LAMPREY RIVER BASELINE FISH SAMPLING
AUGUST 25-29, 2003

NH Department of Environmental Services
in cooperation with
US Environmental Protection Agency
US Fish & Wildlife Service
Massachusetts Fisheries and Wildlife Division
NH Fish & Game Division

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Lamprey Baseline Fish Community Report

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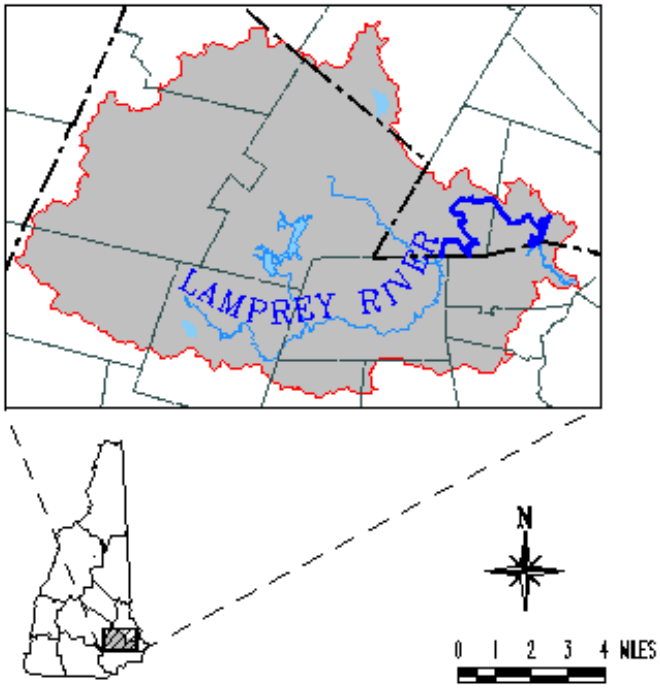
Lamprey Baseline Fish Community

PROJECT OVERVIEW

Fish collections from comprehensive sampling were used to define a baseline fish community (BFC) in a part of the Lamprey River in coastal New Hampshire (Figure 1). The baseline fish community is defined here as the fish community expected within the Lamprey study reach based on presence and relative abundance of the most prevalent species. The fish collections were completed between August 25 and August 29, 2003 at 43 stations using gill nets, shoreline seining, and backpack, barge and boat-mounted electrofishing. This BFC represents the fish community for the study reach at a moment in time.

Fish habitat is a combination of flow, chemistry, geomorphology, substrate, and other parameters. Stream flow was measured at 11 of the backpack and barge electrofishing stations. US Environmental Protection Agency (USEPA) Rapid Bioassessment Protocol (http://www.epa.gov/owow/monitoring/rbp/download.html) habitat assessments were collected at 11 of the backpack and barge electrofishing stations. Water quality parameters were measured at 41 stations. Overviews of water withdrawals and dam operations were conducted and precipitation measurements documented.



The Lamprey River and its watershed.

Figure 1 - Lamprey Watershed Locus Map

(Study reach highlighted in dark blue). Source: http://www.des.state.nh.us/rivers/lamprey1.htm

Project Purpose

The BFC project seeks to expand the understanding of the fish community within a segment of the Lamprey River identified as the study reach highlighted in Figure 1. The project was designed and implemented to collect a complete, representative sample of resident fish species for the two major

macrohabitats within the study reach. The BFC determined from the study will be used in the determination of instream flow requirements. Fish are a stable assemblage representative of long-term conditions in the watershed and an important natural resource for consideration in developing protected instream flows under the Rivers Management and Protection Program. Previous sampling efforts in the Lamprey River have been limited primarily to headwater and wadeable portions of the river and outside the identified study reach. The study reach was chosen for this project because it is a Designated River.

Lamprey Designated River

The study reach is the section of the Lamprey River designated under the Rivers Management and Protection Program (RSA 483). Designation under this program identifies the river as of special value to the people of NH and requires special protections for the river including instream flow. The river was designated in June 1990, and is comprised of the 12-mile segment that flows through the towns of Lee and Durham. The Designated River is a sixth order stream according to UNH assessment (available as GIS coverage at NHDES) and has a watershed area of 212 square miles at its end point at the Newmarket town line. The Designated River is freshwater and not tidally influenced. The Macallen Dam, 1.25 miles downstream of the Designated River in Newmarket, is the upstream limit of tidal influence.

Lamprey River Watershed

The Lamprey River watershed is in the New Hampshire seacoast area. The Lamprey River originates in Northwood, New Hampshire and flows 47 miles east to Great Bay (Figure 2). The river drains a coastal watershed (HUC 01060003-07) covering parts of 15 towns [Northwood, Strafford, Barrington, Deerfield, Nottingham, Lee, Durham, Candia, Raymond, Fremont, Epping, Brentwood, Exeter, Newfields, and Newmarket]. It begins in the upland areas in Northwood, but can be characterized as having a low gradient for most of its length. River flow is regulated by a number of dams including those controlling Mendums Pond and Pawtuckaway Lake. There are four dams on the mainstem of the river: Bunker Pond Dam, Wadley Falls Dam (breached), Wiswall Dam and Macallen Dam, the tidal dam at the confluence of the Lamprey River and Great Bay. Wiswall Dam is an important feature in this study because it occurs within the Designated River. There are thirteen tributaries that flow into the Lamprey River. The major tributaries are (upstream to downstream) Hartford Brook, North Branch River, Onway/Governors Lakes tributaries, Pawtuckaway River, North River, Little River and Piscassic River. There is minimal development within the watershed: over 12 percent of the land is under conservation easements.

A USGS gage station, identified as USGS 01073500 LAMPREY RIVER NEAR NEWMARKET, NH is above Packers Falls near the downstream end of the study reach (Figure 2). The gage has a drainage area of 185 square miles (NHDES GIS). The USGS EXETER RIVER AT HAIGH ROAD NEAR NEWMARKET gage records precipitation data that were collected for this study.

The National Park Service has included a portion of the Lamprey River, including the study reach, in its Wild and Scenic Designation (http://www.nps.gov/rivers/wsr-lamprey.html). The designation occurred in two parts, first on November 12, 1996 when 11.5 miles were designated and later in May 2, 2000 an additional 12 miles were designated. Both segments were designated for the river's recreational features. The Wild and Scenic segment begins at the Bunker Pond Dam (Figure 2) in Epping to the confluence with the Piscassic River in the vicinity of the Durham-Newmarket town line. This designation means no new dams may be constructed in this portion of the Lamprey River.

