none represented greater than 0.4% of the total electrofish catch and the majority have not been observed since prior to 2008.

During the 2008 fish assemblage assessment, Yoder et al. (2009) collected a total of 27 electrofish samples within the Study 10 study area. A total of 3,702 fish representing 11 families and 32 species were collected (Table 6.0-3). Twenty-eight of the 32 species reported by Yoder were also observed during sampling for Study 10. Rainbow Trout (n=3), Atlantic Salmon (n=1), Redbreast Sunfish (n=2) and White Catfish (n=1) were observed in limited numbers by Yoder but were not present in samples collected during this study. Fallfish, Smallmouth Bass and Yellow Perch were among the five most abundant species collected during both studies when all sampling locations are considered.

Field sampling conducted as part of Study 10 has enhanced the existing knowledge of the fish assemblage within the Wilder, Bellows Falls, and Vernon project-affected areas. Previous samples were either conducted with a limited spatial scope (i.e., VY) or a limited temporal scope (i.e., Yoder). The stratified random selection of sampling locations based on available substrate/habitat types, conducted on a seasonal basis, and relying on a suite of sampling techniques has provided a robust and current data set with which to describe the occurrence, distribution and relative abundance of fish in the project-affected areas.

Table 6.0-3. Total catch and percent composition for species collected within the Wilder, Bellows Falls, and Vernon project areas as part of a fish assemblage study conducted by Yoder et al. (2009).

Family/Common Name	Count	% Comp.
Anguillidae		
American Eel	1	<0.1
Catostomidae		
White Sucker	310	8.4
Centrarchidae		
Black Crappie	20	0.5
Bluegill	118	3.2
Largemouth Bass	127	3.4
Pumpkinseed	76	2.1
Redbreast Sunfish	2	0.1
Rock Bass	147	4.0
Smallmouth Bass	666	18.0
Clupeidae		
American Shad	11	0.3
Cyprinidae		
Blacknose Dace	1	<0.1
Bridle Shiner	4	0.1
Common Carp	1	<0.1
Common Shiner	577	15.6
Creek Chub	1	<0.1
Fallfish	581	15.7
Golden Shiner	61	1.6
Mimic Shiner	1	<0.1
Spottail Shiner	230	6.2
Esocidae		
Chain Pickerel	22	0.6
Northern Pike	6	0.2
Fundulidae		
Banded Killifish	3	0.1
Ictaluridae		
Brown bullhead	3	0.1
White Catfish	1	<0.1
Yellow Bullhead	97	2.6
Percidae		
Tessellated Darter	104	2.8
Walleye	4	0.1

Family/Common Name	Count	% Comp.
Yellow Perch	448	12.1
Petromyzontidae		
Sea Lamprey	74	2.0
Salmonidae		
Atlantic Salmon	1	<0.1
Brown Trout	1	<0.1
Rainbow Trout	3	0.1
Total Individuals	**3702**	
Total Families	**11**	
Taxa Richness	**32**	

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APPENDICES

Report appendices are being filed simultaneously in zipfile format:

Appendix A: Length-Weight Data – Excel file

Appendix B: Timing, Location, and Measure of Fish Sampling Effort - Excel file containing:

- Table B-1. Boat electrofish sample times and duration of valid samples by season, river reach, station, and location.
- Table B-2. Portable electrofish sample times and duration of valid samples by season, river reach, station, and location.
- Table B-3. Gill net sample times and duration of valid samples by season, river reach, station, and location.
- Table B-4. Trap net sample times and duration of valid samples by season, river reach, station, and location.
- Table B-5. Beach seine sample times and level of effort for valid samples.

Appendix C: Catch per Unit Effort by Species, Season, River Reach, Substrate/Habitat Type and Sampling Gear - Excel file containing 43 tables

Appendix D: Catch per Unit Area (#/100m^2) by Species, Season, River Reach, and Substrate/Habitat Type - Excel file containing 43 tables

Appendix E: Water Quality, Depth and Velocity Data - Excel file containing:

- Table E-1. Water quality data collected in 2015 as part of Study 10
- Table E-2. Velocity data collected in 2015 as part of Study 10.

Appendix F: Electrofishing Data in the Vicinity of the Vernon Project - Excel file containing:

- Table F-1. Summary of the number and percent of fish species collected by general electrofishing in the Connecticut River upstream of Vernon Dam near Vernon, Vermont, 1991 through 2014. Reproduced from Normandeau (2015c).
- Table F-2. Summary of the number and percent of fish species collected by general electrofishing in the Connecticut River downstream of Vernon Dam near Vernon, Vermont, 1991 through 2014. Reproduced from Normandeau (2015c).

Appendix G: Detailed Data by Study Site - Excel file

Appendix H: Catch per Unit Effort by Species, Season, and River Reach for each Gear Type – pdf file containing 43 figures for each of the four gear types.

Appendix I: Catch per Unit Area by Species, Substrate/Habitat, and River Reach for each Sampling Season – pdf file containing 43 figures for each of the three seasons.

Appendix J: Percent Composition Figures – pdf file containing 57 figures (17 for spring, 20 each for summer and fall sampling seasons).