Casco Bay Estuary Project
Muskie School of Public Service
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Portland, Maine 04104

FINAL HABITAT RESTORATION INVENTORY SUMMARY REPORT

FOR THE LOWER PRESUMPSCOT RIVER WATERSHED

VOLUME I

APRIL 2005

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Gulf of Maine Council on the Marine Environment

TABLE OF CONTENTS

SECTION **PAGE**

VOLUME I

LIST OF TABLES

LIST OF FIGURES

VOLUME II - APPENDICES

1.0 INTRODUCTION

This Habitat Restoration Inventory Summary Report summarizes efforts by the Casco Bay Estuary Project (CBEP) to identify, evaluate, and document potential habitat restoration opportunities in, and directly adjacent to, waterbodies in the lower portion of the Presumpscot River Watershed in Maine (Figure 1). Specifically, inventories were conducted along the main branch of the Presumpscot River, the Presumpscot River Estuary, and the major tributaries to the Presumpscot River including Mill Brook, the East Branch of the Piscataqua, and the West Branch of the Piscataqua.

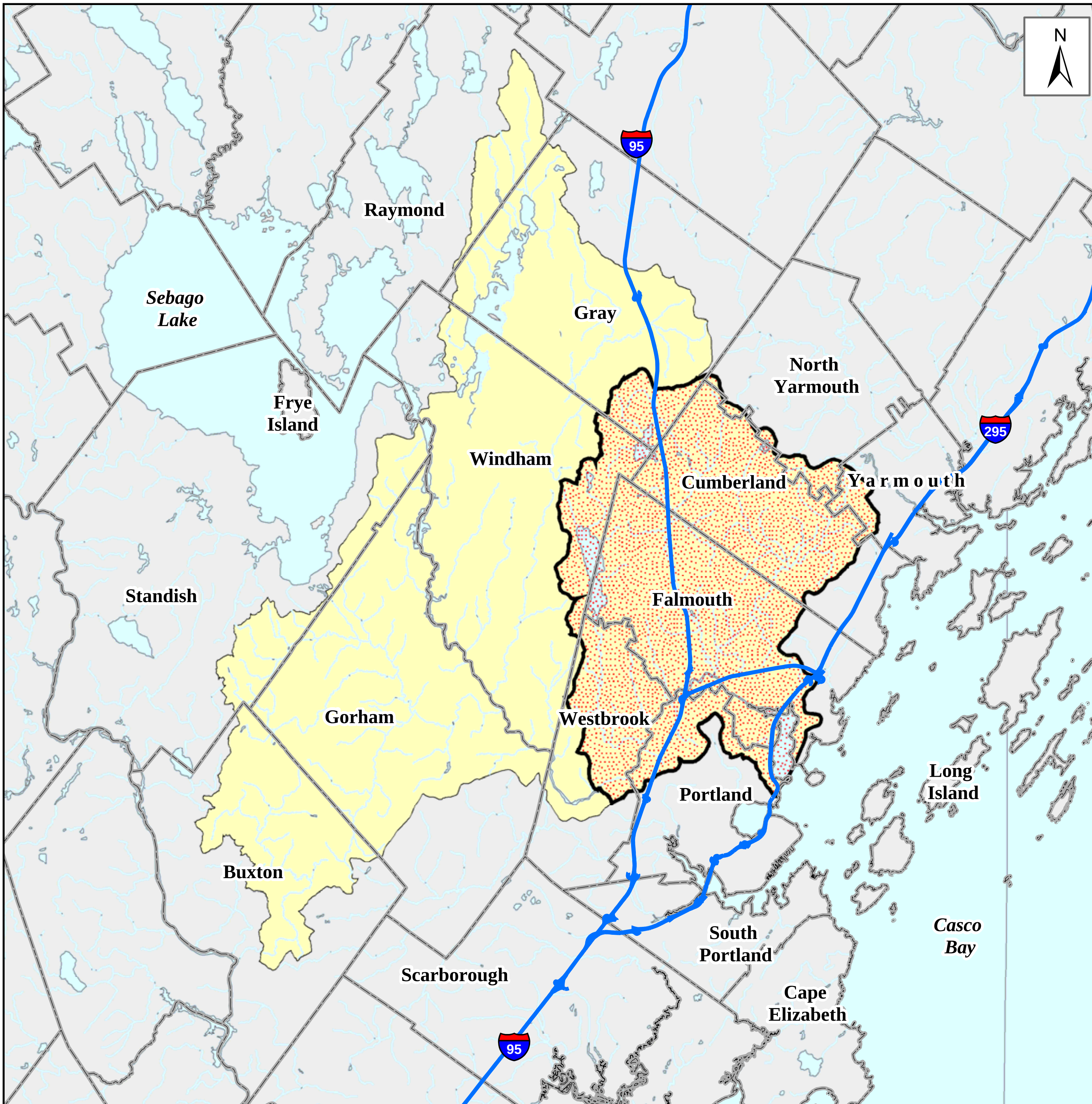
This report presents the objectives of the project, the methods used in site identification and evaluation process, and provides a summary of the restoration sites identified during this survey. This report includes the following: Restoration Site Data Forms (Volume II, Appendix A); a List of Restoration Sites and Restoration Site Summary Reports for all sites (Volume II, Appendix B); and additional figures, including the location of restoration sites on digital-orthoquads (Volume II, Appendix C).