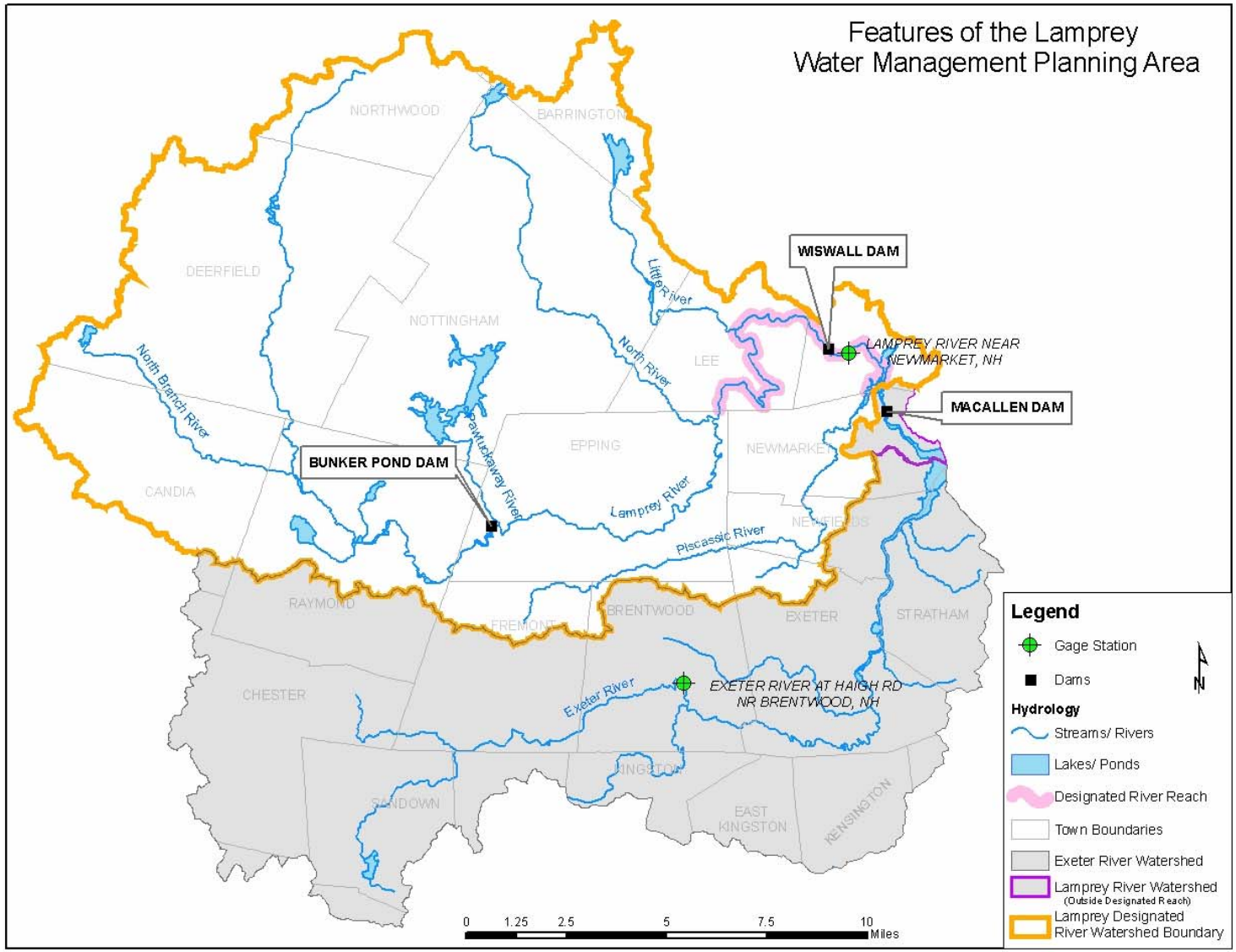


Figure 2 - Features of the Lamprey WMPA

Overview of Fish Community Conditions

The Lamprey River is an important recreational fishery. The NH Fish & Game Department (NHF&G) stocks trout in the upper reaches and tributaries of the Lamprey River. A local Trout Unlimited chapter stocks trout in a river segment below Wiswall Dam. The Lamprey River Management Plan [January 1995] states, "The presence of and potential for additional runs of river herring, American shad, and Atlantic salmon make this the state's most significant river for all species of anadromous fish. Sunfish, catfish, perch, largemouth and smallmouth bass, and pickerel are common warmwater resident species, and coldwater residents include brown and brook trout," (http://www.des.state.nh.us/rivers/plans/lampln13.htm.)

Two dams deserve mention in examining the Lamprey fish community because dams limit the movement of fish within the study reach and have created impounded habitat where free-flowing conditions once existed. The Macallen Dam in Newmarket, downstream of the study reach, allows some anadromous fish passage by way of a fish ladder. The impounded reach extends about two miles upstream to just below Packers Falls. (Packers Falls is just downstream of the Lamprey Near Newmarket Gage.) Wiswall Dam in Durham is an important dividing point in the Lamprey Designated River affecting fish passage. There is no upstream fish passage beyond this point. NHF&G transports shad upstream of the dam to increase access to spawning areas. Fish can and do migrate downstream when flows are sufficient to overtop the dam. Plans for the installation of a fish ladder at Wiswall Dam have been made. Wiswall Dam impounds water for over 1.8 miles upstream. Macallen Dam impounds 65% of the river reach below Wiswall Dam. Together the two dams impound 30% of the study reach.

FISH SAMPLING BACKGROUND AND METHODS

Historical Fish Sampling

From 1983 through 1985, NHF&G collected fish at seventeen stations within the Lamprey watershed to assess the trout stocking program. Collection methods for all stations included backpack electrofishing, minnow traps, and experimental gillnets as capture techniques. Two closely-spaced stations at Wadleigh Falls in Lee, NH were within the study reach. Station 035 used electrofishing methods on September 11, 1985 and Station 034 used a gill net set dated the following day (Table 1). Seven of the seventeen stations were on the Lamprey main stem. Relative abundances for combined fish assemblages from these mainstem stations show fallfish making up 68.6% of the fish captured (Table 2). Where backpack electrofishing was used, an unblocked 100 meter reach was sampled with a single backpack unit (Personal communication with Scott Decker, NHF&G). Gill nets were used at nine of the seventeen stations. All NHF&G fish data are available in Appendix A.

Table 1 - Historical NHF&G Stations in the Lamprey BFC Study Reach

Town	SITE	DATE	METHOD	SPECIES	NUMB_CAUGHT
LEE	034	9/12/1985	GILL NET	common white sucker	14
LEE	034	9/12/1985	GILL NET	chain pickerel	1
LEE	034	9/12/1985	GILL NET	smallmouth bass	1
LEE	035	9/11/1985	ELECTRO	American eel	1
LEE	035	9/11/1985	ELECTRO	bridle shiner	1
LEE	035	9/11/1985	ELECTRO	pumpkinseed	3
LEE	035	9/11/1985	ELECTRO	common white sucker	7
LEE	035	9/11/1985	ELECTRO	chain pickerel	2
LEE	035	9/11/1985	ELECTRO	fallfish	77

Table 2 - Relative abundance of fish collected in the Lamprey River Mainstem (NHF&G) combined from seven sites in the towns of Deerfield, Raymond, Epping, and Lee 1983 – 1985

Common Name	Count	Percent
Fallfish	308	68.6
Pumpkinseed	47	10.5
Common White Sucker	37	8.2
Longnose Dace	17	3.8
Chain Pickerel	12	2.7
Common Shiner	9	2.0
Smallmouth Bass	6	1.3
American Eel	4	0.9
Brown Bullhead	2	0.4
Yellow Perch	2	0.4
Swamp Darter	2	0.4
Blacknose Dace	1	0.2
Largemouth Bass	1	0.2
Bridle Shiner	1	0.2
Totals	449	100.0

The NHDES conducted fish sampling in the Lamprey watershed using backpack electrofishing in wadeable reaches in 1998. Only one historical fish sampling station by NHDES (98P-84) was within the study reach. This station was sampled at Wadley Falls and is approximately coincident with the NHF&G sites sampled in 1985. This sampling event found a preponderance of common shiners (Table 3). Eight other stations in the watershed were sampled by NHDES. The sampling method for all stations used a single backpack electrofishing unit, unblocked, with a single pass on 150 meters of stream (Personal communication with Steve Landry, NHDES and Hilary Snook, USEPA). NHDES Lamprey watershed historical fish data are in Appendix A.

Table 3 - NHDES historical sampling results

Site Name: 98P-84, Lamprey River, Lee/Epping		
Date Fished: August 24, 1998		
Common Name	**Count**	**Percent**
Common Shiner	113	62%
Common White Sucker	35	19%
Redbreasted Sunfish	21	12%
Bridle Shiner	8	4%
Fallfish	2	1.1%
Atlantic Salmon	1	0.5%
Brown Trout	1	0.5%
Redfin Pickerel	1	0.5%
Totals	182	100%

Together these historical datasets show common shiners, fallfish and common white sucker as the dominant fish species at this location comprising 85% of all fish collected, with redbreasted sunfish strongly represented (7%). In the historical fish sampling data, no boat electrofishing and only one occurrence of netting were identified as being used on the study reach. This indicates that the segments of the study reach that were not wadeable, barring the one NHF&G site, were not sampled.

Lamprey River Target Fish Community from historical data

A Target Fish Community (TFC) for the Lamprey River was developed by US Fish & Wildlife Service (USF&W) from the results of fish sampling from 1983-1985 by NHF&G. A TFC is a calculated estimate of the community of fish that ideally should exist in a river. It is an idealized community usually determined from reference rivers similar to the study river. Because no reference rivers could be identified to match the Lamprey River, sampling from within the Lamprey watershed was used to generate a TFC. The TFC was later revised by USF&W using the additional data from NHDES collected in 1998. Almost all sample collection was conducted on upstream reaches and tributaries. Because the TFC was determined from upstream stations, it may not be reflective of conditions in the study reach. The USF&W TFC results for the Lamprey River show an expectation that species requiring flowing waters would dominate the expected community (Table 4).

