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October 4, 2018

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Sent via Email, Fax and USPS

**RE: Friends of Merrymeeting Bay and Friends of Sebago Lake**
**Comment on Department Draft Order #2 (Issued September 27, 2018)**
**#L-19713-33-N-M**
**#L-19714-33-G-M**
**#L-1915-33-G-M**
**#L-19716-33-G-M**
**#L-19717-3D-M-N**

**MWDCA PERMITS & WATER QUALITY CERTIFICATION AMENDMENTS to Saccarappa Dam, Presumpscot River, Westbrook, Maine, FERC Project 2897-048 (Surrender); Mallison Falls Dam, FERC Project 2932-047; Little Falls Dam, FERC Project 2941-043; Gambo Dam, FERC Project 2931-042; Dundee Dam, FERC Project 2942-051**

Dear Mr. Sroka:

Please accept the following comments regarding Draft Order #2 on behalf of the Friends of Sebago Lake (“FOSL”)[1], Friends of Merrymeeting Bay (“FOMB”)[2], and members of these respective organizations concerning your agency’s Draft Order regarding amendments to the Water Quality Certifications (“WQC”) for the following projects:

- Mallison Falls Dam, FERC Project 2932-047
- Little Falls Dam, FERC Project 2941-043
- Gambo Dam, FERC Project 2931-042
- Dundee Dam, FERC Project 2942-051 (hereinafter “Presumpscot River Dams”).

[1] FOSL is a membership organization whose mission is to promote an understanding of the interconnected harmful impacts of unnatural freshwater flows by dam regulation and to advocate for the restoration of natural freshwater seasonal flows from inland waters to the seas. FOSL works for the requirements that all dams in Maine have safe and effective fish passage for full restoration of Maine’s diadromous fish to their historical range.

[2] FOMB is a membership organization whose mission is to preserve, protect and improve the unique ecosystems of Merrymeeting Bay and related waters and does this primarily through research, advocacy, education and land protection.

Both organizations have been long time participants in Presumpscot restoration and water quality proceedings and accepted intervenors in different state and federal proceedings related to this river.

In addition to the comments below, FOSL and FOMB incorporate by reference all prior state and FERC comments the organizations, as well as its members Douglas Watts, Roger Wheeler and Ed Friedman, have submitted throughout public comment periods associated with proposed amendments to the WQC authorizing operation of and extensions to fish passage requirements at the Presumpscot River Dams. As well, FOSL and FOMB specifically request that the full document of each citation referenced in both this and past comments be included in the administrative record associated with this agency action.

Detailed below are FOSL and FOMB's specific issues and comments:

## I. Gambo and Dundee Dams

As mentioned in their prior comment on the agency's original Draft Order, FOSL and FOMB support Sappi's decommissioning of the Saccarappa Dam and installation of anadromous fish passageways at this juncture of the Presumpscot River. In addition, FOSL and FOMB support the proposed WQC at the Mallison Falls Dam and Little Falls Dam in so far as the certifications require fish passage or dam removal once specific numbers of anadromous fish have been accounted for at the downstream locations.

However, FOSL and FOMB continue to oppose the issuance of any WQC, as proposed in the Department of Environmental Protection's ("DEP") September 27, 2018 Second Draft Order, for the Gambo and Dundee Dams, as they do not require fish passage when particular fish populations identified in the 2003 WQC have been recorded at the dam farther downstream. FOSL and FOMB specifically request that prior to the issuance of any WQC for the Gambo and Dundee Dams, such WQC include the requirement of fish passage once specific anadromous fish populations have been reached at downstream dams.

FOSL and FOMB contend that the approval of any WQC for these two dams that does not require fish passage when specific anadromous fish populations have been reached at downstream dams would violate the State's water quality standards and ultimately the Clean Water Act. FOSL and FOMB's position remains that any issuance of a WQC for a federal project along the Presumpscot not requiring anadromous fish passage would have the effect of revising Maine's Water Quality Standards. Nevertheless, neither Draft Order, as written, requires fish passage at Gambo and Dundee Dams should population goals of anadromous fish be attained at the downstream Little Falls Dam. These population numbers are clearly outlined in the Presumpscot River's Draft FMP, and have been historically advocated for by several Maine environmental agencies.

In turn, if DEP implements the Second Draft Order as written, the WQCs for Gambo and Dundee Dams would constitute a new or revised water quality standard requiring approval of EPA pursuant to § 303(c)(3) of the Clean Water Act. As written, the Draft Order degrades water quality standards for the Class A and Class B reaches of the Presumpscot and its tributaries upstream from the Gambo Dam[3] by specifically excluding

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[3] The water quality classifications for the Presumpscot River are as follows:

A. Presumpscot River, main stem.

(1) From the outlet of Sebago Lake to its confluence with Dundee Pond - Class A.

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anadromous fish, even though these fish are indigenous aquatic life species protected by Maine's narrative water quality criteria for Class A and Class B waters. The Draft Order also degrades the water quality standard for the Class GPA pond (Dundee Pond) upstream from the Dundee Dam. Maine's water quality criteria for Class A waters specify that "[t]he *aquatic life . . . shall be as naturally occurs*."[4] "As naturally occurs" means "conditions with essentially the same physical, chemical, and biological characteristics as found in situations with similar habitats free of measurable effects of human activity."[5] Maine's water quality criteria for Class B waters specify that the habitat for fish and other aquatic life "must be characterized as unimpaired."[6] Unimpaired means "without a diminished capacity to support aquatic life."[7] These criteria protect Maine's designated uses for Class A and B water, which include "habitat for fish and other aquatic life."[8] Maine's water quality criteria for Class GPA ponds require that habitat for fish and other aquatic life be characterized as "natural."[9]

EPA's Clean Water Act regulations require that water quality criteria protect designated uses.[10] Designated uses are "those uses specified in water quality standards for each water body or segment, whether or not they are being attained."[11] Designated uses for Class A and Class B waters in Maine include "habitat for fish and other aquatic life" with the habitat being characterized as "natural" for Class A waters and GPA ponds and "unimpaired" for Class B waters.

As the record clearly indicates in this matter, anadromous fish are naturally occurring, indigenous to the Presumpscot River and should thrive in the Presumpscot River upstream to the Gambo Dam once fish passage is constructed via mandatory provisions of the WQCs for the Mallison and Little Falls Dams. In turn, by not mandating fish passage at the Gambo and Dundee Dams for the term of Sappi's WQC, the DEP has effectively revised the above-cited criteria so they now provide that aquatic life in Class A and B waters upstream from the Gambo Dam shall be as naturally occurs or unimpaired, *with the exception that anadromous fish shall not be present*. In addition, DEP's seemingly arbitrary selection of the Gambo Dam as the location where fish passage no longer needs to occur does not even comport with the Legislature's boundary of the Presumpscot's change in water classification from Class B to Class A at the confluence with the Pleasant River.

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> (1-A) From the outlet of Dundee Pond to its confluence with the Pleasant River - Class A. For the purposes of water quality certification of the hydropower project at the Dundee Dam under the Federal Water Pollution Control Act, Public Law 92-500, Section 401, as amended, and licensing modifications to this hydropower project under section 636 and any other licensing proceeding affecting this project, the habitat characteristics and aquatic life criteria of Class A are deemed to be met in the waters immediately downstream and measurably affected by that project if the criteria of section 465, subsection 3, paragraphs A and C are met.
> (2) From its confluence with the Pleasant River to U.S. Route 202 - Class B. Further, there may be no new direct discharges to this segment after January 1, 1999.

*See* 38 M.R.S. § 467(9).
[4] 38 M.R.S. § 465(2)(B)(emphasis added).
[5] *Id*. § 466(2).
[6] *Id*. § 465(3)(A).
[7] *Id*. § 466(11).
[8] *Id*. § 465 (2)(A), (3)(A).
[9] *Id*. § 465-A(1)(A).
[10] *See* 40 C.F.R. § 131.11(a)(1).
[11] *Id*. at § 131.3(f).

By not conditioning Sappi's WQCs for the Gambo and Dundee Dams with a fish passage requirement, the DEP is not protecting those waters' designated uses. This position contradicts DEP's prior position in its 2003 WQCs for these dams where it states:

> Nowhere, as appellant [S.D. Warren] suggests, does the statute state that 'some' of the waters be suitable for the designated uses; that 'some' of the aquatic species indigenous to the waters be supported; or that 'some' of the habitat must be unimpaired or natural. On the contrary the terms 'receiving waters' and 'habitat' are unqualified and the statute specifically states that the water quality must be such as to support 'all' indigenous aquatic species.[12]

This position by DEP (eventually affirmed by the United States Supreme Court) was the basis for its 2003 fish passage conditions in the Presumpscot River Dams WQCs. However, DEP's position has atrophied without legitimate or justifiable reason. As evidenced by its two Draft Orders, it appears as if DEP's reasoning for excluding mandatory fish passage in the Gambo and Dundee WQCs is a litigation threat from Sappi should it not gain this exemption in exchange for the removal of the Saccarappa Dam.

However, both the Clean Water Act and Maine's water quality standards do not permit DEP to authorize the degradation of the nation's waters in order to avoid a possible lawsuit. In fact, Maine's anti-degradation policy is very clear.[13] The Legislature has explicitly stated that a WQC cannot be issued when the proposed activity has a significant impact on the existing use.[14] An existing use includes "aquatic, estuarine and marine life present in the *water body*."[15] In addition, existing uses are "those uses actually attained in the *water body* on or after November 28, 1975, whether or not they are included in the water standards."[16] The term "water body" is not defined in the Clean Water Act, its implementing regulations, or Maine's water quality standards. Wikipedia defines a body of water as "any significant accumulation of water, generally on a planet's surface . . . A body of water does not have to be still or contained; *rivers*, streams, canals, and other geographical features where water moves from one place to another are also considered bodies of water."[17] Without any reason to interpret otherwise, for purposes of 40 C.F.R. §131.3(e), the Presumpscot River as a whole is a "water body," and its uses should be assessed as one *water body*, and not several water bodies artificially created by Sappi's dam operations. Consequently, within this framework and as previously discussed in our past comments, the Presumpscot River is currently active habitat for indigenous populations of anadromous fish, thus making this use of the Presumpscot by anadromous fish an "existing use" protected by the Clean Water Act.[18]

As written, both the first and second Draft Orders establish a desired condition for aquatic life upstream from the Gambo Dam that creates the artificial exclusion of anadromous fish from its habitat. These Orders therefore violate the Clean Water Act and Maine's water quality standards because they do not protect the designated and existing uses for Class A and B waters upstream from the Gambo Dam.

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[12] *See In Matter of S.D. Warren Company*, Presumpscot River Hydro Projects Water Quality Certification, Findings of Fact and Order on Appeal to BEP, p. 9 (Oct. 2, 2003).
[13] *See* 38 M.R.S. § 464(F).
[14] *Id*. § 464(F)(1-A).
[15] *Id*.
[16] *Id*. at 131.3(e)(emphasis added); *also* 38 M.R.S. § 464(F)(1).
[17] *Body of Water*, WIKIPEDIA, https://en.wikipedia.org/wiki/Body_of_water (Sep. 17, 2018)(emphasis added).
[18] *See* Exhibit A, Chris Yoder, et al. Fish Assemblage and Habitat Assessment of the Presumpscot River (July 31, 2009)(documenting the existence of Atlantic and shortnose sturgeon, river herring and shad in the Presumpscot River).

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As described above, and more fully supported by the extensive record in this matter, there is no sound scientific rationale for excluding indigenous anadromous fish from the Presumpscot River upstream from the Gambo Dam. Excluding fish passage from the Gambo and Dundee Dams will impair the viability of the existing population of anadromous fish populations in the Presumpscot River. There is no economic or social benefit from excluding fish passage from the Gambo and Dundee Dams, and it is inappropriate to tie purported benefits from the decommissioning of the Saccarappa Dam to the Gambo and Dundee Dam WQCs.

As written in the Draft Order, should anadromous fish population goals historically identified by MDMR be met at Little Falls, Sappi would not have to construct any form of fish passage around Gambo Dam to allow further upstream migration. A scientific uncertainty of when anadromous fish will reach a certain population at Little Falls Dam does not justify exclusion of mandatory fish passage in the WQCs for the Gambo and Dundee Dams.

In fact, express exclusion of fish passage in the Gambo and Dundee Dams' WQCs would have a dramatic impact on the River's overall water quality if fish population goals are met at Little Falls, but those fish are unable to continue their migration past Gambo. Without passage at Gambo, the receiving downstream waters of the Presumpscot all the way to tidewater lose all of the fish that would be going up to Gambo and going back downstream as juveniles. As such, the lack of anadromous fish inhabitation and access to the Presumpscot upstream from Gambo would have profound and measurable negative water quality impacts on the river immediately below Gambo and extending to tidewater.

If implemented, the current Draft Order would constitute a de facto revision of the narrative criteria for Class A and Class B waters. In turn, it would require EPA approval to move forward, but would likely not be approved because it is not based on sound scientific rationale as required by 40 C.F.R. § 131.11(a)(1). There is no evidence in the record indicating the DEP/AG has submitted their proposed WQC amendments to the EPA for review. Neither is there any evidence or discussion indicating why they have not done so nor why they are not legally required to do so. As a matter of law, we believe EPA review is mandatory.

In addition, if DEP implements the Draft Order without mandatory fish passage at Gambo and Dundee Dams, it would violate the State's anti-degradation law found at 38 M.R.S. § 464(F). As such, the DEP can only issue a WQC that results in "lowering the existing quality of any water body after making a finding, following opportunity for public participation, that the action is necessary to achieve important economic or social benefits to the State . . . that finding must be made following procedures established by rule of the board."[19] In this case, the DEP has not followed any procedures by the Board of Environmental Protection in coming to this Draft Order, which is also absent of any finding of an economic or social benefit related to the exclusion of fish passage from the Gambo and Dundee Dam WQCs.

## II. Reopener Clause

FOSL and FOMB are troubled by and oppose DEP's removal of the Reopener Clause from its Second Draft Order.

The Reopener Clause is the only mechanism that the agency could use to reconsider new conditions on these WQCs pending future changed circumstances – namely whether anadromous fish repopulate upstream regions

[19] 38 M.R.S. § 464(F)(5).

of the Presumpscot following the installation of fish passage at the Saccarappa, Mallison Falls and Little Falls Dams.

Reopener Clauses do not violate federal or state law., They can, should be and typically are included as a precaution in case the conditions instituted [in a WQC] are not sufficient to ensure compliance with state water quality standards and section 303, 33 U.S.C.A. § 1313, limitations."[20] As articulated in the *S.D. Warren* decision, a reopener clause is legal in this matter. Furthermore, the existence of such language needs to be in the WQC for the Gambo and Dundee Dams in order to insure the possibility of requiring fish passage at these dams during the period of the Sappi FERC License. Such language is critical to reevaluate the legality of the Gambo WQC should anadromous fish reestablish themselves at the base of that dam.

## III. Conclusion

For the reasons stated above, FOSL and FOMB continue to oppose the issuance of any WQC for the operation of the Gambo and Dundee Dams that does not contain specific population criteria of anadromous fish that would trigger the construction of fish passage through these dams.

As a matter of law, the DEP cannot issue a WQC that does not mandate fish passage at the Gambo and Dundee Dams, as the absence of this condition 1) changes and impacts the designated and existing uses of the Presumpscot's water quality; and 2) violates Maine law and the Clean Water Act's prohibition on degrading the nation's waters.

Should DEP move forward with issuing the Draft Order as written, then FOSL and FOMB respectfully request the agency to address in its final order 1) why EPA approval is not needed to exclude fish passage at the Gambo and Dundee Dams; 2) why the absence of a fish passage condition at the Gambo and Dundee Dams does not violate Maine law; and 3) why the agency has stricken the Reopener Clause from its previous draft.

Should your agency have any questions concerning these comments, please do not hesitate to contact us.

Sincerely,

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[20] *S.D. Warren v. BEP*, 2005 ME 27, ¶ 24.

# EXHIBIT A

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Midwest Biodiversity Institute
P.O. Box 21561
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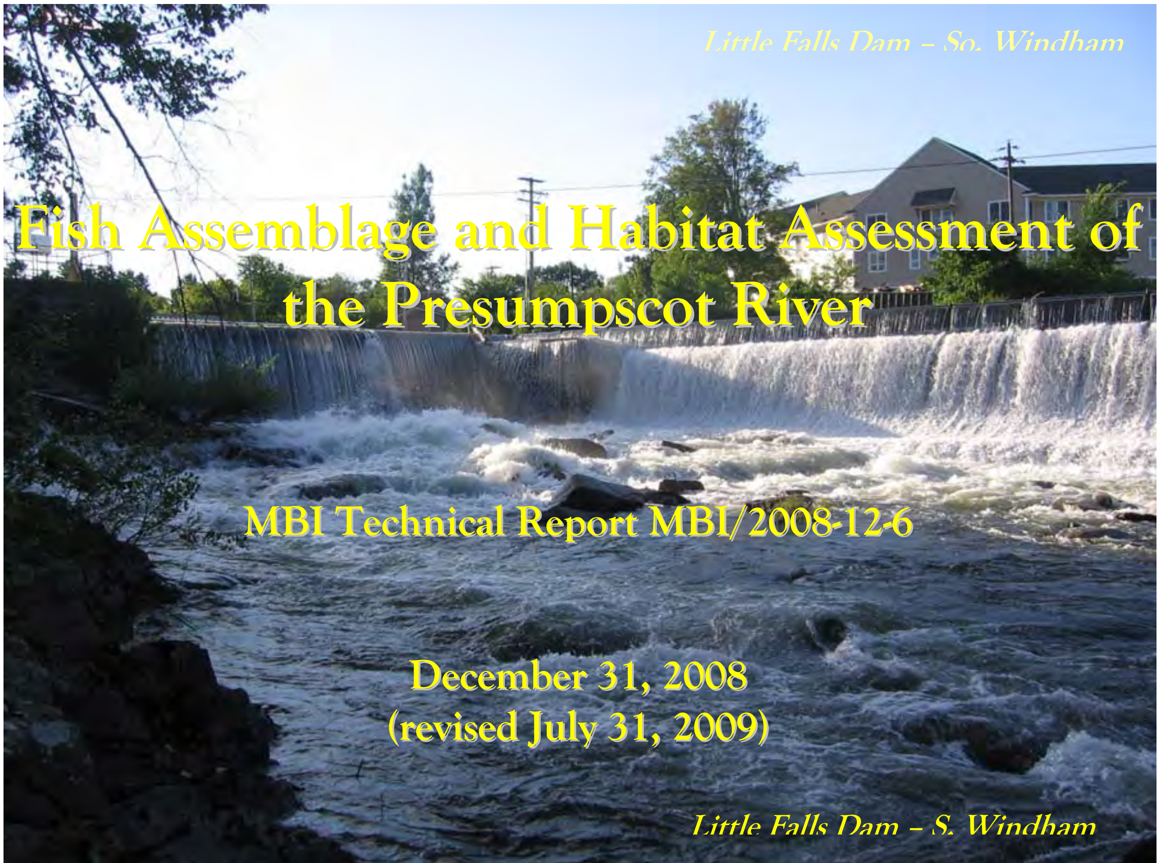
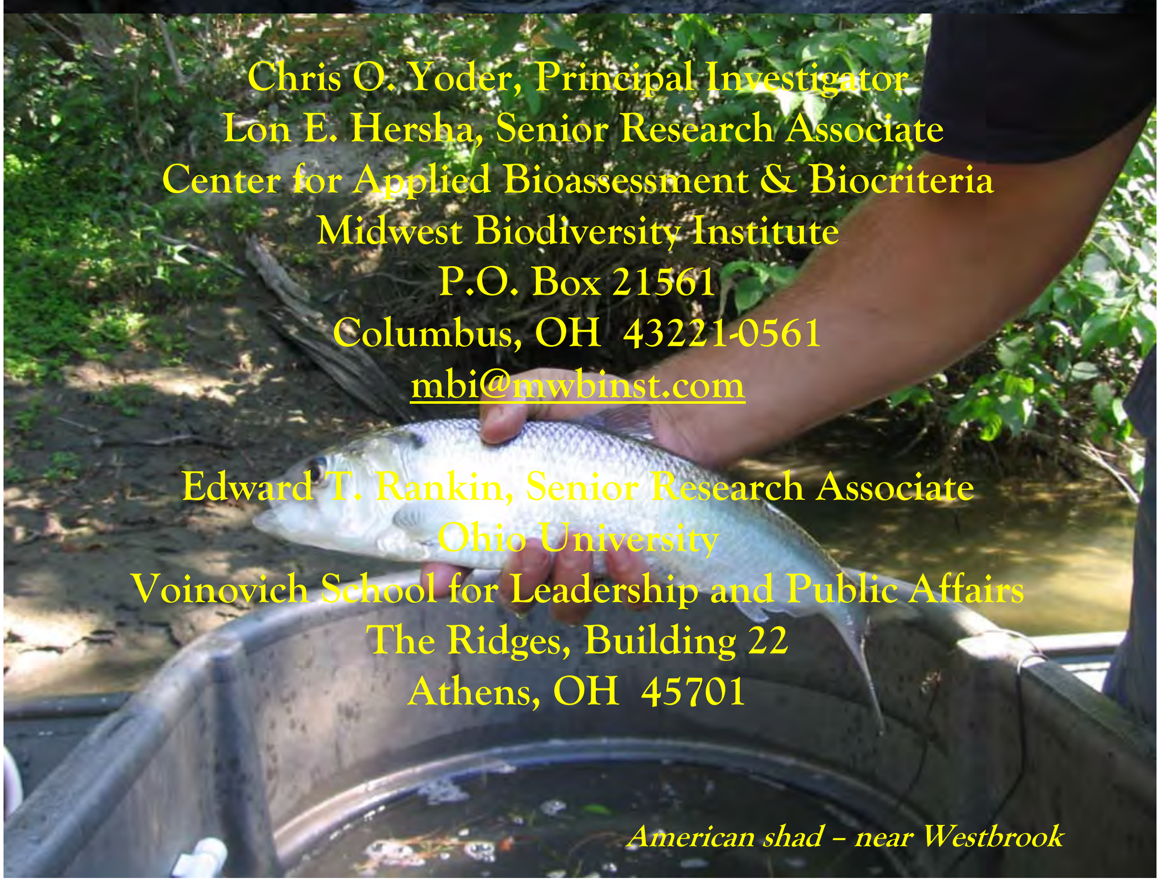



# Fish Assemblage and Habitat Assessment of the Presumpscot River

MBI Technical Report MBI/2008-12-6

December 31, 2008
(revised July 31, 2009)

Little Falls Dam – S. Windham



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American shad – near Westbrook

# Fish Assemblage and Habitat Assessment of the Presumpscot River

# 2006-7

Final Project Report to:

Casco Bay Estuary Partnership
University of Southern Maine
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PO Box 9300, 34 Bedford Street
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Matthew Craig, Project Manager

December 31, 2008
(Revised July 31, 2009)

MBI Technical Report MBI/2008-12-6

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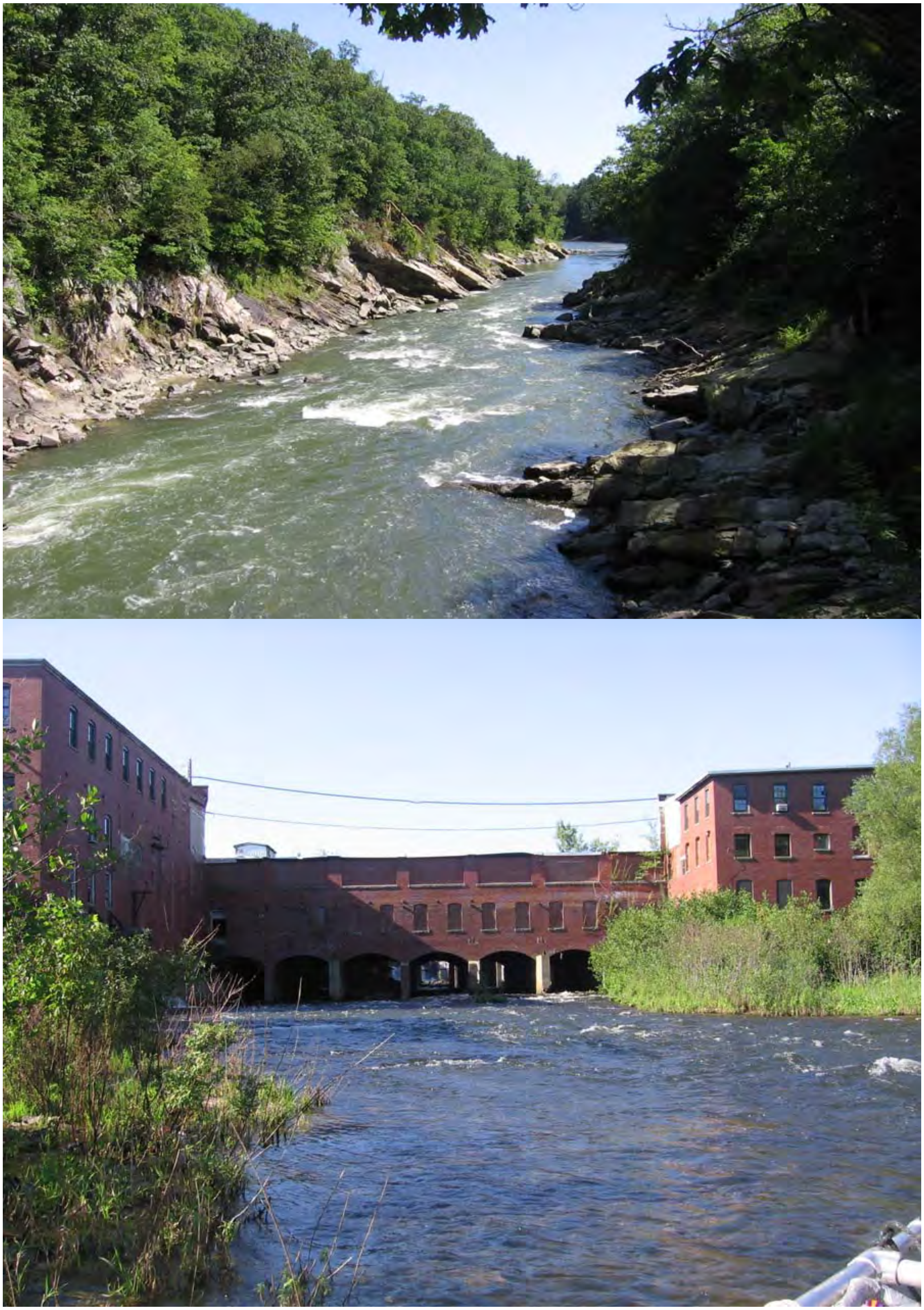

*Plate 1. Upper: Lower Presumpscot Falls looking downstream (August 2006). Lower: Looking upstream at a portion of the Cumberland Mills Dam and SAPPI facility (August 2006).*

# TABLE OF CONTENTS

**Section – Heading/Subheadings** **Page**

**Section – Heading/Subheadings** **Page**

**Section – Heading/Subheadings** **Page**

## SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The Midwest Biodiversity Institute received a grant from the Casco Bay Estuary Partnership in 2006 to conduct an assessment of the fish assemblage of the Presumpscot River between the outlet of Sebago Lake and Casco Bay. The overall goal of this project is to assess the current status of the fish assemblages as it is related to both historical and contemporary biological, chemical, and physical characteristics and stressors. With the exception of a prior study focused on anadromous fishes in the lower mainstem in 2003 (Normandeau Associates 2004), comparatively little is known about the relative abundance, distribution, and composition of the fish assemblage beyond species of historical and immediate management interest. Of particular interest is the documentation of introduced species that occur in the same habitats required by fish species that are the focus of these high profile management and restoration interests. The interim Maine Rivers IBI (Yoder et al. 2008) was used herein as one of the key analytical methodologies to assess the present condition of the resident fish assemblages and reveal how it relates to historical and contemporary stressors and prospects for future restoration.

The study area for this project extends from just downstream from the Eel Weir dam at the Sebago Lake outlet to the tidal influenced reach immediately downstream from Presumpscot Falls and upstream from the I-295 bridge. The approximate lower one mile of each of three tributaries, Pleasant River, Little River, and the Piscataqua River were also included. Within the study area 19 discrete mainstem locations and 3 tributary locations were sampled for fish, qualitative habitat, and limited water quality (temperature, dissolved oxygen, and conductivity) one or two times during August-September 2006 and May-June 2007. May-June sampling was included to ensure adequate sampling of spring anadromous fish runs.

This study consisted of ascertaining the relative abundance, composition, distribution, and general health of the fish assemblage in the Presumpscot River mainstem and 3 tributaries. Boat electrofishing was the method of choice based on its successful application as a single gear method to non-wadeable rivers in Maine rivers during a 2002-7 statewide survey (Yoder et al. 2006 a,b). The methodology follows that developed by the Maine Rivers fish assemblage assessment that was initiated in 2002 (MBI 2002). The data were analyzed using routines available in the Maine ECOS data management system that was adapted for use by MBI in the Maine Rivers project. Habitat was assessed at each electrofishing site using the Qualitative Habitat Evaluation Index (QHEI; Rankin 1989, 1995) as modified for application to large, non-wadeable rivers.

The Presumpscot River mainstem between the Eel Weir Dam and Casco Bay offered a gradient of habitat quality as determined by QHEI scores and attributes. Moderate-high gradient riverine habitats exhibited the highest scores (generally >80-90). Impounded habitats reflected the diminishment or outright loss of riverine habitat attributes scoring in the 60-70 range. Two riverine sites downstream from Cumberland Mills Dam scored <60 and reflected a comparatively low gradient and perhaps prior modifications of the river channel. Riverine QHEIs were generally higher than impounded sites (Figure 8) with a median value of 87. In contrast impounded sites had a median of 60. The habitat assessment demonstrated the impact of impoundments on the naturally occurring riverine habitat. The accumulation of modified attributes coupled with the loss of good attributes is a signature of this type of habitat modification. Especially affected are the QHEI attributes associated with the extent of habitat modification, habitat development, and diversity of flow types. These attributes included fair-poor overall habitat development, slow or no current velocity, and an absence of riffle/run habitats.

A total of 28 fish species were collected from the Presumpscot River mainstem and 3 tributaries during August-September 2006 and May-June 2007. Of these, 23 are considered to be native and the remaining 5 species are introduced (following the definitions of Halliwell 2005). Of the latter, four species are purposely managed and the other is present due to previous unintentional introductions. Overall, American eel *(Anguilla rostrata),* common shiner *(Luxilis cornutus),* smallmouth bass *(Micropterus dolomieui),* and white sucker *(Catostomus commersonii)* were the numerically most abundant species comprising 67.1% of the total numbers in 2006. These were followed numerically by pumpkinseed sunfish *(Lepomis gibbosus),* yellow perch *(Perca flavescens),* fallfish *(Semotilus corporalis),* largemouth bass *(Micropterus salmoides),* alewife *(Alosa pseudoharengus),* golden shiner *(Notemigonus crysoleucas),* and striped bass *(Morone saxatilis).* American eel, white sucker, and striped bass predominated in terms of biomass. Our method produced a median of 7 (range 4-13) species collected at the mainstem sampling sites with an average relative abundance of 199 individuals/km and a biomass of 18.8 kg/km in 2006. The tributaries produced an average of 12.7 (range 11-14) species and an average relative abundance of 523 individuals/km and a biomass of 16.3 kg/km in 2006.

Condition of the fish assemblage was characterized by reporting specific metrics, including species richness, numbers, biomass, and assemblage indices (IBI, MIwb). The metrics were analyzed by river sampling location and by major habitat types (impounded vs. riverine). Total species richness ranged from a low of 4 at RM 3.7 (dst. U.S. Rt. 302) and RM 0.7 (dst. I-95) to a high of 15 below Presumpscot Falls (RM - 0.4). Species richness was highest at impounded sites. Numerical density expressed as the total number of individuals/km ranged from a low of 50 individuals/km (all species combined) to more than 400 individuals/km in the mainstem. Abundance exceeded 800 individuals/km in the Piscataqua and Little Rivers. The longitudinal pattern was roughly similar to species richness, with the lowest values occurring in the Cumberland Mills dam to Presumpscot Falls reach in August. Assemblage biomass (kg/km) showed similar results, except low values were also observed between the Gambo Dam downstream to Sacarappa Falls. Biomass was highest immediately downstream from the North Gorham dam and below Presumpscot Falls. Numerical density was somewhat higher at impounded sites (median = 174.5 individuals/km) compared to riverine sites (median = 125 individuals/km), particularly in the mainstem. Biomass was slightly higher at riverine sites (median = 13.9 kg/km) compared to impounded sites (median = 9.9 kg/km).

The proportion of river-dependent species (fluvial specialist and fluvial dependent species) was generally less than 20% and frequently less than 10%. Most sites in the mainstem failed to meet the Biological Condition Gradient (BCG) tier IV benchmark for proportion of river-dependent species (20%) and values in the lower mainstem were less than 5% in August. In contrast values at two tributary sites exceeded 80% and the third was greater than 50%. River-dependent species were actually slightly less prevalent at the riverine sites along the main stem (median = 10%) than at impounded sites (median = 12.5%). Some impounded sites had values in excess of 40%. The proportion of macrohabitat generalists showed a general decline from very high values >80% at the upstream sites to near 0 in the lower mainstem. Most sites upstream from Cumberland Mills Dam failed to meet the BCG tier IV benchmark (<50%). Riverine sites had a somewhat lower median proportion of macrohabitat generalists (44%) compared to impounded sites (median = 61.5%).

The interim Maine Rivers IBI and the modified index of well-being (MIwb) were used to portray overall assemblage condition. The MIwb results indicate potential issues in the mainstem along two sections of the main stem: (1) from the Dundee Dam to the Little River confluence and (2) between Cumberland Mills Dam and Presumpscot Falls. The data suggest that organic enrichment may be an important impact in the latter reach. Most sites exhibited MIwb scores representative of BCG tier V conditions or worse. Only a few mainstem sites were indicative of tier IV, but all three tributaries had scores consistent with tier III or a high tier IV conditions. MIwb results from riverine and impounded sites overlapped significantly, with riverine sites in particular showing both higher and lower values than observed at impounded sites.

Similar patterns were evident in the IBI, especially for the river segment between Cumberland Mills Dam and Presumpscot Falls. Most of the IBI results were indicative of BCG tier V conditions, but no sites were in tier VI. The three tributaries met tier IV standards and had the highest IBI scores observed. The comparison between the riverine and impounded sites showed overlapping results with a higher median IBI in the impounded sites (38) than at the riverine sites (33). The range in the riverine sites was wider and was more indicative of the potential pollution impacts than habitat alone.

The overall results reveal a mainstem fish assemblage that is minimally attaining BCG tier IV conditions at only a few isolated sites. This approximates the minimally acceptable condition for meeting the goals of the Clean Water Act and more importantly reflects minimal conditions for a sustainable aquatic resource. The Presumpscot mainstem fish assemblage is among the lowest quality in Maine in terms of the IBI and MIwb, ranking 17$^{th}$ (out of 19) in terms of the IBI and 19$^{th}$ in terms of the MIwb. As a result of the initial observations made by this study in 2006, Maine DEP undertook a cumulative effects assessment (CEA) in this segment of the Presumpscot River in 2007. Since the Presumpscot is much smaller than the Androscoggin, Kennebec, and Penobscot (where previous CEA studies had detected impacts from paper mills) and consequently wastewater is a larger proportion of the river flow, these discharges would be more likely to have an effect on fish populations. The initial results were not conclusive with regard to isolating a specific source, but Maine DEP agrees about the potential for an impact to the fish assemblage. Further study of this segment is recommended to better diagnose potential stressors and their sources. Based on the presence of several diadromous species between Cumberland Mills Dam and Presumpscot Falls, the issue of access by these species is settled. Given also that upstream reaches have reasonably good to excellent habitat, this too favors the conclusion that the Presumpscot mainstem has the inherent potential to support a diverse diadromous fishery. Fish passage is obviously the most important issue to address at this point, but long term concerns should also focus on better understanding potential pollution sources in the aforementioned segments.

## LIST OF TABLES

## LIST OF FIGURES

**LIST OF FIGURES** (continued)

**LIST OF FIGURES** (continued)

# LIST OF PLATES

**LIST OF PLATES** (continued)

**ACKNOWLEDGEMENTS**

Several individuals and organizations contributed conceptual, technical, and material support to this project. Dusti Faucher, Friends of the Presumpscot River, provided important advice and knowledge about the study area and the issues that this study was intended to address. The following persons and organizations contributed to the study design, assistance with field logistics, and other important data and information: Jim Stahlnecker, Barry Mower, John Reynolds, Joe Glowa, and Susan Davies, Maine Department of Environmental Protection; Gail Wippelhauser, Maine Department of Marine Resources; Jennie Bridge and Diane Gould, U.S. Environmental Protection Agency; and, Curtis Bohlen, Karen Young, Beverly Bayley-Smith, and Matthew Craig, Casco Bay Estuary Partnership, University of Southern Maine. Karsten Hartel, Harvard University Museum of Comparative Zoology, and David Halliwell, Maine DEP assisted with voucher specimens and final verifications of species identifications. Thanks are also expressed to three anonymous reviewers.

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# Fish Assemblage and Habitat Assessment of the Presumpscot River

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## INTRODUCTION

The Midwest Biodiversity Institute received a grant from the Casco Bay Estuary Partnership in 2006 to conduct an assessment of the fish assemblage of the Presumpscot River between the outlet of Sebago Lake and Casco Bay. This project is also intended to supplement the ongoing assessment of the fish assemblages in the non-wadeable rivers of Maine that has been underway since 2002. Two project reports completed in 2006 (Yoder et al. 2006a,b) describe the methods and logistics of that larger project. A third report (Yoder et al. 2008) completed in 2008 describes the development of an interim Index of Biotic Integrity (IBI) applicable to the non-wadeable freshwater rivers of Maine. That index is used herein to conduct an assessment of the Presumpscot River mainstem fish assemblages. The overall goal of this project is to assess the current status of the fish assemblages and as it is related to both historical and contemporary biological, chemical, and physical characteristics and stressors.