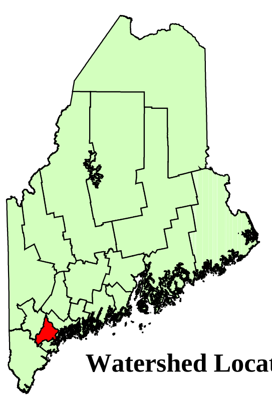
Preparation of this document was funded by the Casco Bay Estuary Project under the US Environmental Protection Agency (USEPA) assistance agreement (# CE 9817051) to the University of Southern Maine. The contents of this document do not necessarily reflect the views and policies of CBEP or the USEPA.

1.1 GOALS AND OBJECTIVES OF THE INVENTORY

As part of an effort to improve conditions of the nations degraded estuaries, Casco Bay was identified by the USEPA in 1990 as an estuary of national significance, and the CBEP office was established in Portland, Maine, to coordinate and facilitate local efforts to research and improve environmental conditions in Casco Bay. In 2002, the CBEP initiated a new Habitat Restoration Program with the goal of restoring notable habitats identified in the *Casco Bay Plan* (CBEP 1996), including degraded marine, estuarine, and freshwater habitats of Casco Bay and surrounding watersheds. The program is guided by a Project Team that includes representatives of the Maine Department of Environmental Protection (MEDEP), Maine State Planning Office (MESPO), Natural Resources Conservation Service (NRCS), Maine Department of Marine Fisheries (DMR), USEPA, U.S. Fish and Wildlife Service's (USFWS) Gulf of Maine Project (GOMP), and Friends of Casco Bay, among others.

The purpose of the Habitat Restoration Program is to identify opportunities to restore habitat within the Casco Bay Watershed and to provide restoration guidance and technical assistance, and to help in identifying funding sources. Prior to this study, the Project Team had taken initial steps towards identifying restoration opportunities, however, conclusions of initial efforts were that very little was known regarding restoration needs in the watershed. The Committee quickly recognized a lack of identified and well-described restoration needs and as a result, initiated the Habitat Restoration Inventory (HRI) to develop a list of potential sites in the lower Presumpscot River Watershed. The HRI was funded with a grant from the Gulf of Maine Council on the Marine Environment/NOAA Habitat Restoration partnership.





Data provided by Maine Office of GIS

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- Project Location
- Presumpscot River Watershed
- Ponds, Lakes, & Rivers
- Town Boundary
- Interstate

Figure 1. Project Location Map for Habitat Restoration Inventory of the Lower Presumpscot River Watershed.

Prepared For: Casco Bay Estuary Project — Habitat Restoration Program: Partnerships to Revitalize Damaged Habitats

Prepared By: NEA

Date: 04/05

The objectives of the HRI effort were to:

1. Identify potential restoration sites in, and directly adjacent to, major waterbodies within the lower portion of the Presumpscot River Watershed;
2. Evaluate and assign a score that represents the level of degradation to restoration sites identified for objective 1; and,
3. Disseminate information to interested parties.

1.2 BACKGROUND INFORMATION ON THE PRESUMPSCOT WATERSHED

The Presumpscot River Watershed covers 205 square miles (131,200 acres) and includes the Presumpscot River, which provides the largest source of freshwater input to Casco Bay (Friends of the Presumpscot 2005). Waterbodies surveyed for this inventory were located within an approximately 65 square-mile (41,600 acres) area in the lower portion of the Presumpscot River Watershed and included the main branch of the Presumpscot River, the Presumpscot Estuary as well as the major tributaries of Mill Brook, the West Branch of the Piscataqua (West Branch) and the East Branch of the Piscataqua (East Branch). The inventory area is located within the towns of Cumberland, Falmouth, Portland and Westbrook in Cumberland County, Maine.