Table 4 - Lamprey River TFC from Historical Data

Lamprey River Target Fish Community (Revised - Includes data from F&G (1983-1985) and NHDES (1998))			
Habitat Classification	Species	Relative Abundance	Pollution Tolerance
RFS	Fallfish	30%	M
FD	Common shiner	15%	M
FD	White sucker	10%	T
FS	Blacknose dace	6%	T
RFS	Longnose dace	6%	M
FS	Creek chubsucker	5%	I
RFS	Brook trout	5%	I
MHG	American eel	3%	T
MHG	Chain pickerel	3%	M
MHG	Pumpkinseed	3%	M
MHG	Brown bullhead	1%	T
MHG	Swamp darter	1%	I
MHG	Bridle shiner	1%	I
MHG	Smallmouth bass	<1%	M
MHG	Yellow perch	<1%	M
FD	Longnose sucker	<1%	I
MHG	Golden shiner	<1%	T
MHG	Largemouth bass	<1%	M
MHG	Bluegill	<1%	T
MHG	Redbreasted sunfish	< 1%	M
MHG	Banded sunfish	< 1%	
MHG	Spottail shiner	< 1%	M
RFS	Creek chub	< 1%	T
MHG	Yellow bullhead	< 1%	T
MHG	Redfin pickerel	< 1%	M
MHG	Northern pike	< 1%	I
MHG	Black crappie	< 1%	M
FD	Rainbow trout	P	I
FD	Sea lamprey (ammocoetes)	P	
FD	Atlantic salmon	P	I
FD	Brown trout	P	I
Diadromous Pulse Species			
FD	Atlantic salmon		I
MHG	Alewife		
FD	Blueback herring		
MHG	American eel		T
FD	Sea lamprey		M

FD	American shad		
RFD	Smelt		
Diadromous pulse species - This term is used to denote those species that migrate into or out of freshwater in a concentrated manner, e.g., a fish run. With the exception of salmon, eel, and sea lamprey, these species typically remain in fresh water for less than a year.			
Key to Habitat Classifications			
FS	=	fluvial specialist	
FD	=	fluvial dependent	
RFS	=	regional fluvial specialist	
RFD	=	regional fluvial dependent	
MHG	=	macrohabitat generalist	

Habitat classification identifies each species as being either a macrohabitat generalist, fluvial-dependent, or fluvial-specialist. The macrohabitat generalist classification is comprised of fish that do not require fluvial conditions. Fluvial specialists are permanent residents that require fluvial conditions for all of their life cycle. Fluvial dependent fish require fluvial conditions for certain life stages, such as spawning, but otherwise can exist without fluvial conditions.

Development of the BFC Sampling Methods

The baseline fish community (BFC) project is intended to be a comprehensive evaluation of the relative species abundance of fish within the study reach. There are few if any rivers available to use as a reference for the Lamprey that have similar geomorphic and hydrologic conditions. Because the historical sampling had not adequately sampled the study reach, the BFC sampling was devised to establish the existing conditions.

In September 2002, state and federal agencies met and decided that a one-day sampling project would meet the needs and interests of several state and federal agencies. NHF&G and NHDES routinely sample fish in wadeable streams using backpack electrofishing techniques. This method was planned for the BFC collections. NHF&G also routinely sample fish in lakes and ponds using boat electrofishing. This method was discussed as another possibility because the river was known to contain deep segments.

Selection of stations was first evaluated in October 2002 during a river reconnaissance by NHDES. Visual observations of depths were noted and keyed to GPS markers. The result was a map of locations suitable at or near that day's flow of 4-5 cfs either for backpack electrofishing or for boat electrofishing, with some segments classified as marginal for either technique (Figure 3). The river habitats identified varied from shallow wadeable riffles and runs from less than a half foot deep to deep runs and impounded segments over 20 feet deep. The map of sampling methods also represented a division of the river into two main macrohabitats representing shallow riffles and runs, and deep runs and impoundments The distribution of these macrohabitats was 40 percent shallow runs and riffles or marginal and 60 percent deep runs. The deep runs comprised too great a portion of the river to leave out of the sampling. Marginal habitat initially referred to whether backpack shocking would be feasible so it is usually closer to wadeable habitat than it is to deep habitat.

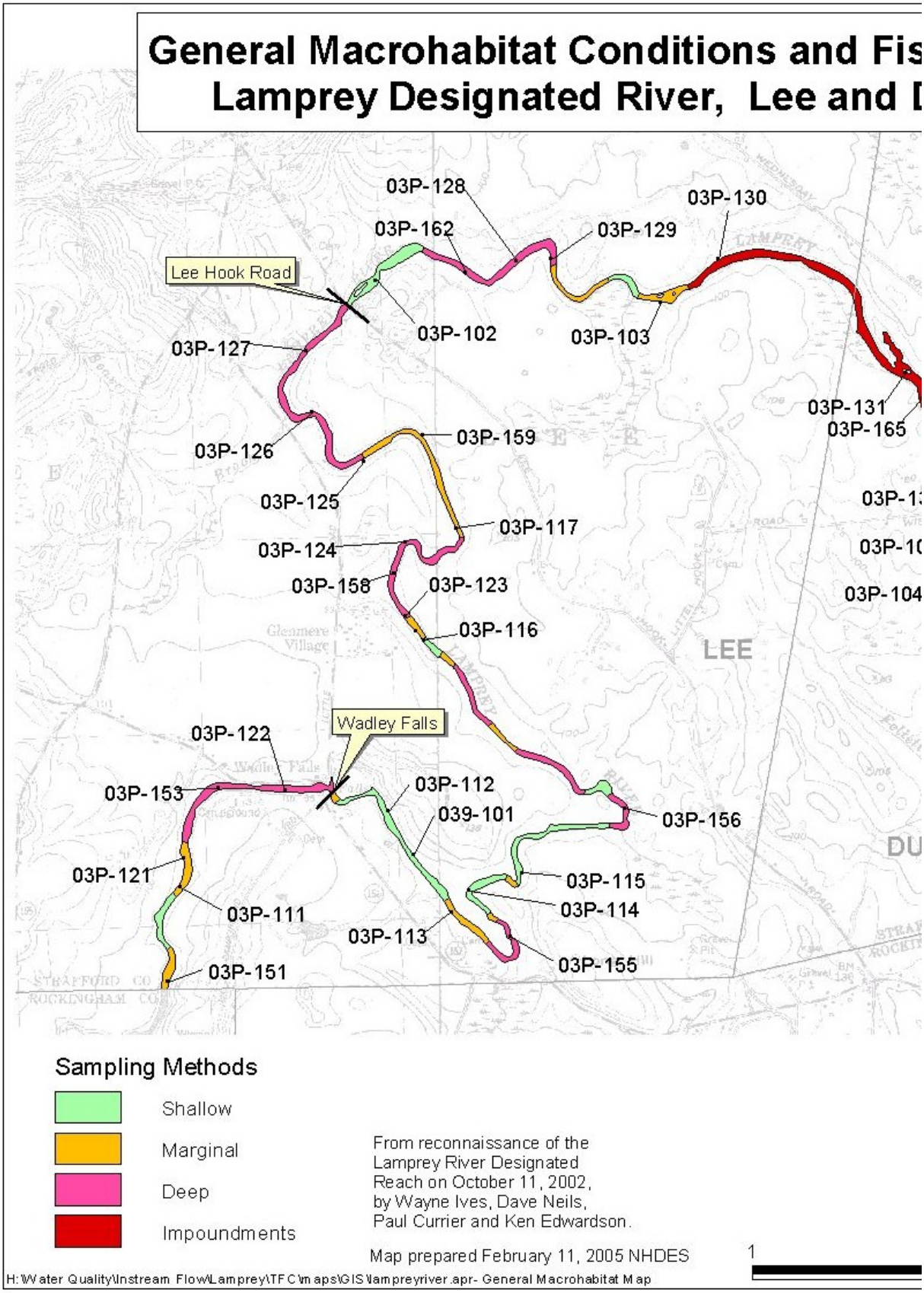
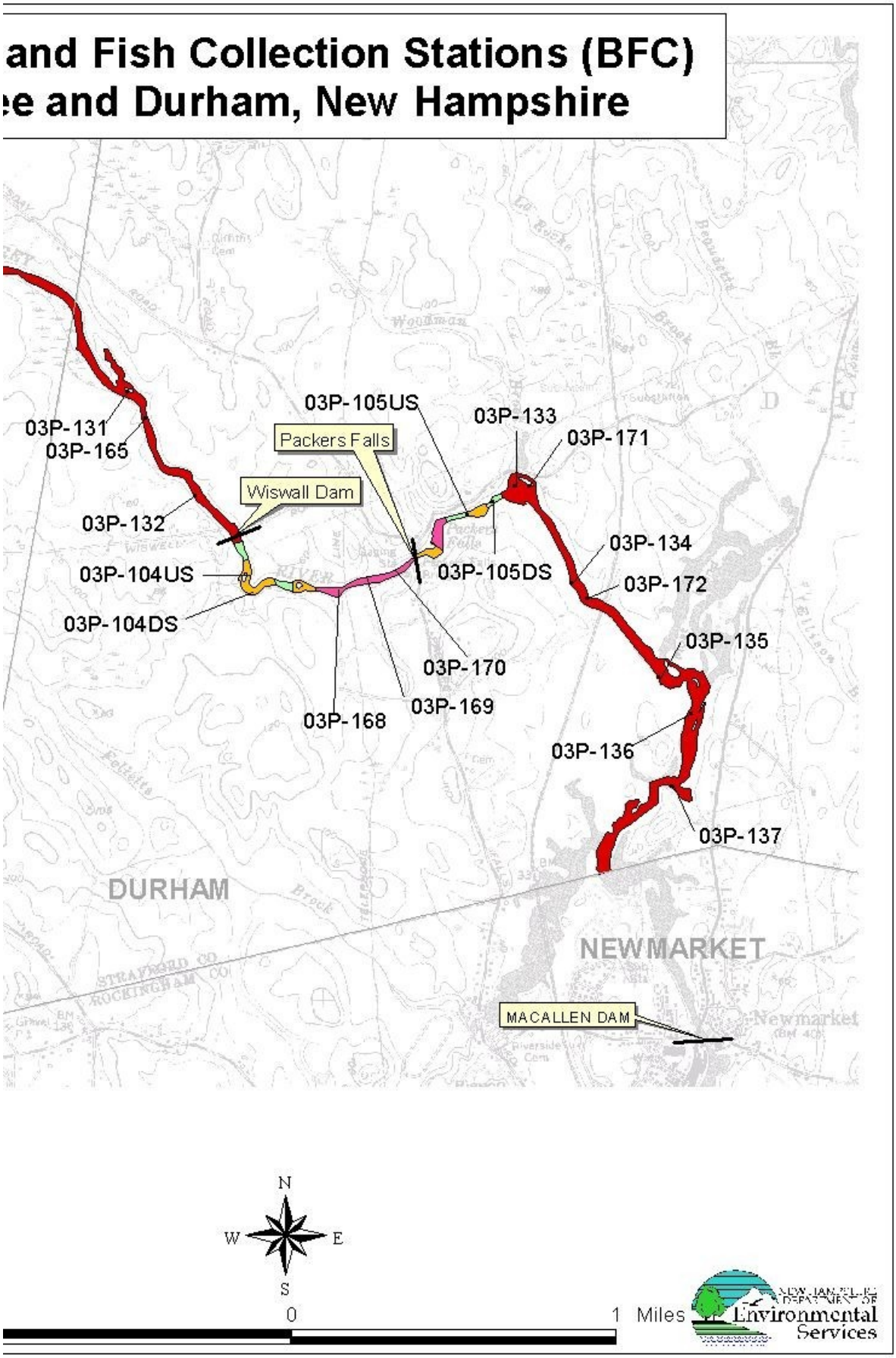