### Maine Rivers Fish Assemblage Assessment

A long term objective of the Maine non-wadeable rivers fish assemblage study is the development of a fish assemblage assessment tool that can be used to systematically assess the status of the non-wadeable rivers and streams of Maine and New England. Such a tool can be used to assess multiple resource management objectives (Figure 1) including the existing status and quality of individual rivers and the effectiveness of management efforts aimed at restoring native fish assemblages including diadromous species. This effort complements the existing macroinvertebrate assemblage and periphyton methodologies of Maine DEP (Davies and Tsomides 1997; Davies et al. 1999) and the efforts of various groups with direct interest in the Presumpscot River. An ongoing purpose of the Maine non-wadeable rivers project is the development and testing of the U.S. EPA Biological Condition Gradient (BCG), which is a product of the U.S. EPA Tiered Aquatic Life Uses working group (U.S. EPA 2005). The development and testing of biological assessment

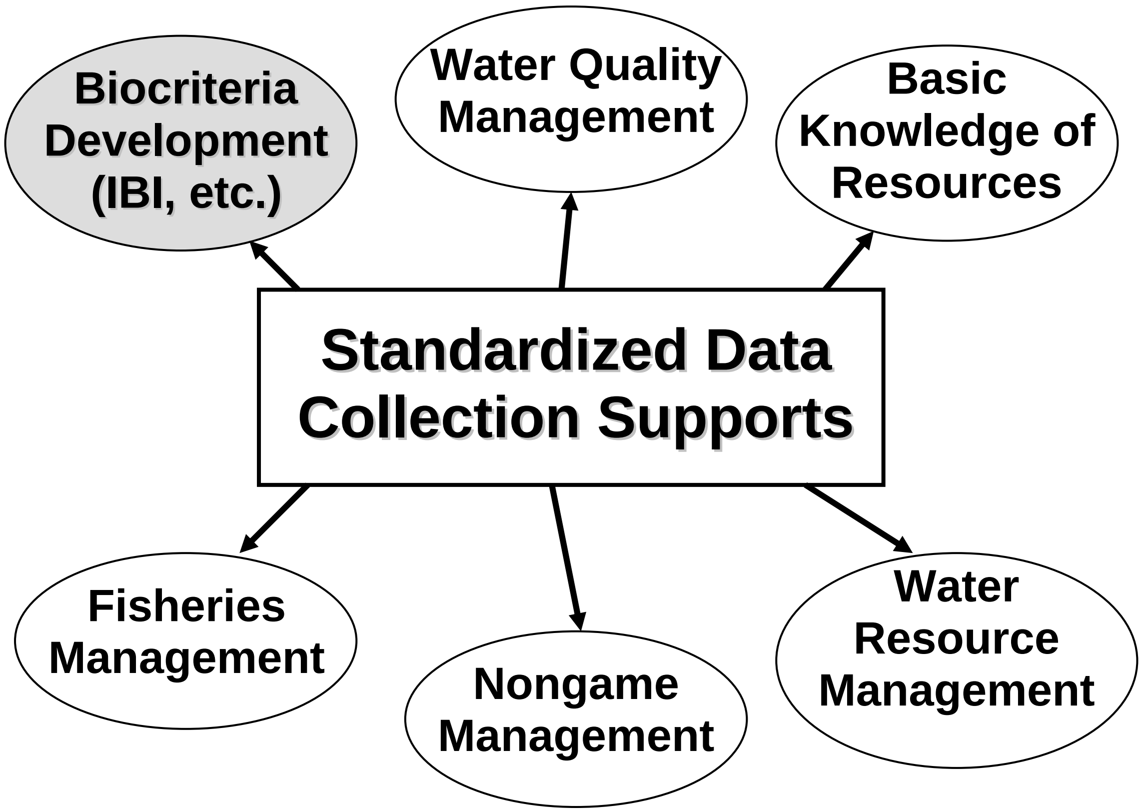


*Figure 1. Multiple and integrated uses of the data and information produced by systematic biological assessment.*

methods and biological criteria for large rivers is also a principal objective of the EPA National Biocriteria Program and this project is directly tied to that effort.

In addition to the biocriteria related objectives of this study, the baseline information provided about the distribution and abundance of fish species supports important resource management objectives including;

1. restoration and management of diadromous species;
2. management of hydroelectric generating facilities;
3. fisheries management issues; and,
4. documentation and management of introduced species.

**Presumpscot River Fish Assemblage Assessment**

This study contributes to the basic understanding of the distribution and abundance of freshwater and diadromous fishes in the Presumpscot River. With the exception of a prior study focused on anadromous fishes in the lower mainstem in 2003 (Normandeau Associates 2004), comparatively little is known about the relative abundance, distribution, and composition of the fish assemblage beyond species of historical and immediate management interest. Of particular interest is the documentation of introduced species that occur in the same habitats required by fish species that are the focus of these high profile management and restoration interests. The interim Maine Rivers IBI was developed in an attempt to highlight and potentially address those very issues. It is used here as one of the key analytical methodologies to assess the present condition of the resident fish assemblages and reveal how it relates to historical and contemporary stressors and prospects for future restoration.

***Background and Management Issues***

The Presumpscot River has been the subject of recent interest and concern in terms of overall quality and restoration of a once thriving diadromous fish assemblage. The Presumpscot River Watershed Coalition is the principal partnership of individuals, organizations, and agencies collaborating to restore and protect the Presumpscot River watershed by cooperating on various projects to realize the goals set forth in the Presumpscot River Management Plan (PRWC 2003). A report by American Rivers (2002) details the historical nature and historic range of native anadromous fish species in the Presumpscot River and Sebago Lake. This report states that migratory fish species specifically mentioned by 18th century Presumpscot River residents included Atlantic salmon (*Salmo salar*), American shad (*Alosa sapidissima*) and alewife (*Alosa pseudoharengus*). These species were an important source of food for both Native Americans and early European settlers living in the area (American Rivers 2002), and as such documents their prior existence in the mainstem above Presumpscot Falls to Sebago Lake. Wippelhauser et al. (2001) included alewife, American shad, Atlantic salmon, blueback herring, rainbow smelt, striped bass, and American eel in their description of the historical diadromous fishery resources of the Presumpscot River.

The Casco Bay Estuary Project (CBEP) initiated a planning effort in 2000 for the Presumpscot River involving a diverse group of stakeholders (PRWC 2003). The CBEP interests in the Presumpscot River at that time included it being the largest freshwater source to Casco Bay, plans for the removal of the head-of-tide dam (Smelt Hill Dam, later removed in the Fall of 2002), and improvements in water quality resulting from the cessation of the former S.D. Warren (now SAPPI) pulp mill operations in Westbrook. The goal of the steering committee has been to work cooperatively to develop a plan for the future of the river, and to develop recommendations that incorporate all relevant interests along the river. Improving water quality and establishing fish passage at the remaining dams have been identified as high priority issues for the near term.

In January 2001, the Maine Department of Marine Resources (MDMR), the Maine Department of Inland Fisheries and Wildlife (MDIFW), and the Maine Atlantic Salmon Commission (MASC) produced a document entitled *Presumpscot River: Interim Goals for Fisheries Management,* (Wippelhauser et al. 2001) which outlined management goals for important fishery resources that currently reside or have historically resided in the Presumpscot River watershed. Species addressed in the document include alewife,

*Plate 2. Upper: Presumpscot River below Presumpscot Falls, looking upstream at the former Smelt Hill Dam site (August 2006). Lower: Eel Weir Dam and power house at the Sebago Lake outlet (August 2006).*

American eel, American shad, landlocked Atlantic salmon, sea-run Atlantic salmon, Atlantic sturgeon, black crappie, blueback herring, brook trout, brown bullhead, brown trout, chain pickerel, largemouth bass, rainbow smelt, smallmouth bass, striped bass, tomcod, yellow perch, and white perch. Interim fisheries management goals were first developed in response to several changes within the watershed including the anticipated removal of the Smelt Hill Dam, the relicensing of six of the seven existing hydropower projects, and improvements in water quality resulting from the closure of the pulping operations at the former S.D. Warren Mill (now SAPPI) in Westbrook. These changes created new opportunities for the restoration of diadromous fish and the enhancement of cold and warmwater fish assemblages within the physical and biological limits of the available habitat.

### *Water Quality and Habitat Classifications*

The Presumpscot River is presently classified under the Maine Water Quality Standards (WQS) in accordance with river segments shown in Table 1. The Maine WQS classifications range from class A in the upper mainstem (RM 16.1-22.4) to class B (RM 7.7-16.1) and C in the lower mainstem (RM 0.0-7.7). The most recent biomonitoring results range from 1995 to 2005. Non-attainment of class A and B was evident in results from the 1995-97 era and these are the most recent results in the upper mainstem. In the lower mainstem, outright non-attainment in the 1990s has improved to class B performance based on results from 2005, an indication of improving water quality conditions. These improvements were attributed to the cessation and/or reduction of point source discharges in Westbrook.

## STUDY AREA DESCRIPTION

The study area for this project extends from just downstream from the Eel Weir Dam at the Sebago Lake outlet to the tidal influenced reach immediately downstream from Presumpscot Falls and upstream from the I-295 bridge. The approximate lower one mile of each of three tributaries, Pleasant River, Little River, and the Piscataqua River were also included in the study area. Within the study area 19 discrete mainstem locations and 3 tributary locations were sampled for fish, qualitative habitat, and limited water quality (temperature, dissolved oxygen, and conductivity) one or two times during August-September 2006 and May-June 2007 (Figure 2; Table 2).

### *Natural Setting*

The upper portion of the Presumpscot River study area below Sebago Lake is situated within the Northeastern Highlands level III ecoregion (Omernik 1987). More recent refinements to the ecoregion delineations for New England place this part of the study area in the Sebago-Ossippee Hills and Plains subregion. This level IV subregion is characterized by rugged hills and mountains interspersed with numerous lakes and wetlands on rolling plains. Soils are well drained and consist of sandy till with sandy loam and loamy sand. It is a transition zone from warm temperate to cool temperate and boreal vegetation

Table 1. Water quality classifications for designated aquatic life uses according to segments established by Maine DEP. The latest biomonitoring results are shown for each segment (S. Davies, Maine DEP, personal communication).

| River Segment | Inclusive RM | Maine WQS Classification | Bioassessment Result[1] |
|---|---|---|---|
| Sebago Lake outlet to Dundee Dam | RM 18.1-22.4 | A | B [2000] |
| Dundee Dam to Pleasant R. confluence | RM 16.1-18.1 | A | C [1997] |
| Pleasant R. confluence to U.S. Rt. 202 | RM 13.3-16.1 | B | C [1997]<br>C [1997] |
| U.S. Rt. 202 to Sacarappa Falls | RM 7.7-13.1 | B | C [1997]<br>B [1994]<br>NA [1997] |
| Sacarappa Falls to tidewater | RM 0.0-7.7 | C | C [1996]<br>NA [1989]<br>NA [1996]<br>B [2000]<br>C [2005]<br>B [2005] |
| All tributaries entering below Sebago L. (Pleasant, Little, & Piscataqua R.) | | B | B [2005][2]<br>B [2004][3] |

consisting of hemlock-hardwood-pine and northern hardwood-conifer. In Maine, several northern species reach their southern range limits near Sebago Lake.

The mainstem enters the Northeastern Coastal Zone level III ecoregion and the Gulf of Maine Coastal Lowland just downstream from the Pleasant River confluence. This level IV subregion is characterized by extensive glacial sand and mud deposits, with a pattern typified by plutonic capes and intervening sand beaches that front the region's largest salt marshes. The subregion has relatively low relief (50-100 feet) and elevations of 0-250 feet. Vegetation consists of southern hardwood species (e.g., shagbark hickory, flowering dogwood, and chestnut oak) that reach the northern limit of their range within this subregion. The vegetation mosaic includes white oak and red oak forests, some chestnut oak woodlands, white pine, pitch pine in sandy areas, pitch pine bogs, some Atlantic white cedar swamps, red maple swamps, and *Spartina* salt marsh along the coast. The region's

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1 Latest bioassessment result reported by Maine DEP; results are reported sequentially at individual locations from upstream to downstream (NA = non-attainment).
2 Pleasant River near Windham.
3 Piscataqua River in Falmouth.

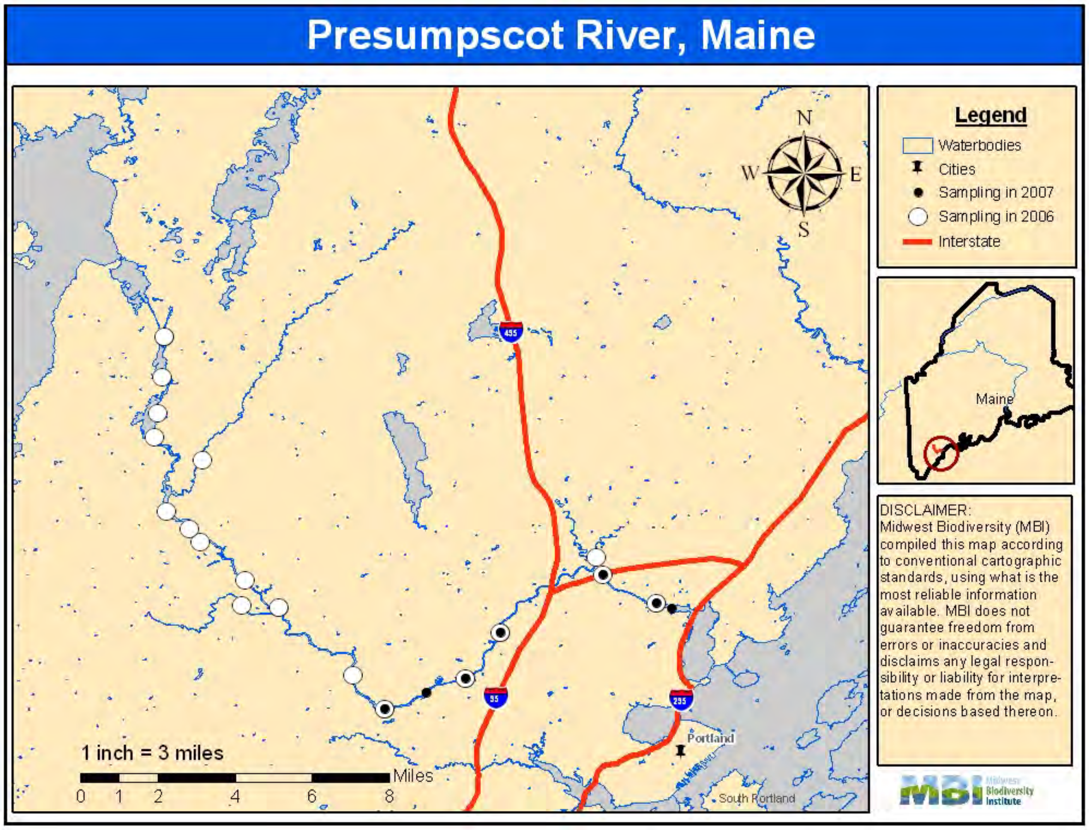


*Figure 2. The Presumpscot River study area in 2006 and 2007. Open symbols represent 2006 sampling locations; closed circles represent 2007 sampling locations. Major waterbodies and interstate highways are shown.*

forests and farms have been converted to residential developments and suburban communities of nearby cities during the past 30 years.

### *Impacts and Alterations*

The variety, number and magnitude of modifications and impacts relative to the size of the Presumpscot River are without parallel on other rivers in Maine, e.g., no other river in Maine had a canal and commercial shipping for its entire length and, no other river in Maine has virtually all its hydraulic head captured behind dams (PRPSC 2002). While all of these have contributed to the economic development of the area, the resulting environmental impacts remain today as either a legacy of the past or the result of ongoing activities. Examples include the obstructions represented by the seven remaining dams that limit access to all but a few miles of the lower Presumpscot River to sea run fish. Only a few decades ago this was virtually a moot issue as poor water quality rendered the habitat unusable to most fish even if it were accessible. Now that these legacy water pollution issues have been reduced the viability of restoring diadromous fisheries is now plausible. However, increased urbanization in the greater Portland area poses a new set of potential

Table 2. Location and description of sampling sites, dams, point sources, and Maine DEP water quality classification segments in the Presumpscot River study area between the Eel Weir in North Windham and the mouth just upstream from I-295. EF – electrofishing and qualitative habitat site; PS – point source discharge; R1 – high gradient riverine; R2 – low gradient riverine; I1 – impounded riverine; T1 – freshwater/brackish tidal riverine. Numbers or letters in brackets correspond to those depicted on the figures.

| River Mile | Site Type | Location - Description | Habitat Type | Map Reference[1] | Maine DEP Classification[2] | | |
|---|---|---|---|---|---|---|---|
| | | | | | Legal Class | Model Result | Year(s) |
| 21.1 | EF | Dst. Eel Weir; ust. North Gorham impoundment | R1 | Sebago Lake | A | B | 2000 |
| 20.6 | EF | North Gorham impoundment | I1 | Sebago Lake | A | - | - |
| 20.0 | Dam | North Gorham Dam [**6**] | - | Dundee Pond | - | - | - |
| 19.9 | EF | Dst. Gorham Dam | R1 | Dundee Pond | A | - | - |
| 18.8 | EF | Dundee impoundment | I1 | Dundee Pond | A | - | - |
| 18.1 | Dam | Dundee Dam [**5**] | - | Dundee Pond | - | - | - |
| 18.1 | EF | Dst. Dundee Dam | R1 | Dundee Pond | A | B | 1997 |
| 16.1 | EF | Pleasant River – ust. mouth | R2 | Little River | B | B | 2005 |
| 15.6 | EF | Gambo impoundment | I1 | Mallison Falls-Gambo | B | C | 1997 |
| 15.0 | Dam | Gambo Dam [**4**] | - | Mallison Falls-Gambo | - | - | - |

[1] River mile maps developed specifically for this study (Appendix B).
[2] Based on closest Maine DEP sampling location.

Table 2. continued

| River Mile | Site Type | Location - Description | Habitat Type | Map Reference[1] | Maine DEP Classification[2] | | |
|---|---|---|---|---|---|---|---|
| | | | | | Legal Class | Model Result | Year(s) |
| 14.9 | EF | Dst. Gambo Dam | R1 | Mallison Falls-Gambo | B | C | 1997 |
| 14.1 | EF | Little Falls impoundment | I1 | Mallison Falls-Gambo | B | C | 1997 |
| 13.2 | Dam | Little Falls Dam | - | Mallison Falls-Gambo | - | - | - |
| 13.1 | EF | Dst. Little falls Dam; ust. Mallison Falls Dam | R1 | Mallison Falls-Gambo | B | B | 1994 |
| 12.8 | Dam | Mallison Falls Dam | - | Mallison Falls-Gambo | - | - | - |
| 12.6 | EF | Dst. Mallison Falls Dam | R1 | Little River | B | - | - |
| 11.7 | EF | Little River – ust. mouth | R2 | Little River | B | - | - |
| 11.3 | EF | Dst. Little River | R2 | Little River | B | - | - |
| 8.6 | EF | Saccarappa impoundment | I1 | Cumberland Mill-Sac. | B | NA | 1997 |
| 7.7 | Dam | Saccarappa Dam [**3**] | - | Cumberland Mill-Sac. | - | - | - |
| 7.6 | EF | Dst. Saccarappa Dam | R1 | Cumberland Mill-Sac. | C | C | 1996 |
| 6.5 | Dam | Cumberland Mills Dam [**2**] | - | Cumberland Mill-Sac. | - | - | - |
| 6.48 | PS | SAPPI discharges [**C**] | - | Cumberland Mill-Sac. | - | - | - |
| 6.4 | EF | Dst. SAPPI; Cumberland Mills | R1 | Cumberland Mill-Sac. | C | - | - |

[1] River mile maps developed specifically for this study (Appendix B).
[2] Based on closest Maine DEP sampling location.

Table 2. continued

| River Mile | Site Type | Location - Description | Habitat Type | Map Reference[3] | Maine DEP Classification[4] | | |
|---|---|---|---|---|---|---|---|
| | | | | | Legal Class | Model Result | Year(s) |
| 5.6 | PS | Westbrook WWTP [**B**] | - | Cumberland Mill-Sac. | - | - | - |
| 5.5 | EF | Dst. Westbrook WWTP | R2 | Cumberland Mill-Sac. | C | B | 2000 |
| 4.2 | Trib. | Mill Brook (Highland Lake outlet) | - | Cumberland Mill-Sac. | - | - | - |
| 4.18 | CSO | Westbrook Pumping Station [**A**] | - | Cumberland Mill-Sac. | - | - | - |
| 3.7 | EF | Dst. U.S. Route 302; Westbrook Pump Sta. | R2 | Smelt Hill | C | C | 2005 |
| 1.0 | EF | Piscataqua River – ust. mouth | R2 | Smelt Hill | B | B | 2004 |
| 0.7 | EF | Dst. I-95 Bridge | R1 | Smelt Hill | C | B | 2005 |
| 0.0 | Dam | Smelt Hill Dam (removed); Presumpscot Falls [**1**] | - | Smelt Hill | - | - | - |
| -0.4 | EF | Dst. Presumpscot Falls; ust. I -295 | T1 | Smelt Hill | - | - | - |

[3] River mile maps developed specifically for this study (Appendix B).
[4] Based on closest Maine DEP sampling location.

*Plate 3. Upper: Impounded mainstem river habitat upstream from the Sacarappa Dam. Lower: Piscataqua River mainstem upstream from the mouth.*

impacts within the watershed. Municipal wastewater treatment plant discharges and nonpoint sources have increased with the larger population that accompanied increased development in southern Maine. This has increased the percentage of land that is impervious to water, resulting in an increased load of pollutants carried to the river by stormwater and alterations to the natural flow regime.

The Presumpscot River is the largest source of freshwater to Casco Bay. The flow regime downstream from Sebago Lake is largely controlled by flow releases from the Eel Weir Dam. The river drains 642 square miles and river elevation drops 267 feet over a distance of 27 miles resulting in an average gradient of 9.88 feet/mile (Figure 3). As such it easily fits the moderate-high gradient riverine ecotype recently described in the statewide riverine

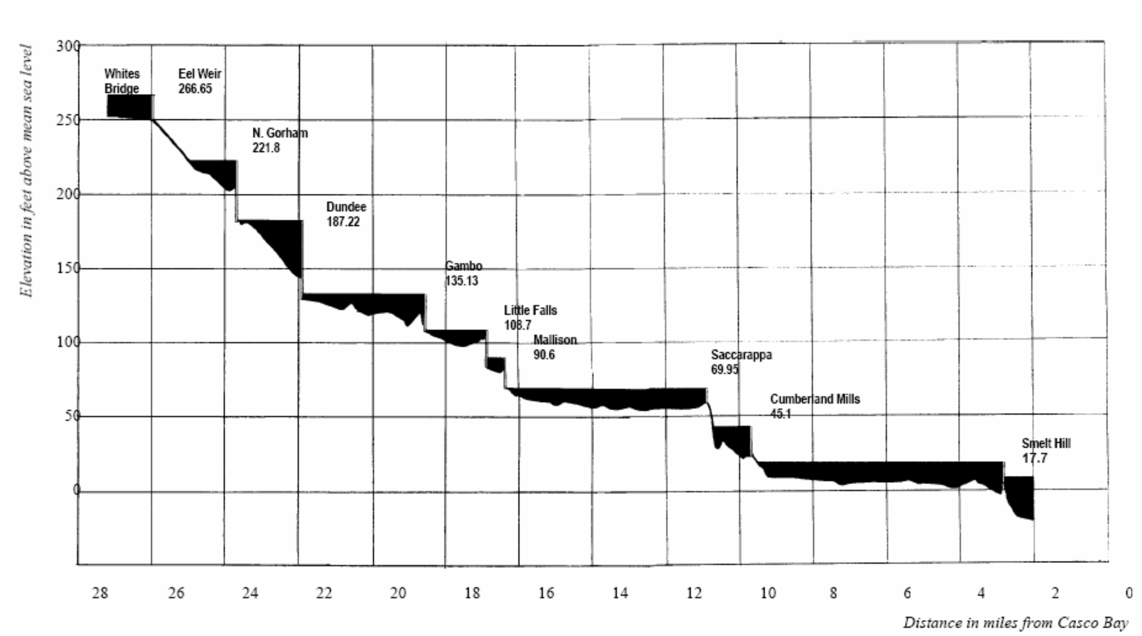


*Figure 3. Elevation profile of the Presumpscot River between White's Bridge to the former Smelt Hill Dam (after PRPSC 2002).*

fish assemblage assessment of Yoder et al. (2008). As with many other Maine rivers, the relatively high gradient was conducive to hydropower development. Eight of the nine dams on the mainstem below Sebago Lake remain today (Table 2). As a result the river was converted from its natural free-flowing state to a series of impoundments created by eight dams that directly affect 22 of the 27 mainstem miles between Sebago Lake and Casco Bay (PRPSC 2002; Figure 3). While the removal of the Smelt Hill dam increased the number free-flowing river miles, the majority of the mainstem remains in a substantially altered state in terms of flow, physical habitat, water quality, and thermal regime.

There are seven point source discharges located within the lower watershed; all except one are comprised of municipal wastewater (PRPSC 2002). Of these the Westbrook WWTP and SAPPI comprises the majority of the discharge flows and loadings of oxygen demanding substances and other substances. The Westbrook WWTP is permitted to discharge 4.54 MGD of wastewater containing oxygen demanding wastes and suspended solids. SAPPI is the only remaining industrial discharge consisting of up to 10 MGD of treated process waste water, treated landfill leachate, 12 MGD of non-contact cooling water, treated stormwater runoff, and 2.5 MGD of sand filter backwash water. Kraft pulping operations were ceased on June 28, 1999. The SAPPI facility is also authorized to treat up to 2,000 GPD of wastewater from the Biofine Renewables LLC facility located in Gorham. The discharge includes quantities of waste heat, oxygen demanding substances, total suspended solids, arsenic, and bacteria, each permitted to maintain class C standards in the Presumpscot River.

*Plate 4. Discharge from the SAPPI facility immediately below the Cumberland Mills Dam observed on August 18, 2006. Note the turbidity plume resulting from suspended solids in the discharge.*

# METHODS

### *General Scope and Design*

This study consisted of ascertaining the relative abundance, composition, distribution, and general health of the fish assemblage in the Presumpscot River mainstem between the Eel Weir Dam at the outlet of Sebago Lake and the tidewater below Presumpscot Falls. The methodology follows that developed by the Maine Rivers fish assemblage assessment that was initiated in 2002 (Yoder et al. 2006a). This methodology specifies sampling within a summer-early fall seasonal index period of July 1 – September 30 particularly when the interim fish Index of Biotic Integrity (IBI; Yoder et al. 2008) and associated data is used to assess the quality of the fish assemblage. As such the majority of the sampling was conducted during August and September 2006. However, a survey of the mainstem between the Cumberland Mills Dam impoundment and Casco Bay was conducted during May 31-June2, 2007 to ascertain the presence and abundance of adult anadromous species. The data is also reported here and within the constraints imposed by the sampling protocols.

### *Equipment Specifications*

Boat electrofishing was the method of choice based on its successful application as a single gear method to non-wadeable rivers in selected Maine rivers by Kleinschmidt in 2000-1 and by MBI and Kleinschmidt in 2002-5 (Yoder et al. 2006 a,b). Rivers that offer sufficient width and depth are sampled using a 16' john boat rigged for daytime and nighttime electrofishing. Electric current generated by a Smith-Root 5.0 GPP generator/pulsator combination is transmitted by anodes and cathodes located in front of the bow. Anodes (+ electrode) consisted of gangs of 3/16" stainless steel woven cable; a gang consisted of 4-6 separate strands bundled together. Cathodes (- electrode) consisted of four ¾" diameter flexible stainless steel conduit cut to lengths of 6-8' (or longer for deep rivers) and suspended directly from the bow. A positive pressure foot pedal switch is located on the bow platform and operated by a primary netter. Two netters were located on the bow platform. Emergency cutoff switches are located within easy reach of the boat driver on the rear seat and on the 5.0 GPP pulsator unit. Lights are affixed the safety railing to enable night sampling. The 16' electrofishing boat is propelled by a 15 and 25 h.p. outboards mounted on the transom.

A 14' heavy duty inflatable raft with an outboard transom was used at sites where width and/or depth precluded the use of the 16' john boat. Electric current was generated by a Smith-Root 2.5 GPP generator/pulsator combination and transmitted by similarly arrayed anodes and cathodes. The electrode configuration was similar to the 16' boat, except that the 6 cathodes of 6-8' in length were suspended from the sides of the raft, 3 from each side. The anode gangs were hung from a retractable (telescoping) aluminum boom that was secured to the raft with locking ratchet straps. A single netter was positioned on a bow a seat. Battery powered 12 volt lights were mounted on the aluminum frame to support nighttime sampling, although all riverine sites in 2006 were sampled during daytime. The 14' raft is propelled by a 15 h.p. short shaft outboard with multiple tilt settings. The latter

*Plate 5. Upper: 16' electrofishing boat below the Little Falls Dam. Lower: Processing an electrofishing sample at the end of an electrofishing zone.*

feature was essential for maneuvering the raft in swift flowing, shallow, and boulder laden habitats. Electrofishing unit settings were typically governed by relative conductivity. At low conductivity sites (15-40 µS/$m^2$) the GPP unit settings selected were the high voltage range (500-1000 v) at 120 Hz and 100% of the voltage range to produce 2-4 A. At sites with higher relative conductivity (>40-100 µS/$m^2$) the same settings at 80-100% of the voltage range produced 5-10A (4-8 A for the 2.5 GPP unit). For the 5.0 GPP unit, higher relative conductivity in excess of 200 µS/$m^2$ necessitated switching to the low voltage range (maximum = 500 v) at 50-80% of the voltage range to produce 12-18A. The latter situations were rare and occurred only at the tidal influenced site. The selection of the 120 Hz pulse frequency was accomplished by trial and error testing in 2001 and initially during the 2002-3 surveys (Yoder et al. 2006a). This was determined to be the most effective pulse setting based on visual observations of the comparative effectiveness in stunning all fish species. Lower settings (30, 60 Hz) were much less effective and are deemed unsuitable for Maine rivers. Care is taken to avoid injury and all processed fish were examined for visible signs of damage.

***Field Data Recording***

Detailed field data recording and sample processing procedures are described in the Maine project QAPP (MBI 2002), which is updated periodically. Captured fish are immediately placed in an aerated live well for processing. If necessary, fish are anesthetized to minimize trauma and handling stress. Trout and salmon are placed in separate aerated containers and processed first to minimize their holding time. Individual fish are identified to species, weighed to the nearest gram, and examined for external anomalies. Species that occur in large numbers are subsampled with a minimum of 15 individuals for large adults and 50 for smaller species and 1+ or 0+ life stages. Most species are distinguished as adults, 1+ (juveniles), or 0+ (young-of-year) in accordance with the criteria in Table 3 (Yoder et al. 2006a). The principal purposes of this differentiation were to increase the accuracy of extrapolations based on subsampling and for potential IBI guild classification. Species of recreational and/or commercial interest are also measured for total length to the nearest mm.

The majority of captured fish are identified to species in the field; however, any uncertainty about the field identification of individual fish requires the retention of voucher specimens for laboratory identification. Fish were preserved in a solution of borax buffered 10% formalin and labeled by date, river, and site designation. Identification is made to the species level in all cases and follows the nomenclature of the American Fisheries Society (Nelson et al. 2004). Immature and post-larval fish less than 15-20 mm in length were generally not included in the sample.

All fish that are weighed, whether done individually, in the aggregate, or as subsamples, were examined for the presence of gross external anomalies. An external anomaly is defined as the presence of a visible skin, extremity (fin, barbell, operculum), skeletal, or subcutaneous disfigurement, and is expressed as the weighted percentage of affected fish among all fish weighed. Light and heavy infestations are noted for certain types of anomalies and follow the guidance in Ohio EPA (1989) and Sanders et al. (1999).

Table 3. Criteria (weight, length, or other) used to determine adult (A), 1+ (juvenile; B), and 0+ (young-of-year; Y) designations for Maine river fish species for the primary purpose of assuring the accuracy of extrapolated total biomass based on subsamples and for IBI guild classification. Not all species were differentiated.

| Species | Adult | 1+[1] | 0+ |
|---|---|---|---|
| Sea lamprey *(Petromyzon marinus)* | fully developed[2] | -[2] | ammocoete |
| American eel *(Anguilla rostrata)* | >500 g | | <10 g |
| Blueback herring *(Alosa aestivalis)* | >100 g | | <10 g |
| Alewife *(Alosa pseudoharengus)* | >100 g | | <10 g |
| American shad *(Alosa sapidissima)* | >100 g | | <10 g |
| Lake chub *(Couesius plumbeus)* | >10 g | | <1 g |
| Common carp *(Cyprinus carpio)* | >1000 g | | <50 g |
| Common shiner *(Luxilis cornutus)* | >10 g | | <1 g |
| Golden shiner *(Notemigonus crysoleucas)* | >100 g | | <10 g |
| Spottail shiner *(Notropis hudsonius)* | >10 g | | <1 g |
| Eastern blacknose dace *(Rhinichthys atratulus)* | | not determined | |
| Longnose dace *(Rhinichthys cataractae)* | | not determined | |
| Creek chub *(Semotilus atromaculatus)* | | not determined | |
| Fallfish *(Semotilus corporalis)* | >50 g | | <3 g |
| Longnose sucker *(Catostomus catostomus)* | >1000 g | | <10 g |
| White sucker *(Catostomus commersonii)* | >1000 g | | <10 g |
| White catfish *(Ameirus catus)* | >100 g | | <10 g |
| Brown bullhead *(Ameirus nebulosus)* | >100 g | | <10 g |
| Northern pike *(Esox lucius)* | >500 g | | <10 g |
| Chain pickerel *(Esox niger)* | >80 g | | <10 g |
| Rainbow trout *(Oncorhynchus mykiss)* | >100 g | | <10 g |
| Atlantic salmon *(Salmo salar)* | >500 mm | | <10 g |
| Landlocked salmon *(Salmo salar sebago)* | >100 g | | <10 g |
| Brown trout *(Salmo trutta)* | >100 g | | <10 g |
| Brook trout *(Salvelinus fontinalis)* | >100 g | | <10 g |
| Burbot *(Lota lota)* | >100 g | | <10 g |
| Banded killifish *(Fundulus diaphanus)* | | not determined | |
| Mummichog *(Fundulus heteroclitus)* | | not determined | |
| Slimy sculpin *(Cottus cognatus)* | >20 g | | <2 g |
| White perch *(Morone americana)* | >100 | | <10 g |
| Striped bass *(Morone saxatilis)* | >500 mm | | <50 g |

1 Juvenile criteria are <adult, >y-o-y.

2 Parasitic habitats fully developed in adults; buccal funnel is fully developed in juveniles, but is not yet parasitic.

Table 3. (continued)

| Species | Adult | 1+ | 0+ |
|---|---|---|---|
| Rock bass *(Ambloplites rupestris)* | >80 g | | <10 g |
| Redbreast sunfish *(Lepomis auritus)* | >50 g | | <5 g |
| Pumpkinseed sunfish *(Lepomis gibbosus)* | >50 g | | <5 g |
| Smallmouth bass *(Micropterus dolomieui)* | >150 mm | | <10 g |
| Largemouth bass *(Micropterus salmoides)* | >150 mm | | <10 g |
| Black crappie *(Pomoxis nigromaculatus)* | >100 g | | <10 g |
| Yellow perch *(Perca flavescens)* | >50 g | | <5 g |

Physical measurements are also taken in the field during fish sampling and include the sample site distance, GPS coordinates, temperature (°C), dissolved oxygen (D.O.; mg/l), relative conductivity (μS/$cm^2$), and the Qualitative Habitat Evaluation Index (QHEI; Rankin 1989, 1995; Ohio EPA 2006) modified for application to Maine rivers.

Site distance was determined with a GPS unit. This was done by tracking the cumulative lineal distance as the sampling progressed in the prescribed downstream direction. Waypoints were established as necessary to account for the curvature of the shoreline and/or the sampling track that was followed within each site. Each river was designated with a unique alpha code (e.g., Presumpscot River = "PRESUM") and each site with a unique numeric descriptor (e.g., "PRESUM21"). The upstream end, or beginning of each site was designated "A" and subsequent waypoints were designated B, C, D, and so on. The downstream terminus of each zone was designated with a "Z".

***Crew Composition and Logistics***

A boat electrofishing crew consists of three persons - two netters and a boat driver. The netter's primary responsibility is to capture all fish sighted; the driver's responsibility is to maneuver the boat so as to provide the netters the best opportunities to capture and land stunned fish (the driver may assist in netting stunned fish that appear near the stern or behind the boat). The boat driver also operates the electrofishing unit. Each task requires skill and training, but boat maneuvering requires the most experience to gain adequate proficiency and ensure safe operation. The latter skill was particularly important in the faster flowing sections of the study area. In actual practice, the boat driver also functions as the crew leader that supervises all aspects of the data collection.

*Plate 6. Upper: Rough launching the 16'electrofishing boat in the Little Falls impoundment.*
*Lower: Recording data from an electrofishing sample.*

The netters are usually seasonal technicians with the physical ability to perform all crew member tasks. The netters are clad in chest waders and wear life jackets and rubber gloves; the driver is also clad in chest waders. Sampling sites are positioned at selected intervals along a contiguous river reach and sampling takes place along the shoreline(s) offering the most diverse macrohabitat features. In other areas of the U.S. this usually includes the gradual outside bends of large rivers (Gammon 1973, 1976), but this is not invariable. Maine's rivers presented many similarities and a few dissimilarities, the latter being manifest in faster current velocities including swift chutes, runs, and rapids and cover types (e.g., large boulders, log cribs, deep runs, bedrock ledges) away from the shoreline that required some adaptations of the existing methods.

A typical sampling day consists of launching the boat at an upstream access point, shuttling the truck and trailer to a downstream retrieval point, and returning to sample sites between the launch and retrieval points by navigating in a downstream direction. Normally, three 1.0 km sites can be sampled each day within river reaches of less than 10 to more than 15 miles in length. If continuous navigation of a river segment was limited or precluded by falls, dams, or other safety concerns, the boat was launched and retrieved from a single access site in proximity to the sampling site. In the Presumpscot River access was precluded mostly by navigational safety concerns, particularly in some of the smaller impoundments. Site location was seldom precluded by a lack of launch or retrieval access, although many locations required what is termed as "rough launching". A four wheel drive truck with the capacity to transport a three-person crew and the electrofishing boat is essential to this type of sampling. Sufficient traction and pulling power is needed to access remote or unimproved access sites.

***Habitat Assessment***

A qualitative evaluation of macrohabitat is made by the fish field crew leader after each location is sampled using the Qualitative Habitat Evaluation Index (QHEI; Rankin 1989, 1995). The QHEI is a physical habitat index designed to provide an empirical, qualitative evaluation of the lotic macrohabitat characteristics that are important to fish assemblages. It consists of a visual estimate of the quality, composition, amount, and extent of substrate, cover, channel, riparian, flow, pool/run/riffle, and gradient variables. It has been shown to correspond predictably with key attributes of fish assemblage quality (Rankin 1989, 1995) and as such is an important tool in the diagnosis of habitat related fish assemblage impairments. The QHEI was originally developed as a rapid assessment tool and in recognition of the constraints associated with the practicalities of conducting a large-scale monitoring program, i.e., the need for a rapid assessment tool that yields meaningful information and which takes advantage of the knowledge and insights of experienced field biologists who conduct the biological assessment. The QHEI has been used widely outside of Ohio and parallel habitat evaluation techniques are in widespread existence throughout the U.S. The QHEI incorporates the types and quality substrate, the types and amounts of instream cover, several characteristics of channel morphology, riparian zone extent and quality, bank stability and condition, and pool-run-riffle quality and characteristics. Slope or gradient is also factored into the QHEI score. We followed the guidance and scoring procedures outlined in Ohio EPA (1989, 2006) and Rankin (1989) with some modifications made during 2002 and 2003 (Yoder et al. 2006a). These modifications include the addition of large boulder and granitic origin to the substrate metric and impoundment to the channel morphology and pool/run/riffle metrics. This data is entered, stored, and analyzed in the Maine ECOS data management system used by MBI.