The name "Presumpscot", having its origin from local native culture, means "many falls" or "many rough places", and historically, the Presumpscot River supported American shad (*Alosa sapidissima*), Atlantic salmon (*Salmo salar*), alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), striped bass (*Morone saxatilis*), and brook trout (*Salvelinus fontinalis*) (Friends of the Presumpscot 2005). However the Presumpscot and many of its associated tributaries were degraded through years of human impacts, primarily from dams and pollution in the form of direct residential waste, agricultural runoff, and untreated industrial discharges from the numerous textile, pulp, and paper mills found along the river. Reports released in 1965 and 1966 declared that the conditions of the Presumpscot River were so severely degraded that the river itself was “dead” and conditions were intolerable for nearby residents (CBEP 1996). Further, despite clean-up efforts through the 1970’s as a result of the Clean Water Act, reports released in 1988 stated that toxic contaminants in Casco Bay hot spots, including the Presumpscot River Estuary, rivaled the country’s worst urban harbors (CBEP 1996).

Water quality in the Lower Presumpscot Watershed has improved significantly since the 1970’s due to the closing of mills, improvements in environmental regulations to reduce nutrient/pollution load in waterbodies, enforcement of regulations, and the efforts by many interested organizations and individuals. However, the “health” of the watershed continues to be threatened. The Presumpscot River and associated tributaries were listed on the USEPA’s 1998 List of Impaired Waterbodies of Maine. The revised 2002 listing identified the East Branch of the Piscataqua and Highland Lake (source water for Mill Brook) as impaired (USEPA 2005). Impairments include dissolved oxygen levels, aquatic life, bacteria, phosphorus and PCB’s. In addition, in-stream habitats for many waterbodies in Maine continue to be impacted by dams. Twenty-two (22) of the original 27 miles of the main branch of the Presumpscot River alone remain impounded by dams (PRMPSC 2003).

Continued population increases in southern Maine, and the associated increases in development and intensive land use, continue to threaten habitat quality in the watershed. Most notable were the direct loss of riparian habitat. Based on data from 1995, of the 108,756 acres of the lower Presumpscot Watershed with available data, 40% is forested, 31% is developed, 16% is in farmland, 9% is wetland or surface water, and 4% is open undeveloped (PRMPSC 2003). The population of Maine increased by about 3.8% from 1990 to 2000 (US Census Bureau 2004) and the population of Portland increased by 1.8% during this same period (ERSys 2005). Trends such as these were expected to continue and the threats to waterbodies in the Presumpscot River Watershed were likely to increase as a result (CBEP 1996, PRMPSC 2003).

2.0 METHODOLOGY

The Presumpscot HRI was designed to document specific locations of habitat degradation and potential threats to the environmental quality of major waterbodies of the lower Presumpscot River Watershed and to facilitate restoration of those sites. To accomplish this, the effort was divided into three tasks: 1) review background information to identify potential sites; 2) conduct field data collection and evaluation of potential sites; and, 3) organize information from potential sites for dissemination to interested parties.

Potential sites were defined as those with: 1) existing conditions that were degraded enough to warrant restoration effort; and, 2) adequate potential for restoration. Examples of typical restoration sites that were documented include the following: sites where forested buffers were replaced by mowed lawns, golf courses, agricultural areas, or impervious surfaces; areas of concentrated runoff; unstable shoreline banks; impaired shoreline vegetation; potential sources of nutrient or pollution; and degraded in-stream habitat. All sites were immediately adjacent to the Presumpscot River Estuary, the Presumpscot River, or major tributaries to the river.

2.1 PRELIMINARY IDENTIFICATION OF POTENTIAL SITES

A review of existing background information was conducted by the Project Team to lay the groundwork for a focused field data collection effort. Sources included *Return the Tides*, the Beginning with Habitat program, oil spill contingency studies, summer 2003 DEP water quality work in the lower Presumpscot, *A Diadromous Fish Survey of the Presumpscot River* conducted in 2003, DEP eelgrass maps, Atlantic Salmon Commission habitat surveys, Maine Stream Team and Presumpscot River Watch habitat and watershed surveys of Presumpscot tributaries, USFWS habitat maps, *Smelt Hill Environmental Restoration Study Falmouth, Maine,* conducted by the U.S. Army Corps of Engineers in 2002, ongoing Wells National Estuarine Research Reserve work in Casco Bay's fringing marshes, Maine State Planning Office wetland functional assessment data, Maine Office of GIS natural resource data, high resolution orthographic photographs, and river corridor habitat maps and restoration opportunities presented in the *Plan for the Future of the Presumpscot River,* 2003. In addition, the Project Team held numerous meetings, and attended meetings of local conservation groups focused on the Presumpscot River Watershed, to discuss potential restoration opportunities.