Figure 3 - General Map of River Macrohabitat Conditions (in two parts)


and Fish Collection Stations (BFC)
e and Durham, New Hampshire
03P-131
03P-165
03P-132
03P-104US
03P-104DS
Wiswall Dam
Packers Falls
03P-105US
03P-105DS
03P-133
03P-171
03P-134
03P-172
03P-135
03P-136
03P-137
03P-170
03P-169
03P-168
DURHAM
NEWMARKET
MACALLEN DAM
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Because of the variability in river conditions, sampling methods evolved to four different fish collection techniques. Sampling was also expanded from a one-day to a week-long event. In March 2003, a meeting between the cooperating agencies expanded the proposed sampling methods to include a barge electrofishing unit to augment backpack electrofishing. Also proposed were gillnets and shoreline seining to augment and complement the boat electrofishing. The experimental gillnets and the shoreline seines can sample deep bottoms and shallow margins of the river beyond the effective reach of the electrofishing boat. A second reconnaissance of the river in June 2003 identified reaches that were suitable for sampling using these methods. Potential for access was also identified.

Development of the BFC stations

NHDES in cooperation with the other agencies developed the BFC project plan over the next month. Reaches that were wadeable were assigned either barge or backpack electrofishing stations. Boat electrofishing stations were distributed within the potentially accessible reaches of deep macrohabitats. Shoreline seine and/or gillnet stations were assigned near each boat electrofishing station and to reaches that were suitable, but inaccessible, for boat electrofishing. A detailed description of the sampling plan can be found in the Lamprey River Baseline Fish Community Sampling Quality Assurance Project Plan July 23, 2003 available from NHDES or at http://www.des.state.nh.us/rivers/instream/lamprey.asp?link=study.

The lengths of fish sampling reaches were chosen to reduce gear bias between the electrofishing methods and equally represent each macrohabitat. The same 150-meter station length was used by all electrofishing techniques to simulate equivalent levels of effort. This distance is applied by NHDES Biomonitoring Program as a standard fish sampling length on smaller (first to fourth order) streams and approximates a 20 to 30-times multiplier of the width of a small stream. [This width multiplier is expected to generate a sampling length that includes two or more repetitions of riffle-run-pool habitat groupings. Some biomonitoring research suggests that longer reaches need to be sampled on medium and larger rivers in order to include similar distributions of habitat as would be found within a 150-meter reach on a small stream. Instead of longer reaches, this study collected data at multiple stations. It was thought that collecting and combining many short reaches could simulate the results of a longer reach.] While boat electrofishing on ponds and lakes is common, fish sampling on larger rivers with deep riverine habitat is rare in New Hampshire. Boat sampling was conducted on 150-meter reaches in an attempt to be comparable to the other electrofishing stations. Boat electrofishing focused on the river margins traveling up one bank and down the other. Each sampling run was timed to standardize the level of effort for boat reaches.

The October 2002 reconnaissance identified the distribution of wadeable, marginal, and deep macrohabitat conditions on the river. Numbers of wadeable stations to boat stations were based on the approximately 60:40 length distribution between deep to wadeable macrohabitats. Of the 12.3 mile study reach, deep and impounded macrohabitat comprised 7.7 miles (63%) and shallow and marginal macrohabitat comprised 4.6 miles (37%). There were 17 proposed boat electrofishing sites and 12 proposed wadeable electrofishing sites so that the 60:40 ratio was maintained. Net stations were expected to augment the boat electrofishing results.

RESULTS

Stream flow, precipitation and other data were measured or obtained to put the BFC fish assemblage identified in this project into context of the flow and habitat conditions occurring during sampling, and to some degree, prior to sampling. Appendix B contains historical and BFC water quality measurements. Appendix C contains detailed information concerning flow measurements, precipitation, water withdrawals, dam operations, and habitat assessment data. Water quality data is also available online from the NHDES Environmental Monitoring Database at http://www.des.state.nh.us/OneStop/Environmental_Monitoring_Query.aspx.

Precipitation and Streamflow

A period of abnormally dry to drought conditions persisted for two years preceding the BFC sampling. The BFC sampling is a snapshot of the fish community at the time of sampling and may reflect the long term or residual impacts of this drought period. Heavy precipitation in late July - early August 2003 may have the visual appearance of better stream flow conditions as measured by this study than had actually existed during the previous years. If the fish assemblage was impacted by the drought, it unlikely to have recovered as quickly as stream flow, therefore comparison of the BFC with stream flow values should be used with caution.

Water Quality

Certain water quality parameters have been measured in the Lamprey over many years—by USGS since the 1950s, by NHDES under the Total Maximum Daily Load Study for the Lamprey River in 1995, by the NHDES Volunteer Rivers Assessment Program (VRAP) annually since 1998. NHDES Ambient Rivers Program (ARMP) has database stored records back through 1990. NH Ambient Rivers Monitoring Program (ARMP) also collected water quality measurements and samples during the BFC sampling (Figure 4). ARMP collected water samples for Total Residue and Total Suspended Residue analysis and deployed four multiprobe water quality recorders in the study reach.

Water quality measurements including dissolved oxygen, specific conductance, pH, turbidity, and temperature were taken at 37 of the BFC sampling stations (Figure 4). None of the water quality sampling showed extreme conditions or results outside of the ordinary (Table 5).

The Lamprey River is defined as Class B water under NH RSA 485-A: 8. Water quality standards for NH surface waters are found in Env-Ws 1700 Surface Water Quality Regulations (NH SWQR). Water quality in the study reach met standards for dissolved oxygen and turbidity, and did not meet NH water quality standards for pH at several stations. There are no standards for specific conductivity. An assessment of compliance with temperature standards requires background data beyond the scope of this project.