Elevated flow conditions can adversely affect electrofishing efficiency, particularly if they result in abnormally turbid conditions. High flows can also temporarily affect fish distribution by displacing them away from their typical habitats. Our protocol requires that sampling be conducted under "normal, summer-fall low flow conditions." Knowing what this is requires local knowledge and a familiarity with flow gage readings and conditions. Generally, these conditions coincide with low flow durations of approximately 80% or greater, i.e., flows that are exceeded 80% of the time for the period of record. These statistics are available for Maine rivers from the U.S. Geological Survey at: http://waterdata.usgs.gov/me/nwis/rt. The key is to avoid sampling during conditions that deter and reduce sampling efficiency. In such cases sampling should be delayed until flow and water conditions return to "normal" conditions.

## Sampling and Survey Design

Mainstem rivers are treated as linear assessment units in order to understand how changes take place along a longitudinal continuum with respect to both natural and anthropogenic influences. Important in the delineation of these assessment units are natural features and transitional boundaries (e.g., thermal, ecological, and geological boundaries) and clusters of anthropogenic sources (e.g., major urban/industrial areas, impoundments, discharges, etc.). Study areas can include up to 150-200 km long river reaches in order to capture all relevant influences, include zones of impact and recovery thus exposing pollution gradients, and to provide context for interpreting results within a localized reach or at a given location. This design yields a detailed assessment of status, the extent and severity of indicator responses in a particular series of river reaches, and temporal changes both within season and between years. This produces assessments of the severity (departure from the desired state) and extent (lineal extent of the departures) of biological impairments in a river (Yoder et al. 2005).

We followed a combination of the preceding designs, which are similar in many respects in that the goal of each is to produce a dataset capable of providing information for multiple environmental and natural resource management purposes (Figure 1). We targeted the largest volume point sources directly and bracketed major aggregations of point sources, urban areas, and changes in habitat of both natural and man-made origin. This is done irrespective of actual site quality, but includes the range of conditions from minimally impacted background (usually upstream) through the gradient of impacts and conditions that reflect the severity of impacts in a particular study area. In the Presumpscot mainstem this resulted in sampling sites that generally occurred within 1-2 miles of each other. As such, we sampled 18 mainstem sites (1.0 km each) in 27 miles of the Presumpscot River study area in 2006 and 7 sites in 8 miles of the lower mainstem in 2007. The lower sections of 3 tributaries were also sampled in 2006.

### Data Management and Analysis

Data were analyzed using routines available in the Maine ECOS data management system that was adapted for use by MBI in the Maine Rivers project. Maine ECOS produces standardized data reports on fish species relative abundance and condition that includes assemblage attributes such as numbers, biomass, functional and tolerance guilds, condition metrics, and compositional expressions. Recently the interim Maine Rivers IBI was added along with the Modified Index of Well-Being (MIwb). These outputs can also be exported as Excel files. Relative abundance data is reported as numbers and biomass per kilometer.

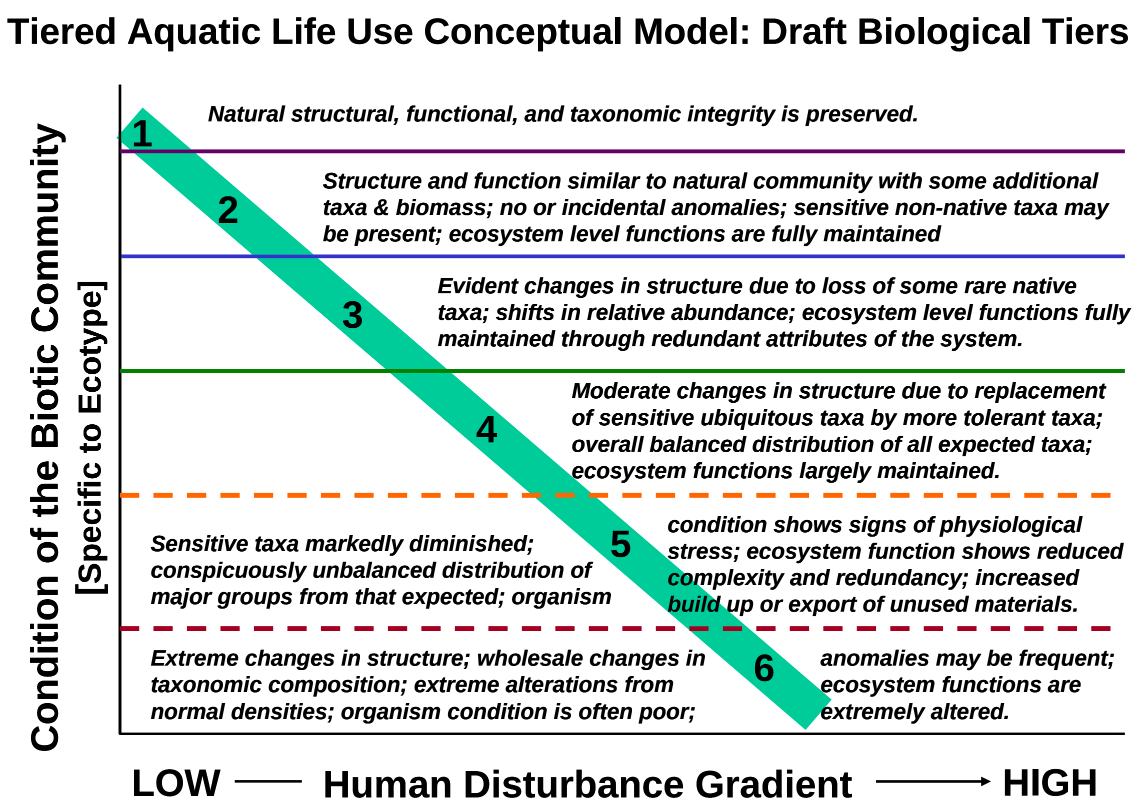


*Figure 4. The Biological Condition Gradient (BCG) conceptual model and descriptive attributes of tiers along a gradient of quality and increasing disturbance (Davies and Jackson 2006).*

***Expected Fish Assemblages along the Biological Condition Gradient (BCG)***

Developing an understanding of the native fish assemblages that historically occurred in Maine's non-wadeable rivers is critical to determining the current status of the fish assemblages and their potential for restoration. We used the Biological Condition

Gradient (BCG) concept developed by U.S. EPA (2005; Figure 4) and as detailed by Davies and Jackson (2006) for this task. This process required us to characterize the "as naturally occurs" assemblage as the ultimate potential for quality and restoration. While restoring all rivers to such a condition may be impractical given the economically dependent activities and ingrained species introductions that have substantially altered the Maine fish fauna, it is important to at least qualitatively visualize this penultimate condition. It serves as an essential anchor for the "upper end" of the BCG. We accomplished this by visualizing the "as naturally occurs" fish fauna that was likely encountered by the first European settlers coupled with our knowledge of how such assemblages were most likely organized based on current knowledge of species autecology and distribution. The latter was partly derived from analyses of the statewide database (Yoder et al. 2006b, 2008).

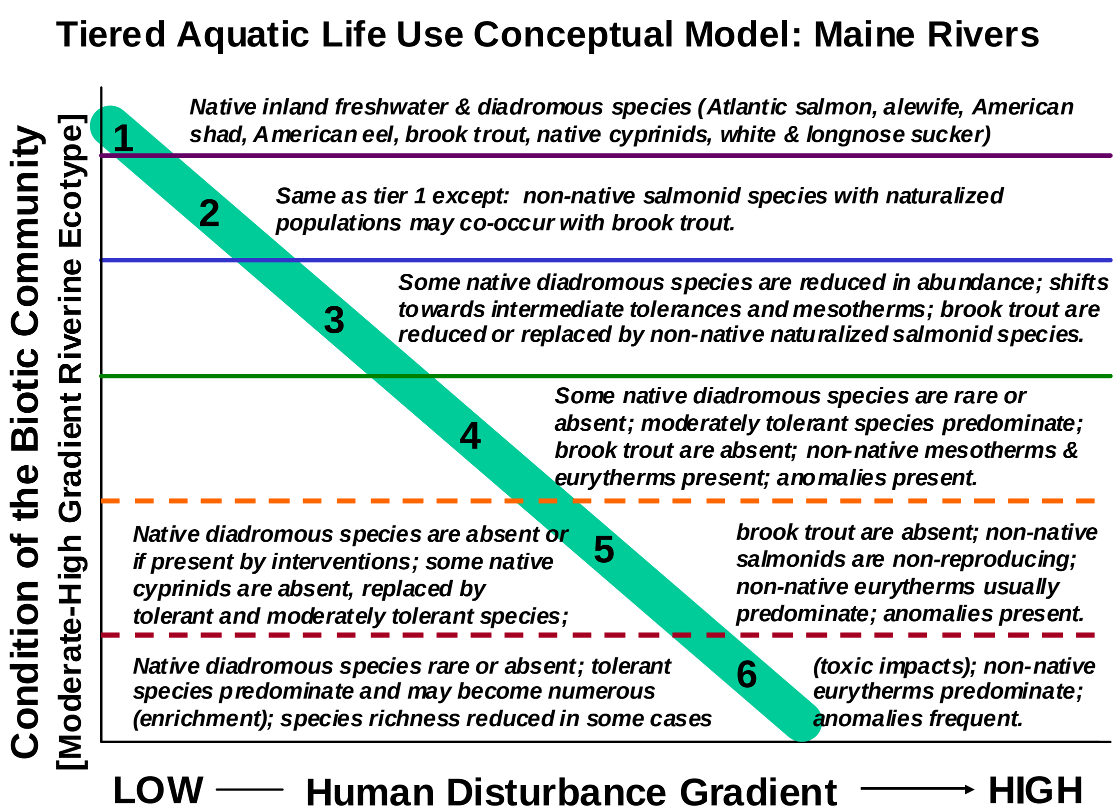


*Figure 5. The Biological Condition Gradient (BCG) model for the moderate-high gradient riverine ecotype in Maine (Yoder et al. 2006b, 2008).*

This process permits the visualization about how the "as naturally occurs" fish fauna likely changes as the effect of large scale human disturbances such as land uses (forestry, agriculture, urbanization), water pollution (point source discharges, nonpoint source runoff), habitat modification (dams/impoundments, riparian encroachment, channel modification), hydrologic alterations (flow diversions, withdrawals), changes to energy processing (nutrient enrichment, climatic changes), and biotic changes (introductions of non-native species) increased in magnitude and scope through space and time. Each of these stressor categories illustrates the fundamental concept of Karr's five factors that determine the integrity of a water resource (Karr et al. 1986). Many of these impacts are well documented in Maine's rivers and the biological consequences as currently reported in terms of the macroinvertebrate assemblage (Davies et al. 1999), using Maine DEP's standardized methods and biological criteria (Davies and Tsomides 1997), key species of management interest (Warner 2005; Saunders et al. 2006), environmental tolerance and guilds (Halliwell et al. 1999), and native status (Halliwell 2005). The BCG is a conceptual model that describes how ecological attributes change in response to increasing levels of the *effect* of stressors (Davies and Jackson 2006; Figure 4). It is portrayed as a "gradient of condition" with descriptions about how key assemblage attributes and properties are expected to change with increasing stress in a succession of six tiers from "as naturally occurs" to "severely degraded". Ten attributes that include characteristics of taxa representation, proportion, membership, condition, along with two functional categories are included for each of the six BCG tiers. This template can be used to develop a model for aquatic assemblages that are representative of a specific region or aquatic ecotype. This provides an organized starting point for assuring that specific quantitative measures (e.g., IBI) are conceptually sound and consistent with our best understanding of how aquatic ecosystems respond to stress. It also promotes the incremental measurement and characterization of biological assemblage data beyond comparatively simple and less detailed "pass/fail" thresholds. It also enables the development of tiered expectations for specific water bodies. U.S. EPA (2005) described this as tiered aquatic life uses (TALU), a concept that is emulated by Maine DEP's codified and quantitative biological criteria for macroinvertebrates (Davies et al. 1997).

In developing a BCG model for Maine's non-wadeable fish assemblages Yoder et al. (2006b, 2008) accessed general information about the riverine fish assemblages relying on historical information and expert judgment in the process. Some of this was accomplished via an ad hoc project advisory group comprised of U.S. EPA, U.S. F&WS, NOAA, the applicable Maine state agencies (DEP, IF&W, DMR), and other interested groups (Trout Unlimited, Penobscot Indian Nation). One important outcome of these discussions was the conclusion that the "as naturally occurs" fish assemblage in the moderate-high gradient riverine ecotype was largely comprised of native cold water species. The comparatively simple BCG for Maine's non-wadeable moderate-high gradient rivers was the result (Figure 5; Yoder et al. 2006b, 2008). This reflects a comparatively simple, qualitative method of visualizing what has happened in many instances to the "as naturally occurs" fish assemblage for this riverine ecotype in Maine through time. The current departures from tier 1 attributes and characteristics are the result of multiple modifications to water quality, habitat, flow regime, and the native fauna via the introduction of alien species. This was initially used by Yoder et al. (2008) to generally vet the efficacy of the interim Maine Rivers IBI.

***Index of Biotic Integrity (IBI)***

The interim Maine Rivers IBI consists of 12 metrics that were selected based on the consideration of the metric responsiveness to a reference based gradient analysis and

Table 4. Interim Maine non-wadeable rivers IBI metrics with calibrated scoring equations and manual scoring adjustment criteria. Proportional (%) metrics are based on numbers unless indicated otherwise (after Yoder et al. 2008).

| **Metric** | **Scoring Equation** | **Scoring Adjustments** | |
|---|---|---|---|
| | | **Score = 0** | **Score = 10** |
| Native Species Richness | 10 * (-0.2462 + (0.0828*numspec2))) | <3 sp. | ≥15 sp. |
| Native Cyprinid Species (excluding fallfish) | (10 * (0.4457 + (0.0109*allcyp_ff) - (0.00005629 * (allcyp_ff$^{2}$)))) | Eq[4] | Eq |
| Adult white & longnose sucker abundance (biomass) | (10 * (0.3667 + (0.008*ws_lns_pb) - (0.000023592 * (ws_lns_pb$^{2}$)))) | 0 | ≥128 kg/km |
| %Native Salmonids | (10 * (0.9537 + (0.00000000039*nat_salm) - (0.000078892 * (nat_salm$^{2}$)))) | 0 | ≥20% |
| %Benthic Insectivores | 10 * (0.010966*benth_pc_n) | 0 | ≥91.2% |
| %Blackbasses | 10 - (10 * (-0.09684 + (0.5638*log10(blackbass)))) | Eq | 0 |
| %Fluvial Specialist/ Dependent | (10 * (0.2775 + (0.0073*fluv_pc_n))) | 0% | Eq |
| %Macrohabitat Generalists | 10 - (10 * (0.1017 + (0.0096*macro_gen))) | >90% | Eq |
| Temperate Stenothermic Species | (10 * (0.7154 + (0.4047*(log10(steno))))) | 0 sp. | >5 sp. |
| Non-guarding Lithophilic Species | (10 * (0.2979 + (0.8975*log10(lith_ng)))) | <1 | >10 |
| Alien Species | 10 - (10 * (0.1063 + (0.3271*Alien_sp) - (0.029*(Alien_sp$^{2}$)))) | ≥5 | 0 |
| %DELT Anomalies | 10 - (10 * (0.8965 + (0.1074*log10(delta))) | Eq | 0 |

[4] No scoring adjustments are necessary; scoring determined by equation (Eq) across entire metric scoring range of 0-10.

ecological role fulfillment and relevance (Yoder et al. 2008). The metrics and their resulting scoring equations and other necessary adjustments appear in Table 4. The Maine ECOS programming produces a report that includes the individual metrics values and scores and the aggregate interim IBI score by sampling location (Appendix A).

***Modified Index of Well-Being (MIwb)***

Gammon (1976) and Gammon et al. (1981) originally developed and tested the Index of Well-Being (Iwb) as a multiparameter evaluation of large river fish assemblages. The Iwb is based on four measures of diversity, abundance, and biomass and represents an attempt to produce an integrated evaluation of these baseline assemblage attributes. The individual performance of numbers, biomass, and the Shannon index as consistent indicators of the quality of fish communities has historically been disappointing. However, when combined in the Iwb these individual community attributes respond in a more complimentary and intuitively predictable manner. For example, an increase in total numbers and/or biomass caused by one or two predominant species is usually offset by a corresponding decline in the Shannon index. In addition, the $\log_e$ transformation of the numbers and biomass components acts to reduce much of the variability inherent to these parameters alone. Gammon (1976) found the variability of each of the four Iwb components as measured by a coefficient of variation to range from 20-50%, yet the composite variability reflected by the Iwb was only 7%. High numbers and/or biomass are commonly, and at times inaccurately, perceived as a positive attribute of a fish assemblage. High numbers and biomass result in a high Iwb score only if a relative "evenness" is maintained between the abundance of the common species. However, this is not invariable, especially with environmental perturbations which tend to restructure fish assemblages without corresponding decreases in diversity (e.g., nutrient enrichment, habitat modification). Fish assemblages in habitat modified rivers can frequently exhibit very high numbers, biomass, and moderate species richness. Such assemblages are usually predominated by tolerant and intermediate species. Species intolerant of such disturbances either decline in abundance or are eliminated altogether.

A modification of the original Iwb was developed by Ohio EPA (1987) and further explained by Yoder and Smith (1999). The modified Iwb retains the same computational formula as the original Iwb, but eliminates species designated as highly tolerant , aliens, and hybrids from the numbers and biomass metrics; these species are retained in the Shannon index calculations. This modification eliminates the "undesired" effect caused by a high abundance of tolerant or alien species, but retains their "desired" influence in the Shannon indices. The computational formula used is as follows:

Modified Index of Well-Being (MIwb) = $0.5 \ln N + 0.5 \ln B + H(\text{no.}) + H(\text{wt.})$;
where:

N = CPUE; relative numbers minus species designated highly tolerant (Ohio EPA 1987);
B = CPUE; relative biomass minus species designated highly tolerant (Ohio EPA 1987);
H (no.) = Shannon diversity index based on numbers (version which uses $\log_e$);
H (wt.) = Shannon diversity index based on numbers (version which uses $\log_e$).

We used the MIwb to primarily assess the assemblage level properties of the 2006 results.

## CHEMICAL/PHYSICAL WATER QUALITY

Limited chemical/physical water quality data consisted of grab measurements of dissolved oxygen (D.O., mg/l), temperature (°C), and relative conductivity (µS/cm$^2$) all collected during daylight hours. The data were plotted in a longitudinal display and as box-and-whisker plots comparing riverine to impounded sites (Figure 6).

### *Dissolved Oxygen (D.O.)*

Daytime D.O. values ranged from 8-10 mg/l being higher in September than August. No obvious patterns were evident in either the longitudinal mainstem plot or the comparison of impounded and riverine sites (Figure 6). While our results do not point to any serious D.O. problems in 2006, the prior failure to meet Maine Class C dissolved oxygen (D.O.) saturation criteria in the lower 2 miles of the mainstem (60% saturation) led to the development of a TMDL (total maximum daily load) for biochemical oxygen demand (BOD) and total suspended solids in 1998 (PRPSC 2002). The TMDL set limits on the BOD load discharged by the former S.D. Warren -Westbrook Mill. The BOD in the mill effluent has been considerably reduced with the elimination of the pulping operation.

### *Temperature (°C)*

August 2006 temperatures generally ranged from 22-24.5°C with a slight increasing trend downstream (Figure 6). Impoundment sites temperature were only slightly higher than riverine sites temperature during August 2006. September temperatures, as expected were lower, generally ranging from 15-18°C. It is likely that the modification of flows and the impoundment of more than 50% of the mainstem have increased temperatures above natural.

### *Relative Conductivity (µS/cm$^2$)*

Relative conductivity in August 2006 increased in a downstream direction ranging from the high 40s in the upper mainstem, through the 50s in the middle mainstem, and increasing above 60 downstream from the Cumberland Mills dam and SAPPI discharge (Figure 6). September 2006 values were somewhat higher ranging from 60-75 downstream from Sacarappa Falls. The highest value of 1055 occurred below Presumpscot Falls and reflected the influence of brackish water during and incoming tide. Values were somewhat higher in riverine compared to impounded sites and were likely a reflection of the occurrence of riverine sites downstream of the major point sources in the study area. Conductivity values were no doubt higher when point sources were less well controlled. During June – September 1996, the specific conductance of the river water at the Presumpscot Falls USGS monitoring site ranged from 68 to 233 µS/cm$^2$ @ 25°C (PRPSC 2002). This predated the remaining pollution controls and discharger cessations that took place afterwards.

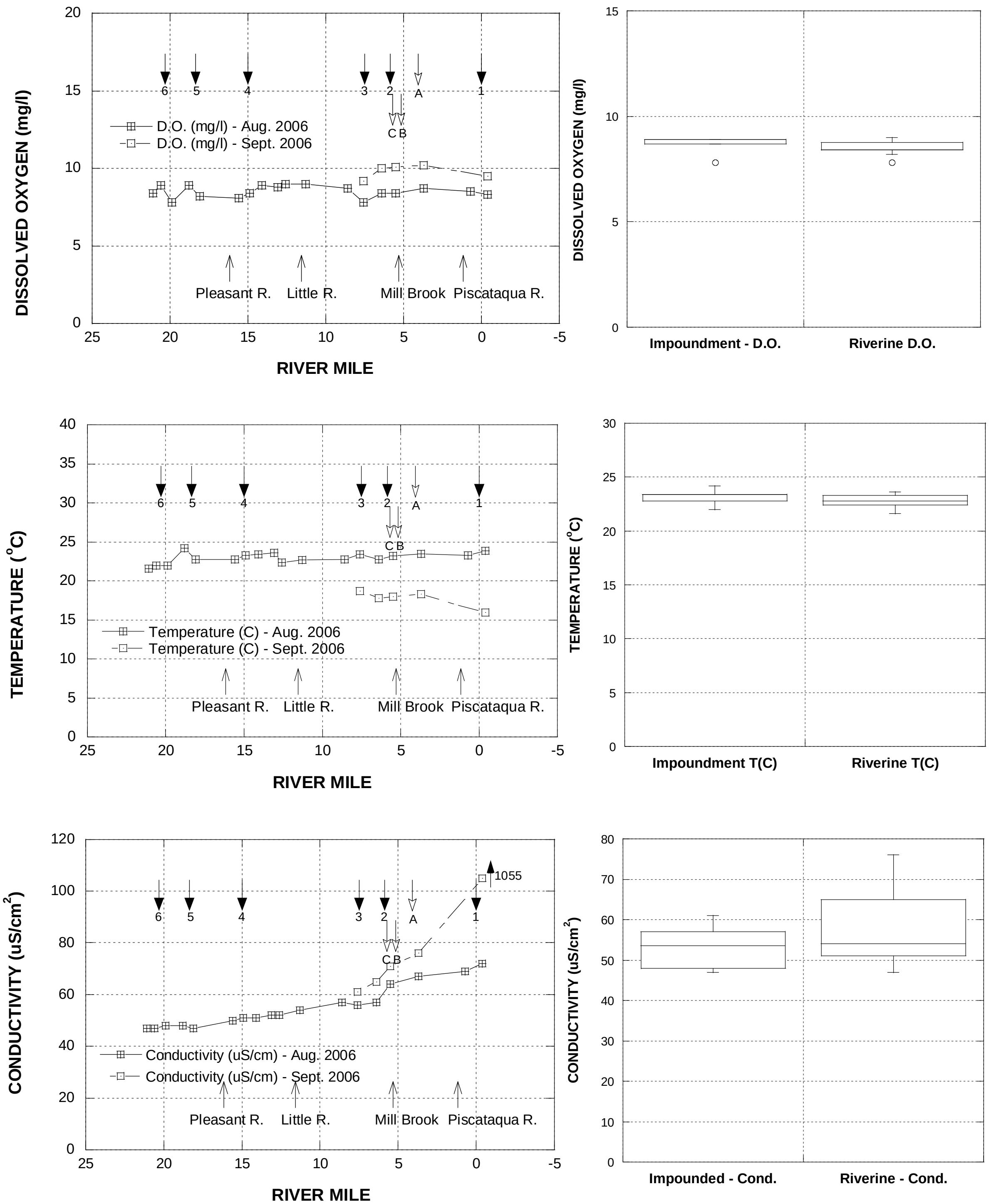


*Figure 6. Grab measurements of dissolved oxygen (D.O., mg/l) (upper), temperature (°C) (middle), and relative conductivity ($\mu S/cm^2$) taken in August-September 2006 in the Presumpscot River mainstem. Results are plotted by river mile (left column) and between impounded and riverine mainstem sites in August 2006.*

# HABITAT ASSESSMENT

Habitat was assessed at each electrofishing site using the Qualitative Habitat Evaluation Index (QHEI; Rankin 1989, 1995) as modified for application to large, non-wadeable rivers. Each electrofishing site was assessed to ascertain the diversity and quality of the available aquatic habitat during and immediately after the collection of fish assemblage data. We modified the QHEI for application to large, non-wadeable rivers as part of the exploratory sampling and the ensuing surveys of the Kennebec River in 2002, Androscoggin River in 2003, and used it in subsequent surveys of other Maine rivers through 2007 (MBI 2002). The QHEI is a visual-based physical habitat index designed to provide an empirical, qualitative evaluation of the lotic macrohabitat characteristics that are important to fish assemblages and other aquatic macrofauna. It is generally correlated with fish assemblage measures of biotic integrity and other assemblage properties including species of management interest (Rankin 1989, 1995). It was developed as a rapid assessment tool and in recognition of the constraints associated with the practicalities of conducting a large-scale monitoring program, i.e., the need for a rapid assessment tool that yields meaningful information and which takes advantage of the knowledge and insights of experienced field biologists who are conducting he affiliated biological assessments. It has been used widely in the Midwest and similarly designed habitat evaluation techniques are in widespread use throughout the U.S. The QHEI incorporates the types and quality of substrate, the types and amounts of instream cover, channel morphology characteristics, riparian zone extent and quality, bank stability and condition, and pool-run-riffle quality and characteristics. Slope or gradient is also factored into the QHEI. A practical scoring range of 20 to 100 is produced as an index of habitat quality. We followed the guidance and scoring procedures outlined in Ohio EPA (1989, 2006) and Rankin (1989) with appropriate modifications made during the initial Maine river surveys in 2002 and 2003. A QHEI users guide is available in the Quality Assurance Project Plan (QAPP; MBI 2002).

A QHEI habitat assessment form was completed for each fish sampling site in the study area. These observations were made at the time of the electrofishing sample by the crew leader with assistance from crew members. The final QHEI data sheet is completed by the crew leader at the conclusion of each site. The data from the QHEI assessment is entered into the Maine ECOS database.

### *QHEI Matrix*

Two standard habitat reports are produced in Maine ECOS. One report provides a summary of the QHEI and component metric scores by sampling location (Appendix C). The second report produces a matrix of “good” and “modified” habitat attributes derived from the QHEI data collection. Rankin (1989) determined sets of specific QHEI attributes that were positively and negatively correlated with a calibrated fish Index of Biotic Integrity (IBI) in Ohio. These attributes include specific components of habitat such as aggregations of substrate types, substrate condition, extent of cover, current types, channel morphology, etc. Attributes that were positively correlated with high IBI scores are termed “good” attributes and those that were negatively correlated with the IBI are termed “modified” attributes. The resulting number and ratio of modified:good attributes is then used to diagnose habitat related biological impairments and to determine if the existing habitat is a potentially limiting factor (Rankin 1995).

We modified this approach for application to Maine rivers by extracting what we estimated were the most relevant attributes of the Maine rivers QHEI classifying each as "good" (i.e., corresponds to high quality riverine fish assemblage attributes) and "modified" (i.e., correspond to modified or degraded fish assemblage attributes). Included in the modifications for application to Maine rivers was the addition of a large boulder substrate type, adding impoundment as a channel morphology attribute, and including its effect in the flow and riffle/run habitat categories. We are treating run-of-river impoundments as an unnatural modification of riverine habitat based on prior experiences with this type of habitat modification on riverine fish assemblages elsewhere (Lyons et al. 2001; Yoder et al. 2005). Hence, free-flowing riverine habitats are considered the natural, baseline condition for the habitat of Maine's rivers. This is apart from how impoundments may eventually be treated within a tiered use classification scheme, which would only be possible following a more thorough assessment of the fish assemblage data using the recently developed IBI (Yoder et al. 2008).

The QHEI matrix developed for Maine rivers presents specific attributes that are extracted from the QHEI database and which correspond to the maintenance of good quality riverine fish assemblages (good attributes) and degraded fish assemblages (modified attributes). For our analyses, 10 good attributes and 13 modified attributes are included in the QHEI matrix. The presence of each attribute at a site is indicated by a symbol in the resulting QHEI matrix. In addition, the QHEI site score, the local gradient, the total number of good and modified attributes, and the ratio of modified:good attributes is also provided. Good attributes are those that have been shown to be positively correlated with good quality fish assemblages, i.e., those that correspond to a least impacted reference assemblage; modified attributes are those that are associated with fish assemblages that depart to varying degrees from a reference assemblage and are hence considered to be degraded. The modified:good attributes ratio has been useful in determining the likelihood of a particular site being able to meet biologically-based attainment goals based on habitat as a key controlling factor (Rankin 1995). The empirical relationships between the ratio of habitat attributes and fish assemblage quality were initially established based on stream and river fish assemblage assessments in Ohio (Rankin 1989, 1995). Since we have not yet determined these same relationships for Maine River fish assemblages, we used best professional judgment, the field observations made during the 2002-7 statewide surveys, and initial exploratory analyses (Yoder et al. 2006 a,b) to determine what are good and modified attributes. The QHEI results are portrayed in this study as the QHEI score by river mile, by river habitat segment (riverine, impounded, tidal), and the QHEI matrix.

***Presumpscot River QHEIs***

We plotted modified QHEI scores by sampling site on a longitudinal basis for the purpose of visualizing overall habitat quality in relation to dams and other physical features along the Presumpscot River mainstem. We also extracted a QHEI matrix that shows the

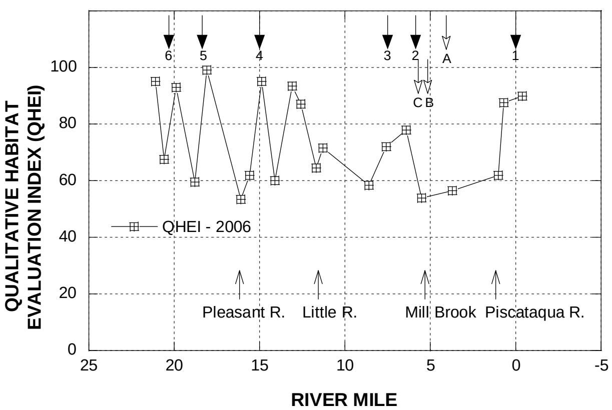


*Figure 7. QHEI scores determined at electro-fishing locations in the Presumpscot River mainstem, 2006. Letters and numbers denote dams and major point sources (see study area description Table 2).*

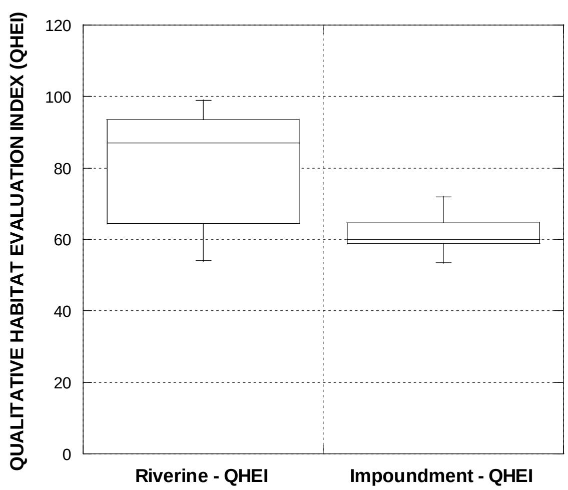


*Figure 8. Box-and-whisker plots of QHEI scores at impounded and riverine sites in the Presumpscot River mainstem, 2006.*

occurrence and ratio of "good" and "modified" attributes in addition to the overall QHEI score by sampling site in an upstream to downstream format (Table 5). Finally, box-and-whisker plots comparing freshwater riverine, impounded, and tidal influenced sites were constructed for each of the major study areas. We also concentrated this analysis on the 2006 data as it represents the most complete set of data and it was accomplished within the seasonal index period established by the project QAPP (MBI 2002).

The Presumpscot River mainstem between the Eel Weir Dam and Casco Bay offered a gradient of habitat quality as determined by QHEI scores and attributes (Figure 7). Moderate-high gradient riverine habitats exhibited the highest scores (generally >80-90). Impounded habitats reflected the diminishment or outright loss of riverine habitat attributes scoring in the 60-70 range. Two riverine sites downstream from Cumberland Mills Dam scored <60 and reflected a comparatively low gradient and perhaps prior modifications of the river channel. This portion of the mainstem flows through a formation of marine clays and is of a different characteristic than the more frequently occurring moderate-high gradient habitats in the upper mainstem. There was a downward trend in QHEI scores in a downstream direction from the confluence of the Little River in the Sacarappa impoundment. These recovered briefly in the vicinity of Sacarappa Falls and Cumberland Mills Dam, and then declined in the segment below Cumberland Mills Dam. QHEI values recovered to upstream values above and below Presumpscot Falls. Riverine QHEIs were generally higher than impounded sites (Figure 8) with a median value of 87. In contrast impounded sites had a median of 60. There was an extended lower range of QHEI values in the aggregation of riverine sites that reflects the inclusion of the lower gradient sites below Cumberland Mills Dam and the Piscataqua and Little Rivers.

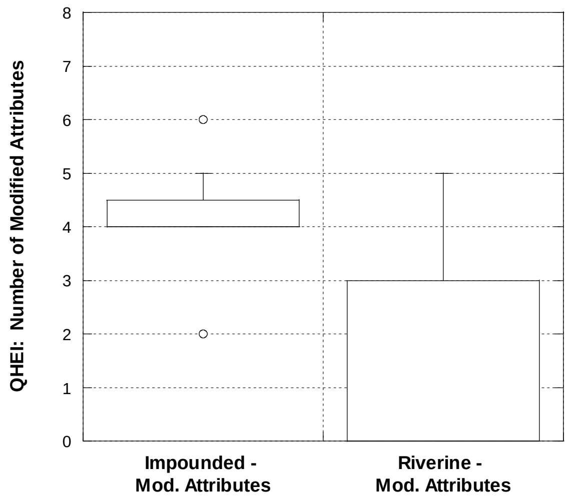


*Figure 9. Box-and-whisker plots of the number of modified QHEI attributes at impounded and riverine sites in the Presumpscot River mainstem, 2006.*

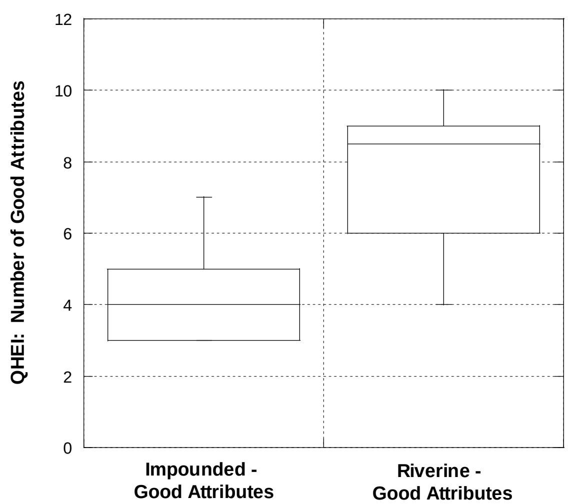


*Figure 10. Box-and-whisker plots of the number of good QHEI attributes at impounded and riverine sites in the Presumpscot River mainstem, 2006.*

### *QHEI Matrix Analysis*

The QHEI matrix showing the number and importance of good and modified habitat attributes demonstrates the impact of impoundment on the naturally occurring riverine habitat (Table 5). The accumulation of modified attributes coupled with the loss of good attributes is a signature of this type of habitat modification. Especially affected are the QHEI attributes associated with the extent of overall modification, overall habitat development, and flow diversity. Modified attributes that are associated with impoundment included fair-poor overall habitat development, slow or no current velocity, and an absence of riffle/run habitats. While these changes were evident in the mainstem, the impacts were not as severe as those observed in other impounded Maine rivers. The ratio of modified:good attributes at the impounded sites generally ranged from 0.8-1.5, well below the ratios of >1.5-2.0 that have been observed in other impounded rivers in Maine. Nevertheless, the comparison to free-flowing riverine sites indicates a marked loss of habitat diversity and quality due to impoundment in the mainstem. Impounded sites exhibited higher modified and lower good attributes than riverine sites (Figures 9 and 10). Impounded sites had a median of 4 modified attributes and 4 good attributes. This compares to riverine sites having a median of 0 modified attributes and 8.5 good attributes. One riverine site, the Piscataqua River, had a total of 5 modified attributes of which 3 were related to excessive siltation and substrate embeddedness. The low gradient sites downstream from Cumberland Mills Dam (RM 5.5 and 3.7) each had 3 modified attributes. The relatively low QHEI scores of 54 and 56.5 were due more to a lack of good attributes as opposed to an accumulation of modified attributes.