The background review effort identified numerous sources of existing information and several ongoing efforts within the sub-watershed to document the physical, chemical and biological characteristics of the waterbodies and riparian areas. However, each of these ongoing efforts had a relatively specific focus (e.g., documenting site conditions relative to geomorphologic factors, anadromous fish habitat, recreational opportunities, etc.), covered a relatively limited area of evaluation within the lower Presumpscot River Watershed, or in some cases covered too broad of an area of evaluation, and thus few specific potential restoration sites were identified.

2.2 FIELD DATA COLLECTION AND SITE EVALUATION

Due to the limited number of specific potential sites that were identified during the background data review process, a full on-site evaluation of all waterbodies in the inventory area was warranted. The overall goal of site evaluations was to identify sites, characterize the existing condition at each potential site, and to identify restoration opportunity, including an estimate of cost, challenges to restoration, and likely restoration options. One specific objective of the field evaluations was to collect enough information regarding specific site characteristics to allow for the evaluation of sites based on the level and types of degradation.

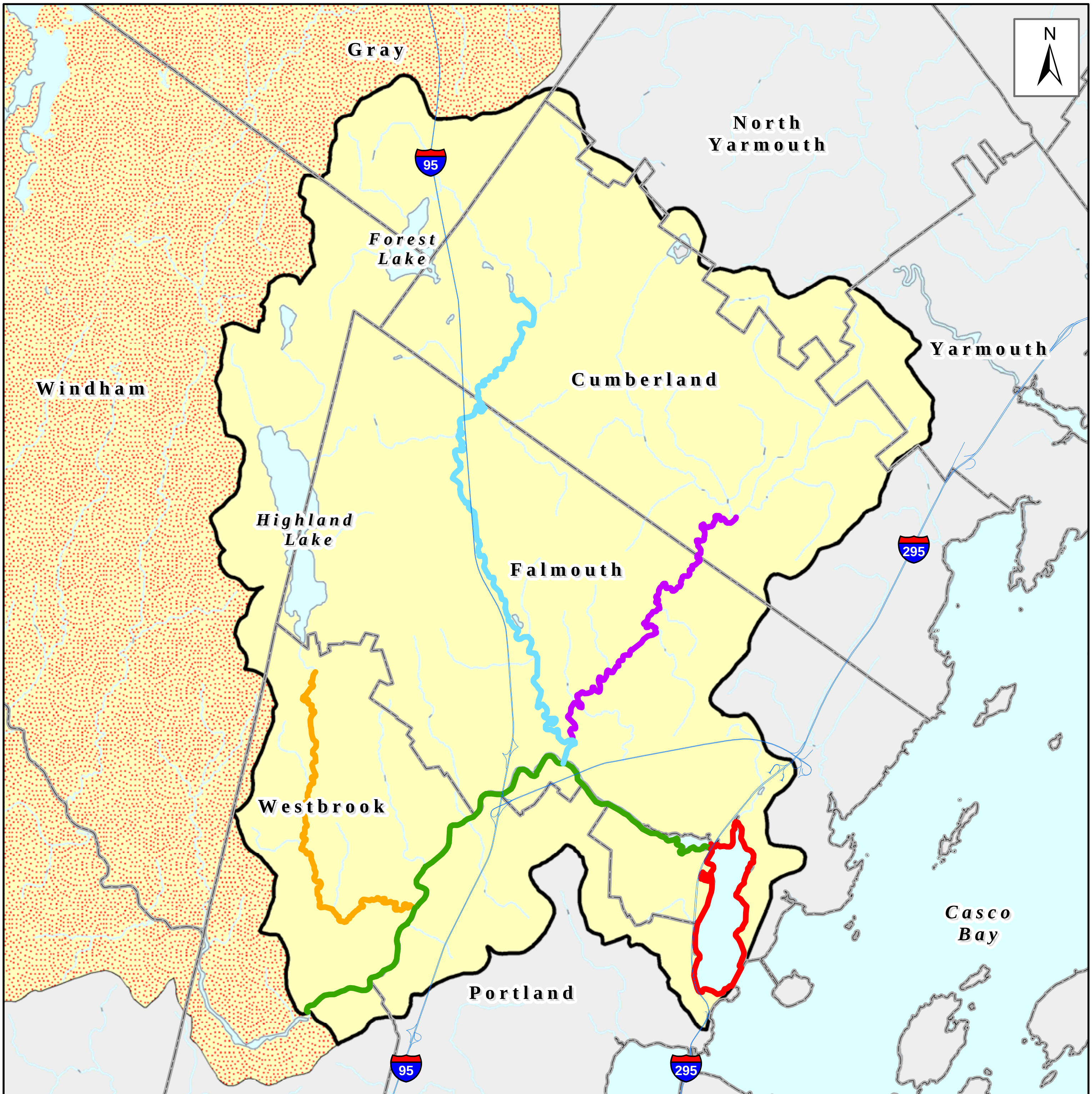
A two-person team of scientists conducted on-site field evaluations of all waterbodies. Ninety-eight (98) percent of all surveys were completed between July and November 2005. One small section in the West Branch was completed in February 2005. Approximately 34.6 miles of river, stream, and estuarine waters were evaluated, which included 8.1 miles of the Presumpscot River, the entire 5.6 mile length of Mill Brook, the 5.6 mile length of the East Branch of the Piscataqua, and the 8.9 mile length of the West Branch of the Piscataqua, as well as 6.4 miles of the Presumpscot Estuary as shown in Figure 2. Sampling events were scheduled to capture normal average waterbody conditions by avoiding sampling during periods of drought or excessive rainfall. Teams had expertise in identifying habitat restoration opportunities in anadromous fish habitat, riverine restoration, coastal wetland restoration, and tidal/intertidal habitats and all participants were experienced in the ecology of freshwater and coastal systems, restoration planning, data collection, GPS data collection, and QA/QC procedures. Table 1 provides a list of key personnel who completed significant portions of HRI sampling.