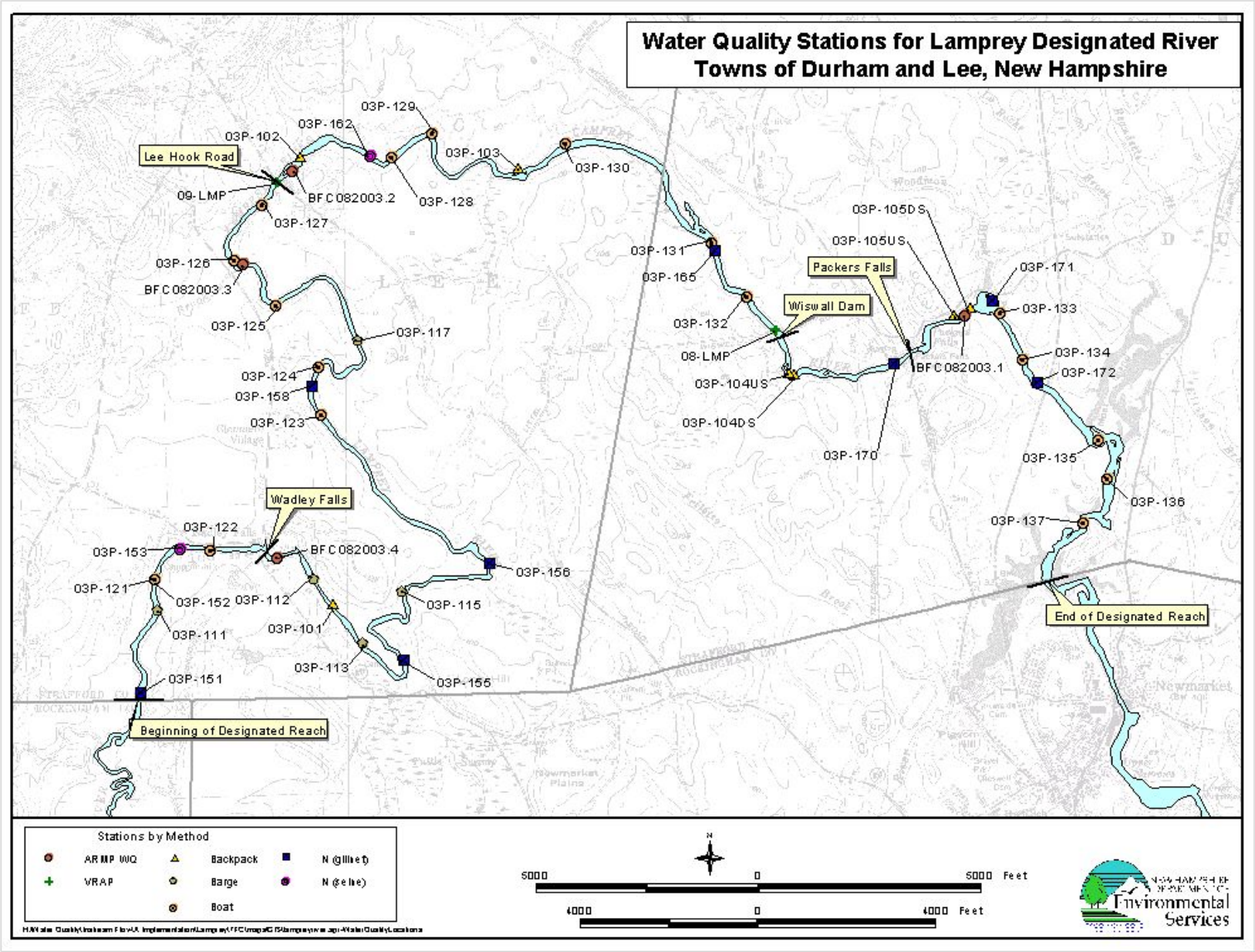

Figure 4 - Map of Water Quality Stations

Table 5 - Summary of BFC WQ Measurements (37 stations)

	Dissolved oxygen (mg/l)	Dissolved oxygen saturation (%)	pH	Specific conductance (us/cm)	Temperature water (deg c)	Turbidity (ntu)
Maximum	9.76	112.7	7.45	190	26.2	1.9
Minimum	7.11	83.0	5.7	116.6	18.8	0.25
Mean	8.11	94.3	6.7	167	22.5	1.02
Geometric mean	8.10	94.0	6.7	166	22.5	0.97

Dissolved Oxygen: RSA 485 requires dissolved oxygen content for Class B waters of at least 75 percent of saturation. The minimum dissolved oxygen saturation value was 83% at 03P-127. NH SWQR further require dissolved oxygen concentrations of at least 5 mg/L in Class B waters. All stations measured met that criterion. The lowest dissolved oxygen concentrations were near the beginning and the end of the study reach at 03P-151 and 03P-137 where values of 7.23 mg/L and 7.11 mg/L were measured respectively. The highest values were measured at 03P-101 and 03P-115 where values of 9.76 mg/L and 9.04 mg/L occurred respectively.

Specific Conductance: NH SWQR have no regulatory standards for specific conductance, but the results during the BFC were consistent with the trend of increasing specific conductance over time shown by historical USGS data. All stations sampled for specific conductance were below 190 uS/cm.

pH: RSA 485 requires the pH range for Class B waters shall be 6.5 to 8.0 except when due to natural causes. pH was below 6.5 at nine of the stations measured.

Turbidity: Turbidity levels are required to be no more than 10 NTU above naturally occurring levels by RSA 485 and none of the levels measured met 10 NTU. The highest turbidity was recorded near the end of the study reach at 03P-137.

Water Temperature: These measurements are sensitive to diurnal variations and had an increasing trend over the BFC sampling event; however other factors may have had more influence on water temperature. Stations in impounded portions of the stream generally had higher temperatures, but a more important factor seems to be whether the sampling location was shaded either by dense or overhanging canopy or by the river's aspect relative to the sun.

2003 Lamprey Fish Sampling

Between August 25 and 29, 2003, fish were collected at 43 stations within the study reach (Figure 3 and Table 6). Four sampling teams worked independently to collect fish data. A team leader, qualified as a fisheries expert and experienced in the collection method, was assigned for each fish collection method. Identification and verification of fish species was their responsibility. The first 25 fish identified of each species were measured to allow assessment of the presence of multiple age classes. That assessment is not part of this study. Barge and backpack teams collected habitat assessment data for their stations that is not a part of the BFC assessment but are available in Appendix C. The final sampling plan, documented in the draft Lamprey River Baseline Fish

Community Sampling Quality Assurance Project Plan dated July 23, 2003, proposed 53 stations broken down as 5 backpack electrofishing stations, 7 barge electrofishing stations, 17 boat electrofishing stations and 24 gillnet or shoreline seine stations.

All proposed boat, barge, and backpack stations were completed. Of the 24 proposed net stations, sampling was completed at 14 stations distributed evenly throughout the study reach. The plan for net stations to conduct more than one collection per net per day was changed because of the low capture rate during the first day. Longer set periods for each net station were employed with some nets being left overnight to improve the capture rate but with only limited improvement.

Table 6 - Lamprey BFC Sampling Dates

Fish Sampler Gear Type	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug
Backpack	03P-102	03P-103	03P-104, 03P-105	03P-101	
Barge	03P-111, 03P-112	03P-115, 03P-114, 03P-113,	03P-117, 03P-116		
Boat	03P-127, 03P-126, 03P-125	03P-128, 03P-129,	03P-130, 03P-131, 03P-132, 03P-121, 03P-122	03P-137, 03P-136, 03P-135, 03P-134, 03P-133	03P-123, 03P-124,
Net (*= left net overnight; <u>underlined</u> are seine stations)	03P-168, 03P-169, 03P-170	03P-151*, <u>03P-152</u>, <u>03P-153</u>	03P-155*, 03P-156*, 03P-158*, 03P-159*	03P-165*	03P-171, 03P-172, <u>03P-162</u>

At 43 BFC stations a total of 6305 fish were captured of which common shiners, redbreasted sunfish and fallfish comprised 61% of the total assemblage (Table 7). Tables of fish species, numbers, and length measurement data are in Appendix A. The ten most numerous species represent 93% of the fish captured. Anadromous fish, such as Atlantic salmon and blueback herring, were not found in large numbers. Assessment of anadromous species for the Lamprey should be studied and addressed separately.

Table 7 - Summary of Lamprey Fish Assemblage (August 25-29, 2004)

Fish Species	# of individuals	Percent of total fish captured	# of stations found (n=43)	% of stations found
Common shiner (FD)*	2140	33.9%	17	40%
Redbreasted sunfish (MHG)	948	15.0%	24	56%
Fallfish (RFS)	767	12.2%	24	56%
Pumpkinseed (MHG)	377	6.0%	30	70%
Bluegill (MHG)	358	5.7%	9	21%
Common white sucker (FD)	324	5.1%	29	67%
American Eel (MHG)	288	4.6%	26	60%
Longnose dace (RFS)	287	4.6%	8	19%
Golden shiner (MHG)	239	3.8%	17	40%
Smallmouth bass (MHG)	128	2.0%	23	53%
Largemouth bass (MHG)	95	1.51%	20	47%
Yellow perch (MHG)	77	1.22%	18	42%
Bridle shiner	54	0.86%	5	12%
Yellow bullhead	51	0.81%	15	35%
Eastern chain pickerel	38	0.60%	17	40%
Creek chubsucker	22	0.35%	10	23%
Alewife	21	0.33%	4	9%
Blacknose dace	19	0.30%	2	5%
Black crappie	18	0.29%	3	7%
Rock bass	18	0.29%	1	2%
Atlantic Salmon	13	0.21%	4	9%
Brown bullhead	11	0.17%	6	14%
Redfin pickerel	6	0.10%	4	9%
Brown trout	3	0.048%	2	5%
Blueback herring	2	0.032%	2	5%
Rainbow trout	1	0.016%	1	2%
Sum	6305	100%		

*See Key to Table 4 for Habitat Classification.

Twenty-six fish species were identified from the 43 stations in the study reach. The most widely distributed species were pumpkinseed (30 stations), common white sucker (29), and American eel (26) (Figure 5). The most numerous species, common shiner, was found at fewer stations (17). Bluegill and longnose dace were also among the most numerous but found at relatively few stations.