**Table 5. QHEI matrix showing good and modified attributes at fish sampling locations in the Presumpscot River study area, 2006.**

Key QHEI Components

| River Mile | QHEI | Gradient (ft/mile) | Good Attributes: No Channelization/Recovered | Boulder, Cobble, Gravel Substrates | Silt Free Substrates | Good/Excellent Development | Five or More Substrate Types | Extensive-Moderate Cover | Fast Current/Eddies | Low-Normal Overall Embeddedness | Max Depth > 1 m | Low-Normal Riffle/Run Embeddedness | Good Habitat Attributes | Modified Attributes: Impounded | Channelized or No Recovery | Silt/Muck Substrates | Sparse or No Cover | Max Depth < 70 cm | Recovering Channel | High/Moderate Silt Cover | Fair-Poor Development | Only 1-2 Cover Types | Slow or No Flow | High-Mod Overall Embeddedness | High-Mod Riffle-Run Embeddedness | No Riffle/Run | Total Modified Attributes | Modified: Good Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (20-001) Presumpscot River | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 2006 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 21.1 | 87.0 | 0.00 | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | 9 | | | | | | | | | | | | | | 0 | 0.00 |
| 20.6 | 58.5 | 0.00 | | ■ | | | ■ | ■ | | ■ | ■ | | 5 | ◆ | | | | | | ■ | ■ | | | | | ■ | 4 | 0.80 |
| 19.9 | 87.0 | 0.00 | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | | 8 | | | | | | | | | | | | | | 0 | 0.00 |
| 19.1 | 52.5 | 0.00 | | ■ | | | | ■ | | ■ | ■ | | 4 | ◆ | | ◆ | | | | | ■ | | | | | ■ | 3 | 0.75 |
| 18.8 | 54.0 | 0.00 | | ■ | | | ■ | ■ | | | ■ | | 3 | ◆ | | ◆ | | | | ■ | ■ | | ■ | ■ | | ■ | 6 | 1.50 |
| 18.1 | 90.0 | 0.00 | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | 9 | | | | | | | | | | | | | | 0 | 0.00 |
| 15.0 | 55.0 | 0.00 | | ■ | | | ■ | ■ | | ■ | ■ | | 4 | ◆ | | ◆ | | | | | ■ | | ■ | | | ■ | 4 | 0.80 |
| 14.9 | 88.0 | 0.00 | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | 9 | | | | | | | | | | | | | | 0 | 0.00 |
| 12.6 | 81.5 | 0.00 | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | 9 | | | | | | | | | | | | | | 0 | 0.00 |
| 8.6 | 53.0 | 0.00 | | ■ | | | | ■ | | ■ | ■ | | 5 | ◆ | | | | | | | ■ | | ■ | | | ■ | 4 | 1.00 |
| 7.6 | 66.0 | 0.00 | | ■ | | | ■ | ■ | ■ | ■ | ■ | ■ | 7 | ◆ | | | | | | | ■ | | | | | | 2 | 0.29 |
| 6.3 | 74.0 | 0.00 | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | 9 | | | | | | | ■ | | | | | | | 1 | 0.11 |
| 5.5 | 52.0 | 0.00 | ■ | | | | | ■ | | ■ | ■ | | 5 | | | | | | | ■ | ■ | | | | | ■ | 3 | 0.75 |
| 3.7 | 41.5 | 0.00 | | | | | | ■ | | ■ | ■ | | 3 | | | | | | | ■ | | | | | | ■ | 2 | 0.67 |
| 2.4 | 86.5 | 0.00 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | 10 | | | | | | | | | | | | | | 0 | 0.00 |
| 1.3 | 63.5 | 0.00 | ■ | ■ | | | ■ | ■ | | ■ | ■ | | 6 | | | | | | | | ■ | | | | | ■ | 2 | 0.33 |
| 0.7 | 79.0 | 0.00 | ■ | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | 8 | | | | | | | | | | | | | | 0 | 0.00 |
| (20-100) Piscataqua River | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 2006 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.0 | 44.5 | 0.00 | ■ | | | | ■ | ■ | | | | | 4 | | | | | | | ■ | ■ | | ■ | ■ | | ■ | 5 | 1.67 |
| (20-200) Pleasant River | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 2006 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.0 | 44.5 | 0.00 | | | | | ■ | ■ | | ■ | ■ | | 3 | ◆ | ◆ | ◆ | | | | | ■ | | ■ | | | ■ | 5 | 1.25 |
| (20-300) Little River | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 2006 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.0 | 59.5 | 0.00 | ■ | | | ■ | ■ | ■ | | ■ | ■ | | 6 | | ◆ | ◆ | | | | | ■ | | ■ | | | ■ | 4 | 0.67 |
| (21-001) Presumpscot R. - dst. Falls | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 2006 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.3 | 84.0 | 0.00 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | 10 | | | | | | | | | | | | | | 0 | 0.00 |

## SPECIES ACCOUNTS

A total of 28 fish species were collected from the Presumpscot River mainstem and 3 tributaries during August-September 2006 and May-June 2007 (see Appendix A for data summaries by river, year, and sampling location). Of these, 23 are considered to be native and the remaining 5 species are introduced (following the definitions of Halliwell 2005). Of the latter, four species are purposely managed and the other is present due to previous unintentional introductions. Overall, American eel *(Anguilla rostrata),* common shiner *(Luxilis cornutus),* smallmouth bass *(Micropterus dolomieui),* and white sucker *(Catostomus commersonii)* were the numerically most abundant species comprising 67.1% of the total numbers in 2006. These were followed numerically by pumpkinseed sunfish *(Lepomis gibbosus),* yellow perch *(Perca flavescens),* fallfish *(Semotilus corporalis),* largemouth bass *(Micropterus salmoides),* alewife *(Alosa pseudoharengus),* golden shiner *(Notemigonus crysoleucas),* and striped bass *(Morone saxatilis).* American eel, white sucker, and striped bass predominated in terms of biomass. Our method produced a median of 7 (range 4-13) species collected at the mainstem sampling sites with an average relative abundance of 199 individuals/km and a biomass of 18.8 kg/km in 2006. The tributaries produced an average of 12.7 (range 11-14) species and an average relative abundance of 523 individuals/km and a biomass of 16.3 kg/km in 2006. Two species, ninespine stickleback *(Pungitius pungitius)* and brook trout *(Salvelinus fontinalis)* were unique to the tributaries, the former occurring in both the Piscataqua River and Little River, and the latter as a single individual in the Little River.

Our accounting of fish species in the study area is the product of single-gear sampling and is thus subject to the biases of the methodology. However, the majority of species that have either been previously recorded or were expected to occur were included in the collections. The occurrence and current status of each of the 28 fish species are described as follows (by major family and species order per Hartel et al. 2002).

### **Family Acipenseridae** (Sturgeons)

Sturgeons are represented in the Gulf of Maine by two species, Atlantic sturgeon *(Acipenser oxyrinchus)* and shortnose sturgeon *(Acipenser breviceps).* These anadromous species were formerly more abundant in the coastal rivers of Maine and they have been negatively affected by dams and other hydromodifications that have precluded or deterred upstream movement, perhaps more so than other anadromous species. The shortnose sturgeon is presently listed as endangered under the Endangered Species Act. It is likely that both species of sturgeon used the Presumpscot River for spawning prior to the hydromodifications and pollution that occurred with 16$^{th}$ century European settlement of the watershed including dam construction and the unregulated discharge of pollutants. These runs were likely small compared to those that took place in the larger Gulf of Maine tributaries such as the Merrimac, Androscoggin, Kennebec, and Penobscot Rivers.

***Atlantic sturgeon*** *(Acipenser oxyrinchus)*
A singe Atlantic sturgeon was collected in August 2006 at the site immediately downstream from Presumpscot Falls. This single specimen weighed 2.7 kg.

*Plate 7. Upper: Atlantic sturgeon from the Presumpscot R. mainstem immediately below Presumpscot Falls, August 2006. Lower: Shortnose sturgeon from the Presumpscot R. mainstem immediately below Presumpscot Falls, September 2006.*

***Shortnose sturgeon*** *(Acipenser breviceps)*
A single shortnose sturgeon was collected in September at the site immediately downstream from Presumpscot Falls. This single specimen weighed 4.05 kg.

**Family Anguillidae** (Freshwater Eels)

***American Eel*** *(Anguilla rostrata)*
American eel is an economically important species that is managed as a commercial fishery in Maine. A commercial elver fishery existed at the mouth of the Presumpscot River in 1995, but had diminished with the collapse of the market by 1999 (Wippelhauser et al. 2001). It occurs in coastal rivers and their tributaries as both immature and adult life stages, with juveniles being the most common. Electrofishing proved to be an effective technique for collecting American eels of all sizes. We differentiated 3 general size classes that *approximate* general life stages; specimens weighing more than 0.5 kg were considered adults, individuals weighing more than 0.01 kg, but less than 0.5 kg were considered juveniles, and those weighing less than 0.01kg were considered young-of-year. These were not intended as definitive life stage determinations, but were done to more accurately determine relative abundance via the sub-sampling techniques that we employed.

*Plate 8. Adult American eel collected from the Presumpscot R. mainstem, 2007.*

American eel was the most numerous species in the study area. Relative abundance ranged mostly between 10-100 individuals/km and was highest in the August-September 2006 survey (Figure 11). They were most numerous in the low gradient riverine habitat type with a median abundance of 40 individuals/km (Figure 12). Median abundance was roughly one-half that in the tidal, free-flowing riverine, and impounded habitat types. American eel were present at all sampling sites and their ability to scale dams results in access to all segments of the study area. This was not the case in other impounded Maine Rivers as American eel abundance was observed to decline sharply above the first dam and be comprised of adult size fish (Yoder et al. 2006a,b).

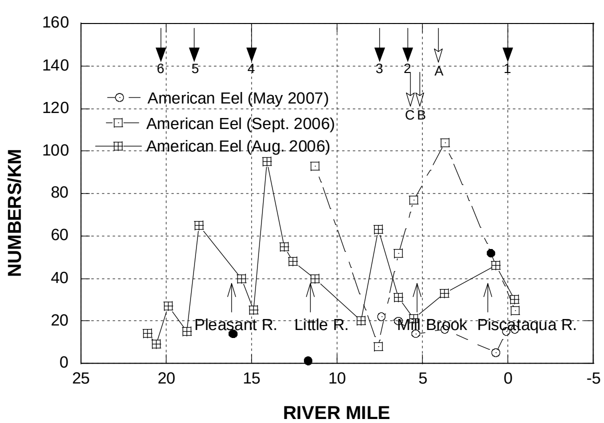


*Figure 11. Relative abundance of American eel (all stages combined) in the Presumpscot R. mainstem, August and September 2006 and May 2007.*

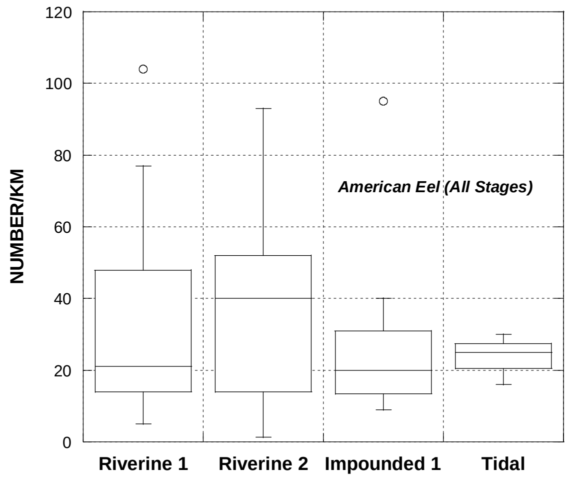


*Figure 12. Relative abundance of American eel (all stages combined) by major habitat type in the Presumpscot R. mainstem, 2006-7 (habitat types are listed in Table 2).*

**Family Clupeidae** (Herrings)

Two members of the herring family were collected in the study area in 2006 and 2007; alewife and American shad. At present these species are restricted to the mainstem and tributaries downstream from the Cumberland Mills Dam, although they were historically documented throughout the study area prior to dam construction (American Rivers 2002). The lower portion of the mainstem supports a run of alewife and a remnant American shad population (Wippelhauser et al. 2001). Maine DMR constructed a fishway at the outlet of Highland Lake (Mill Brook outlet) to allow alewife access to that spawning habitat. A fishway constructed in 1990 at Smelt Hill Dam re-established access to the lower reaches of the mainstem for both species until 1996, when it was destroyed by a flood. Alewife were either stocked into Highland Lake (1997-1998; 2000-1) or the dam gates were opened (1999-2001) to allow passage during the spring run.

***Alewife** (Alosa pseudoharengus)*

This native anadromous species was found in the lower mainstem and the Piscataqua River in 2006 and 2007. Young-of-year predominated the late summer and early fall samples whereas adults were collected in May-June 2007. Young-of-year occurred in low abundances compared to what we have observed in other coastal Maine rivers. A total of four individuals were collected at two locations, RM 3.7 (downstream U.S. 302 and Mill Brook) and at the mouth of the Piscataqua River in September 2006. A total of 60 adult alewife were collected in May-June 2007 all downstream from the Cumberland Mills Dam; 36 were collected below Presumpscot Falls, the remainder above the falls (Figure 13). These results seem to be in line with recent descriptions of the alewife population (Wippelhauser et al. 2001) and perhaps slightly higher than the Normandeau (2004) results from May 2003.

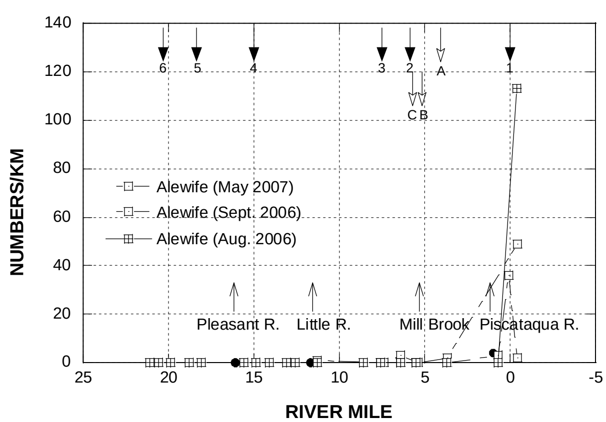


*Figure 13. Relative abundance of alewife (all stages combined) in the Presumpscot R. mainstem, August and September 2006 and May 2007.*

***American Shad** (Alosa sapidissima)*

American shad were collected only as adults and from the lower Presumpscot River mainstem immediately downstream from the Cumberland Mills Dam in 2006 and 2007. Individuals were

*Plate 9. Upper: Adult alewife from the Kennebec R., 2002. Lower: American shad from the Presumpscot R. mainstem immediately below Cumberland Mills Dam, August 2006.*

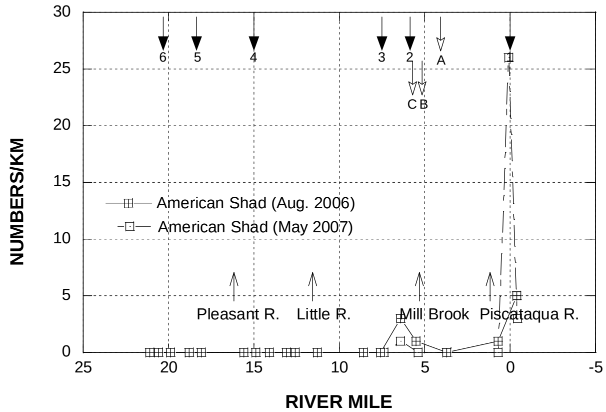


*Figure 14. Relative abundance of American shad (all stages combined) in the Presumpscot R. mainstem, August and September 2006 and May 2007.*

collected during each of the sampling passes in 2006 and 2007 (Figure 14). In 2006 adults were observed immediately below Cumberland Mills Dam (RM 6.4), downstream from the Westbrook WWTP (RM 5.5), upstream from Presumpscot Falls at the I-95 bridge (RM 0.7), and immediately below Presumpscot Falls (RM -0.4), all during the August sampling pass; no individuals were collected in September 2006.. In 2007, a total of 13 American shad were collected downstream from the Cumberland Mills Dam; 10 were collected below Presumpscot Falls (Figure 14). These results also seem to be in line with previous descriptions of the American shad population (Wippelhauser et al. 2001; Normandeau 2003).

### **Family Cyprinidae** (Minnows)

In terms of the number of species, this is the most diverse of all fish families represented in Maine's rivers. Traditionally, it is also one of the most overlooked being relegated to the significance of "forage species" by previous fishery focused descriptions of the Maine fish fauna (e.g., Foye et al. 1969). While this is indeed true in relation to other fish species, this group exhibits a diversity of environmental tolerance and indicator roles that is vital to express within an assemblage assessment process. It is therefore important that assemblage assessment tools appropriately include the various species of this family and this is accomplished in the interim Maine Rivers IBI. Cyprinids play a direct role in 6 of the 12 Maine Rivers IBI metrics. Five species of Cyprinidae were collected in the Presumpscot River study area. One species, **bridle shiner** *(Notropis bifrenatus)* was collected at one location (RM 15.6) only.

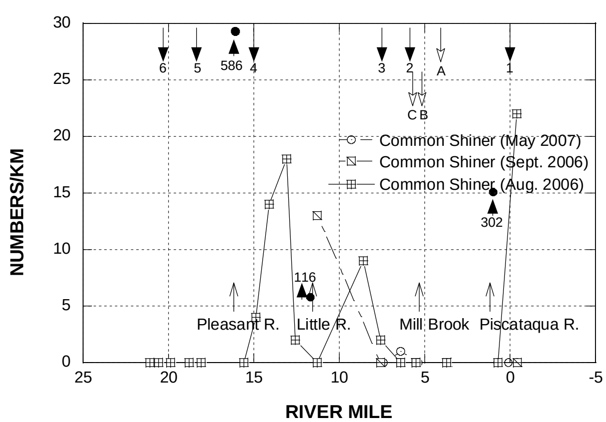


*Figure 15. Relative abundance of common shiner (all stages combined) in the Presumpscot R. mainstem, August and September 2006 and May 2007.*

***Common shiner** (Luxilis cornutus)*

Common shiner *(Luxilis cornutus)* is one of the most ubiquitous fish species in Maine Rivers (Yoder et al. 2006b). It is a native species throughout the state and is intermediate in its tolerance to general pollution. It was the second most numerous species in the study area. The relative abundance of the indigenous common shiner *(Luxilis cornutus)* was highest in the Pleasant, Little, Piscataqua Rivers exceeding 100-500 individuals/km (Figure 15). Abundances in the mainstem were less ranging from 0 to less than 20 individuals/km. Comparatively few common shiners occurred


*Plate 10. Upper: Common shiner (middle) and fallfish (lower) with a creek chub (upper) from the Kennebec R., 2002. Lower: Golden shiners from the adjacent Saco R., 2006. All except creek chub were collected from the Presumpscot River study area.*

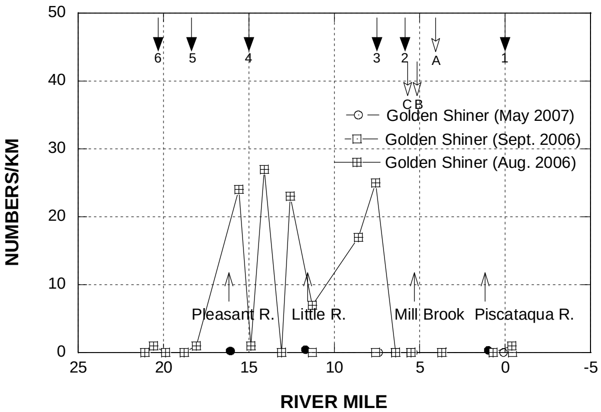


*Figure 16. Relative abundance of golden shiner (all stages combined) in the Presumpscot R. mainstem, August and September 2006 and May 2007.*

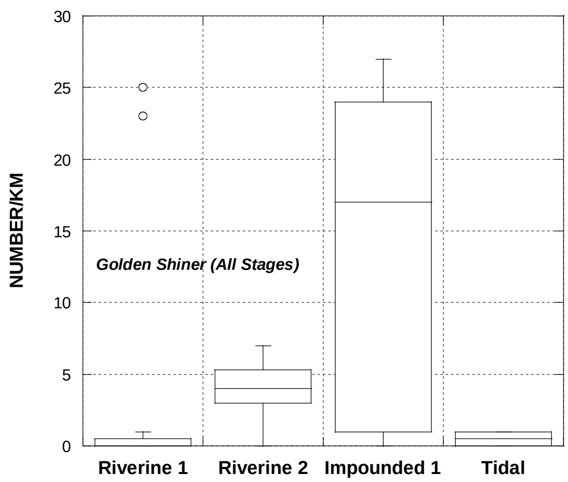


*Figure 17. Relative abundance of golden shiner (all stages combined) by major habitat type in the Presumpscot R. mainstem, 2006-7 (habitat types are listed in Table 2).*

between the Cumberland Mills Dam and Presumpscot Falls and upstream from the Pleasant River confluence. Their reduced abundance downstream from Cumberland Mills Dam and the SAPPI discharge is similar to their reduced abundance and absence in the Androscoggin River below paper mill discharges in Rumford and Jay (Yoder et al. 2006a).

***Golden Shiner*** *(Notemigonus crysoleucas)*
Golden shiner (Notemigonus crysoleucas) is a ubiquitous species in Maine that can occur in a wide variety of aquatic habitat and water quality conditions. It is widely recognized as being highly tolerant of pollution (Halliwell et al. 1999) and other environmental conditions. It is indigenous to the study area, but it has been introduced in other regions of Maine (Halliwell 2005). The occurrence in the study area was strongly related to impounded habitats, where it reached the highest abundance (Figures 16 and 17). Relative numbers were less than 1 individual/km in riverine and tidal habitats, but ranged up to 20-25/km in impounded habitats. As with common shiner it was virtually absent upstream from the Pleasant River and between Cumberland Mills Dam and Presumpscot Falls.

***Fallfish*** *(Semotilus corporalis)*
Fallfish are not only one of the most common Cyprinid species, but one of the most widely occurring species throughout Maine's rivers being found at virtually every sampling site in Maine during 2002-7 (Yoder et al. 2006b). They are generally regarded as being tolerant of general pollution and as such they were excluded from the native Cyprinidae metric of the interim Maine Rivers IBI (Yoder et al. 2008). Like common shiner fallfish were generally the most numerous in the three tributaries; an exception was the highest abundance in the study area near the confluence with Pleasant River (Figure 18). As such it showed a distinct preference for the low gradient riverine habitat type and a virtual avoidance of impounded habitat (Figure 19). It is classified as a fluvial dependent by Bain and Meixler (2000) and it is assigned to that guild in the Maine Rivers IBI. However, it occurred in very low abundances at most of the moderate-high riverine sites in the study area.

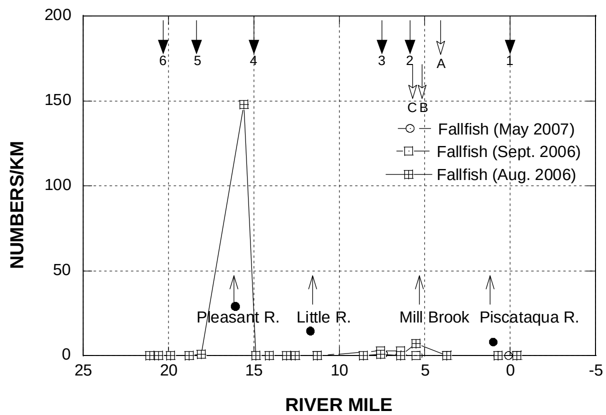


*Figure 18. Relative abundance of fallfish (all stages combined) in the Presumpscot R. mainstem, August and September 2006 and May 2007.*

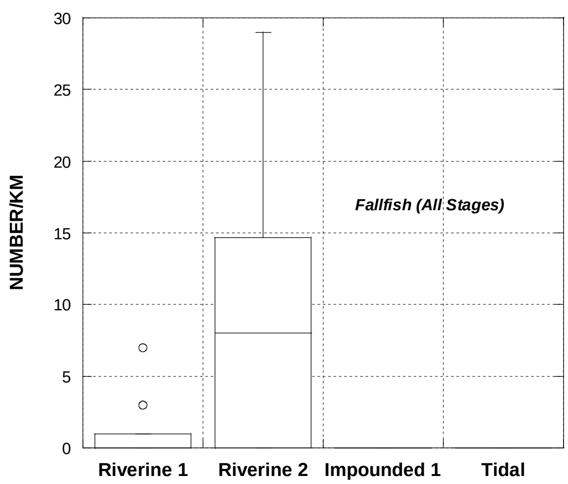


*Figure 19. Relative abundance of fallfish (all stages combined) by major habitat type in the Presumpscot R. mainstem, 2006-7 (habitat types are listed in Table 2).*

### **Family Catostomidae** (Suckers)

***Common white sucker** (Catostomus commersonii)*

One species of sucker, white sucker *(Catostomus commersonii),* occurred in the study area and it is widely distributed throughout Maine. It is indigenous to nearly all Maine streams, rivers, and lakes. It occurred at nearly every statewide sampling site and in all reaches and habitat types. Adult white suckers (defined here as individuals >500 g) were generally found in greater numbers in the swift flowing waters of the deeper runs and chutes in the moderate-high gradient riverine habitat type. In contrast, adults were virtually absent in habitats with slow or no current such as low gradient and impounded sites. In these locations, juveniles and young-of-year were more commonly found (Yoder et al. 2006b).

White sucker abundance was highest in the three tributaries exceeding 50-300 individuals/km (Figure 20). Abundances were generally <20 individuals/km in mainstem riverine habitats (Figure 21). The majority of fish occurred as juveniles and young-of-year. Adults were numerous (13 individuals/km) in only one sample collected below Cumberland Mills Dam in September 2006.

### **Family Ictaluridae** (Catfishes)

***Brown bullhead** (Ameirus nebulosus)*

Catfishes are represented in Maine by one indigenous (brown bullhead) and one introduced (white catfish) species. Brown bullhead *(Ameirus nebulosus)* is widely distributed throughout Maine occurring in a variety of river and lake habitats. Brown bullhead occurred in only 10 samples in the study area with no more than 5 individuals in any one sample. It was restricted to the mainstem and occurred in both riverine and impounded habitats. It was most numerous in the upper mainstem between the Dundee Dam and Little Falls. Like several other species in the study area it was virtually absent from the mainstem between Cumberland Mills Dam dam and Presumpscot Falls (Figure 20).

*Plate 11. Upper: Adult white sucker from the Kennebec R., 2002. Lower: Brown bullhead from the lower adjacent Saco R., 2006. Both species were collected in the Presumpscot River study area.*

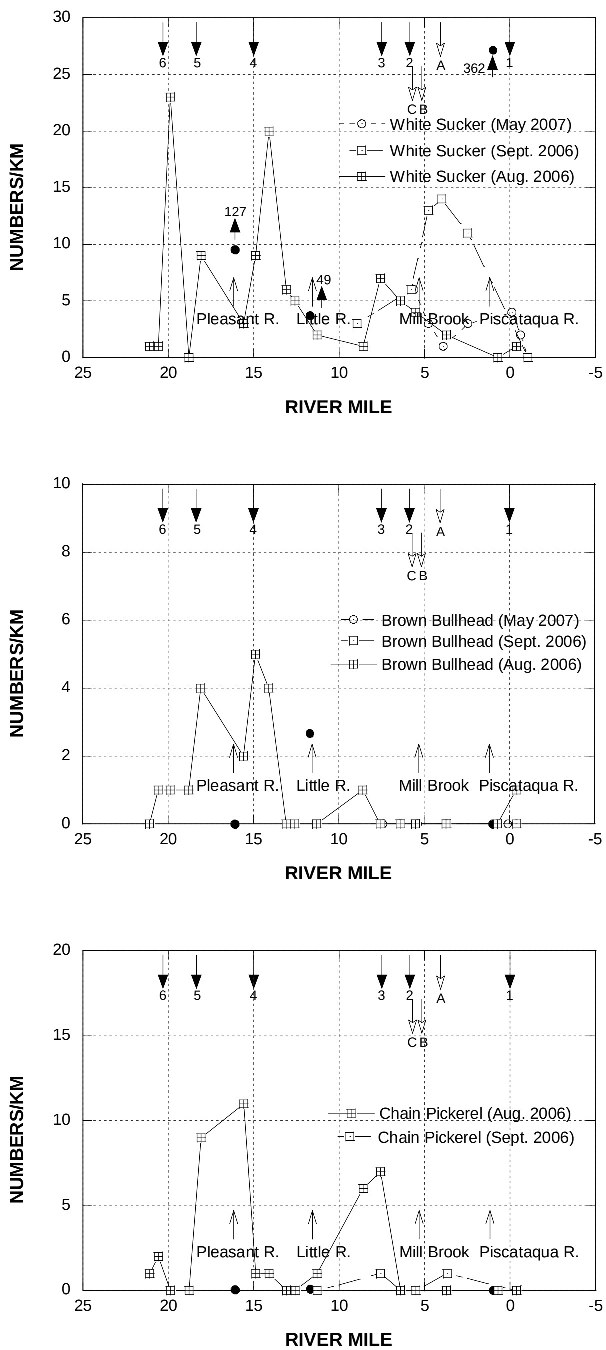


*Figure 20. Relative abundance of white sucker, brown bullhead, and chain pickerel (all stages combined) in the Presumpscot R. mainstem, August and September 2006 and May 2007.*

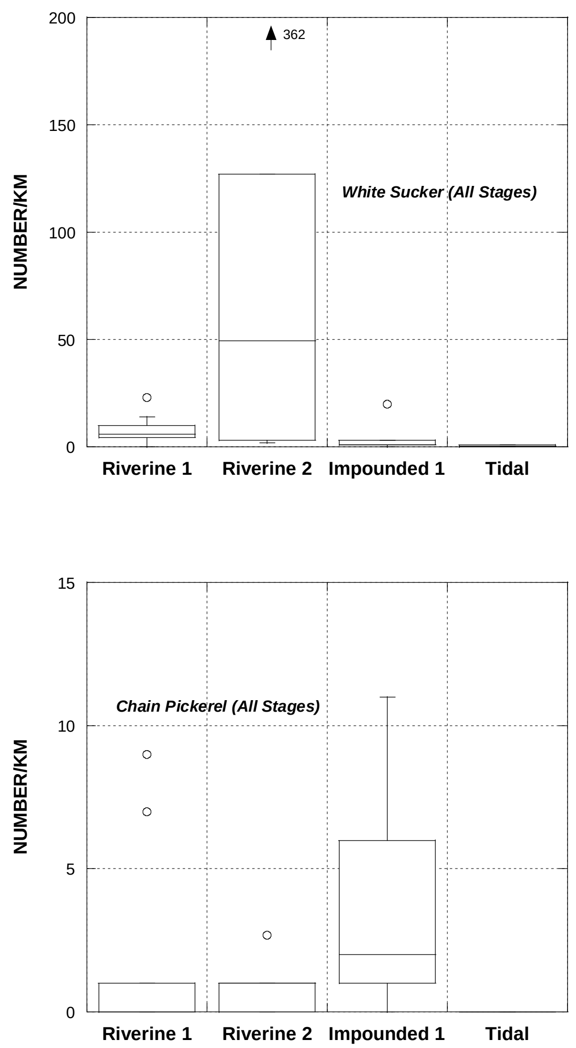


*Figure 21. Relative abundance of white sucker and chain pickerel (all stages combined) by major habitat type in the Presumpscot R. mainstem, 2006-7 (habitat types are listed in Table 2).*

### **Family Esocidae** (Pike and Pickerel)

***Chain pickerel** (Esox niger)*
Chain pickerel are indigenous to southern Maine and have been introduced to many waters outside of their original range (Halliwell 2005). This species has a decided preference for warmer, slow flowing or lentic habitats that include submergent aquatic vegetation. It is considered a key species member of the low gradient riverine habitat fish assemblage. In more natural settings these habitats are bordered by or contained within extensive wetland complexes.

It exhibited a preference for low gradient habitats in the study area occurring in the highest abundance in the impounded habitat type (Figures 20 and 21). Longitudinally the highest abundances occurred above the Sacarappa and Gambo dams.

### **Family Osmeridae** (Smelts)

Rainbow smelt *(Osmerus mordax)* are an anadromous species that occurred in one collection comprised of 18 individuals at RM – 0.4 below Presumpscot Falls in September 2006.

### **Family Salmonidae** (Trout and Salmon)

Three species of Salmonidae are known to occur in the study area. These include brown trout *(Salmo trutta),* brook trout *(Salvelinus fontinalis),* and Atlantic salmon *(Salmo salar).* Sea run Atlantic salmon only sporadically occur in the lower mainstem and juvenile salmon have been observe in Maine IF&W surveys in the Piscataqua River (Wippelhauser et al. 2001). The origin of these fish is unknown, but they were apparently able to pass the former Smelt Hill Dam. The limitations to access of the historical spawning and nursery habitat in the tributaries have precluded the re-development of a significant Atlantic salmon run. Brook trout and landlocked Atlantic salmon are also indigenous to the Presumpscot River drainage. Several tributaries currently support wild populations of brook trout, but there are essentially no self-sustaining populations of landlocked salmon outside of Sebago Lake and the Crooked River, both of which are located well upstream from the study area.

Three Salmonid species are stocked to support a sport fishery in the upper mainstem and in the tributaries. Existing recreational fisheries are primarily comprised of landlocked Atlantic salmon, brook trout, and brown trout. Maine IF&W stocking programs include recreational fisheries for brown and brook trout and landlocked salmon, although wild brook trout are produced in river tributaries and wild landlocked salmon originating from Sebago Lake makeup a small part of the river fisheries. Fisheries for predominantly stocked trout and salmon occur in the tailrace and bypass reaches of the Eel Weir, North Gorham, Dundee, and Mallison Dams. The Eel Weir bypass is intensively managed for brook trout. Up to 2,500 trout and salmon are stocked annually in the Eel Weir Bypass reach. The other three bypass reaches that are the focus of current stocking programs are managed primarily for brown trout and are stocked annually at much lower levels, typically 250 fish per reach. Limiting environmental factors and available resources currently

*Plate 12. Upper: Chain pickerel from the Penobscot R., 2004. Lower: Brown trout from the Kennebec R., 2002. Both species were collected in the Presumpscot River study area.*

preclude opportunities to provide season-long recreational fisheries for native salmonid species in some river reaches. In these reaches management has favored the more thermally tolerant and available nonnative brown trout (Wippelhauser et al. 2001). It has also been noted that the re-establishment of a sea run Atlantic salmon population could potentially conflict with current recreational fisheries for trout and salmon.

***Brown Trout** (Salmo trutta)*
Brown trout are an exotic species of intercontinental origin being first introduced in Maine waters the late 1800s (Halliwell 2005). It occurred in the study area primarily in and near Pleasant River and the Piscataqua River (4 individuals). A single individual was collected in the mainstem at RM 3.7 (downstream U.S. 202) in September 2006. The majority of individuals were collected during the May-June 2007 sampling in the lower mainstem, 8 individuals in all between the Cumberland Mills Dam and Presumpscot Falls.

***Brook trout** (Salvelinus fontinalis)*
Brook trout are one of two native salmonids that occur in Maine Rivers. It was formerly widely distributed in Maine rivers and streams and is a key species that exemplifies a tier 1 fish assemblage along the Biological Condition Gradient for the moderate-high gradient riverine ecotype (Yoder et al. 2008). A single brook trout was collected in the Little River in August 2006 and was the only occurrence in the study area.

**Family Gadidae** (Cods)

***Burbot** (Lota lota)*
The single freshwater member of the cod family is the burbot, which is indigenous to Maine waters. They are typically found in cold, deepwater lakes and large rivers (Hartel et al. 2002). They are classified as a native stenotherm in the Maine Rivers IBI (Yoder et al. 2008). A single burbot was collected immediately below Presumpscot Falls (RM – 0.4) in August 2006.

***Atlantic Tomcod** (Microgadus tomcod)*
Atlantic tomcod (Microgadus tomcod) are a brackish water species that occurred in the study area below Presumpscot Falls. Four and six individuals, respectively, were collected in September 2006 and June 2007.

**Family Fundulidae** (Topminnows)

***Banded Killifish** (Fundulus diaphanus) and **Mummichog** (Fundulus heteroclitus)*
Two species of topminnows were collected in the study area, banded killifish *(Fundulus diaphanus)* and mummichog *(Fundulus heteroclitus).* Both tend to occur in schools and inhabit shallow areas along the margins. Two banded killifish were collected in the upper mainstem, one each in the Gambo and Little Falls impoundments. The remaining individuals were collected immediately below Presumpscot Falls (RM – 0.4) in August 2006. Mummichog is typically a saltwater species, but can occur in fresh to slightly brackish waters. Eleven individuals were collected immediately below Presumpscot Falls (RM – 0.4) in September 2006.

*Plate 13. Upper: Burbot from the Androscoggin R., 2003. This species was collected in the Presumpscot River study area. Lower: Atlantic tomcod from the Presumpscot River below Presumpscot Falls, 2006.*

*Plate 14. Upper: Rainbow smelt collected from the Presumpscot River below Presumpscot Falls, 2006. Lower: Mummichog from the Presumpscot River below Presumpscot Falls, 2006. Both species were unique to this location.*

**Family Gasterosteidae** (Sticklebacks)

One species of stickleback was collected in the study area. Ninespine stickleback *(Pungitius pungitius)* occurred in the Piscataqua River and Pleasant River, the former being comprised of 10 individuals.

**Family Moronidae** (Temperate Basses)

Temperate basses are represented in Maine by two species, striped bass *(Morone saxatilis)* and white perch *(Morone americana).* Striped bass are an indigenous anadromous species that enters the freshwater sections of coastal rivers and streams, but which are commonly found in coastal marine habitats. They are one of the most sought after game fish in the northeast U.S. that suffered a dramatic population decline in the late 1970s and early 1980s. Management intervention restored some of those losses in the 1990s. White perch are also indigenous to freshwater coastal streams and rivers and in some lakes where landlocked populations can be found. They have been perhaps the most widely introduced fish into numerous lakes and ponds and as such represent an intrastate native introduced species in these situations (Halliwell 2005).

***Striped bass** (Morone saxatilis)*

Striped bass were collected in large numbers immediately below Presumpscot Falls in every sampling event at that location in August and September 2006 and May-June 2007. Numeric abundance ranged from 30-57 individuals. During the May-June 2007 survey, 16 and 24 individuals were collected on May 31 and June 1, respectively, at RM 0.1, a new site established in 2007. Given that this species can surmount Presumpscot Falls we had expected to find it upstream to Cumberland Mills Dam, but no fish were found above RM 0.1.

***White perch** (Morone americana)*

White perch occurred at only two sites in the study area. Three individuals ere collected in the North Gorham impoundment in August 2006. A single individual was collected below Presumpscot Falls in August 2006.

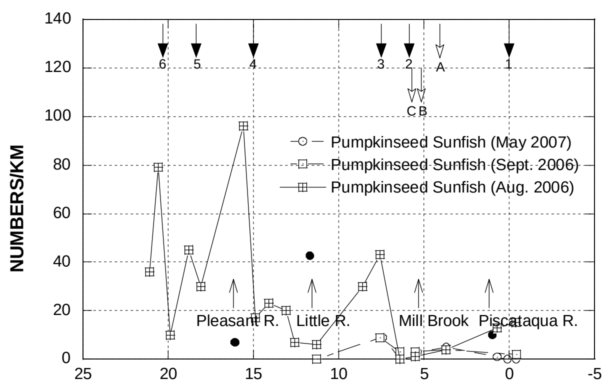


*Figure 22. Relative abundance of pumpkinseed sunfish (all stages combined) in the Presumpscot R. mainstem, August and September 2006 and May 2007.*

**Family Centrarchidae** (Sunfishes)

Sunfishes are a widely distributed family throughout the eastern U.S. and Canada. They have been widely stocked and transplanted for fisheries enhancement and most species are highly adaptable for this purpose. There are at least seven species of sunfishes known to occur in Maine waters. Of these only two are indigenous, pumpkinseed *(Lepomis gibbosus)* and redbreast sunfish *(Lepomis auritus).* Of the remaining five, green sunfish *(Lepomis*


*Plate 15. Upper: Striped bass from the Presumpscot River below Presumpscot Falls, 2006. Lower: White perch from Merrymeeting Bay, 2002. This species was collected in the Presumpscot River study area.*

*cyanellus),* bluegill *(Lepomis macrochirus),* black crappie *(Pomoxis nigromaculatus),* smallmouth bass *(Micropterus dolomieui),* and largemouth bass *(Micropterus salmoides)* are intracontinental or interstate non-native introduced species (Halliwell 2005). Another centrarchid species, rock bass *(Ambloplites rupestris),* was collected by statewide study in the New Hampshire portion of the Androscoggin River nearly to the Maine state border (Yoder et al. 2006a). Four of these species occurred in the study area.