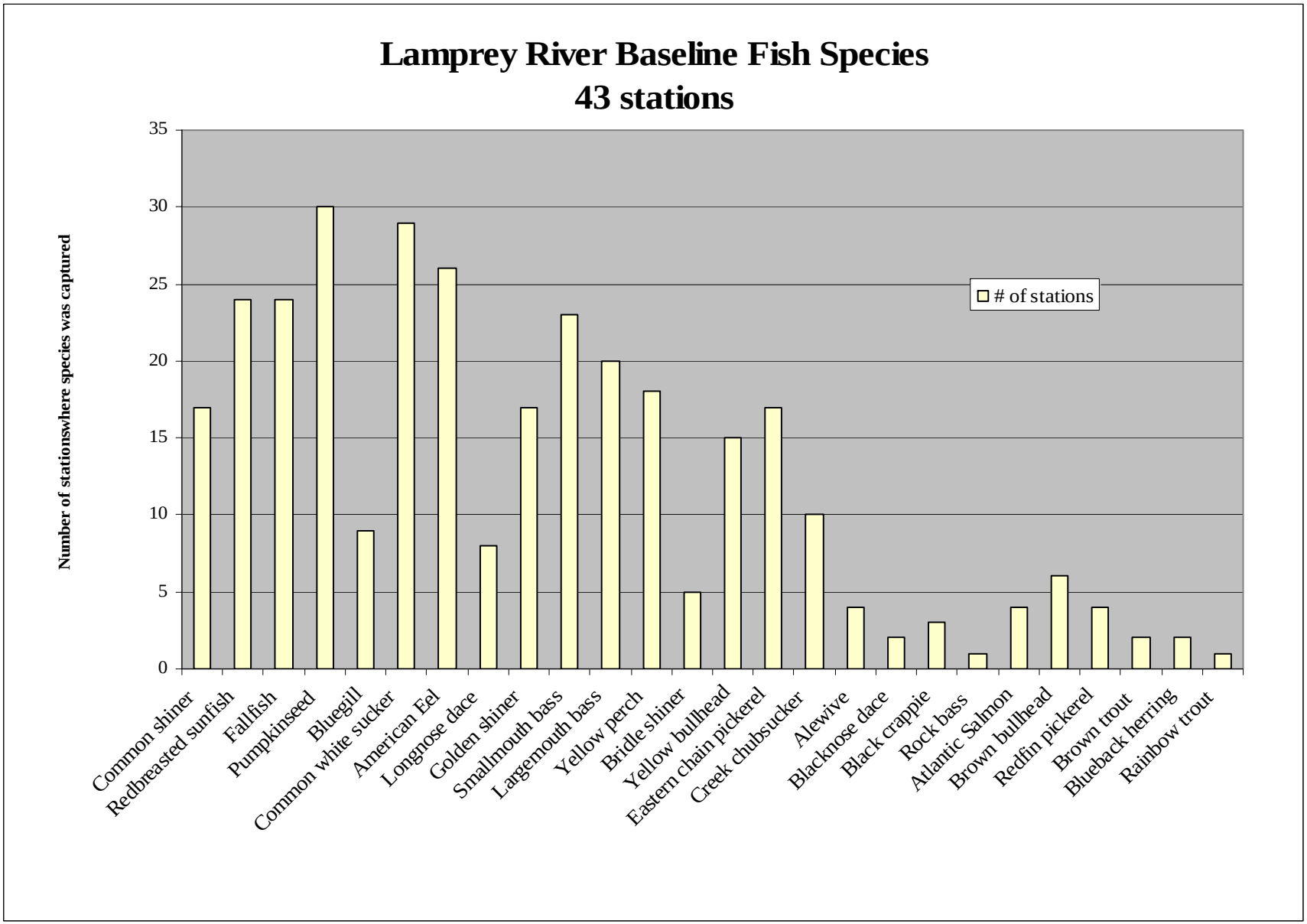

Figure 5 - Lamprey 2003 Sampling - Species by number of stations where found

Fish Capture by Macrohabitat

Collection methods were assigned to match two macrohabitat conditions: shallow riffles and runs, and broad, deep runs or impoundments. Shallow electrofishing methods (barge and backpack) collected 74% of the fish captured (Table 8). At five backpack electrofishing stations, fish capture ranged from 203 to 824 fish with between 8 and 13 species per site. At seven barge electrofishing sites, fish capture ranged from 107 to 396 fish with between 10 and 15 species per site. At 17 boat electrofishing stations, fish capture ranged from 31 to 170 fish with between 6 and 12 species per site. At three seine stations, fish capture ranged from 11 to 135 fish with between 3 and 8 species per site. At eleven, gill net stations, the maximum fish capture was 9 fish with a maximum species count of 3. No fish were captured at three of the gill net stations.

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Table 8 - Fish Capture by Macrohabitat

Macrohabitat	Capture Method	Individuals	% of total	Number of stations	Average fish per station
Shallow	Fish caught by backpack method	2734	43.4%	5	547
Shallow	Fish caught by barge method	1927	30.6%	7	275
Deep	Fish caught by boat method	1382	21.9%	17	81
Deep*	Fish caught by net methods	262	4.16%	14	19
Deep	Net (Experimental Gill Nets)	22	0.35%	11	2
*Shallow	Net (Shoreline Seines)	240	3.81%	3	80

Nets as a Sampling Technique

The results of net sampling are difficult to integrate into the electrofishing results. Nets were used at selected stations to complement the collection effort at boat stations and where boat electrofishing equipment could not gain access. The gill nets were intended to sample deep portions of the runs below the effective depth of the boat electrofisher. The shoreline seines were intended to capture fish in the shallow margins of deep macrohabitats.

The expectation was that net techniques would be used to augment collection by the boat electrofishing method and also might capture species not captured by this method. Netting techniques did not capture any species that were not represented by other capture methods other than a single stocked rainbow trout. Gill netting produced few fish for the amount of effort expended. Gill nets were set longitudinally in the river because of the possible effect of the current, which have limited their success. Gill nets were set at 11 stations and fished for a total of 153 hours. Six stations were set overnight (mean # hours =22.5) and captured a total of 19 fish, mostly large common white suckers. Three of the overnight stations produced no fish at all. Shoreline seines were fished at three stations and produced 240 fish, mostly small common shiners and golden shiners. Much of the river has steep banks with bedrock and woody debris common limiting seining opportunities.

Fish Collection Results Relative to Wiswall Dam

The distribution of stations above and below Wiswall Dam was reflective of the number of miles of river being studied. Most of the study reach is above the dam so the upstream reach more closely

reflects the whole study reach (Table 9). Over 80% of the fish captured were from the 31 stations upstream of Wiswall Dam.

There was also a difference in the distribution of shallow and deep macrohabitats. Almost 80% of the study reach below Wiswall dam was deep water habitat, mostly the Macallen impoundment, whereas above Wiswall dam less than 60% was deep water habitat. Ten of the stations upstream of Wiswall Dam were sampled using wading techniques (backpack or barge electrofishing) compared with two stations below Wiswall Dam. Fish density was consistently greater in the riffle zones and shallow reaches than in the deeper reaches. The upstream/downstream distribution of fish captured reflects the greater proportion of riffle zones upstream of Wiswall Dam.

It should also be noted that of the species captured, 25 were found upstream and 15 downstream of Wiswall Dam (Tables 10 and 11). Fourteen species were common to each: the only species found downstream of Wiswall Dam that was not found upstream was black crappie. Of species unique to upstream of Wiswall Dam, the following were not present downstream of the dam: bridle shiner, yellow bullhead, creek chubsucker, alewife, blacknose dace, rock bass, Atlantic salmon, brown bullhead, brown trout, blueback herring, and rainbow trout. Each of these species represents less than 1% of the fish captured in this study.

Table 9 - Upstream versus Downstream of Wiswall Dam

	# of stream miles (GIS measured)	Percent of Stream Miles	# of stations	Percent of Stations	Fish Number	Percent of total fish captured	Percent deep macro-habitat	# of Fish Species
Study Reach	12.34	100%	43	100%	6305	100%	63%	26
U/S of Wiswall Dam	9.27	74%	31	72%	5160	82%	57%	25
D/S of Wiswall Dam	3.07	26%	12	28%	1145	18%	79%	15

Table 10 - Fish Species Distribution by Count Frequency Relative to Wiswall Dam

Fish species at all stations (43 stations)	Number of fish at all stations	% of fish at all stations	Fish species occurring in stations downstream of Wiswall Dam (12 stations)	Number of fish at DS stations	% of fish at DS stations	Fish species occurring in stations upstream of Wiswall Dam (31 stations)	Number of fish at US stations	% of fish at US stations
Common Shiner (CS)	2140	34%	Common Shiner (CS)	56	5%	Common Shiner (CS)	2084	40%
Redbreasted Sunfish (RBS)	948	15%	Redbreasted Sunfish (RBS)	278	24%	Redbreasted Sunfish (RBS)	670	13%
Fallfish (FF)	767	12%	Fallfish (FF)	111	10%	Fallfish (FF)	656	13%
Pumpkinseed (CSF)	377	6%	Pumpkinseed (CSF)	51	4%	Pumpkinseed (CSF)	326	6%
Bluegill (BG)	358	6%	Bluegill (BG)	341	30%	Bluegill (BG)	17	0.3%
Common White Sucker (CWS)	324	5%	Common White Sucker (CWS)	5	0.4%	Common White Sucker (CWS)	319	6%
American Eel (AE)	288	5%	American Eel (AE)	166	14%	American Eel (AE)	122	2%
Longnose Dace (LND)	287	5%	Longnose Dace (LND)	15	1%	Longnose Dace (LND)	272	5%
Golden Shiner (GS)	239	4%	Golden Shiner (GS)	4	0.3%	Golden Shiner (GS)	235	5%
Smallmouth Bass (SMB)	128	2%	Smallmouth Bass (SMB)	19	2%	Smallmouth Bass (SMB)	109	2%
Largemouth Bass (LMB)	95	2%	Largemouth Bass (LMB)	49	4%	Largemouth Bass (LMB)	46	0.9%
Yellow Perch (YP)	77	1%	Yellow Perch (YP)	20	2%	Yellow Perch (YP)	57	1%
Bridle Shiner (BS)	54	0.9%				Bridle Shiner (BS)	54	1.0%
Yellow Bullhead (YBH)	51	0.8%				Yellow Bullhead (YBH)	51	1.0%
Eastern Chain Pickerel (ECP)	38	0.6%	Eastern Chain Pickerel (ECP)	10	0.9%	Eastern Chain Pickerel (ECP)	28	0.5%
Creek Chubsucker (CCS)	22	0.3%				Creek Chubsucker (CCS)	22	0.4%
Alewife (AW)	21	0.3%				Alewife (AW)	21	0.4%
Blacknose Dace (BND)	19	0.3%				Blacknose Dace (BND)	19	0.4%
Black Crappie (BC)	18	0.3%	Black Crappie (BC)	18	2%			
Rock Bass (RB)	18	0.3%				Rock Bass (RB)	18	0.3%
Atlantic Salmon (ATS)	13	0.2%				Atlantic Salmon (ATS)	13	0.3%
Brown Bullhead (BBH)	11	0.2%				Brown Bullhead (BBH)	11	0.2%
Redfin Pickerel (RFP)	6	0.1%	Redfin Pickerel (RFP)	2	0.2%	Redfin Pickerel (RFP)	4	0.1%
Brown Trout (BT)	3	0.05%				Brown Trout (BT)	3	0.1%
Blueback Herring (BB)	2	0.03%				Blueback Herring (BB)	2	0.04%
Rainbow Trout (RT)	1	0.02%				Rainbow Trout (RT)	1	0.02%

Table 11 - Fish Species Distribution by Station Frequency Relative to Wiswall Dam

Fish species occurrence at all stations (43 stations)	Number of stations species occurs	Fish species occurring in stations downstream of Wiswall Dam (12 stations)	Number of DS stations species occurs	Percent of DS stations species occurs	Fish species occurring in stations upstream of Wiswall Dam (31 stations)	Number of US stations species occurs	Percent of US stations species occurs
Pumpkinseed (CSF)	30	Pumpkinseed (CSF)	6	50%	Pumpkinseed (CSF)	24	77%
Common White Sucker (CWS)	29	Common White Sucker (CWS)	5	42%	Common White Sucker (CWS)	24	77%
American Eel (AE)	26	American Eel (AE)	7	58%	American Eel (AE)	19	61%
Fallfish (FF)	24	Fallfish (FF)	2	17%	Fallfish (FF)	22	71%
Redbreasted Sunfish (RBS)	24	Redbreasted Sunfish (RBS)	3	25%	Redbreasted Sunfish (RBS)	21	68%
Smallmouth Bass (SMB)	23	Smallmouth Bass (SMB)	5	42%	Smallmouth Bass (SMB)	18	58%
Largemouth Bass (LMB)	20	Largemouth Bass (LMB)	8	67%	Largemouth Bass (LMB)	12	39%
Yellow Perch (YP)	18	Yellow Perch (YP)	4	33%	Yellow Perch (YP)	14	45%
Common Shiner (CS)	17	Common Shiner (CS)	2	17%	Common Shiner (CS)	15	48%
Eastern Chain Pickerel (ECP)	17	Eastern Chain Pickerel (ECP)	5	42%	Eastern Chain Pickerel (ECP)	12	39%
Golden Shiner (GS)	17	Golden Shiner (GS)	1	8%	Golden Shiner (GS)	16	52%
Yellow Bullhead (YBH)	15				Yellow Bullhead (YBH)	15	48%
Creek Chubsucker (CCS)	10				Creek Chubsucker (CCS)	10	32%
Bluegill (BG)	9	Bluegill (BG)	5	42%	Bluegill (BG)	4	13%
Longnose Dace (LND)	8	Longnose Dace (LND)	2	17%	Longnose Dace (LND)	6	19%
Brown Bullhead (BBH)	6				Brown Bullhead (BBH)	6	19%
Bridle Shiner (BS)	5				Bridle Shiner (BS)	5	16%
Alewife (AW)	4				Alewife (AW)	4	13%
Atlantic Salmon (ATS)	4				Atlantic Salmon (ATS)	4	13%
Redfin Pickerel (RFP)	4	Redfin Pickerel (RFP)	1	8%	Redfin Pickerel (RFP)	3	10%
Black Crappie (BC)	3	Black Crappie (BC)	3	25%			
Blacknose Dace (BND)	2				Blacknose Dace (BND)	2	6%
Blueback Herring (BB)	2				Blueback Herring (BB)	2	6%
Brown Trout (BT)	2				Brown Trout (BT)	2	6%
Rainbow Trout (RT)	1				Rainbow Trout (RT)	1	3%
Rock Bass (RB)	1				Rock Bass (RB)	1	3%
NO FISH	5	**NO FISH**	**3**	25%	**NO FISH**	**2**	6%

Lamprey BFC

The Lamprey BFC is defined as the fish community expected within the study reach based on presence and abundance of the most prevalent species. The subset of fish captured by barge, backpack, and boat methods were used to make this determination. Results from net stations were not used for the following reasons. The experimental gill nets captured few fish and were effectively dismissed by the determination of presence or absence. The seine nets captured fish from shallow margins similar to conditions found for the backpack and barge stations. These stations were not used so that shallow conditions would not be overrepresented. The net methods did not identify any species in numbers that had not been found by the other methods.

To determine the BFC, species were defined as present or absent. Species presence at a given station was defined as having 5 or more individuals that represented 5 percent or more of the fish captured at a station. Fish meeting the presence criteria were summed across all stations and ranked by most numerous species to define the BFC (Table 12).

Table 12 - Lamprey BFC

Individuals (present subset)	% of individuals	BFC Species (includes only species meeting presence criteria)	# of stations (n=29)	% of stations
2026	37.6%	Common Shiner (CS)	12	41.4%
938	17.4%	Redbreasted Sunfish (RBS)	19	65.5%
744	13.8%	Fallfish (FF)	12	41.4%
356	6.6%	Bluegill (BG)	7	24.1%
276	5.1%	Pumpkinseed (CSF)	14	48.3%
267	5.0%	Longnose Dace (LND)	4	13.8%
217	4.0%	Common White Sucker (CWS)	11	37.9%
193	3.6%	American Eel (AE)	5	17.2%
121	2.2%	Golden Shiner (GS)	4	13.8%
61	1.1%	Largemouth Bass (LMB)	7	24.1%
46	0.9%	Smallmouth Bass (SMB)	5	17.2%
39	0.7%	Bridle Shiner (BS)	1	3.4%
32	0.6%	Yellow Perch (YP)	4	13.8%
18	0.3%	Rock Bass (RB)	1	3.4%
16	0.3%	Black Crappie (BC)	2	6.9%
15	0.3%	Blacknose Dace (BND)	1	3.4%
14	0.3%	Alewife (AW)	1	3.4%
8	0.1%	Eastern Chain Pickerel (ECP)	1	3.4%
5387	100.0%	Total		

Conclusions

At 43 BFC stations a total of 6305 fish comprising twenty-six species were captured during August 25-29, 2003. During study design, no one fishing technique was considered adequate to measure the macrohabitats available within the study reach. Collection methods were chosen so as to capture fish species representative of the two major macrohabitats identified in the study reach. Riffle and shallow run reaches were sampled using backpack or barge-mounted electrofishing techniques. Deeper reaches were sampled using a boat-mounted electrofishing unit and complemented with gill net sets and shoreline seining. Along with the fish collection, measurements were taken of stream flow and water quality parameters (pH, specific conductivity, dissolved oxygen, and temperature). Habitat evaluations were conducted at selected stations using Rapid Bioassessment Protocols.