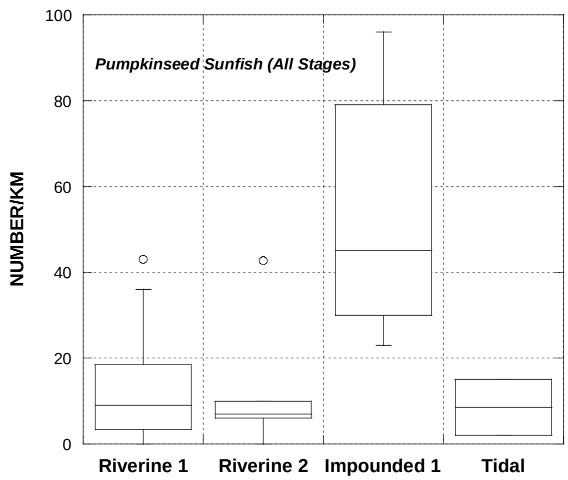


*Figure 23. Relative abundance of pumpkinseed sunfish (all stages combined) by major habitat type in the Presumpscot R. mainstem, 2006-7 (habitat types are listed in Table 2).*

***Pumpkinseed** (Lepomis gibbosus)*

Pumpkinseed is the lone indigenous centrarchid in the study area. It occurs widely throughout Maine in lakes, ponds, and in the pool and slow current habitats of streams and rivers. They have a decided preference for submergent aquatic vegetation (Hartel et al. 2002), which separates it somewhat from the other native centrarchid, redbreast sunfish. This was the fourth most numerous species in the study area. It was most numerous in the upper mainstem in the Gambo and north Gorham impoundments (Figure 22). It declined in a general downstream direction and exhibited a preference for the impounded habitat type (Figure 23), but occurred at nearly every sampling site.

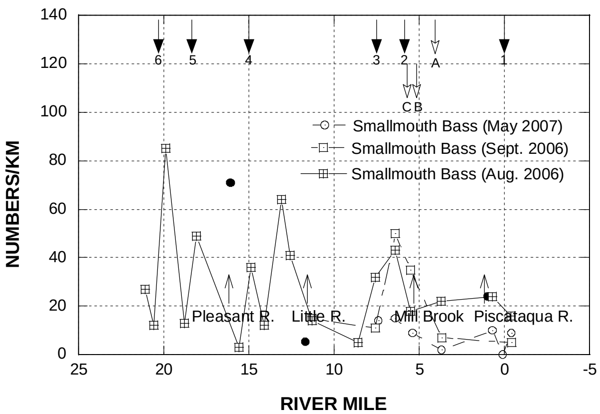


*Figure 24. Relative abundance of smallmouth bass (all stages combined) in the Presumpscot R. mainstem, August and September 2006 and May 2007.*

***Smallmouth bass** (Micropterus dolomieui)*

Smallmouth bass are an introduced species of intracontinental origin (Halliwell 2005) that were legally stocked by the state of Maine initially in 51 water bodies between 1868 and 1881 (Warner 2005). Since that time they have become naturalized with reproducing populations in many lakes, ponds, streams, and rivers in southern and central Maine. Since the mid-1980s they have been illegally transplanted within the state thus further expanding their range (Warner 2005). The rationale for their introduction into Maine waters was to provide sport fishing in waters that contained a mostly non-salmonid fish assemblage consisting of perch (yellow perch, *Perca flavescens),* sunfish *(Lepomis spp.),* and pickerel (chain pickerel; Warner 2005). The original intent was to carefully manage these introductions so as to not adversely impact native salmonid populations. However, the effort to preclude negative impacts of smallmouth bass introductions was not entirely successful as unsupervised private transplanting took place and the expansion of the species proceeded naturally. Presently this species is thought to occur in more than 470 lakes and ponds mostly in the southern and central portions of Maine where it provides

*Plate 16. Upper: Pumpkinseed sunfish from the Presumpscot River, 2006. Lower: Smallmouth bass from the Presumpscot River, 2006.*

a significant sport fishery (Halliwell 2005; Warner 2005). Apparent negative effects on native brook trout and cyprinid populations via general competition and direct predation in a number of lakes, streams, and rivers have been and are continuing to be documented (Whittier et al. 1997; Jackson 2002; Warner 2005; Yoder et al. 2008). It is hypothesized that warming water temperatures will present even more advantageous conditions favoring this species. As such it remains a significant management issue and challenge in Maine. Smallmouth bass are cast as a negative influence in the Maine Rivers IBI contributing directly to three metrics, all negative (Yoder et al. 2008).

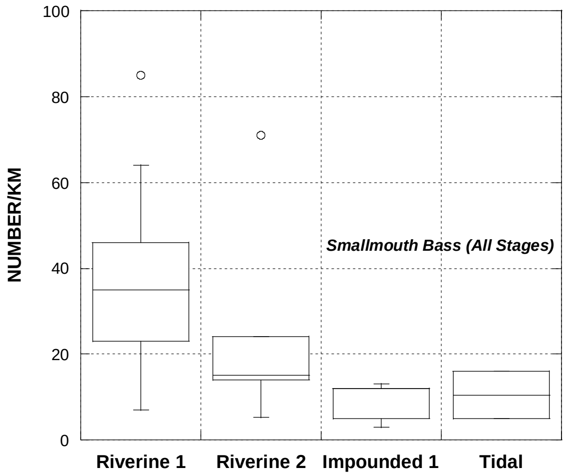


*Figure 25. Relative abundance of smallmouth bass (all stages combined) by major habitat type in the Presumpscot R. mainstem, 2006-7 (habitat types are listed in Table 2).*

Smallmouth bass were the third most numerous species in the study area. Numeric abundance generally ranged from 10-80 individuals/km (Figure 24) being highest in the upper mainstem. All life stages were well represented an indication of successful reproduction. It exhibited a preference for the moderate-high gradient habitat type with twice the numbers of the low gradient riverine ecotype and more than three times the impounded habitat type (Figure 25). The plasticity of this species to environmental conditions is evident not only in the habitat preferences, but also its occurrence below Presumpscot Falls.

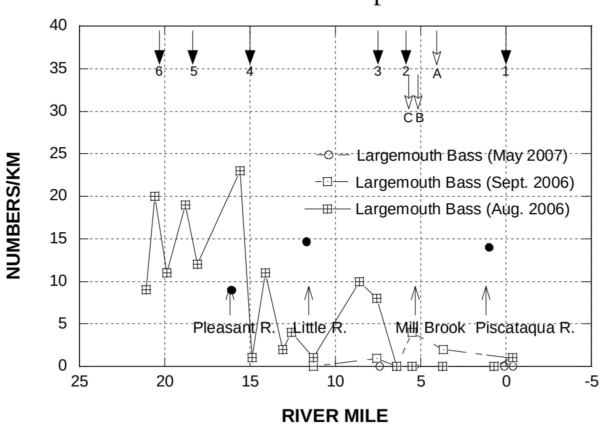


*Figure 26. Relative abundance of largemouth bass (all stages combined) in the Presumpscot R. mainstem, August and September 2006 and May 2007.*

***Largemouth bass** (Micropterus salmoides)*

Largemouth bass are an introduced species of intracontinental (interstate) origin in Maine waters (Halliwell 2005). The first fish were likely introduced as part of the original stockings of smallmouth bass in the late 1800s and they quickly became established in several lakes and ponds of southern and central Maine. They now occur in more than 370 water bodies in Maine and are expanding into new waters either naturally or through illegal stocking (Warner 2005; Halliwell 2005). Successful eradication has been accomplished in some northern counties where they constituted a threat to native salmonids. This species is commonly thought of as a "lake species", but it is adaptable to riverine environments provided water quality and habitat conditions are suitable. Like smallmouth bass, largemouth bass are cast as a negative influence in the Maine Rivers IBI contributing directly to three metrics all negative (Yoder et al. 2008).

*Plate 17. Upper: Largemouth bass from the adjacent Saco River 2006. Lower: Black crappie from the Kennebec River, 2002. Both species were collected in the Presumpscot River study area.*

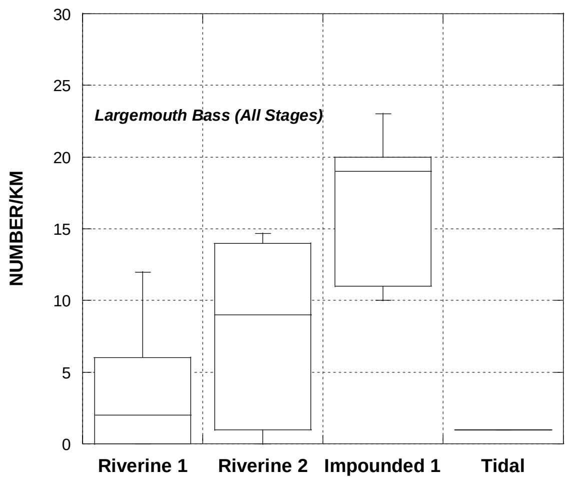


*Figure 27. Relative abundance of largemouth bass (all stages combined) by major habitat type in the Presumpscot R. mainstem, 2006-7 (habitat types are listed in Table 2).*

Largemouth bass were the eighth ranked species numerically in the study area. They exhibited a similar longitudinal distribution to smallmouth bass being most numerous at upstream sites (Figure 26). However, and opposite the smallmouth bass, they exhibited a preference for the impounded and low gradient riverine habitat types (Figure 27). This is not unexpected given their preference for pool and lake type habitats.

***Black crappie** (Pomoxis nigromaculatus)*

Black crappie *(Pomoxis nigromaculatus)* is an introduced species of intracontinental (interstate) origin in Maine (Halliwell 2005). Originally introduced in the 1920s in southern Maine, they were first introduced into Sebasticook Lake as part of a stocking of largemouth bass. Since that time they have become established in several central Maine lakes and ponds, and more recently several rivers. A total of six black crappie were collected at 3 sites in the study area, one impoundment and two tailwaters in August 2006.

## **Family Percidae** (Perches)

The Percidae are represented by a single native species in Maine, yellow perch *(Perca flavescens).* Yellow perch, like their close associate the chain pickerel, are indigenous to southern and central Maine waters, but have been introduced into northern Maine lakes, ponds, and streams (Halliwell 2005). Unlike its status in the upper Midwestern U.S., it is not a widely sought after game species in Maine. It is a part of the

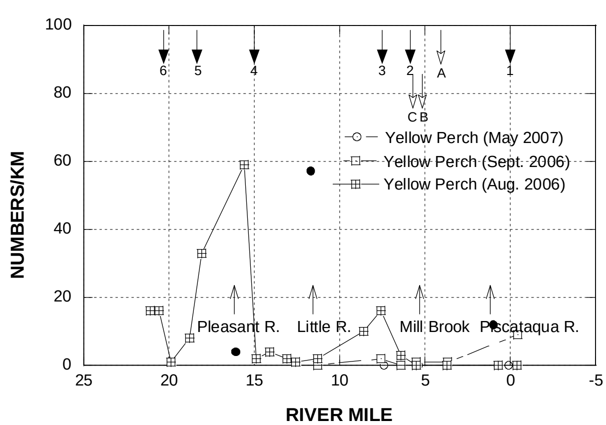


*Figure 28. Relative abundance of yellow perch (all stages combined) in the Presumpscot R. mainstem, August and September 2006 and May 2007.*

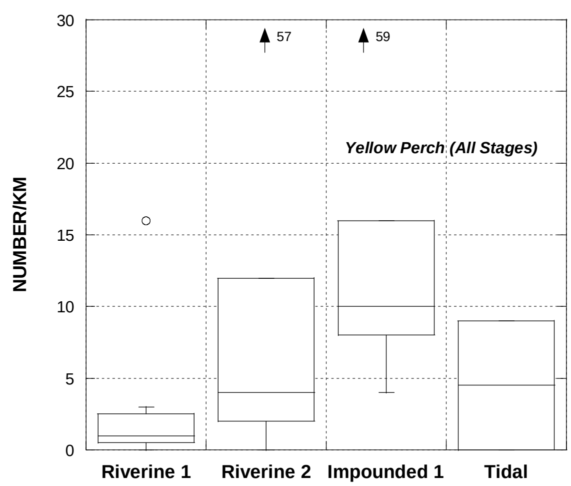


*Figure 29. Relative abundance of yellow perch (all stages combined) by major habitat type in the Presumpscot R. mainstem, 2006-7 (habitat types are listed in Table 2).*

association of warmwater fish species that apparently justified the original introduction of smallmouth bass in Maine (Warner 2005).

Yellow perch were the sixth most numerous species in the study area. They were most numerous in the upper mainstem in the Gambo impoundment (Figure 28). They exhibited their highest numbers in the impounded and low gradient riverine habitat types, but were also well represented at the tidal site below Presumpscot Falls (Figure 29) an indication of their plasticity to environmental conditions.

*Plate 18. Yellow perch from Merrymeeting Bay, 2002. This species was collected in the Presumpscot River study area.*

# FISH ASSEMBLAGE PROPERTIES AND CHARACTERISTICS

This section describes the compositional and relative abundance characteristics of the fish assemblages in the Presumpscot River study area. The term "assemblage" has recently replaced the formerly used term "community" in that an assemblage refers to a phylogentically similar group of organisms whereas a community includes all organisms across all phylogenetic groupings (Rinne et al. 2005). Hence the use of the term fish assemblage in this report.

The properties and characteristics of the fish assemblages of the study area are portrayed by analyses of baseline assemblage parameters including richness, numbers, and biomass and assemblage indices (IBI, MIwb) and the metrics thereof analyzed by river sampling location and between the major habitat types, impounded and riverine. These analyses are an attempt to better understand both natural and anthropogenic associated changes in assemblage composition in the study area.

## Patterns in Assemblage Parameters

We used common assemblage parameters such as total species richness, numbers, biomass, the interim Maine rivers IBI, the Modified Index of Well-Being (MIwb), and selected IBI metrics to explore spatial patterns in the study area and between the two major habitat types. The first set of analyses involved analyzing selected attributes, indices, or metrics at each site as longitudinal plots by distance or river mile in an upstream to downstream direction for the 2006 results. The second set of analyses involved aggregating the data by the two major habitat types, riverine and impounded. These were displayed as box-and-whisker plots of each attribute, index, or metric.

### *Longitudinal Analyses*

Longitudinal analyses consist of graphical plots of indices, metrics, and other assemblage attributes by river mile for each individual river mainstem in an upstream to downstream format. The data being the product of the spatially intensive design can be used to comprehensively assess and "visualize" the assemblage responses to naturally occurring gradients and anthropogenic disturbances. The design yields multiple data points positioned in proximity to suspected sources such that results can be analyzed and displayed in a longitudinal context. This sampling design and the interpretation of the data relative to potential disturbance sources is based on the concept of "pollution zones" originated by Bartsch (1948) and Doudoroff and Warren (1951). As such the severity (i.e., departure from a desired state or condition) and extent (i.e., the proportion of the resource over which the departures occur) of changes can be assessed.

### *Habitat Type Analyses*

Habitat type analyses consisted of aggregating assemblage parameter data by the two major habitat types, riverine and impounded. Box-and-whisker plots were constructed for the same assemblage parameters that were analyzed for the longitudinal analyses.

***Species Richness***

Species richness included analysis of total species (all species included) and native species (alien and intercontinental species introduced excluded). Total species richness ranged from a low of 4 species at RM 3.7 (dst. U.S. Rt. 302) and RM 0.7 (dst. I-95) to a high of 15 below Presumpscot Falls (RM - 0.4) (Figure 30). There were no obvious patterns in the results with exception of comparatively low species richness in the August data between Cumberland Mills Dam and Presumpscot Falls. More species were observed in the September data especially at the RM 3.7 (dst. U.S. Rt. 302) site. Native species richness showed the same longitudinal pattern (Figure 30), the difference being 1-3 alien/introduced species at each site.

The results for the comparison between riverine and impounded sites showed a higher species richness in the impounded sites (Figure 30). Impounded sites had a median of 11 species and riverine sites a median of 7 species. The pattern was the same for native species – impoundments had a median of 8 native species and riverine sites had a median of 5 native species.

***Assemblage Abundance***

Numerical density expressed as the total number of individuals/km ranged from a low of 50 individuals/km (all species combined) to more than 400 individuals/km in the mainstem in 2006 (Figure 31). Abundance exceeded 800 individuals/km in the Piscataqua and Little Rivers. The longitudinal pattern was roughly similar to species richness, with the lowest values occurring in the Cumberland Mills Dam to Presumpscot Falls reach in August and slightly higher numbers in September. Assemblage biomass (kg/km) showed a similar longitudinal pattern (Figure 31), except low values were also observed between the Gambo Dam downstream to Sacarappa Falls. Biomass was highest immediately downstream from the North Gorham Dam and below Presumpscot Falls, each >60 kg/km.

Assemblage density was somewhat higher at impounded sites (median = 174.5 individuals/km) compared to riverine sites (median = 125 individuals/km), particularly in the mainstem (Figure 31). Biomass was slightly higher at riverine sites (median = 13.9 kg/km) compared to impounded sites (median = 9.9 kg/km).

***Fluvial Guilds***

Two fluvial guilds that comprise two metrics of the interim Maine Rivers IBI were analyzed. These metrics are based on the original development of fluvial guilds by Bain and Meixler (2000, 2008) in support of the Target Fish Community approach. The proportion of fluvial specialist and dependent species is a combination of two fluvial guilds and results from metric testing of these two guilds both independently and combined (Yoder et al. 2008). The intent of this metric is to reflect a dependency on natural riverine flow and habitat characteristics hence it functions as a positive metric in the IBI. The reference and calibration results verify that this is a positive metric with very a distinct separation of reference from the gradient of impacted sites. This metric is also a functional replacement for the intolerant metric that is usually a component of other IBIs, particularly for warmwater ecotypes. The intent of the proportion of macrohabitat generalists metric is the opposite of the fluvial specialist and dependent metric and includes species that are tolerant of flow and habitat alterations. The reference and calibration results verify that this is a negative metric with very a distinct separation of reference from the impacted sites and a gradient within these sites as well (Yoder et al. 2008). This metric is a functional replacement for the tolerant metric that is usually a component of other IBIs, particularly for warmwater ecotypes.

The proportion of fluvial specialist and dependent species was generally less than 20% and frequently less than 10% (Figure 32). Using the interim IBI calibration results (Yoder et al. 2008) a value of 20% is needed to score 40% of the maximum metric score which is

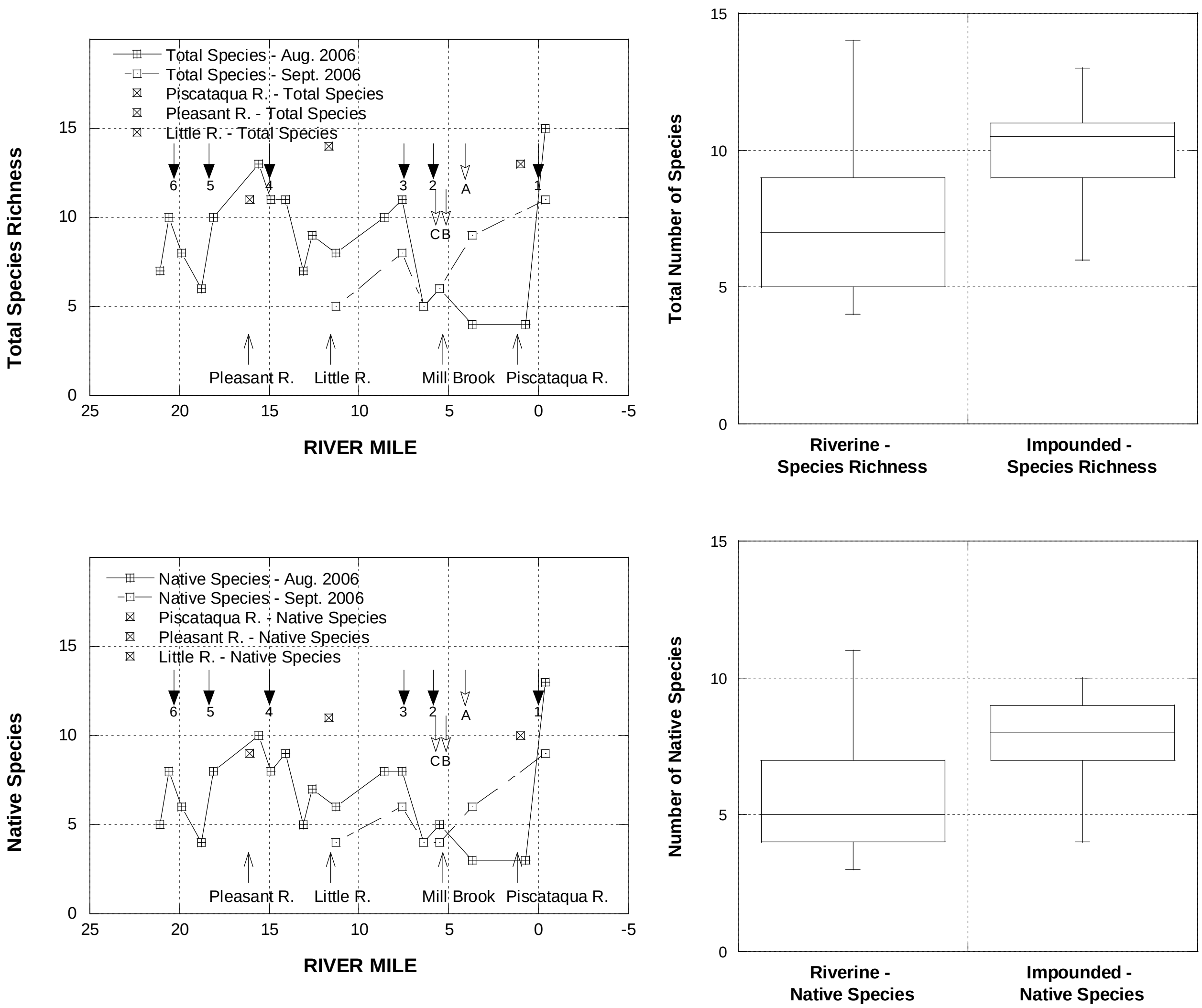


*Figure 30. Upper Left: Total species richness in the Presumpscot R. mainstem, August and September 2006. Lower Left: Native species richness in the Presumpscot R. mainstem, August and September 2006. Upper Right: Total species richness at riverine and impounded sites. Lower Right: Native species richness at riverine and impounded sites. Letters and numbers denote dams and major point sources (see study area description Table 2).*

consistent with minimally meeting a BCG tier IV condition. Thus most sites in the mainstem failed to meet this benchmark and values in the lower mainstem were less than 5% in August. In contrast values at two tributary sites exceeded 80% and the other was >50%. The comparison of riverine and impounded sites showed a slightly lower median proportion (10%) at the riverine sites compared to impounded sites (median = 12.5%). However, some impounded sites had values in excess of 40% (Figure 32).

The proportion of macrohabitat generalists showed a general decline from very high values >80% at the upstream sites to near 0 in the lower mainstem September results and both months below Presumpscot Falls (Figure 32). Using the interim IBI calibration results (Yoder et al. 2008) a value of <50% is needed to score 40% of the maximum metric score

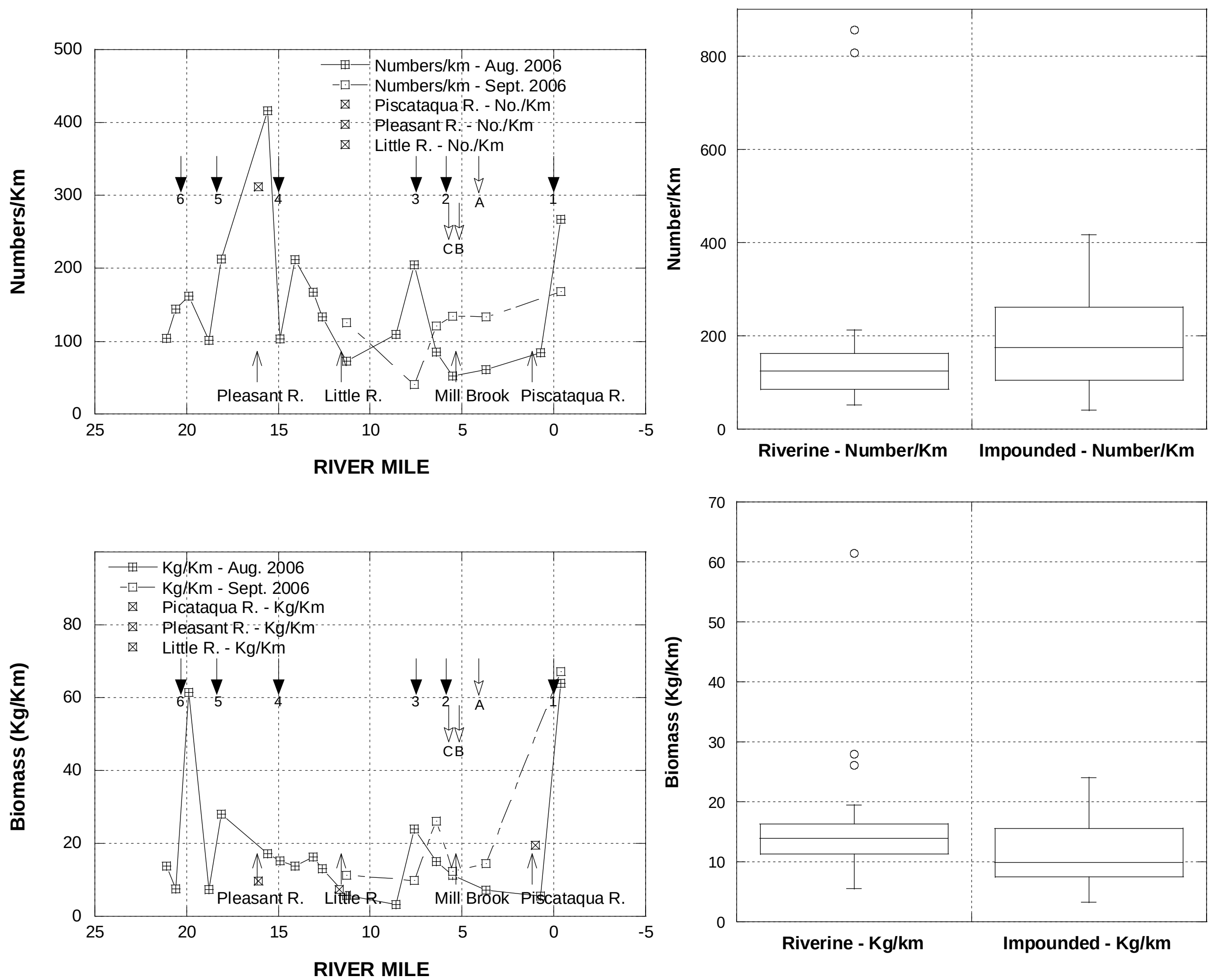


*Figure 31. Upper Left: Assemblage density (numbers/km) in the Presumpscot R. mainstem, August and September 2006. Lower Left: Assemblage biomass (kg/km) in the Presumpscot R. mainstem, August and September 2006. Upper Right: Assemblage density (numbers/km) at riverine and impounded sites. Lower Right: Assemblage biomass (kg/km) at riverine and impounded sites. Letters and numbers denote dams and major point sources (see study area description Table 2).*

which is consistent with minimally meeting a BCG tier IV condition. Most sites upstream from Cumberland Mills Dam failed to meet this benchmark. The comparison of riverine and impounded sites showed a lower median proportion (44%) at the riverine sites compared to impounded sites (median = 61.5%). This would be the expected result, the reverse of the results for the fluvial specialist and dependent results.

***Modified Index of Well-Being (MIwb)***

The MIwb exhibited a longitudinal pattern similar to its underlying parameters, species richness, density, and biomass (Figure 33). However, being a composite index it tempered some of the variability in those individual measures of assemblage condition. This index

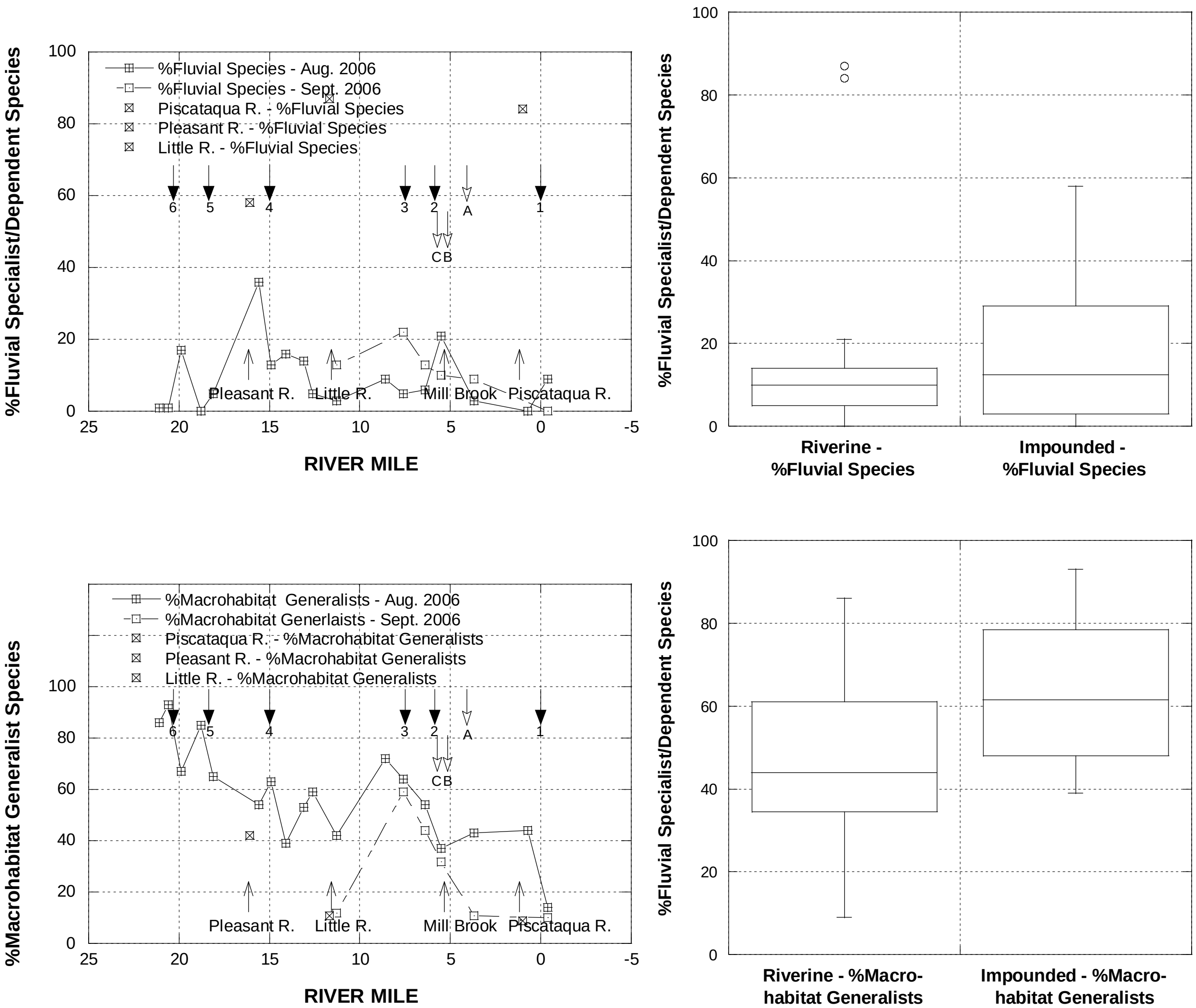


*Figure 32. Upper Left: Proportion of fluvial specialist and dependent species in the Presumpscot R. mainstem, August and September 2006. Lower Left: Proportion of macrohabitat generalist species in the Presumpscot R. mainstem, August and September 2006. Upper Right: Proportion of fluvial specialist and dependent species at riverine and impounded sites. Lower Right: Proportion of macrohabitat generalist species at riverine and impounded sites. Letters and numbers denote dams and major point sources (see study area description Table 2).*

can be indicative of instream pollution and other stressor gradients (Yoder and Smith 1999). As such it indicates potential issues in the mainstem beginning at the Dundee Dam downstream to the Little River confluence and the segment between Cumberland Mills Dam and Presumpscot Falls. The pattern in the latter is generally indicative of an organic enrichment type of impact and it was most evident in the August results. In terms of how the MIwb results correspond to the BCG, most sites were representative of tiers V and many declined to tier VI. Only a few mainstem sites and the tributaries were indicative of tier IV. The interquartile range of the MIwb in the mainstem was the lowest of any river in the state (Yoder et al. 2008), but the range was the widest.

The comparison of riverine and impounded sites (Figure 33) showed widely overlapping results even though the median at the impounded sites (5.1) was higher than the riverine

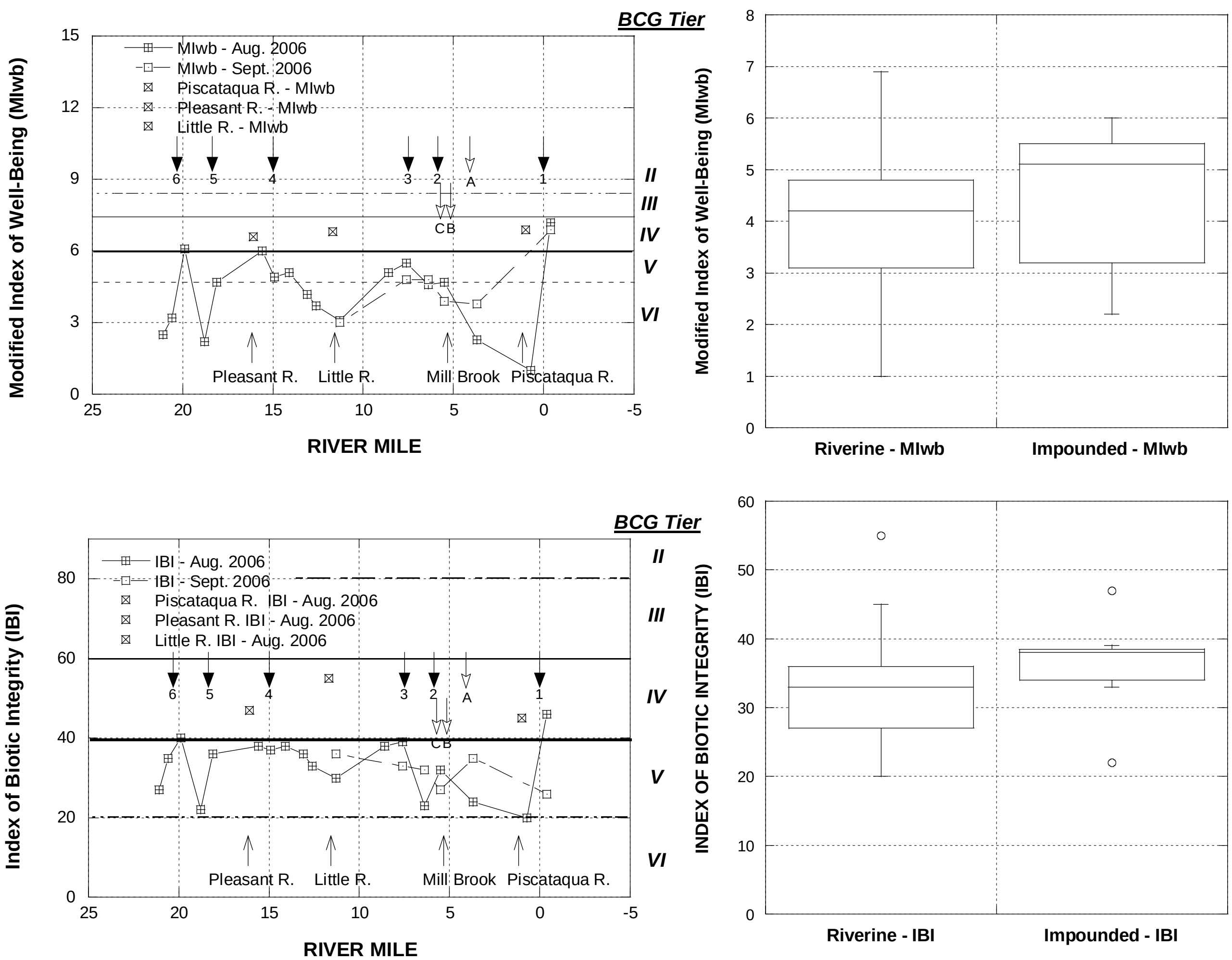


*Figure 33. Upper Left: Modified Index of Well-Being (MIwb) in the Presumpscot R. mainstem, August and September 2006. Lower Left: Interim Maine Rivers IBI in the Presumpscot R. mainstem, August and September 2006. Upper Right: Modified Index of Well-Being (MIwb) at riverine and impounded sites. Lower Right: Interim Maine Rivers IBI at riverine and impounded sites. Letters and numbers denote dams and major point sources (see study area description Table 2).*

sites (4.2). Some riverine sites were both much higher and lower than the impounded range and were likely unrelated to habitat alone.

***Interim Index of Biotic Integrity (IBI)***

The interim Maine Rivers IBI and metric values are depicted in Table 6 and are the basis for the analysis that follows. We focused on the 2006 results since these were generated by data collected within the seasonal index period of July 1 – September 30. The 2007 results are based on data collected outside of the index period, hence these results were not included in the discussion below.

The interim Maine Rivers IBI (Figure 33) also showed a longitudinal pattern similar to the MIwb and its underlying parameters, but in a more compressed overall performance range. The pollution/stressor gradients that were exhibited by the MIwb were also evident in the IBI, especially in the segment between Cumberland Mills Dam and Presumpscot Falls in August. Also as with the MIwb, most of the results were indicative of BCG tier V conditions, but no sites were in tier VI. The three tributaries were representative of tier IV and had the highest quality assemblages in the study area as measured by the interim IBI.

Some metrics had 0 values and scored at or near 0 (out of a possible 10) and included stenothermic species, native salmonids, and benthic insectivores (Table 6). The species that make up these metrics were absent throughout the Presumpscot study area and are generally either absent or in low abundance throughout southern and central Maine (Yoder et al. 2006b). These species may be present in selected smaller streams of the region, but they have been virtually eliminated as sustainable populations in the large mainstem rivers and in response to the extensive modifications that took place over the past two centuries. Other metrics exhibited longitudinally variable results and included cyprinids and white and longnose sucker adults. DELT anomalies were observed at only two mainstem locations, downstream from Mallison Falls (RM 12.6) and immediately downstream from Cumberland Mills Dam (RM 6.4), both during August. The values were high enough to result in very low metric scores, but their comparative isolation indicates that they are localized in terms of magnitude.