Fish were collected at stations distributed in proportion to the lengths of the two macrohabitats Shallow and marginal depth macrohabitats represented 37% of the study reach. Fish in shallow macrohabitats were collected at five backpack stations and seven barge stations representing 41 % of the electrofishing stations. Deep and impounded macrohabitat represented 59 % of the study reach. Seventeen boat stations representing the remaining 59 % were conducted in the deep macrohabitats. Electrofishing stations were 29 of the 43 stations completed. Each was nominally 150 meters in length representing approximately 2.7 miles of sampling in the 12.3 mile study reach (22% coverage).

Eleven species were identified upstream of Wiswall Dam that were not found downstream: bridle shiner, yellow bullhead, creek chubsucker, alewife, blacknose dace, rock bass, Atlantic salmon, brown bullhead, brown trout, blueback herring, and rainbow trout. Only black crappie was unique to the downstream reach. None of these species represented greater than 1% of the assemblage captured in this study. Evaluation of the redistribution and changes in population of these species may be a key to determining the effectiveness of the fish ladder/bypass proposed at Wiswall Dam.

Drought conditions had persisted in the river during the previous two years. The stream flow conditions during the BFC sampling had been regressing from rainstorms at the end of July-early August. Without adequate historical sampling in the study reach, there is insufficient information to determine whether the drought period had impacted the fish assemblage or numbers of fish. Water quality during the BFC sampling does not appear to be markedly different from conditions over the previous years.

Fish collections were sampled in proportion to the two major macrohabitat conditions in the Lamprey River. Fish species from deep, impounded habitat, both natural and manmade, and shallow riffles and run habitat are represented. These macrohabitats occur in an approximate ratio of 60 percent deep water macrohabitat to 40 percent shallow and marginal depth macrohabitat. The result is a community of fluvial fish species and macrohabitat generalist fish species that inhabit these two main habitat conditions and make up the study reach fish community. The community upstream of Wiswall Dam is certainly different from the downstream community, but this probably is a reflection of the distribution of the major habitat types.

The habitat classifications of the study reach fish community were compared to those in the TFC based on collections in 1983-85 and 1998. The fish habitat classifications for the species making up greater than or equal to 1% of individuals of the TFC and of the study assemblage were compared (Figure 6). The 2003 Lamprey assemblage had a higher percentage of macrohabitat generalists and lower percentages for fluvial specialists than the TFC. Fluvial-dependent species were approximately equivalent. These two assemblages may not be comparable because they are derived from collections in different parts of the watershed.

A Baseline Fish Community was defined from the 2003 sampling assemblage. The BFC was defined from collections at the electrofishing stations only: net collections were not used. The BFC included only species from stations where 5 or more individuals occurred and that represented 5% or more of the station's individuals. This resulted in eighteen species that were identified as the BFC. The eight species that were eliminated each represented less than one percent of the total fish captured for the study.
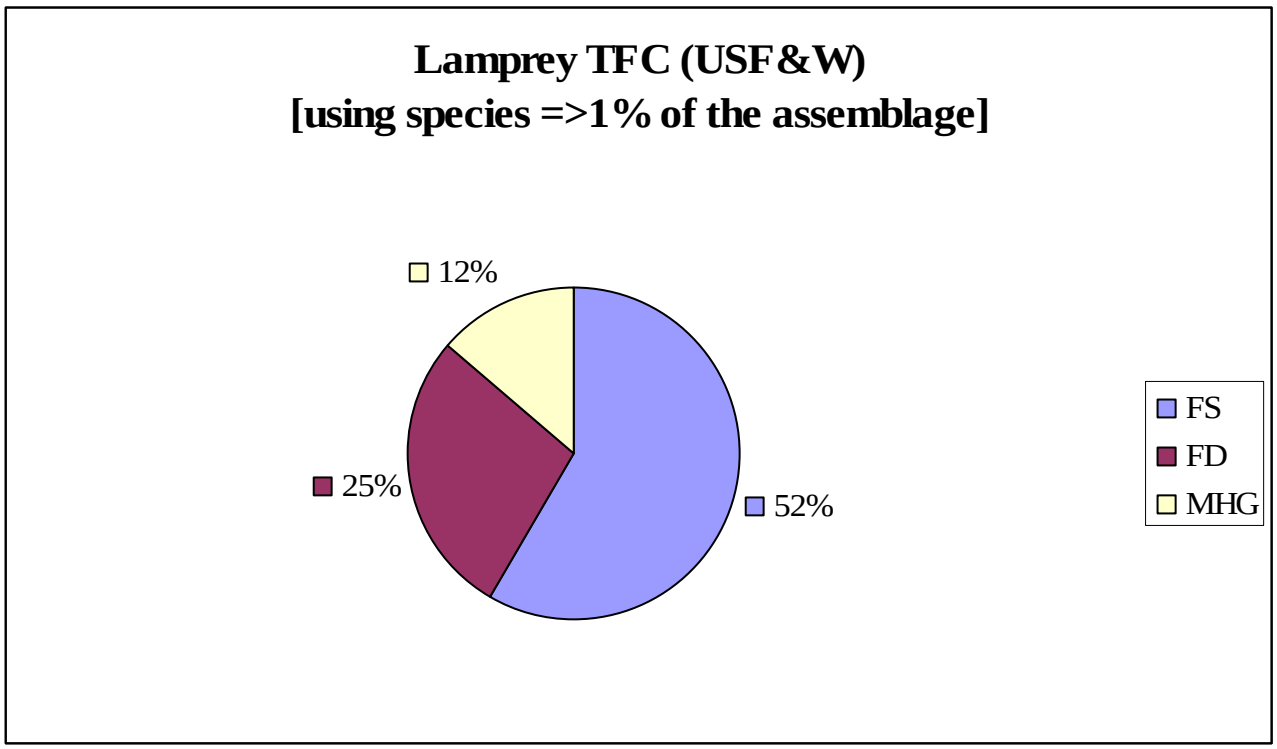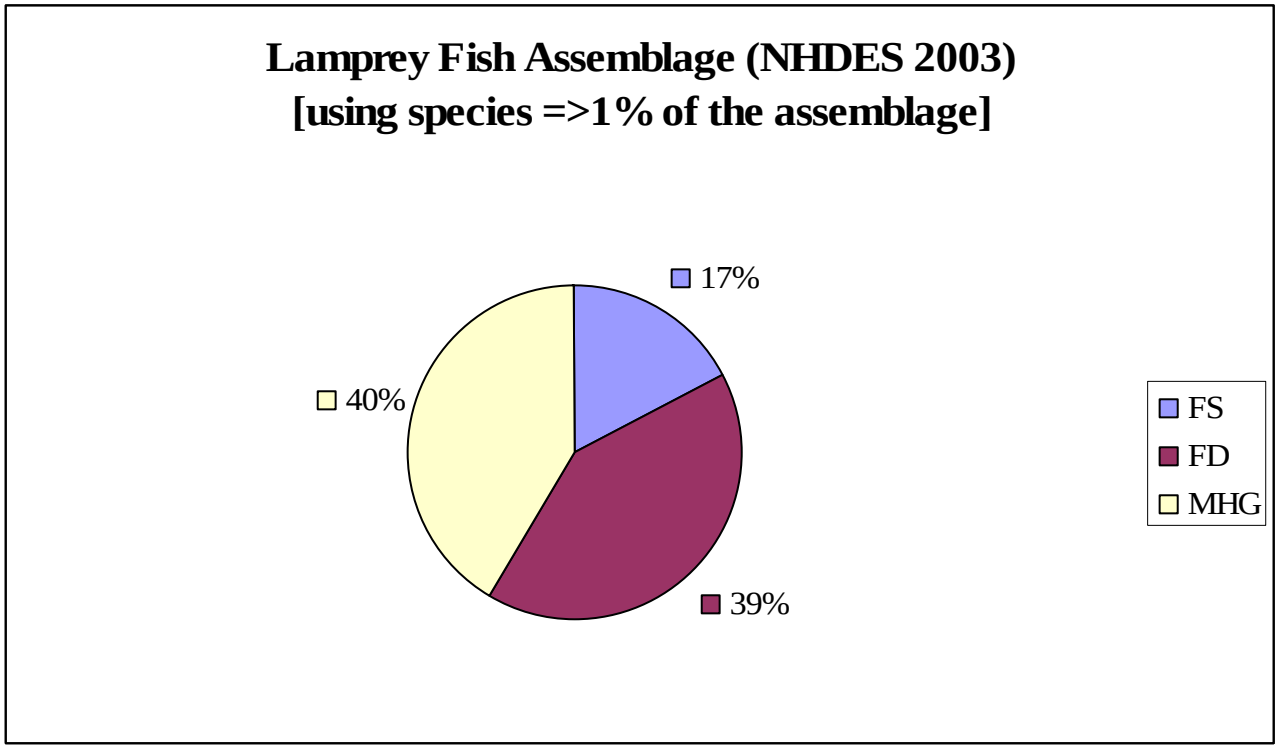
Figure 6 – Comparison of Lamprey Assemblages Habitat Classification