The comparison between the riverine and impounded sites (Figure 33) showed overlapping results with a higher median IBI in the impounded sites (38) than at the riverine sites (33). The range in the riverine sites was wider and was more indicative of the potential pollution impacts than habitat alone.

## SYNTHESIS AND DISCUSSION

The overall results reveal a mainstem fish assemblage that is minimally attaining BCG tier IV conditions at only a few isolated sites. This approximates the minimally acceptable condition for meeting the goals of the Clean Water Act and more importantly reflects minimal conditions for a sustainable aquatic resource. The fish assemblage at most sites performed below this benchmark condition and reflected the extensively modified

**Table 6. Maine IBI scores and metrics at boat sites in Presumpscot River mainstem and tributaries in 2006 and 2007.**

| | | | | | Number of | | | | Percent of Individuals | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| River Mile | Type | Date | Distance (meters) | Drainage area (sq mi) | Total Native♦ species | Steno-therm species | Alien species | Non-Guard. Litho-phils | Cyp-rinids** | Native Salmonids | Benthic Insect-vores | Black Basses | Fluvial Specialist | Macrohab. Generalists | White & Longnose Sucker (PB) | DELT anomalies | IBI | Modified Iwb |
| Presumpscot River - (20001) | | | | | | | | | | | | | | | | | | |
| Year: 2006 | | | | | | | | | | | | | | | | | | |
| 21.10 | P | 08/14/2006 | 1000 | 445 | 5( 1.7) | 0( 0.0) | 2( 3.6) | 1( 3.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 35( 2.3) | 1( 2.8) | 86( 0.8) | 0( 0.0) | 0.0(10.0) | **20** | 2.5 |
| 20.60 | A | 08/14/2006 | 1000 | 446 | 8( 4.2) | 0( 0.0) | 2( 3.6) | 1( 3.0) | 1( 4.5) | 0( 0.0) | 0( 0.0) | 22( 3.4) | 1( 2.8) | 93( 0.0) | 0( 0.0) | 0.0(10.0) | **26** | 3.2 |
| 19.90 | A | 08/14/2006 | 1000 | 446 | 6( 2.5) | 1( 7.2) | 2( 3.6) | 2( 5.7) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 59( 1.0) | 17( 4.0) | 67( 2.6) | 37( 6.3) | 0.0(10.0) | **36** | 6.1 |
| 18.80 | A | 08/14/2006 | 1000 | 448 | 4( 0.9) | 0( 0.0) | 2( 3.6) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 32( 2.5) | 0( 0.0) | 85( 0.8) | 0( 0.0) | 0.0(10.0) | **15** | 2.2 |
| 18.10 | A | 08/15/2006 | 1000 | 449 | 8( 4.2) | 0( 0.0) | 2( 3.6) | 1( 3.0) | 0( 4.5) | 0( 0.0) | 0( 0.0) | 29( 2.8) | 5( 3.1) | 65( 2.8) | 14( 4.8) | 0.0(10.0) | **32** | 4.7 |
| 15.60 | A | 08/15/2006 | 1000 | 523 | 10( 5.8) | 0( 0.0) | 3( 1.7) | 1( 3.0) | 6( 5.1) | 0( 0.0) | 0( 0.0) | 6( 6.5) | 36( 5.4) | 54( 3.8) | 6( 4.1) | 0.0(10.0) | **38** | 6.0 |
| 14.90 | A | 08/15/2006 | 1000 | 524 | 8( 4.2) | 0( 0.0) | 3( 1.7) | 2( 5.7) | 5( 5.0) | 0( 0.0) | 0( 0.0) | 36( 2.2) | 13( 3.7) | 63( 2.9) | 7( 4.2) | 0.0(10.0) | **33** | 4.9 |
| 14.10 | A | 08/16/2006 | 1000 | 524 | 9( 5.0) | 0( 0.0) | 2( 3.6) | 2( 5.7) | 19( 6.4) | 0( 0.0) | 0( 0.0) | 11( 5.1) | 16( 3.9) | 39( 5.2) | 0( 0.0) | 0.0(10.0) | **37** | 5.1 |
| 13.10 | A | 08/16/2006 | 1000 | 529 | 5( 1.7) | 0( 0.0) | 2( 3.6) | 2( 5.7) | 11( 5.6) | 0( 0.0) | 0( 0.0) | 40( 2.0) | 14( 3.8) | 53( 3.9) | 6( 4.1) | 0.0(10.0) | **34** | 4.2 |
| 12.60 | A | 08/16/2006 | 1000 | 529 | 7( 3.3) | 0( 0.0) | 2( 3.6) | 2( 5.7) | 19( 6.3) | 0( 0.0) | 0( 0.0) | 34( 2.3) | 5( 3.2) | 59( 3.4) | 0( 0.0) | 1.5( 0.8) | **24** | 3.7 |
| 11.30 | A | 08/16/2006 | 1000 | 586 | 6( 2.5) | 0( 0.0) | 2( 3.6) | 1( 3.0) | 10( 5.5) | 0( 0.0) | 0( 0.0) | 21( 3.6) | 3( 3.0) | 42( 4.9) | 0( 0.0) | 0.0(10.0) | **30** | 3.1 |
| 11.30 | A | 09/26/2006 | 1000 | 586 | 4( 0.9) | 0( 0.0) | 1( 6.0) | 2( 5.7) | 10( 5.5) | 0( 0.0) | 0( 0.0) | 12( 4.9) | 13( 3.7) | 12( 7.8) | 9( 4.4) | 0.0(10.0) | **41** | 3.0 |
| 8.60 | A | 08/16/2006 | 1000 | 594 | 8( 4.2) | 0( 0.0) | 2( 3.6) | 2( 5.7) | 24( 6.7) | 0( 0.0) | 0( 0.0) | 14( 4.5) | 9( 3.4) | 72( 2.0) | 0( 0.0) | 0.0(10.0) | **33** | 5.1 |
| 7.60 | A | 08/18/2006 | 1000 | 595 | 8( 4.2) | 0( 0.0) | 3( 1.7) | 2( 5.7) | 13( 5.8) | 0( 0.0) | 0( 0.0) | 20( 3.7) | 5( 3.1) | 64( 2.8) | 25( 5.5) | 0.0(10.0) | **35** | 5.5 |
| 7.60 | A | 09/25/2006 | 1000 | 595 | 6( 2.5) | 0( 0.0) | 2( 3.6) | 1( 3.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 29( 2.7) | 22( 4.4) | 59( 3.4) | 60( 7.6) | 0.0(10.0) | **31** | 4.8 |
| 6.40 | A | 08/17/2006 | 1000 | 596 | 4( 0.9) | 0( 0.0) | 1( 6.0) | 1( 3.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 51( 1.4) | 6( 3.2) | 54( 3.8) | 33( 6.1) | 1.2( 1.0) | **21** | 4.6 |
| 6.40 | A | 09/26/2006 | 1000 | 596 | 4( 0.9) | 0( 0.0) | 1( 6.0) | 1( 3.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 41( 1.9) | 13( 3.7) | 44( 4.8) | 50( 7.1) | 0.0(10.0) | **31** | 4.8 |
| 5.50 | A | 08/17/2006 | 1000 | 598 | 5( 1.7) | 0( 0.0) | 1( 6.0) | 1( 3.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 35( 2.3) | 21( 4.3) | 37( 5.5) | 35( 6.2) | 0.0(10.0) | **33** | 4.7 |
| 5.50 | A | 09/26/2006 | 1000 | 598 | 4( 0.9) | 0( 0.0) | 2( 3.6) | 1( 3.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 29( 2.7) | 10( 3.5) | 32( 5.9) | 8( 4.3) | 0.0(10.0) | **28** | 3.9 |
| 3.70 | A | 08/17/2006 | 1000 | 613 | 3( 0.0) | 0( 0.0) | 1( 6.0) | 1( 3.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 36( 2.2) | 3( 3.0) | 43( 4.9) | 0( 0.0) | 0.0(10.0) | **24** | 2.3 |
| 3.70 | A | 09/26/2006 | 1000 | 613 | 6( 2.5) | 1( 7.2) | 3( 1.7) | 1( 3.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 7( 6.3) | 9( 3.4) | 11( 7.9) | 28( 5.7) | 0.0(10.0) | **40** | 3.8 |
| 0.70 | A | 08/17/2006 | 1000 | 641 | 3( 0.0) | 0( 0.0) | 1( 6.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 29( 2.8) | 0( 0.0) | 44( 4.8) | 0( 0.0) | 0.0(10.0) | **20** | 1.9 |
| Year: 2007 | | | | | | | | | | | | | | | | | | |
| 7.40 | A | 05/29/2007 | 1000 | 595 | 4( 0.9) | 0( 0.0) | 1( 6.0) | 1( 3.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 27( 2.9) | 13( 3.8) | 44( 4.7) | 38( 6.4) | 0.0(10.0) | **31** | 4.3 |

* - Native species and intra-state introduced species
** - Excludes fallfish

**Table 6. continued.**

| River Mile | Type | Date | Distance (meters) | Drainage area (sq mi) | Number of: Total Native♦ species | Number of: Steno-therm species | Number of: Alien species | Number of: Non-Guard. Litho-phils | Percent of Individuals: Cyp-rinids** | Percent of Individuals: Native Salmonids | Percent of Individuals: Benthic Insect-vores | Percent of Individuals: Black Basses | Percent of Individuals: Fluvial Specialist | Percent of Individuals: Macrohab. Generalists | White & Longnose Sucker (PB) | DELT anomalies | IBI | Modified Iwb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7.40 | A | 05/30/2007 | 1000 | 595 | 3( 0.0) | 0( 0.0) | 1( 6.0) | 1( 3.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 37( 2.1) | 23( 4.5) | 37( 5.5) | 47( 6.9) | 3.3( 0.5) | **24** | 4.1 |
| 6.40 | A | 05/30/2007 | 1000 | 596 | 6( 2.5) | 1( 7.2) | 2( 3.6) | 2( 5.7) | 2( 4.7) | 0( 0.0) | 0( 0.0) | 33( 2.4) | 15( 3.9) | 33( 5.9) | 25( 5.5) | 4.3( 0.3) | **35** | 5.0 |
| 6.40 | A | 06/01/2007 | 1000 | 596 | 6( 2.5) | 0( 0.0) | 1( 6.0) | 1( 3.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 30( 2.7) | 15( 3.9) | 33( 5.8) | 21( 5.2) | 7.4( 0.1) | **24** | 4.7 |
| 5.40 | A | 05/30/2007 | 1000 | 598 | 3( 0.0) | 1( 7.2) | 2( 3.6) | 1( 3.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 32( 2.5) | 7( 3.3) | 43( 4.9) | 20( 5.2) | 3.6( 0.4) | **25** | 2.7 |
| 5.40 | A | 06/01/2007 | 1000 | 598 | 5( 1.7) | 1( 7.2) | 2( 3.6) | 1( 3.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 31( 2.5) | 19( 4.1) | 34( 5.7) | 45( 6.8) | 6.3( 0.2) | **29** | 4.9 |
| 3.70 | A | 05/30/2007 | 1000 | 613 | 3( 0.0) | 1( 7.2) | 2( 3.6) | 1( 3.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 7( 6.1) | 15( 3.9) | 26( 6.5) | 52( 7.2) | 0.0(10.0) | **40** | 3.4 |
| 3.70 | A | 06/01/2007 | 1000 | 613 | 4( 0.9) | 0( 0.0) | 1( 6.0) | 1( 3.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 25( 3.1) | 17( 4.0) | 42( 5.0) | 17( 5.0) | 0.0(10.0) | **31** | 4.2 |
| 0.70 | A | 05/30/2007 | 1000 | 641 | 4( 0.9) | 1( 7.2) | 2( 3.6) | 1( 3.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 38( 2.0) | 27( 4.7) | 42( 4.9) | 42( 6.6) | 3.8( 0.4) | **28** | 4.7 |
| 0.70 | A | 06/01/2007 | 1000 | 641 | 4( 0.9) | 1( 7.2) | 2( 3.6) | 1( 3.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 38( 2.1) | 8( 3.4) | 39( 5.2) | 43( 6.7) | 0.0(10.0) | **35** | 5.2 |
| 0.10 | A | 05/29/2007 | 1000 | 642 | 5( 1.7) | 0( 0.0) | 0(10.0) | 1( 3.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 0(10.0) | 2( 3.5) | 0(10.0) | 0( 0.0) | 0.0(10.0) | **40** | 6.8 |
| 0.10 | A | 05/31/2007 | 1000 | 642 | 5( 1.7) | 0( 0.0) | 1( 6.0) | 1( 3.0) | 2( 4.7) | 0( 0.0) | 0( 0.0) | 5( 7.1) | 2( 3.0) | 7( 8.3) | 0( 0.0) | 0.0(10.0) | **37** | 5.2 |
| Piscataqua River - (20100) | | | | | | | | | | | | | | | | | | |
| Year: 2006 | | | | | | | | | | | | | | | | | | |
| 1.00 | P | 08/17/2006 | 500 | 21 | 10( 5.8) | 1( 7.2) | 3( 1.7) | 2( 5.7) | 38( 7.8) | 0( 0.0) | 0( 0.0) | 5( 7.2) | 84( 8.9) | 9( 8.1) | 0( 0.0) | 0.2( 1.7) | **45** | 6.9 |
| Pleasant River - (20200) | | | | | | | | | | | | | | | | | | |
| Year: 2006 | | | | | | | | | | | | | | | | | | |
| 1.00 | P | 08/15/2006 | 750 | 63 | 9( 5.0) | 0( 0.0) | 2( 3.6) | 2( 5.7) | 39( 7.8) | 0( 0.0) | 0( 0.0) | 6( 6.4) | 58( 7.0) | 42( 5.0) | 27( 5.7) | 0.0(10.0) | **47** | 6.6 |
| Little River - (20300) | | | | | | | | | | | | | | | | | | |
| Year: 2006 | | | | | | | | | | | | | | | | | | |
| 1.00 | P | 08/16/2006 | 1000 | 50 | 11( 6.6) | 2( 8.4) | 3( 1.7) | 2( 5.7) | 69( 9.3) | 0( 9.5) | 0( 0.0) | 9( 5.5) | 87( 9.1) | 11( 7.9) | 0( 0.0) | 0.1( 2.0) | **55** | 6.8 |
| Presumpscot R. - dst. Falls - (21001) | | | | | | | | | | | | | | | | | | |
| Year: 2006 | | | | | | | | | | | | | | | | | | |
| 0.40 | A | 08/18/2006 | 1000 | 642 | 13( 8.3) | 1( 7.2) | 2( 3.6) | 4( 8.4) | 9( 5.4) | 0( 0.0) | 0( 0.0) | 6( 6.4) | 9( 3.4) | 14( 7.7) | 0( 0.0) | 0.0(10.0) | **50** | 7.2 |
| 0.40 | A | 09/27/2006 | 1000 | 642 | 9( 5.0) | 0( 0.0) | 2( 3.6) | 1( 3.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 4( 7.9) | 0( 0.0) | 10( 8.0) | 0( 0.0) | 0.0(10.0) | **31** | 6.9 |
| Year: 2007 | | | | | | | | | | | | | | | | | | |
| 0.40 | A | 06/01/2007 | 1000 | 642 | 5( 1.7) | 0( 0.0) | 1( 6.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 0( 0.0) | 14( 4.6) | 0( 0.0) | 14( 7.7) | 0( 0.0) | 1.5( 0.8) | **17** | 5.8 |

* - Native species and intra-state introduced species
** - Excludes fallfish

character of the entire study area. The fish assemblage in the three tributaries consistently performed within tier IV revealing fewer impacts due to hydrological and water quality related alterations. The Presumpscot mainstem fish assemblage is among the lowest quality in Maine in terms of the IBI and MIwb (Figures 34 and 35). Yoder et al. (2008) depicted the statewide results by 19 major river segments within which the Presumpscot mainstem ranked $17^{th}$ (ranked by 75%ile value) in terms of the IBI and $19^{th}$ in terms of the MIwb.

Habitat modification was mostly in the form of impoundment by dams and hydroelectric projects, but the net result in terms of habitat quality was not as severe as that noted in other Maine Rivers. However, the intensity of the impoundment and the accompanying interruption of longitudinal connectivity by eight dams have created an overlying and extensive hydrological alteration that likely masks other potential impacts. However, two river segments stood out in terms of comparative departures along the mainstem. A decline to tier V (IBI) and tier VI (MIwb) conditions occurred between the Mallison Falls Dam and Sacarappa Falls, with recovery to borderline tier IV (IBI) and tier V (MIwb) conditions occurring between Sacarappa Falls and Cumberland Mills Dam. A more distinct decline occurred below Cumberland Mills Dam with the assemblage indices reaching their lowest values just upstream from Presumpscot Falls. Furthermore this decline was much more accentuated in August than in late September. Water quality impacts can exert their most serious impacts during the summer months when flows are lower and temperatures are at their highest. This segment is also subjected to the largest permitted loadings of pollutants, in this case suspended solids and oxygen demanding wastes. The trend in both the IBI and especially the MIwb parallel what could be expected in terms of a "D.O. sag" effect. While no marginal D.O. values were measured during the fish sampling, this does not rule out an effect from these loadings which may include modes other than oxygen demand. This is an area of continuing study by Maine DEP. As a result of the initial observations made by this study in 2006, Maine DEP undertook a cumulative effects assessment (CEA) in this segment of the Presumpscot River in 2007. Since the Presumpscot is much smaller than the Androscoggin, Kennebec, and Penobscot (where previous CEA studies had detected impacts from paper mills) and consequently wastewater is a larger proportion of the river flow these discharges would be more likely to have an effect on fish populations (Maine DEP 2008). The initial results were not conclusive with regard to isolating a specific source, but Maine DEP (2008) agrees about the potential for an impact to the fish assemblage. Further study of this segment is recommended to better diagnose potential stressors and their sources.

Although not a primary objective of this study, the potential for reestablishing diadromous fisheries is within our analyses. Based on the presence of several diadromous species between Cumberland Mills Dam and Presumpscot Falls, the issue of access by these species is settled. Given also that upstream reaches have reasonably good to excellent habitat, this too favors the conclusion that the Presumpscot mainstem has the inherent potential to support a diverse diadromous fishery. Fish passage is obviously the most important issue to address at this point, but long term concerns should focus on better understanding potential pollution sources in the aforementioned segments.

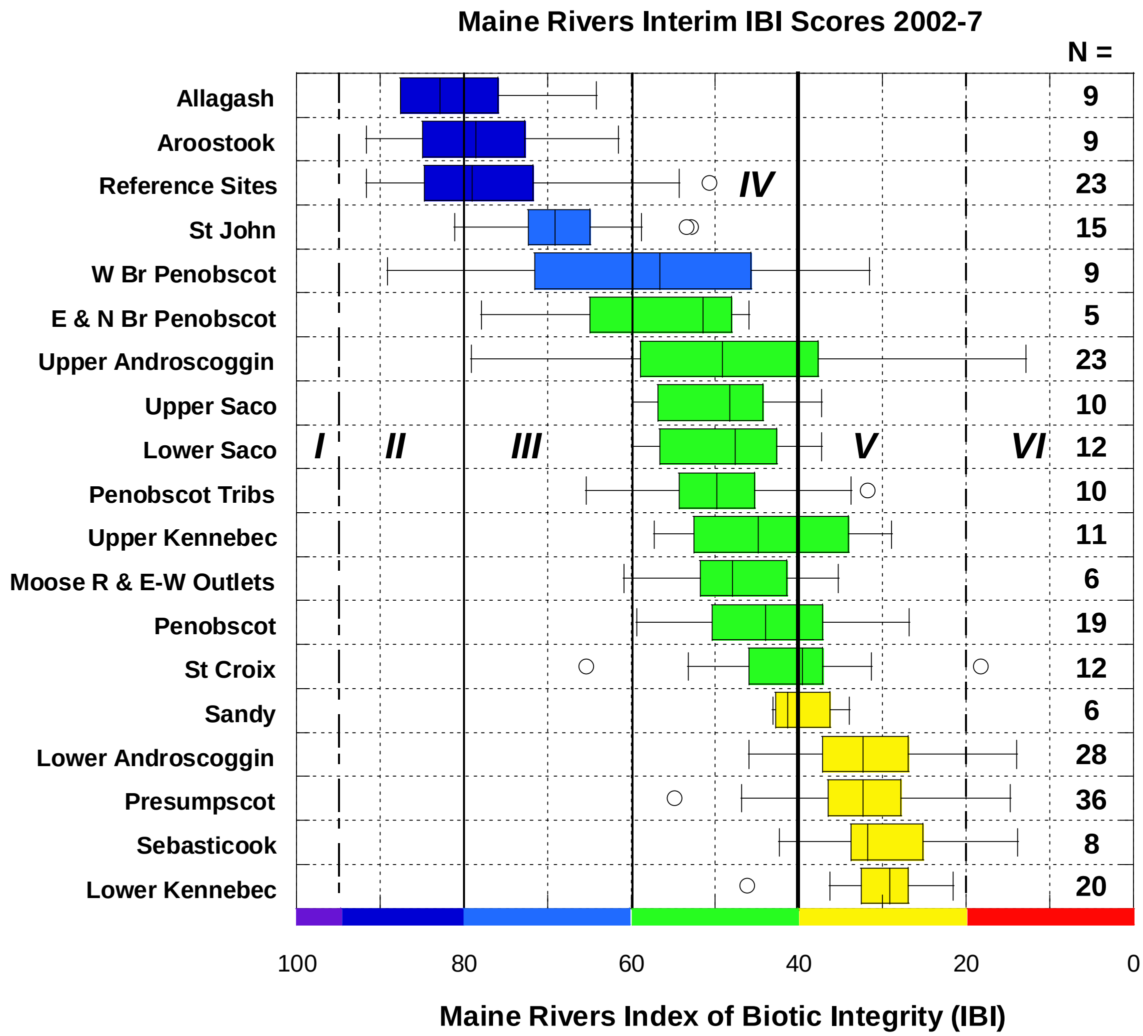


*Figure 34. Box-and-whisker plots of interim Maine river IBI values by major river segment arranged by 75th percentile values from highest to lowest (N for each river segment is shown). The approximate BCG tiers (I-VI) represented by ranges of the interim IBI are depicted along the y-axis (purple – tier I; dark blue – tier II; blue – tier III; green – tier IV; yellow – tier V: red – tier VI). After Yoder et al. (2008).*

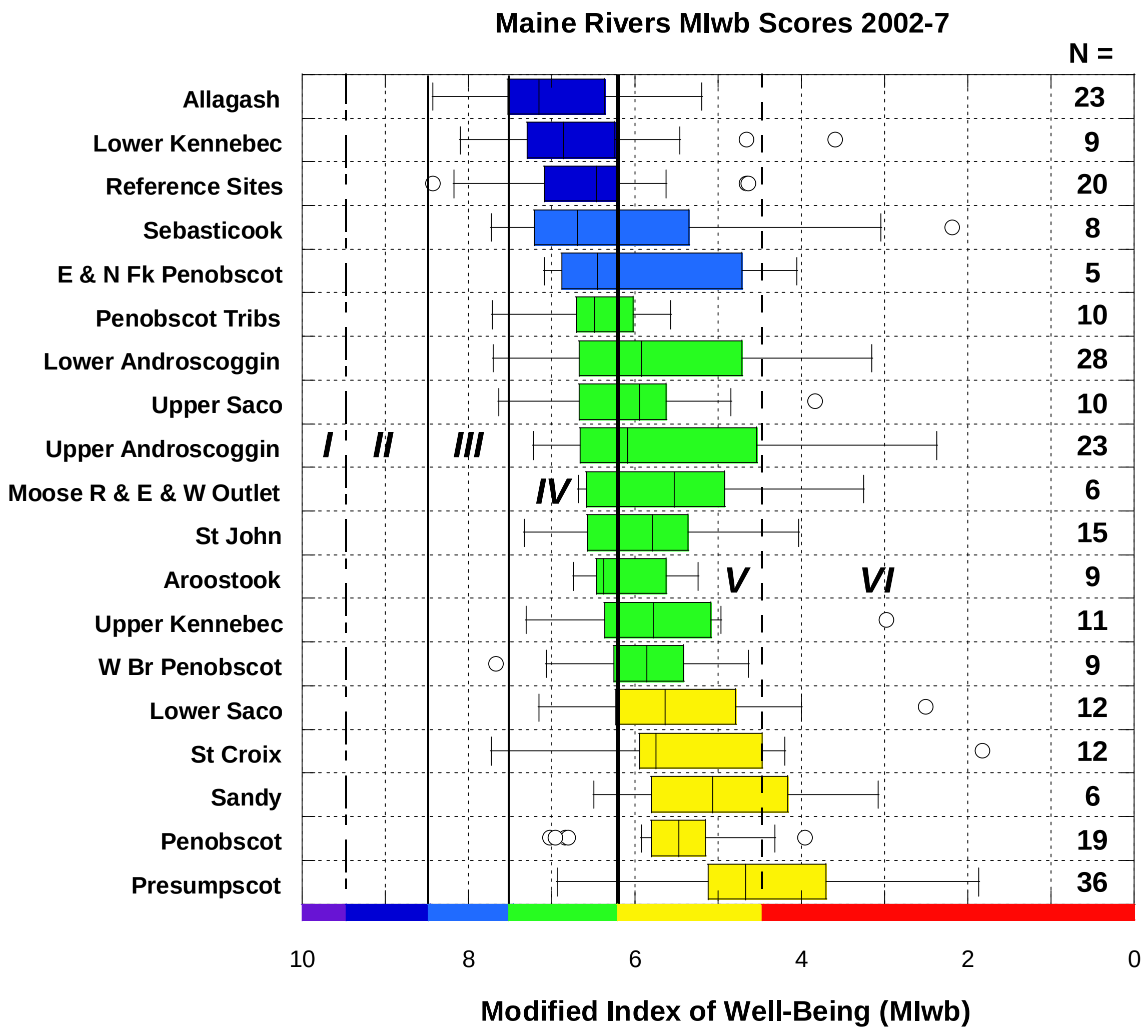


*Figure 35. Box-and-whisker plots of modified Index of Well-Being (MIwb) values by major river segment arranged by 75th percentile values from highest to lowest (N for each river segment is shown). The approximate BCG tiers (I-VI) represented by ranges of the interim IBI are depicted along the y-axis (purple – tier I; dark blue – tier II; blue – tier III: green – tier IV: yellow – tier V: red – tier VI). After Yoder et al. (2008).*

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# Fish Assemblage and Habitat Assessment of the Presumpscot River

# Appendix A

## Species Data by Date and Location

**August-September 2006**
**May-June 2007**

| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **08/14/2006** |
|---|---|---|---|
| River Mile: **21.10** | Location: | | Invalid Sample: |
| Time Fished: 4083 sec | Drainage: 445.4 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: P |
| | Lat: 43.817250 | Long: -70.448830 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Chain Pickerel | E | P | MG | | 1 | 1.00 | 0.96 | 0.00 | 0.01 | 1.00 |
| White Sucker | W | O | MG | T | 1 | 1.00 | 0.96 | 0.25 | 1.80 | 250.00 |
| American Eel | | C | C | | 14 | 14.00 | 13.46 | 6.03 | 43.41 | 430.36 |
| Smallmouth Bass | F | C | MG | M | 27 | 27.00 | 25.96 | 5.86 | 42.21 | 216.96 |
| Largemouth Bass | F | C | MG | | 9 | 9.00 | 8.65 | 0.27 | 1.95 | 30.00 |
| Pumpkinseed Sunfish | S | I | MG | P | 36 | 36.00 | 34.62 | 1.05 | 7.59 | 29.28 |
| Yellow Perch | | | MG | | 16 | 16.00 | 15.38 | 0.42 | 3.03 | 26.25 |
| *Date Total* | | | | | 104 | 104.00 | | 13.88 | | |
| *Number of Species* | | | | | 7 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | | |
|---|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **08/14/2006** |
| River Mile: **20.60** | Location: | | Invalid Sample: |
| Time Fished: 5120 sec | Drainage: 446.0 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.817250 | Long: -70.448830 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Chain Pickerel | E | P | MG | | 2 | 2.00 | 1.39 | 0.50 | 6.65 | 250.00 |
| White Sucker | W | O | MG | T | 1 | 1.00 | 0.69 | 0.34 | 4.52 | 340.00 |
| Golden Shiner | N | I | MG | T | 1 | 1.00 | 0.69 | 0.03 | 0.40 | 30.00 |
| Brown Bullhead | | I | MG | T | 1 | 1.00 | 0.69 | 0.18 | 2.39 | 180.00 |
| American Eel | | C | C | | 9 | 9.00 | 6.25 | 1.94 | 25.79 | 215.56 |
| White Perch | E | | MG | | 3 | 3.00 | 2.08 | 0.17 | 2.26 | 56.67 |
| Smallmouth Bass | F | C | MG | M | 12 | 12.00 | 8.33 | 1.06 | 14.09 | 88.33 |
| Largemouth Bass | F | C | MG | | 20 | 20.00 | 13.89 | 0.81 | 10.70 | 40.27 |
| Pumpkinseed Sunfish | S | I | MG | P | 79 | 79.00 | 54.86 | 2.07 | 27.45 | 26.14 |
| Yellow Perch | | | MG | | 16 | 16.00 | 11.11 | 0.43 | 5.74 | 27.00 |
| *Date Total* | | | | | 144 | 144.00 | | 7.52 | | |
| *Number of Species* | | | | | 10 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | | |
|---|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **08/14/2006** |
| River Mile: **19.90** | Location: | | Invalid Sample: |
| Time Fished: 4671 sec | Drainage: 446.4 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.801880 | Long: -70.449630 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| White Sucker | W | O | MG | T | 23 | 23.00 | 14.20 | 29.11 | 47.42 | 1,265.65 |
| Brown Bullhead | | I | MG | T | 1 | 1.00 | 0.62 | 0.02 | 0.03 | 16.00 |
| American Eel | | C | C | | 27 | 27.00 | 16.67 | 10.74 | 17.49 | 397.65 |
| Burbot | | | B | | 4 | 4.00 | 2.47 | 0.77 | 1.25 | 192.00 |
| Smallmouth Bass | F | C | MG | M | 85 | 85.00 | 52.47 | 11.18 | 18.21 | 131.49 |
| Largemouth Bass | F | C | MG | | 11 | 11.00 | 6.79 | 9.04 | 14.72 | 821.36 |
| Pumpkinseed Sunfish | S | I | MG | P | 10 | 10.00 | 6.17 | 0.52 | 0.85 | 52.30 |
| Yellow Perch | | | MG | | 1 | 1.00 | 0.62 | 0.02 | 0.03 | 20.00 |
| *Date Total* | | | | | 162 | 162.00 | | 61.39 | | |
| *Number of Species* | | | | | 8 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | | |
|---|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **08/14/2006** |
| River Mile: **18.80** | Location: | | Invalid Sample: |
| Time Fished: 4051 sec | Drainage: 448.8 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.788660 | Long: -70.451500 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Brown Bullhead | | I | MG | T | 1 | 1.00 | 0.99 | 0.00 | 0.03 | 2.00 |
| American Eel | | C | C | | 15 | 15.00 | 14.85 | 4.80 | 64.59 | 320.00 |
| Smallmouth Bass | F | C | MG | M | 13 | 13.00 | 12.87 | 0.12 | 1.56 | 8.92 |
| Largemouth Bass | F | C | MG | | 19 | 19.00 | 18.81 | 1.81 | 24.30 | 95.05 |
| Pumpkinseed Sunfish | S | I | MG | P | 45 | 45.00 | 44.55 | 0.61 | 8.14 | 13.44 |
| Yellow Perch | | | MG | | 8 | 8.00 | 7.92 | 0.10 | 1.39 | 12.88 |
| | | *Date Total* | | | 101 | 101.00 | | 7.43 | | |
| | | *Number of Species* | | | 6 | | | | | |
| | | *Number of Hybrids* | | | 0 | | | | | |

| | | | |
|---|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **08/15/2006** |
| River Mile: **18.10** | Location: | | Invalid Sample: |
| Time Fished: 4830 sec | Drainage: 449.8 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.779690 | Long: -70.452550 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Chain Pickerel | E | P | MG | | 9 | 9.00 | 4.23 | 0.04 | 0.14 | 4.44 |
| White Sucker | W | O | MG | T | 9 | 9.00 | 4.23 | 3.50 | 12.50 | 388.89 |
| Golden Shiner | N | I | MG | T | 1 | 1.00 | 0.47 | 0.00 | 0.01 | 4.00 |
| Fallfish | N | | FD | | 1 | 1.00 | 0.47 | 0.07 | 0.25 | 70.00 |
| Brown Bullhead | | I | MG | T | 4 | 4.00 | 1.88 | 0.37 | 1.32 | 92.50 |
| American Eel | | C | C | | 65 | 65.00 | 30.52 | 15.27 | 54.52 | 234.90 |
| Smallmouth Bass | F | C | MG | M | 49 | 49.00 | 23.00 | 6.98 | 24.93 | 142.45 |
| Largemouth Bass | F | C | MG | | 12 | 12.00 | 5.63 | 0.28 | 1.00 | 23.33 |
| Pumpkinseed Sunfish | S | I | MG | P | 30 | 30.00 | 14.08 | 1.01 | 3.61 | 33.67 |
| Yellow Perch | | | MG | | 33 | 33.00 | 15.49 | 0.48 | 1.71 | 14.55 |
| *Date Total* | | | | | 213 | 213.00 | | 28.00 | | |
| *Number of Species* | | | | | 10 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| River Code: | **20-001** | Stream: | **Presumpscot River** | Sample Date: | **08/15/2006** |
| River Mile: | **15.60** | Location: | | Invalid Sample: | |
| Time Fished: | 6173 sec | Drainage: | 523.4 sq mi | Depth: | Data Source: 01 |
| Dist Fished: | 1.00 km | Basin: | | Flow: C | Sampler Type: A |
| | | Lat: | 43.752000 | Long: | -70.448000 |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Chain Pickerel | E | P | MG | | 11 | 11.00 | 2.64 | 1.49 | 8.60 | 135.45 |
| White Sucker | W | O | MG | T | 3 | 3.00 | 0.72 | 1.30 | 7.51 | 433.33 |
| Golden Shiner | N | I | MG | T | 24 | 24.00 | 5.77 | 0.31 | 1.78 | 12.83 |
| Bridle Shiner | N | I | MG | R | 3 | 3.00 | 0.72 | 0.00 | 0.02 | 1.33 |
| Fallfish | N | | FD | | 148 | 148.00 | 35.58 | 0.28 | 1.64 | 1.92 |
| Brown Bullhead | | I | MG | T | 2 | 2.00 | 0.48 | 0.42 | 2.43 | 210.00 |
| American Eel | | C | C | | 40 | 40.00 | 9.62 | 9.24 | 53.35 | 230.95 |
| Eastern Banded Killifish | E | I | MG | T | 1 | 1.00 | 0.24 | 0.01 | 0.06 | 10.00 |
| Black Crappie | S | I | MG | | 3 | 3.00 | 0.72 | 0.01 | 0.05 | 3.00 |
| Smallmouth Bass | F | C | MG | M | 3 | 3.00 | 0.72 | 0.18 | 1.05 | 60.67 |
| Largemouth Bass | F | C | MG | | 23 | 23.00 | 5.53 | 0.77 | 4.42 | 33.30 |
| Pumpkinseed Sunfish | S | I | MG | P | 96 | 96.00 | 23.08 | 1.50 | 8.64 | 15.58 |
| Yellow Perch | | | MG | | 59 | 59.00 | 14.18 | 1.81 | 10.45 | 30.68 |
| *Date Total* | | | | | 416 | 416.00 | | 17.32 | | |
| *Number of Species* | | | | | 13 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| River Code: 20-001 | Stream: **Presumpscot River** | | Sample Date: **08/15/2006** |
|---|---|---|---|
| River Mile: **14.90** | Location: | | Invalid Sample: |
| Time Fished: 3659 sec | Drainage: 524.3 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.745410 | Long: -70.439520 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Chain Pickerel | E | P | MG | | 1 | 1.00 | 0.97 | 0.11 | 0.69 | 105.00 |
| White Sucker | W | O | MG | T | 9 | 9.00 | 8.74 | 2.36 | 15.42 | 262.22 |
| Golden Shiner | N | I | MG | T | 1 | 1.00 | 0.97 | 0.03 | 0.21 | 32.00 |
| Common Shiner | N | I | FD | | 4 | 4.00 | 3.88 | 0.00 | 0.03 | 1.00 |
| Brown Bullhead | | I | MG | T | 5 | 5.00 | 4.85 | 0.90 | 5.85 | 179.00 |
| American Eel | | C | C | | 25 | 25.00 | 24.27 | 7.37 | 48.18 | 294.93 |
| Black Crappie | S | I | MG | | 2 | 2.00 | 1.94 | 0.08 | 0.51 | 39.00 |
| Smallmouth Bass | F | C | MG | M | 36 | 36.00 | 34.95 | 3.69 | 24.12 | 102.56 |
| Largemouth Bass | F | C | MG | | 1 | 1.00 | 0.97 | 0.00 | 0.01 | 2.00 |
| Pumpkinseed Sunfish | S | I | MG | P | 17 | 17.00 | 16.50 | 0.56 | 3.68 | 33.12 |
| Yellow Perch | | | MG | | 2 | 2.00 | 1.94 | 0.20 | 1.31 | 100.00 |
| *Date Total* | | | | | 103 | 103.00 | | 15.30 | | |
| *Number of Species* | | | | | 11 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| River Code: 20-001 | Stream: **Presumpscot River** | Sample Date: **08/16/2006** |
|---|---|---|
| River Mile: **14.10** | Location: | Invalid Sample: |
| Time Fished: 3829 sec | Drainage: 524.6 sq mi    Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin:    Flow: C | Sampler Type: A |
| | Lat: 43.740580    Long: -70.435360 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Chain Pickerel | E | P | MG | | 1 | 1.00 | 0.47 | 0.07 | 0.47 | 65.00 |
| White Sucker | W | O | MG | T | 20 | 20.00 | 9.43 | 2.56 | 18.45 | 128.00 |
| Golden Shiner | N | I | MG | T | 27 | 27.00 | 12.74 | 0.41 | 2.92 | 15.00 |
| Common Shiner | N | I | FD | | 14 | 14.00 | 6.60 | 0.03 | 0.22 | 2.14 |
| Brown Bullhead | | I | MG | T | 4 | 4.00 | 1.89 | 0.52 | 3.78 | 131.00 |
| American Eel | | C | C | | 95 | 95.00 | 44.81 | 9.11 | 65.64 | 95.87 |
| Eastern Banded Killifish | E | I | MG | T | 1 | 1.00 | 0.47 | 0.00 | 0.03 | 4.00 |
| Smallmouth Bass | F | C | MG | M | 12 | 12.00 | 5.66 | 0.80 | 5.76 | 66.58 |
| Largemouth Bass | F | C | MG | | 11 | 11.00 | 5.19 | 0.16 | 1.15 | 14.55 |
| Pumpkinseed Sunfish | S | I | MG | P | 23 | 23.00 | 10.85 | 0.17 | 1.19 | 7.17 |
| Yellow Perch | | | MG | | 4 | 4.00 | 1.89 | 0.06 | 0.40 | 13.75 |
| *Date Total* | | | | | 212 | 212.00 | | 13.88 | | |
| *Number of Species* | | | | | 11 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **08/16/2006** |
|---|---|---|---|
| River Mile: **13.10** | Location: | | Invalid Sample: |
| Time Fished: 4957 sec | Drainage: 529.9 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.726190 | Long: -70.418610 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| White Sucker | W | O | MG | T | 6 | 6.00 | 3.59 | 1.09 | 6.69 | 181.67 |
| Common Shiner | N | I | FD | | 18 | 18.00 | 10.78 | 0.07 | 0.43 | 3.89 |
| American Eel | | C | C | | 55 | 55.00 | 32.93 | 8.37 | 51.35 | 152.12 |
| Smallmouth Bass | F | C | MG | M | 64 | 64.00 | 38.32 | 4.49 | 27.54 | 70.11 |
| Largemouth Bass | F | C | MG | | 2 | 2.00 | 1.20 | 1.82 | 11.17 | 910.00 |
| Pumpkinseed Sunfish | S | I | MG | P | 20 | 20.00 | 11.98 | 0.45 | 2.76 | 22.50 |
| Yellow Perch | | | MG | | 2 | 2.00 | 1.20 | 0.01 | 0.06 | 4.50 |
| *Date Total* | | | | | 167 | 167.00 | | 16.29 | | |
| *Number of Species* | | | | | 7 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | | |
|---|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **08/16/2006** |
| River Mile: **12.60** | Location: | | Invalid Sample: |
| Time Fished: 5070 sec | Drainage: 529.9 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.726190 | Long: -70.418610 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| White Sucker | W | O | MG | T | 5 | 5.00 | 3.76 | 0.46 | 3.49 | 92.00 |
| Golden Shiner | N | I | MG | T | 23 | 23.00 | 17.29 | 0.56 | 4.25 | 24.35 |
| Common Shiner | N | I | FD | | 2 | 2.00 | 1.50 | 0.04 | 0.27 | 17.50 |
| Brown Bullhead | | I | MG | T | 2 | 2.00 | 1.50 | 0.69 | 5.24 | 345.00 |
| American Eel | | C | C | | 48 | 48.00 | 36.09 | 8.51 | 64.65 | 177.37 |
| Smallmouth Bass | F | C | MG | M | 41 | 41.00 | 30.83 | 2.50 | 18.94 | 60.85 |
| Largemouth Bass | F | C | MG | | 4 | 4.00 | 3.01 | 0.24 | 1.78 | 58.75 |
| Pumpkinseed Sunfish | S | I | MG | P | 7 | 7.00 | 5.26 | 0.18 | 1.35 | 25.43 |
| Yellow Perch | | | MG | | 1 | 1.00 | 0.75 | 0.00 | 0.02 | 3.00 |
| | *Date Total* | | | | 133 | 133.00 | | 13.17 | | |
| | *Number of Species* | | | | 9 | | | | | |
| | *Number of Hybrids* | | | | 0 | | | | | |

| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **08/16/2006** |
|---|---|---|---|
| River Mile: **11.30** | Location: | | Invalid Sample: |
| Time Fished: 3457 sec | Drainage: 586.9 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.715860 | Long: -70.405910 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Chain Pickerel | E | P | MG | | 1 | 1.00 | 1.37 | 0.34 | 5.88 | 340.00 |
| White Sucker | W | O | MG | T | 2 | 2.00 | 2.74 | 0.22 | 3.81 | 110.00 |
| Golden Shiner | N | I | MG | T | 7 | 7.00 | 9.59 | 0.15 | 2.60 | 21.43 |
| American Eel | | C | C | | 40 | 40.00 | 54.79 | 3.21 | 55.53 | 80.21 |
| Smallmouth Bass | F | C | MG | M | 14 | 14.00 | 19.18 | 1.42 | 24.49 | 101.07 |
| Largemouth Bass | F | C | MG | | 1 | 1.00 | 1.37 | 0.09 | 1.47 | 85.00 |
| Pumpkinseed Sunfish | S | I | MG | P | 6 | 6.00 | 8.22 | 0.23 | 3.98 | 38.33 |
| Yellow Perch | | | MG | | 2 | 2.00 | 2.74 | 0.13 | 2.25 | 65.00 |
| *Date Total* | | | | | 73 | 73.00 | | 5.78 | | |
| *Number of Species* | | | | | 8 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | | |
|---|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **09/26/2006** |
| River Mile: **11.30** | Location: | | Invalid Sample: |
| Time Fished: 3222 sec | Drainage: 586.9 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.715860 | Long: -70.405910 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Alewife | E | | A | | 1 | 1.00 | 0.80 | 0.03 | 0.27 | 30.00 |
| White Sucker | W | O | MG | T | 3 | 3.00 | 2.40 | 0.99 | 8.79 | 330.00 |
| Common Shiner | N | I | FD | | 13 | 13.00 | 10.40 | 0.01 | 0.09 | 0.77 |
| American Eel | | C | C | | 93 | 93.00 | 74.40 | 9.32 | 82.69 | 100.16 |
| Smallmouth Bass | F | C | MG | M | 15 | 15.00 | 12.00 | 0.92 | 8.17 | 61.33 |
| *Date Total* | | | | | 125 | 125.00 | | 11.27 | | |
| *Number of Species* | | | | | 5 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | | |
|---|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **08/16/2006** |
| River Mile: **8.60** | Location: | | Invalid Sample: |
| Time Fished: 3381 sec | Drainage: 594.5 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.690770 | Long: -70.378440 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Chain Pickerel | E | P | MG | | 6 | 6.00 | 5.50 | 0.41 | 12.36 | 67.50 |
| White Sucker | W | O | MG | T | 1 | 1.00 | 0.92 | 0.15 | 4.58 | 150.00 |
| Golden Shiner | N | I | MG | T | 17 | 17.00 | 15.60 | 0.34 | 10.38 | 20.00 |
| Common Shiner | N | I | FD | | 9 | 9.00 | 8.26 | 0.03 | 0.92 | 3.33 |
| Brown Bullhead | | I | MG | T | 1 | 1.00 | 0.92 | 0.07 | 2.14 | 70.00 |
| American Eel | | C | C | | 20 | 20.00 | 18.35 | 0.77 | 23.47 | 38.46 |
| Smallmouth Bass | F | C | MG | M | 5 | 5.00 | 4.59 | 0.53 | 16.18 | 106.00 |
| Largemouth Bass | F | C | MG | | 10 | 10.00 | 9.17 | 0.16 | 4.88 | 16.00 |
| Pumpkinseed Sunfish | S | I | MG | P | 30 | 30.00 | 27.52 | 0.77 | 23.38 | 25.53 |
| Yellow Perch | | | MG | | 10 | 10.00 | 9.17 | 0.06 | 1.71 | 5.56 |
| *Date Total* | | | | | 109 | 109.00 | | 3.28 | | |
| *Number of Species* | | | | | 10 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | |
|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | Sample Date: **08/18/2006** |
| River Mile: **7.60** | Location: | Invalid Sample: |
| Time Fished: 5198 sec | Drainage: 595.5 sq mi Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: Flow: C | Sampler Type: A |
| | Lat: 43.677860 Long: -70.366380 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Chain Pickerel | E | P | MG | | 7 | 7.00 | 3.41 | 0.60 | 2.50 | 86.00 |
| White Sucker | W | O | MG | T | 7 | 7.00 | 3.41 | 7.84 | 32.58 | 1,119.71 |
| Golden Shiner | N | I | MG | T | 25 | 25.00 | 12.20 | 0.84 | 3.49 | 33.60 |
| Common Shiner | N | I | FD | | 2 | 2.00 | 0.98 | 0.03 | 0.11 | 13.50 |
| Fallfish | N | | FD | | 1 | 1.00 | 0.49 | 0.03 | 0.10 | 25.00 |
| American Eel | | C | C | | 63 | 63.00 | 30.73 | 9.72 | 40.40 | 154.25 |
| Black Crappie | S | I | MG | | 1 | 1.00 | 0.49 | 0.00 | 0.01 | 3.00 |
| Smallmouth Bass | F | C | MG | M | 32 | 32.00 | 15.61 | 2.20 | 9.16 | 68.88 |
| Largemouth Bass | F | C | MG | | 8 | 8.00 | 3.90 | 0.65 | 2.69 | 81.00 |
| Pumpkinseed Sunfish | S | I | MG | P | 43 | 43.00 | 20.98 | 2.09 | 8.69 | 48.60 |
| Yellow Perch | | | MG | | 16 | 16.00 | 7.80 | 0.06 | 0.25 | 3.75 |
| | *Date Total* | | | | 205 | 205.00 | | 24.06 | | |
| | *Number of Species* | | | | 11 | | | | | |
| | *Number of Hybrids* | | | | 0 | | | | | |

| | | | |
|---|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **09/25/2006** |
| River Mile: **7.60** | Location: | | Invalid Sample: |
| Time Fished: 3081 sec | Drainage: 595.5 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.677860 | Long: -70.366380 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Chain Pickerel | E | P | MG | | 1 | 1.00 | 2.44 | 0.05 | 0.50 | 50.00 |
| White Sucker | W | O | MG | T | 6 | 6.00 | 14.63 | 6.92 | 69.30 | 1,153.33 |
| Fallfish | N | | FD | | 3 | 3.00 | 7.32 | 0.00 | 0.03 | 1.00 |
| American Eel | | C | C | | 8 | 8.00 | 19.51 | 1.64 | 16.42 | 205.00 |
| Smallmouth Bass | F | C | MG | M | 11 | 11.00 | 26.83 | 0.95 | 9.49 | 86.18 |
| Largemouth Bass | F | C | MG | | 1 | 1.00 | 2.44 | 0.00 | 0.04 | 4.00 |
| Pumpkinseed Sunfish | S | I | MG | P | 9 | 9.00 | 21.95 | 0.41 | 4.11 | 45.56 |
| Yellow Perch | | | MG | | 2 | 2.00 | 4.88 | 0.01 | 0.10 | 5.00 |
| *Date Total* | | | | | 41 | 41.00 | | 9.99 | | |
| *Number of Species* | | | | | 8 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | |
|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | Sample Date: **05/29/2007** |
| River Mile: **7.40** | Location: | Invalid Sample: |
| Time Fished: 4106 sec | Drainage: 595.8 sq mi Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: Flow: C | Sampler Type: A |
| | Lat: 43.677860 Long: -70.366380 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| White Sucker | W | O | MG | T | 6 | 6.00 | 11.54 | 4.30 | 41.17 | 716.83 |
| Fallfish | N | | FD | | 1 | 1.00 | 1.92 | 0.03 | 0.28 | 29.00 |
| American Eel | | C | C | | 22 | 22.00 | 42.31 | 3.04 | 29.10 | 138.18 |
| Smallmouth Bass | F | C | MG | M | 14 | 14.00 | 26.92 | 2.61 | 25.02 | 186.71 |
| Pumpkinseed Sunfish | S | I | MG | P | 9 | 9.00 | 17.31 | 0.46 | 4.43 | 51.44 |
| *Date Total* | | | | | 52 | 52.00 | | 10.45 | | |
| *Number of Species* | | | | | 5 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | |
|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | Sample Date: **05/30/2007** |
| River Mile: **7.40** | Location: | Invalid Sample: |
| Time Fished: 3241 sec | Drainage: 595.8 sq mi Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: Flow: C | Sampler Type: A |
| | Lat: 43.677860 Long: -70.366380 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| White Sucker | W | O | MG | T | 5 | 5.00 | 16.67 | 6.51 | 61.21 | 1,302.00 |
| Fallfish | N | | FD | | 2 | 2.00 | 6.67 | 0.03 | 0.28 | 15.00 |
| American Eel | | C | C | | 12 | 12.00 | 40.00 | 1.38 | 12.98 | 115.00 |
| Smallmouth Bass | F | C | MG | M | 11 | 11.00 | 36.67 | 2.72 | 25.53 | 246.82 |
| *Date Total* | | | | | 30 | 30.00 | | 10.64 | | |
| *Number of Species* | | | | | 4 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

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|---|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **08/17/2006** |
| River Mile: **6.40** | Location: | | Invalid Sample: |
| Time Fished: 4479 sec | Drainage: 596.5 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.684000 | Long: -70.351000 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| American Shad | N | P | A | | 3 | 3.00 | 3.53 | 2.02 | 13.42 | 673.33 |
| White Sucker | W | O | MG | T | 5 | 5.00 | 5.88 | 5.75 | 38.19 | 1,150.00 |
| American Eel | | C | C | | 31 | 31.00 | 36.47 | 3.01 | 19.99 | 97.10 |
| Smallmouth Bass | F | C | MG | M | 43 | 43.00 | 50.59 | 3.89 | 25.85 | 90.49 |
| Yellow Perch | | | MG | | 3 | 3.00 | 3.53 | 0.38 | 2.55 | 128.00 |
| *Date Total* | | | | | 85 | 85.00 | | 15.06 | | |
| *Number of Species* | | | | | 5 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | | |
|---|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **09/26/2006** |
| River Mile: **6.40** | Location: | | Invalid Sample: |
| Time Fished: 4002 sec | Drainage: 596.5 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.684000 | Long: -70.351000 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| White Sucker | W | O | MG | T | 13 | 13.00 | 10.74 | 16.40 | 62.96 | 1,261.54 |
| Fallfish | N | | FD | | 3 | 3.00 | 2.48 | 0.00 | 0.01 | 1.00 |
| American Eel | | C | C | | 52 | 52.00 | 42.98 | 6.53 | 25.05 | 125.50 |
| Smallmouth Bass | F | C | MG | M | 50 | 50.00 | 41.32 | 2.95 | 11.32 | 58.98 |
| Pumpkinseed Sunfish | S | I | MG | P | 3 | 3.00 | 2.48 | 0.17 | 0.65 | 56.67 |
| *Date Total* | | | | | 121 | 121.00 | | 26.05 | | |
| *Number of Species* | | | | | 5 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | | |
|---|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **05/30/2007** |
| River Mile: **6.40** | Location: | | Invalid Sample: |
| Time Fished: 3744 sec | Drainage: 596.5 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.684000 | Long: -70.351000 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Alewife | E | | A | | 3 | 3.00 | 6.52 | 0.70 | 5.89 | 233.33 |
| American Shad | N | P | A | | 1 | 1.00 | 2.17 | 0.98 | 8.24 | 980.00 |
| Brown Trout | E | | FS | | 2 | 2.00 | 4.35 | 0.86 | 7.23 | 430.00 |
| White Sucker | W | O | MG | T | 3 | 3.00 | 6.52 | 4.82 | 40.55 | 1,606.67 |
| Common Shiner | N | I | FD | | 1 | 1.00 | 2.17 | 0.02 | 0.13 | 15.00 |
| Fallfish | N | | FD | | 1 | 1.00 | 2.17 | 0.01 | 0.08 | 10.00 |
| American Eel | | C | C | | 20 | 20.00 | 43.48 | 3.44 | 28.94 | 172.00 |
| Smallmouth Bass | F | C | MG | M | 15 | 15.00 | 32.61 | 1.06 | 8.94 | 70.87 |
| *Date Total* | | | | | 46 | 46.00 | | 11.89 | | |
| *Number of Species* | | | | | 8 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | | |
|---|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **06/01/2007** |
| River Mile: **6.40** | Location: | | Invalid Sample: |
| Time Fished: 2469 sec | Drainage: 596.5 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.684000 | Long: -70.351000 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Alewife | E | | A | | 1 | 1.00 | 3.70 | 0.26 | 2.62 | 255.00 |
| American Shad | N | P | A | | 1 | 1.00 | 3.70 | 2.30 | 23.63 | 2,300.00 |
| White Sucker | W | O | MG | T | 3 | 3.00 | 11.11 | 2.81 | 28.89 | 937.33 |
| Fallfish | N | | FD | | 1 | 1.00 | 3.70 | 0.00 | 0.02 | 2.00 |
| American Eel | | C | C | | 12 | 12.00 | 44.44 | 1.92 | 19.72 | 160.00 |
| Smallmouth Bass | F | C | MG | M | 8 | 8.00 | 29.63 | 2.43 | 24.96 | 303.75 |
| Pumpkinseed Sunfish | S | I | MG | P | 1 | 1.00 | 3.70 | 0.02 | 0.15 | 15.00 |
| *Date Total* | | | | | 27 | 27.00 | | 9.73 | | |
| *Number of Species* | | | | | 7 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | |
|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | Sample Date: **08/17/2006** |
| River Mile: **5.50** | Location: | Invalid Sample: |
| Time Fished: 4096 sec | Drainage: 598.1 sq mi Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: Flow: C | Sampler Type: A |
| | Lat: 43.689528 Long: -70.336250 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| American Shad | N | P | A | | 1 | 1.00 | 1.92 | 0.00 | 0.02 | 2.00 |
| White Sucker | W | O | MG | T | 4 | 4.00 | 7.69 | 5.83 | 51.18 | 1,457.50 |
| Fallfish | N | | FD | | 7 | 7.00 | 13.46 | 0.42 | 3.69 | 60.00 |
| American Eel | | C | C | | 21 | 21.00 | 40.38 | 1.95 | 17.12 | 92.86 |
| Smallmouth Bass | F | C | MG | M | 18 | 18.00 | 34.62 | 3.12 | 27.38 | 173.28 |
| Pumpkinseed Sunfish | S | I | MG | P | 1 | 1.00 | 1.92 | 0.07 | 0.61 | 70.00 |
| *Date Total* | | | | | 52 | 52.00 | | 11.39 | | |
| *Number of Species* | | | | | 6 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | |
|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | Sample Date: **09/26/2006** |
| River Mile: **5.50** | Location: | Invalid Sample: |
| Time Fished: 3732 sec | Drainage: 598.1 sq mi    Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin:    Flow: C | Sampler Type: A |
| | Lat: 43.689528    Long: -70.336250 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| White Sucker | W | O | MG | T | 14 | 14.00 | 10.45 | 2.36 | 19.12 | 168.43 |
| American Eel | | C | C | | 77 | 77.00 | 57.46 | 6.65 | 53.95 | 86.41 |
| Smallmouth Bass | F | C | MG | M | 35 | 35.00 | 26.12 | 3.05 | 24.77 | 87.26 |
| Largemouth Bass | F | C | MG | | 4 | 4.00 | 2.99 | 0.05 | 0.39 | 12.00 |
| Pumpkinseed Sunfish | S | I | MG | P | 3 | 3.00 | 2.24 | 0.21 | 1.70 | 70.00 |
| Yellow Perch | | | MG | | 1 | 1.00 | 0.75 | 0.01 | 0.06 | 8.00 |
| | *Date Total* | | | | 134 | 134.00 | | 12.33 | | |
| | *Number of Species* | | | | 6 | | | | | |
| | *Number of Hybrids* | | | | 0 | | | | | |

| River Code: 20-001 | Stream: **Presumpscot River** | | Sample Date: **05/30/2007** |
|---|---|---|---|
| River Mile: **5.40** | Location: | | Invalid Sample: |
| Time Fished: 3865 sec | Drainage: 598.1 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.689528 | Long: -70.336250 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Brown Trout | E | | FS | | 1 | 1.00 | 3.57 | 0.50 | 10.21 | 500.00 |
| White Sucker | W | O | MG | T | 1 | 1.00 | 3.57 | 1.50 | 30.64 | 1,500.00 |
| American Eel | | C | C | | 14 | 14.00 | 50.00 | 2.21 | 45.15 | 157.86 |
| Smallmouth Bass | F | C | MG | M | 9 | 9.00 | 32.14 | 0.50 | 10.11 | 55.00 |
| Pumpkinseed Sunfish | S | I | MG | P | 3 | 3.00 | 10.71 | 0.19 | 3.88 | 63.33 |
| *Date Total* | | | | | 28 | 28.00 | | 4.90 | | |
| *Number of Species* | | | | | 5 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| River Code: 20-001 | Stream: Presumpscot River | | Sample Date: 06/01/2007 |
|---|---|---|---|
| River Mile: 5.40 | Location: | | Invalid Sample: |
| Time Fished: 2793 sec | Drainage: 598.1 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.689528 | Long: -70.336250 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Alewife | E | | A | | 4 | 4.00 | 12.50 | 1.14 | 12.83 | 285.00 |
| Rainbow Trout | E | | FD | | 1 | 1.00 | 3.13 | 0.51 | 5.74 | 510.00 |
| Chain Pickerel | E | P | MG | | 1 | 1.00 | 3.13 | 0.16 | 1.75 | 155.00 |
| White Sucker | W | O | MG | T | 4 | 4.00 | 12.50 | 5.16 | 58.10 | 1,290.00 |
| Fallfish | N | | FD | | 1 | 1.00 | 3.13 | 0.19 | 2.08 | 185.00 |
| American Eel | | C | C | | 11 | 11.00 | 34.38 | 1.29 | 14.52 | 117.27 |
| Smallmouth Bass | F | C | MG | M | 10 | 10.00 | 31.25 | 0.44 | 4.98 | 44.20 |
| *Date Total* | | | | | 32 | 32.00 | | 8.88 | | |
| *Number of Species* | | | | | 7 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | | |
|---|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **08/17/2006** |
| River Mile: **3.70** | Location: | | Invalid Sample: |
| Time Fished: 3894 sec | Drainage: 613.5 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.706630 | Long: -70.323270 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| White Sucker | W | O | MG | T | 2 | 2.00 | 3.28 | 0.46 | 6.33 | 230.00 |
| American Eel | | C | C | | 33 | 33.00 | 54.10 | 4.44 | 61.07 | 134.55 |
| Smallmouth Bass | F | C | MG | M | 22 | 22.00 | 36.07 | 2.14 | 29.44 | 97.27 |
| Pumpkinseed Sunfish | S | I | MG | P | 4 | 4.00 | 6.56 | 0.23 | 3.16 | 57.50 |
| *Date Total* | | | | | 61 | 61.00 | | 7.27 | | |
| *Number of Species* | | | | | 4 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | | |
|---|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **09/26/2006** |
| River Mile: **3.70** | Location: | | Invalid Sample: |
| Time Fished: 3944 sec | Drainage: 613.5 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.706630 | Long: -70.323270 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Alewife | E | | A | | 2 | 2.00 | 1.50 | 0.01 | 0.06 | 4.00 |
| Brown Trout | E | | FS | | 1 | 1.00 | 0.75 | 0.18 | 1.21 | 176.00 |
| Chain Pickerel | E | P | MG | | 1 | 1.00 | 0.75 | 0.05 | 0.33 | 48.00 |
| White Sucker | W | O | MG | T | 11 | 11.00 | 8.27 | 3.82 | 26.33 | 347.27 |
| American Eel | | C | C | | 104 | 104.00 | 78.20 | 9.95 | 68.55 | 95.63 |
| Smallmouth Bass | F | C | MG | M | 7 | 7.00 | 5.26 | 0.34 | 2.36 | 48.86 |
| Largemouth Bass | F | C | MG | | 2 | 2.00 | 1.50 | 0.02 | 0.12 | 9.00 |
| Pumpkinseed Sunfish | S | I | MG | P | 4 | 4.00 | 3.01 | 0.14 | 0.97 | 35.25 |
| Yellow Perch | | | MG | | 1 | 1.00 | 0.75 | 0.01 | 0.07 | 10.00 |
| *Date Total* | | | | | 133 | 133.00 | | 14.51 | | |
| *Number of Species* | | | | | 9 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | | |
|---|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **05/30/2007** |
| River Mile: **3.70** | Location: | | Invalid Sample: |
| Time Fished: 3831 sec | Drainage: 613.5 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.706630 | Long: -70.323270 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Brown Trout | E | | FS | | 1 | 1.00 | 3.70 | 0.53 | 9.04 | 525.00 |
| White Sucker | W | O | MG | T | 3 | 3.00 | 11.11 | 3.78 | 65.06 | 1,260.00 |
| American Eel | | C | C | | 16 | 16.00 | 59.26 | 1.28 | 22.03 | 80.00 |
| Smallmouth Bass | F | C | MG | M | 2 | 2.00 | 7.41 | 0.18 | 3.08 | 89.50 |
| Pumpkinseed Sunfish | S | I | MG | P | 5 | 5.00 | 18.52 | 0.05 | 0.79 | 9.20 |
| | *Date Total* | | | | 27 | 27.00 | | 5.81 | | |
| | *Number of Species* | | | | 5 | | | | | |
| | *Number of Hybrids* | | | | 0 | | | | | |

| | | | |
|---|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **06/01/2007** |
| River Mile: **3.70** | Location: | | Invalid Sample: |
| Time Fished: 3100 sec | Drainage: 613.5 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.706630 | Long: -70.323270 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Alewife | E | | A | | 1 | 1.00 | 4.17 | 2.03 | 35.47 | 2,030.00 |
| White Sucker | W | O | MG | T | 4 | 4.00 | 16.67 | 1.79 | 31.28 | 447.50 |
| American Eel | | C | C | | 9 | 9.00 | 37.50 | 1.49 | 26.04 | 165.56 |
| Smallmouth Bass | F | C | MG | M | 6 | 6.00 | 25.00 | 0.19 | 3.23 | 30.83 |
| Pumpkinseed Sunfish | S | I | MG | P | 4 | 4.00 | 16.67 | 0.23 | 3.98 | 57.00 |
| *Date Total* | | | | | 24 | 24.00 | | 5.72 | | |
| *Number of Species* | | | | | 5 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| River Code: 20-001 | Stream: Presumpscot River | | Sample Date: 08/17/2006 |
|---|---|---|---|
| River Mile: 0.70 | Location: | | Invalid Sample: |
| Time Fished: 4227 sec | Drainage: 641.5 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.728190 | Long: -70.284650 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| American Shad | N | P | A | | 1 | 1.00 | 1.19 | 0.00 | 0.05 | 3.00 |
| American Eel | | C | C | | 46 | 46.00 | 54.76 | 3.07 | 54.83 | 66.67 |
| Smallmouth Bass | F | C | MG | M | 24 | 24.00 | 28.57 | 2.23 | 39.94 | 93.08 |
| Pumpkinseed Sunfish | S | I | MG | P | 13 | 13.00 | 15.48 | 0.29 | 5.18 | 22.31 |
| *Date Total* | | | | | 84 | 84.00 | | 5.59 | | |
| *Number of Species* | | | | | 4 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **05/30/2007** |
|---|---|---|---|
| River Mile: **0.70** | Location: | | Invalid Sample: |
| Time Fished: 2810 sec | Drainage: 641.5 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.728190 | Long: -70.284650 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Alewife | E | | A | | 3 | 3.00 | 11.54 | 1.80 | 18.88 | 600.00 |
| Brown Trout | E | | FS | | 3 | 3.00 | 11.54 | 0.61 | 6.34 | 201.67 |
| White Sucker | W | O | MG | T | 4 | 4.00 | 15.38 | 5.81 | 60.93 | 1,452.50 |
| American Eel | | C | C | | 5 | 5.00 | 19.23 | 0.50 | 5.24 | 100.00 |
| Smallmouth Bass | F | C | MG | M | 10 | 10.00 | 38.46 | 0.82 | 8.60 | 82.00 |
| Pumpkinseed Sunfish | S | I | MG | P | 1 | 1.00 | 3.85 | 0.00 | 0.01 | 1.00 |
| | *Date Total* | | | | 26 | 26.00 | | 9.54 | | |
| | *Number of Species* | | | | 6 | | | | | |
| | *Number of Hybrids* | | | | 0 | | | | | |

| | | | |
|---|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **06/01/2007** |
| River Mile: **0.70** | Location: | | Invalid Sample: |
| Time Fished: 2918 sec | Drainage: 641.5 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.728190 | Long: -70.284650 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Alewife | E | | A | | 17 | 17.00 | 27.87 | 3.25 | 35.25 | 191.18 |
| Brown Trout | E | | FS | | 1 | 1.00 | 1.64 | 0.08 | 0.87 | 80.00 |
| White Sucker | W | O | MG | T | 4 | 4.00 | 6.56 | 3.40 | 36.87 | 850.00 |
| American Eel | | C | C | | 15 | 15.00 | 24.59 | 0.86 | 9.33 | 57.33 |
| Smallmouth Bass | F | C | MG | M | 23 | 23.00 | 37.70 | 1.62 | 17.58 | 70.48 |
| Pumpkinseed Sunfish | S | I | MG | P | 1 | 1.00 | 1.64 | 0.01 | 0.11 | 10.00 |
| | *Date Total* | | | | 61 | 61.00 | | 9.22 | | |
| | *Number of Species* | | | | 6 | | | | | |
| | *Number of Hybrids* | | | | 0 | | | | | |

| River Code: 20-001 | Stream: **Presumpscot River** | | Sample Date: **05/29/2007** |
|---|---|---|---|
| River Mile: **0.10** | Location: | | Invalid Sample: |
| Time Fished: 2874 sec | Drainage: 642.3 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.715690 | Long: -70.258900 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Alewife | E | | A | | 36 | 36.00 | 34.95 | 7.10 | 8.40 | 197.22 |
| American Shad | N | P | A | | 26 | 26.00 | 25.24 | 17.63 | 20.85 | 678.08 |
| White Sucker | W | O | MG | T | 2 | 2.00 | 1.94 | 0.19 | 0.23 | 97.00 |
| American Eel | | C | C | | 15 | 15.00 | 14.56 | 2.32 | 2.74 | 154.51 |
| Striped Bass | E | P | A | | 24 | 24.00 | 23.30 | 57.30 | 67.78 | 2,387.50 |
| *Date Total* | | | | | 103 | 103.00 | | 84.54 | | |
| *Number of Species* | | | | | 5 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| River Code: **20-001** | Stream: **Presumpscot River** | | Sample Date: **05/31/2007** |
|---|---|---|---|
| River Mile: **0.10** | Location: | | Invalid Sample: |
| Time Fished: 2620 sec | Drainage: 642.3 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.715690 | Long: -70.258900 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| White Sucker | W | O | MG | T | 1 | 1.00 | 2.44 | 0.03 | 0.06 | 30.00 |
| Golden Shiner | N | I | MG | T | 1 | 1.00 | 2.44 | 0.00 | 0.00 | 1.00 |
| American Eel | | C | C | | 12 | 12.00 | 29.27 | 1.12 | 2.10 | 93.33 |
| Atlantic Tomcod | | | | | 9 | 9.00 | 21.95 | 1.50 | 2.80 | 166.11 |
| Striped Bass | E | P | A | | 16 | 16.00 | 39.02 | 50.62 | 94.87 | 3,163.75 |
| Smallmouth Bass | F | C | MG | M | 2 | 2.00 | 4.88 | 0.09 | 0.17 | 46.50 |
| *Date Total* | | | | | 41 | 41.00 | | 53.36 | | |
| *Number of Species* | | | | | 6 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| River Code: **20-100** | Stream: **Piscataqua River** | | Sample Date: **08/17/2006** |
|---|---|---|---|
| River Mile: **1.00** | Location: | | Invalid Sample: |
| Time Fished: 2883 sec | Drainage: 21.2 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 0.50 km | Basin: | Flow: C | Sampler Type: P |
| | Lat: 43.734583 | Long: -70.287060 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Alewife | E | | A | | 2 | 4.00 | 0.50 | 0.01 | 0.03 | 1.50 |
| Brown Trout | E | | FS | | 1 | 2.00 | 0.25 | 0.46 | 2.34 | 228.00 |
| White Sucker | W | O | MG | T | 181 | 362.00 | 44.91 | 7.78 | 39.93 | 21.50 |
| Golden Shiner | N | I | MG | T | 2 | 4.00 | 0.50 | 0.01 | 0.06 | 3.00 |
| Creek Chub | N | G | FS | T | 1 | 2.00 | 0.25 | 0.00 | 0.01 | 1.00 |
| Common Shiner | N | I | FD | | 151 | 302.00 | 37.47 | 0.30 | 1.55 | 1.00 |
| Fallfish | N | | FD | | 4 | 8.00 | 0.99 | 0.01 | 0.04 | 1.00 |
| American Eel | | C | C | | 26 | 52.00 | 6.45 | 7.82 | 40.13 | 150.40 |
| Smallmouth Bass | F | C | MG | M | 12 | 24.00 | 2.98 | 2.76 | 14.15 | 114.92 |
| Largemouth Bass | F | C | MG | | 7 | 14.00 | 1.74 | 0.13 | 0.68 | 9.43 |
| Pumpkinseed Sunfish | S | I | MG | P | 5 | 10.00 | 1.24 | 0.11 | 0.58 | 11.40 |
| Yellow Perch | | | MG | | 6 | 12.00 | 1.49 | 0.09 | 0.45 | 7.33 |
| Nine-spine Stickleback | | | TS | | 5 | 10.00 | 1.24 | 0.01 | 0.04 | 0.80 |
| | *Date Total* | | | | 403 | 806.00 | | 19.49 | | |
| | *Number of Species* | | | | 13 | | | | | |
| | *Number of Hybrids* | | | | 0 | | | | | |

| | | | |
|---|---|---|---|
| River Code: **20-200** | Stream: **Pleasant River** | | Sample Date: **08/15/2006** |
| River Mile: **1.00** | Location: | | Invalid Sample: |
| Time Fished: 5022 sec | Drainage: 63.4 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 0.75 km | Basin: | Flow: C | Sampler Type: P |
| | Lat: 43.770883 | Long: -70.434600 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Chain Pickerel | E | P | MG | | 2 | 2.67 | 0.85 | 0.03 | 0.29 | 10.50 |
| White Sucker | W | O | MG | T | 37 | 49.33 | 15.81 | 4.76 | 48.82 | 96.43 |
| Golden Shiner | N | I | MG | T | 4 | 5.33 | 1.71 | 0.03 | 0.26 | 4.75 |
| Common Shiner | N | I | FD | | 87 | 116.00 | 37.18 | 0.46 | 4.68 | 3.93 |
| Fallfish | N | | FD | | 11 | 14.67 | 4.70 | 0.36 | 3.72 | 24.73 |
| Brown Bullhead | | I | MG | T | 2 | 2.67 | 0.85 | 0.09 | 0.95 | 35.00 |
| American Eel | | C | C | | 1 | 1.33 | 0.43 | 0.08 | 0.79 | 58.00 |
| Smallmouth Bass | F | C | MG | M | 4 | 5.33 | 1.71 | 0.41 | 4.22 | 77.00 |
| Largemouth Bass | F | C | MG | | 11 | 14.67 | 4.70 | 0.04 | 0.44 | 2.91 |
| Pumpkinseed Sunfish | S | I | MG | P | 32 | 42.67 | 13.68 | 0.59 | 6.08 | 13.91 |
| Yellow Perch | | | MG | | 43 | 57.33 | 18.38 | 2.90 | 29.75 | 50.58 |
| *Date Total* | | | | | 234 | 312.00 | | 9.75 | | |
| *Number of Species* | | | | | 11 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | | |
|---|---|---|---|
| River Code: **20-300** | Stream: **Little River** | | Sample Date: **08/16/2006** |
| River Mile: **1.00** | Location: | | Invalid Sample: |
| Time Fished: 5081 sec | Drainage: 50.0 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: P |
| | Lat: 43.716833 | Long: -70.419917 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Brown Trout | E | | FS | | 2 | 2.00 | 0.23 | 0.80 | 10.88 | 400.00 |
| Brook Trout | | | FS | | 1 | 1.00 | 0.12 | 0.27 | 3.67 | 270.00 |
| Chain Pickerel | E | P | MG | | 1 | 1.00 | 0.12 | 0.02 | 0.24 | 18.00 |
| White Sucker | W | O | MG | T | 127 | 127.00 | 14.84 | 1.73 | 23.47 | 13.59 |
| Golden Shiner | N | I | MG | T | 3 | 3.00 | 0.35 | 0.02 | 0.23 | 5.67 |
| Creek Chub | N | G | FS | T | 1 | 1.00 | 0.12 | 0.01 | 0.11 | 8.00 |
| Common Shiner | N | I | FD | | 586 | 586.00 | 68.46 | 1.24 | 16.86 | 2.12 |
| Fallfish | N | | FD | | 29 | 29.00 | 3.39 | 0.06 | 0.76 | 1.93 |
| American Eel | | C | C | | 14 | 14.00 | 1.64 | 1.91 | 25.95 | 136.29 |
| Smallmouth Bass | F | C | MG | M | 71 | 71.00 | 8.29 | 1.21 | 16.40 | 16.99 |
| Largemouth Bass | F | C | MG | | 9 | 9.00 | 1.05 | 0.05 | 0.69 | 5.67 |
| Pumpkinseed Sunfish | S | I | MG | P | 7 | 7.00 | 0.82 | 0.01 | 0.08 | 0.86 |
| Yellow Perch | | | MG | | 4 | 4.00 | 0.47 | 0.05 | 0.65 | 12.00 |
| Nine-spine Stickleback | | | TS | | 1 | 1.00 | 0.12 | 0.00 | 0.01 | 1.00 |
| *Date Total* | | | | | 856 | 856.00 | | 7.35 | | |
| *Number of Species* | | | | | 14 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | |
|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot R. - dst. Falls** | Sample Date: **08/18/2006** |
| River Mile: **-0.40** | Location: | Invalid Sample: |
| Time Fished: 5143 sec | Drainage: 642.5 sq mi Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: Flow: C | Sampler Type: A |
| | Lat: 43.717440 Long: -70.265000 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Atlantic Sturgeon | | I | | | 1 | 1.00 | 0.37 | 2.70 | 4.22 | 2,700.00 |
| Alewife | E | | A | | 113 | 113.00 | 42.32 | 0.33 | 0.51 | 2.88 |
| American Shad | N | P | A | | 5 | 5.00 | 1.87 | 0.16 | 0.25 | 32.00 |
| White Sucker | W | O | MG | T | 1 | 1.00 | 0.37 | 0.08 | 0.12 | 75.00 |
| Golden Shiner | N | I | MG | T | 1 | 1.00 | 0.37 | 0.08 | 0.13 | 80.00 |
| Common Shiner | N | I | FD | | 22 | 22.00 | 8.24 | 0.01 | 0.02 | 0.59 |
| Brown Bullhead | | I | MG | T | 1 | 1.00 | 0.37 | 0.17 | 0.27 | 170.00 |
| American Eel | | C | C | | 30 | 30.00 | 11.24 | 10.68 | 16.69 | 355.96 |
| Eastern Banded Killifish | E | I | MG | T | 2 | 2.00 | 0.75 | 0.01 | 0.01 | 4.50 |
| Burbot | | | B | | 1 | 1.00 | 0.37 | 0.16 | 0.25 | 160.00 |
| Striped Bass | E | P | A | | 57 | 57.00 | 21.35 | 48.31 | 75.51 | 847.46 |
| White Perch | E | | MG | | 1 | 1.00 | 0.37 | 0.08 | 0.12 | 75.00 |
| Smallmouth Bass | F | C | MG | M | 16 | 16.00 | 5.99 | 0.93 | 1.45 | 58.13 |
| Largemouth Bass | F | C | MG | | 1 | 1.00 | 0.37 | 0.02 | 0.03 | 20.00 |
| Pumpkinseed Sunfish | S | I | MG | P | 15 | 15.00 | 5.62 | 0.27 | 0.42 | 18.07 |
| *Date Total* | | | | | 267 | 267.00 | | 63.97 | | |
| *Number of Species* | | | | | 15 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| River Code: **20-001** | Stream: **Presumpscot R. - dst. Falls** | | Sample Date: **09/27/2006** |
|---|---|---|---|
| River Mile: **-0.40** | Location: | | Invalid Sample: |
| Time Fished: 3969 sec | Drainage: 642.5 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.717440 | Long: -70.265000 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Shortnose Sturgeon | | | | | 1 | 1.00 | 0.60 | 4.05 | 6.04 | 4,050.00 |
| Alewife | E | | A | | 49 | 49.00 | 29.17 | 0.50 | 0.74 | 10.10 |
| Rainbow Smelt | | | TS | | 18 | 18.00 | 10.71 | 0.03 | 0.04 | 1.39 |
| American Eel | | C | C | | 25 | 25.00 | 14.88 | 5.04 | 7.51 | 201.50 |
| Mummichog | | I | TS | | 11 | 11.00 | 6.55 | 0.04 | 0.06 | 3.64 |
| Atlantic Tomcod | | | | | 4 | 4.00 | 2.38 | 0.13 | 0.19 | 31.25 |
| Striped Bass | E | P | A | | 43 | 43.00 | 25.60 | 57.00 | 84.96 | 1,325.55 |
| Smallmouth Bass | F | C | MG | M | 5 | 5.00 | 2.98 | 0.21 | 0.31 | 42.00 |
| Largemouth Bass | F | C | MG | | 1 | 1.00 | 0.60 | 0.01 | 0.01 | 8.00 |
| Pumpkinseed Sunfish | S | I | MG | P | 2 | 2.00 | 1.19 | 0.03 | 0.04 | 13.50 |
| Yellow Perch | | | MG | | 9 | 9.00 | 5.36 | 0.07 | 0.10 | 7.78 |
| *Date Total* | | | | | 168 | 168.00 | | 67.09 | | |
| *Number of Species* | | | | | 11 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

| | | | |
|---|---|---|---|
| River Code: **20-001** | Stream: **Presumpscot R. - dst. Falls** | | Sample Date: **06/01/2007** |
| River Mile: **-0.40** | Location: | | Invalid Sample: |
| Time Fished: 2558 sec | Drainage: 642.5 sq mi | Depth: | Data Source: 01 |
| Dist Fished: 1.00 km | Basin: | Flow: C | Sampler Type: A |
| | Lat: 43.717440 | Long: -70.265000 | |

| Species Name | IBI Grp | Feed Guild | Target Spec. | Tol | # of Fish | Relative Number | % by Number | Relative Weight | % by Weight | Ave(gm) Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Alewife | E | | A | | 2 | 2.00 | 3.03 | 1.12 | 1.00 | 560.00 |
| American Shad | N | P | A | | 3 | 3.00 | 4.55 | 4.74 | 4.21 | 1,580.00 |
| American Eel | | C | C | | 16 | 16.00 | 24.24 | 1.70 | 1.51 | 106.00 |
| Atlantic Tomcod | | | | | 6 | 6.00 | 9.09 | 0.29 | 0.25 | 47.50 |
| Striped Bass | E | P | A | | 30 | 30.00 | 45.45 | 104.08 | 92.50 | 3,469.33 |
| Smallmouth Bass | F | C | MG | M | 9 | 9.00 | 13.64 | 0.60 | 0.53 | 66.67 |
| *Date Total* | | | | | 66 | 66.00 | | 112.52 | | |
| *Number of Species* | | | | | 6 | | | | | |
| *Number of Hybrids* | | | | | 0 | | | | | |

# Fish Assemblage and Habitat Assessment of the Presumpscot River

## Appendix B

## QHEI Data and Metrics

**August-September 2006**
**May-June 2007**

**Appendix Table 1. QHEI metric scores for stations sampled in Presumpscot River basin during 2006.**

| River Mile | QHEI | Substrate | Cover | Channel | Riparian | Pool | Riffle | Gradient & Score |
|---|---|---|---|---|---|---|---|---|
| | | QHEI Metrics: | | | | | | |
| (20001) Presumpscot River | | | | | | | | |
| Year: 2006 | | | | | | | | |
| 21.1 | **95.00** | 17.0 | 22.0 | 17.0 | 10.00 | 12.0 | 8.0 | 9.90 - (10) |
| 20.6 | **67.50** | 15.0 | 22.0 | 6.0 | 9.50 | 7.0 | 0.0 | 9.90 - (10) |
| 19.9 | **93.00** | 17.0 | 22.0 | 19.0 | 10.00 | 12.0 | 6.0 | 12.05 - ( 8) |
| 18.8 | **59.50** | 14.0 | 18.0 | 4.0 | 9.50 | 6.0 | 0.0 | 12.05 - ( 8) |
| 18.1 | **99.00** | 17.0 | 22.0 | 20.0 | 10.00 | 12.0 | 8.0 | 6.37 - (10) |
| 15.6 | **62.00** | 16.0 | 17.0 | 5.0 | 10.00 | 6.0 | 0.0 | 10.10 - ( 8) |
| 14.9 | **95.00** | 17.0 | 18.0 | 20.0 | 10.00 | 12.0 | 8.0 | 10.10 - ( 8) |
| 14.1 | **60.00** | 13.0 | 16.0 | 5.0 | 9.00 | 7.0 | 0.0 | 7.04 - (10) |
| 13.1 | **93.50** | 20.0 | 18.0 | 19.0 | 6.50 | 12.0 | 8.0 | 7.05 - (10) |
| 12.6 | **87.00** | 16.0 | 18.0 | 17.0 | 9.00 | 12.0 | 8.0 | 18.87 - ( 6) |
| 11.3 | **71.50** | 16.0 | 17.0 | 13.0 | 9.50 | 8.0 | 0.0 | 2.51 - ( 8) |
| 8.6 | **58.30** | 14.0 | 16.0 | 6.0 | 8.30 | 6.0 | 0.0 | 2.51 - ( 8) |
| 7.6 | **72.00** | 16.0 | 17.0 | 8.0 | 4.00 | 11.0 | 8.0 | 10.64 - ( 8) |
| 6.4 | **78.00** | 15.0 | 17.0 | 16.0 | 4.00 | 12.0 | 8.0 | 1.75 - ( 6) |
| 5.5 | **54.00** | 10.0 | 15.0 | 12.0 | 5.00 | 8.0 | 0.0 | 1.75 - ( 4) |
| 3.7 | **56.50** | 10.0 | 16.0 | 11.0 | 5.50 | 8.0 | 0.0 | 1.75 - ( 6) |
| 0.7 | **87.50** | 15.0 | 16.0 | 17.0 | 8.50 | 12.0 | 8.0 | 1.75 - (10) |
| (20100) Piscataqua River | | | | | | | | |
| Year: 2006 | | | | | | | | |
| 1.0 | **61.80** | 12.5 | 16.0 | 14.5 | 7.80 | 5.0 | 0.0 | 5.29 - ( 6) |
| (20200) Pleasant River | | | | | | | | |
| Year: 2006 | | | | | | | | |
| 1.0 | **53.50** | 4.0 | 18.0 | 7.0 | 9.50 | 5.0 | 0.0 | 10.24 - (10) |
| (20300) Little River | | | | | | | | |
| Year: 2006 | | | | | | | | |
| 1.0 | **64.50** | 10.5 | 17.0 | 15.5 | 9.50 | 6.0 | 0.0 | 4.13 - ( 6) |
| (21001) Presumpscot R. - dst. Falls | | | | | | | | |
| Year: 2006 | | | | | | | | |
| 0.4 | **90.00** | 19.0 | 15.0 | 19.0 | 8.00 | 12.0 | 8.0 | 41.70 - ( 8) |

**Appendix Table 1. QHEI metric scores for stations sampled in Presumpscot River basin during 2007.**

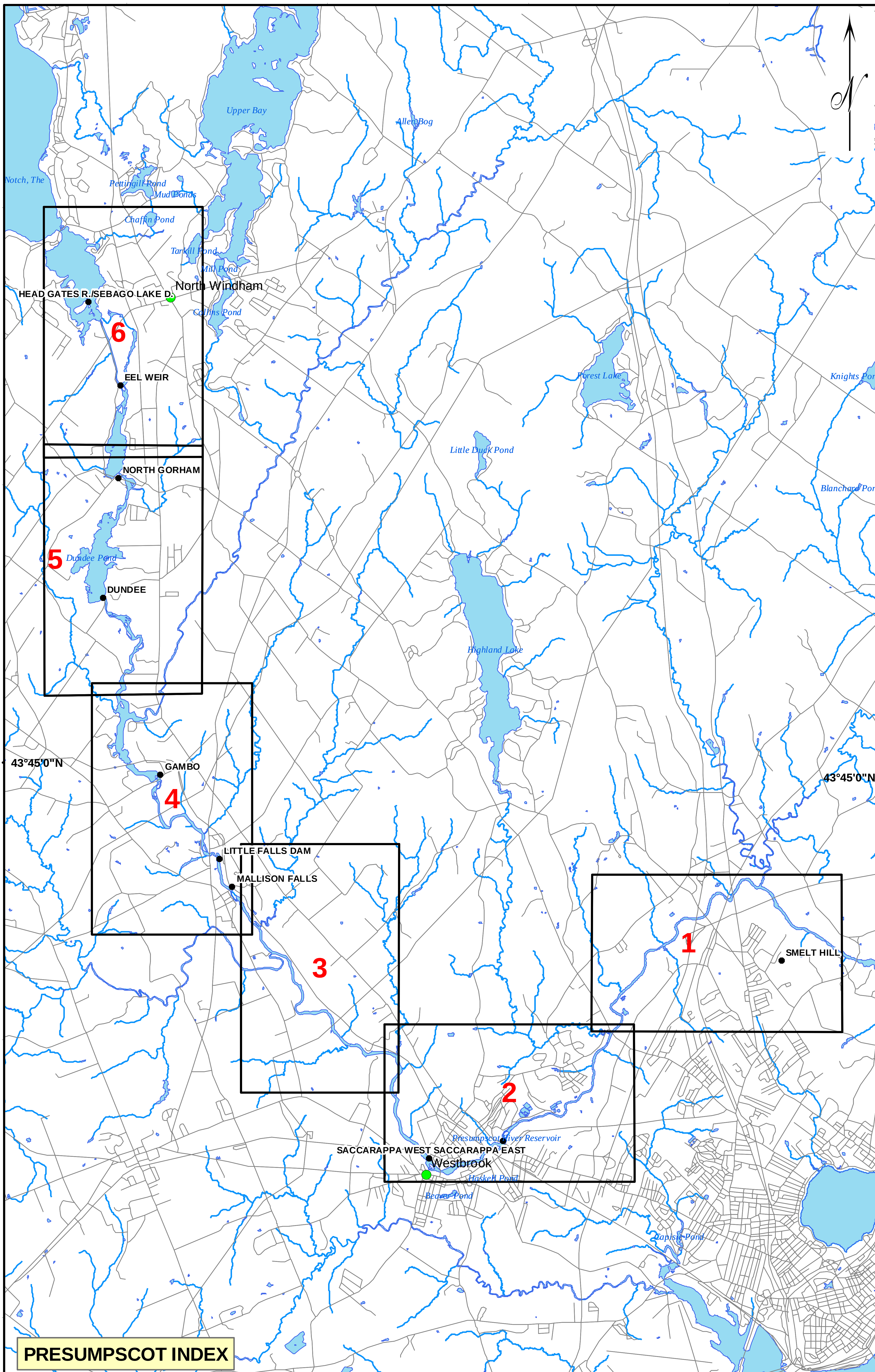
| River Mile | QHEI | QHEI Metrics: Substrate | Cover | Channel | Riparian | Pool | Riffle | Gradient & Score |
|---|---|---|---|---|---|---|---|---|
| (20001) Presumpscot River | | | | | | | | |
| Year: 2007 | | | | | | | | |
| 7.4 | **59.30** | 13.0 | 16.0 | 7.0 | 6.30 | 9.0 | 0.0 | 10.64 - ( 8) |
| 6.4 | **77.00** | 16.0 | 15.0 | 15.0 | 8.00 | 12.0 | 7.0 | 1.76 - ( 4) |
| 5.4 | **58.00** | 13.0 | 14.0 | 13.0 | 7.00 | 7.0 | 0.0 | 1.75 - ( 4) |
| 3.7 | **80.00** | 15.0 | 16.0 | 14.0 | 10.00 | 12.0 | 8.0 | 1.75 - ( 4) |
| 0.7 | **80.00** | 16.0 | 14.0 | 16.0 | 8.50 | 12.0 | 7.0 | 1.75 - ( 6) |
| 0.1 | **83.00** | 16.0 | 13.0 | 16.0 | 9.00 | 12.0 | 8.0 | 41.70 - ( 8) |

# Fish Assemblage and Habitat Assessment of the Presumpscot River

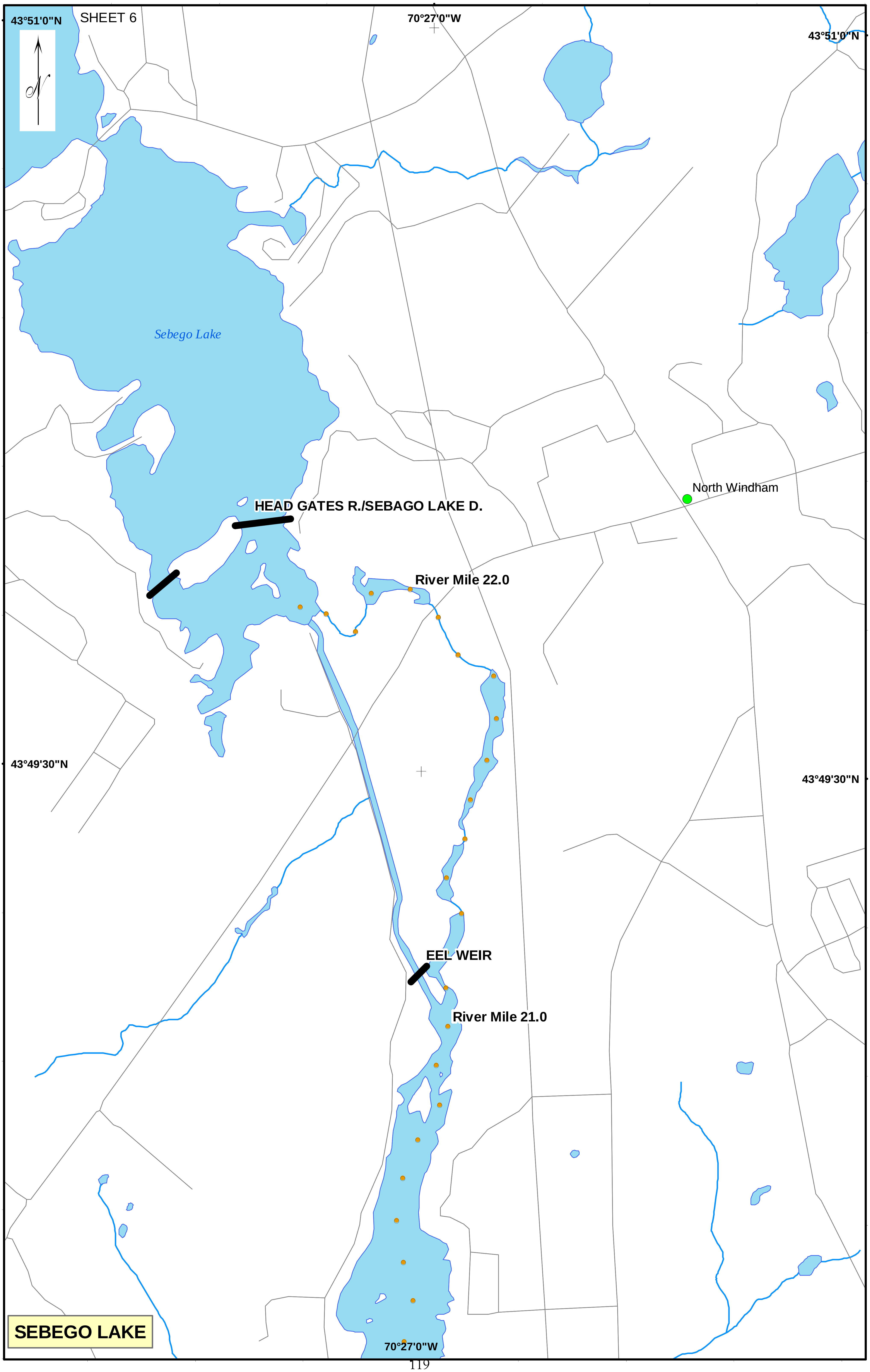
## Appendix C

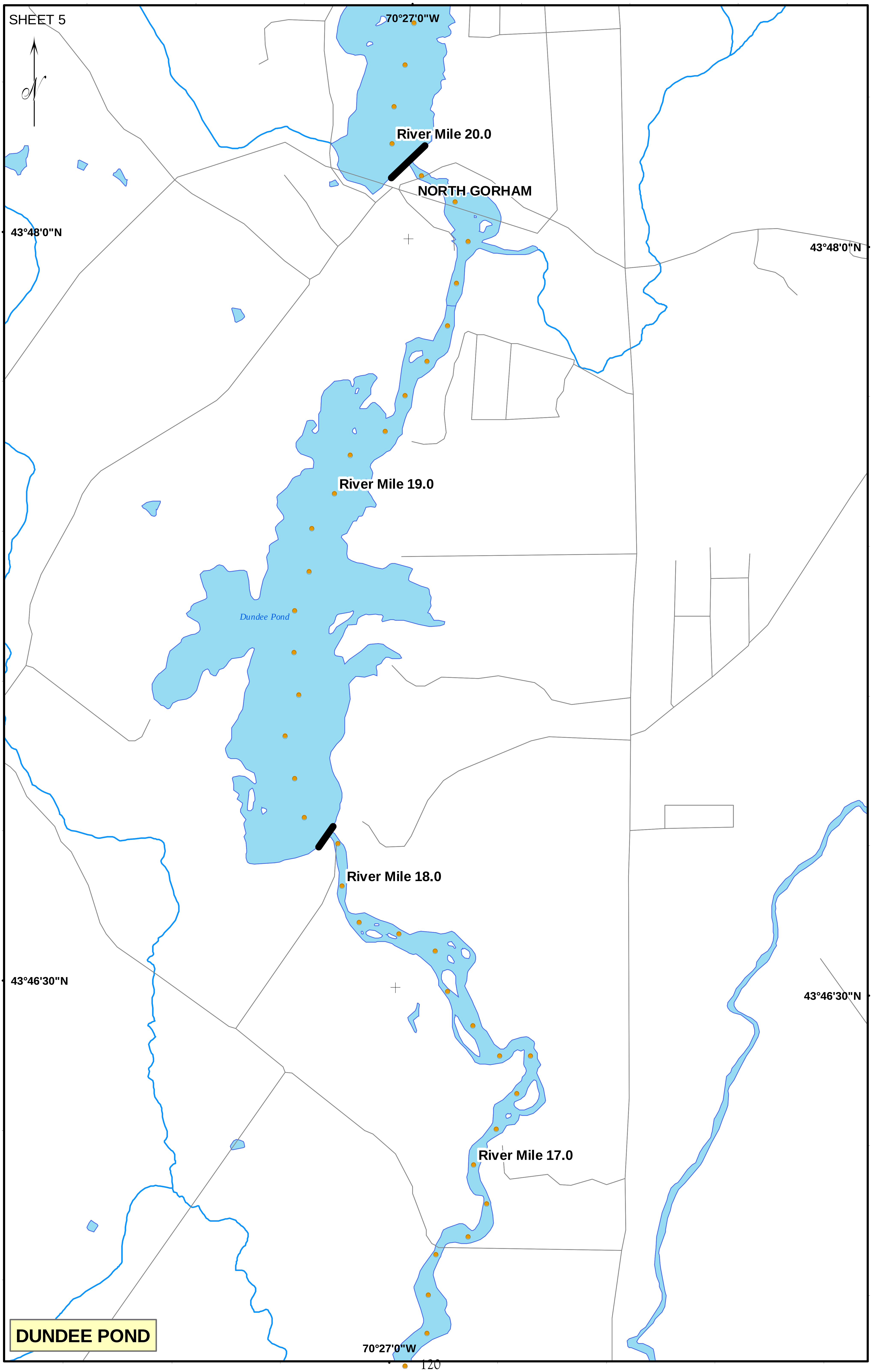
## River Mile Maps

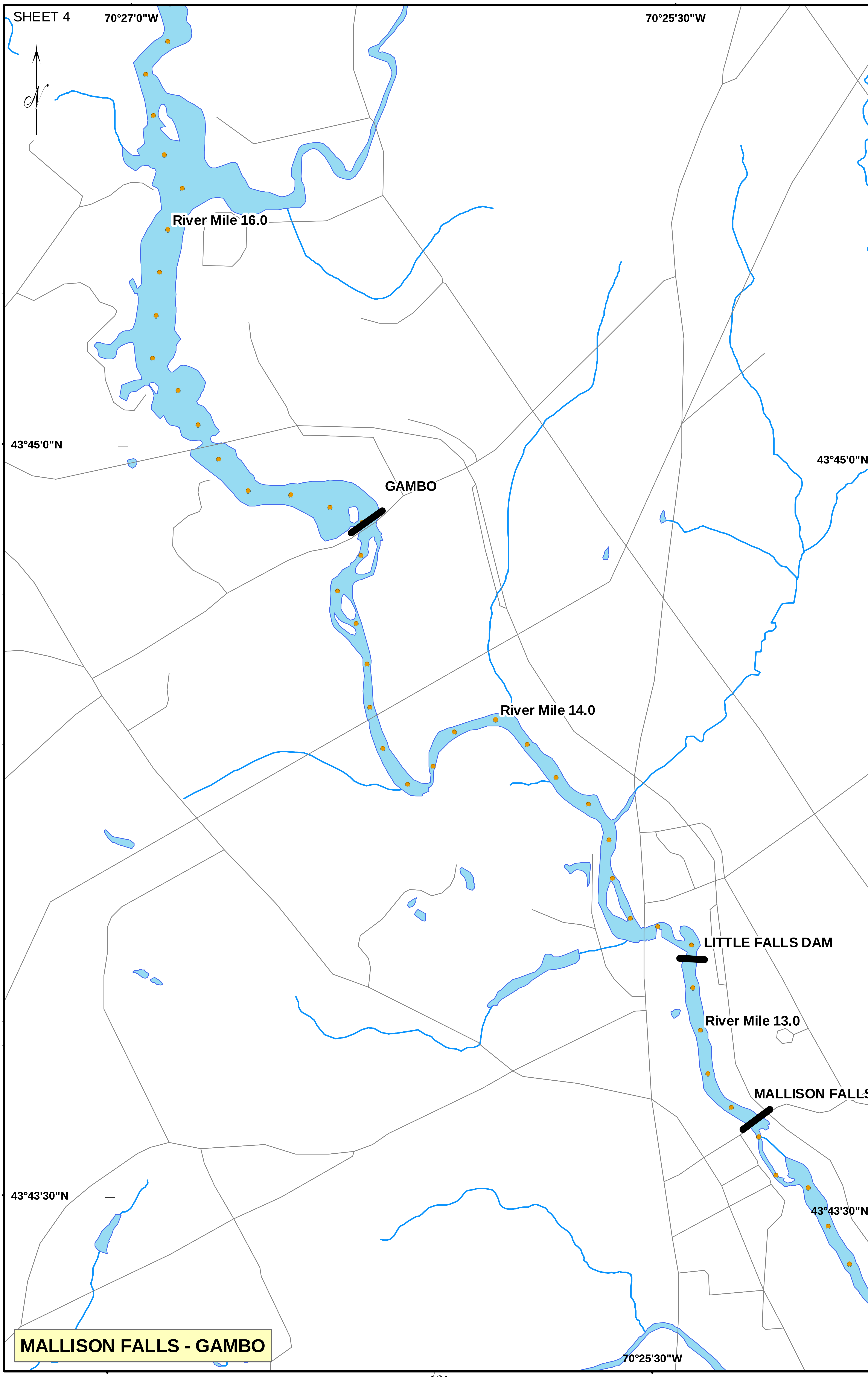
**August-September 2006**
**May-June 2007**



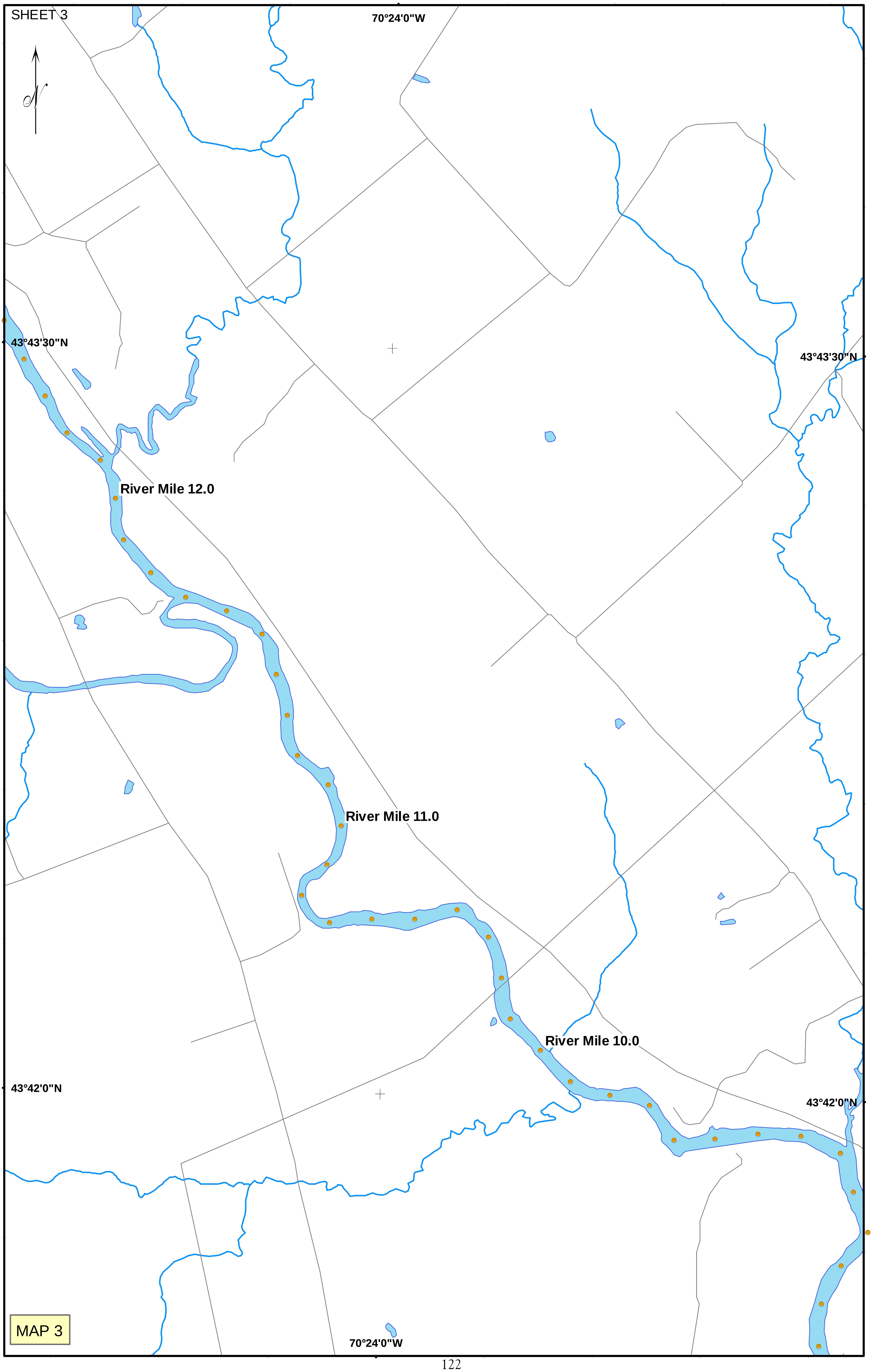
Upper Bay
Allen Bog
Notch, The
Pettingill Pond
Mud Ponds
Chaffin Pond
Tarkill Pond
Mill Pond
North Windham
HEAD GATES R./SEBAGO LAKE D.
Collins Pond
6
EEL WEIR
Forest Lake
Knights Pond
Little Duck Pond
NORTH GORHAM
Blanchard Pond
5
Dundee Pond
DUNDEE
Highland Lake
43°45'0"N
GAMBO
4
43°45'0"N
LITTLE FALLS DAM
MALLISON FALLS
1
SMELT HILL
3
2
Presumpscot River Reservoir
SACCARAPPA WEST
SACCARAPPA EAST
Westbrook
Haskell Pond
Beaver Pond
Capisic Pond
PRESUMPSCOT INDEX

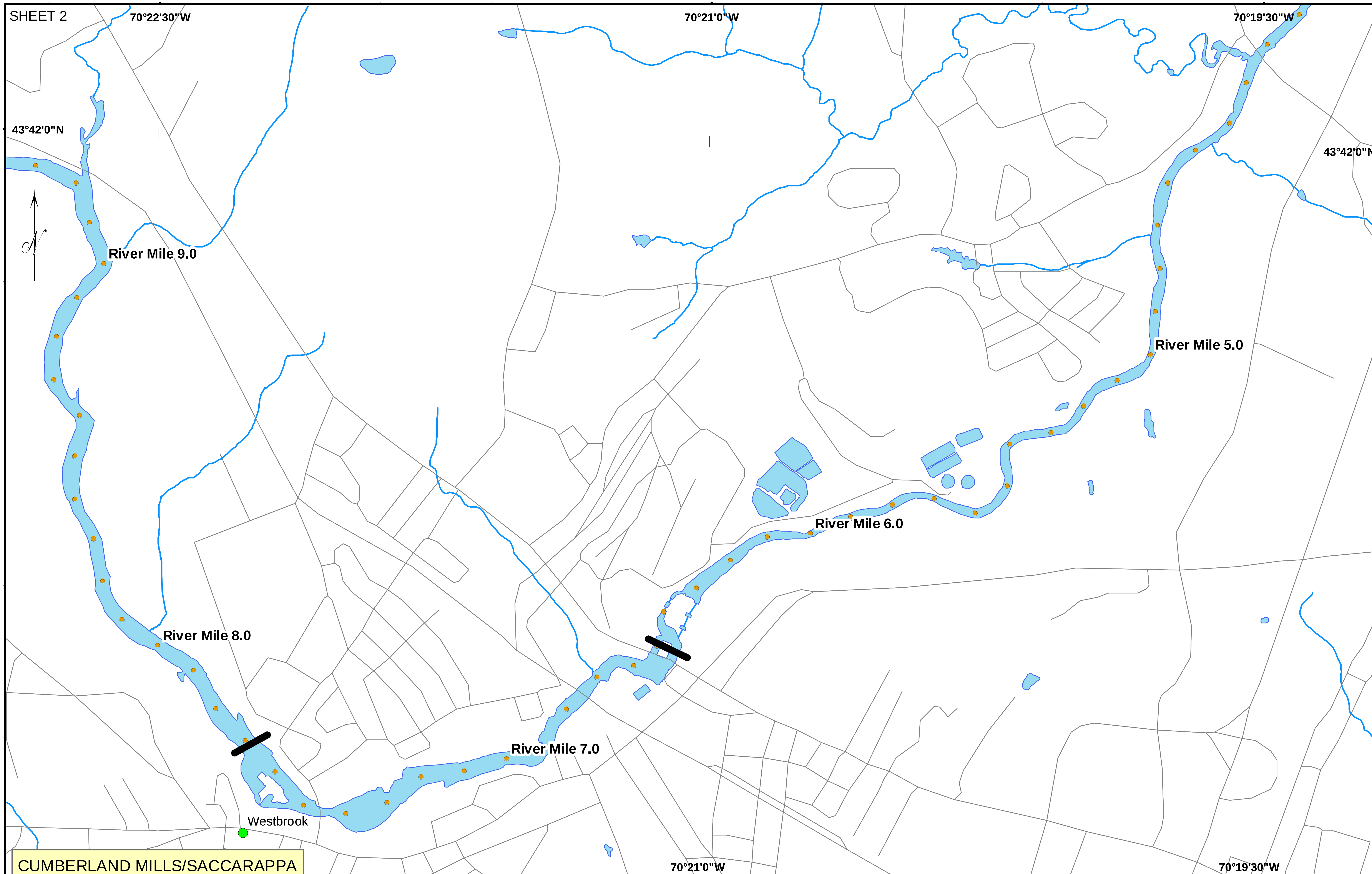

SHEET 6
43°51'0"N
70°27'0"W
43°51'0"N
Sebego Lake
North Windham
HEAD GATES R./SEBAGO LAKE D.
River Mile 22.0
43°49'30"N
43°49'30"N
EEL WEIR
River Mile 21.0
SEBEGO LAKE
70°27'0"W


SHEET 5
70°27'0"W
River Mile 20.0
NORTH GORHAM
43°48'0"N
43°48'0"N
River Mile 19.0
Dundee Pond
River Mile 18.0
43°46'30"N
43°46'30"N
River Mile 17.0
DUNDEE POND
70°27'0"W

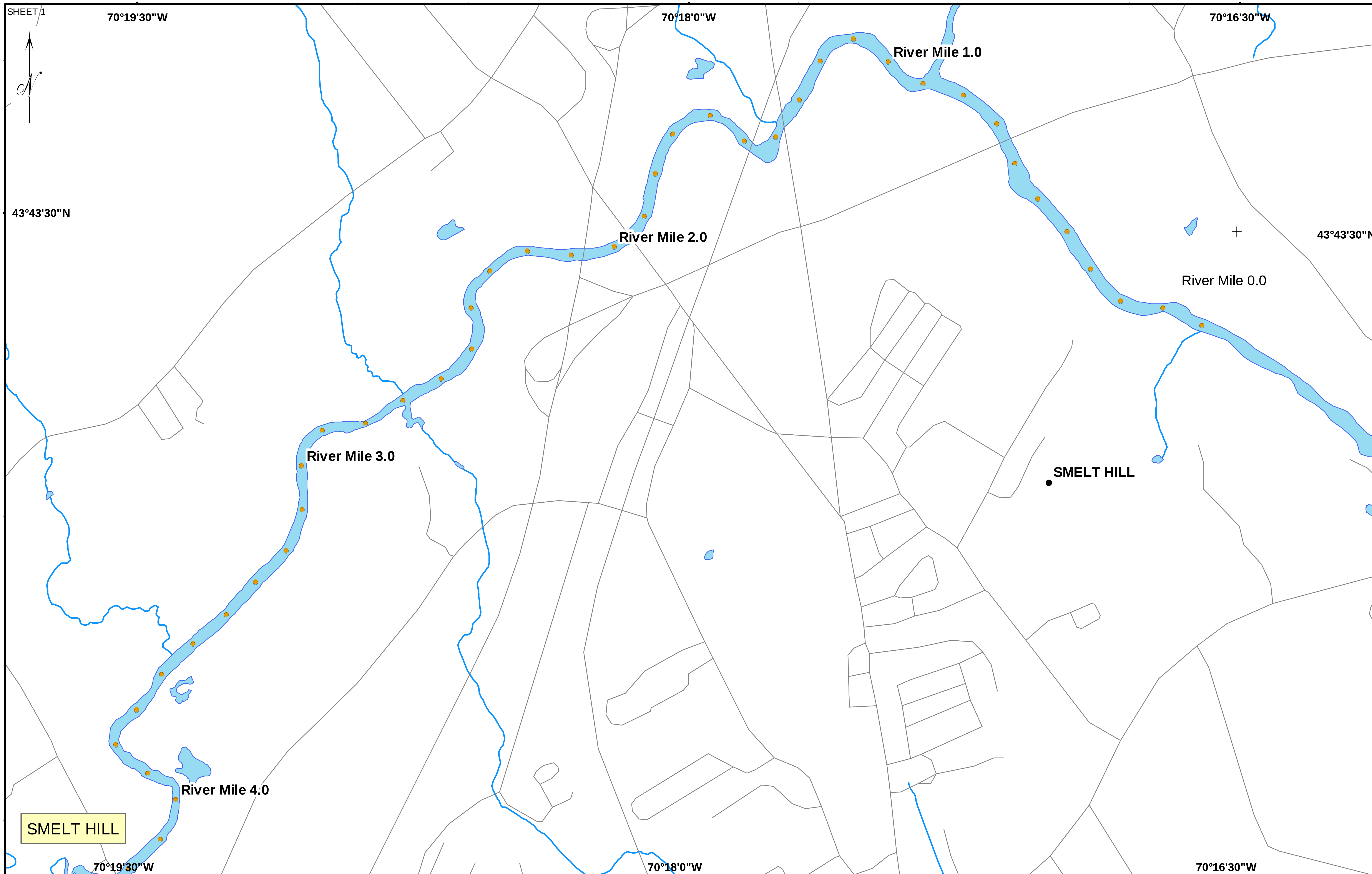


SHEET 4
70°27'0"W
70°25'30"W
N
River Mile 16.0
43°45'0"N
43°45'0"N
GAMBO
River Mile 14.0
LITTLE FALLS DAM
River Mile 13.0
MALLISON FALLS
43°43'30"N
43°43'30"N
70°25'30"W
MALLISON FALLS - GAMBO


SHEET 3
N
70°24'0"W
43°43'30"N
43°43'30"N
River Mile 12.0
River Mile 11.0
River Mile 10.0
43°42'0"N
43°42'0"N
MAP 3
70°24'0"W



SHEET 2
70°22'30"W
70°21'0"W
70°19'30"W
43°42'0"N
43°42'0"N
River Mile 9.0
River Mile 8.0
River Mile 7.0
River Mile 6.0
River Mile 5.0
Westbrook
CUMBERLAND MILLS/SACCARAPPA
70°21'0"W
70°19'30"W


SHEET 1
70°19'30"W
70°18'0"W
70°16'30"W
River Mile 1.0
43°43'30"N
River Mile 2.0
43°43'30"N
River Mile 0.0
River Mile 3.0
SMELT HILL
River Mile 4.0
SMELT HILL
70°19'30"W
70°18'0"W
70°16'30"W