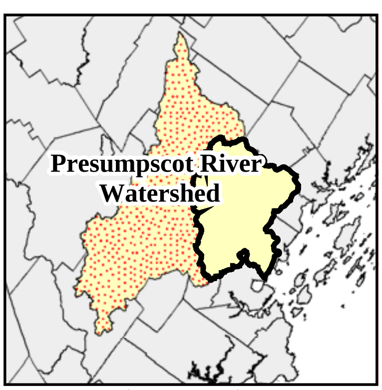
Table 1. Key Personnel

Name	Title
David Santillo, Ph.D.	Principal Ecologist, Professional Wetland Scientist
Stacie Grove	Senior Environmental Biologist
Jack Wu	Associate Fisheries/Aquatics Ecologist
Sarah Haugh	Associate Environmental Scientist

Field evaluations included a qualitative visual assessment of upland, wetland, and in-stream habitats, identification of specific restoration options for each site, photographic documentation of site conditions, and GPS data collection to record site location. GPS coordinates were taken at approximately the center of the linear distance of each site. In cases where a specific feature within the site needed to be documented, a GPS coordinate was recorded at the location of the feature. Surveys were conducted using various watercraft or while walking each linear mile of waterbody and the perimeter of the estuary.

Field team members evaluated characteristics within the waterbody, the shoreline bank, and up to 250 feet of the adjacent riparian and buffer areas to identify areas in need of restoration. Surveys were extended beyond the 250-foot area when warranted. For example, if a problem was encountered at the mouth of a small tributary that connected to one of the waterbodies included in this survey, the field team evaluated beyond the 250 feet to document potential sources of the degradation and to identify restoration opportunities.





Project Location
Data provided by Maine Office of GIS

Figure 2. Waterbodies Included in the Habitat Restoration Inventory for the Lower Presumpscot River Watershed.

Prepared For: Casco Bay Estuary Project HABITAT RESTORATION PROGRAM: Partnerships to Revitalize Damaged Habitats

Prepared By: NEA

Date: 04/05

To standardize the evaluation process, the Project Team developed four field data collection forms that included the following:

- Form 1: Site Identification and Degradation Scoring;
- Form 2: Conceptual Costs;
- Form 3: Potential Challenges; and,
- Form 4: Supplemental Site Evaluation.

Each form is discussed in detail below and copies of the data forms are provided in Volume II, Appendix A. This information was used to assist the Project Team in the evaluation of restoration need and potential at each site.

Form 1: Site Identification and Degradation Scoring

The ***Site Identification and Degradation Scoring*** form was developed to facilitate rapid assessment and documentation of potential restoration sites. The primary purpose of this form was to document the location and characteristics of the site, identify the sources or causes of the degradation on site, and to assign a degradation score that was indicative of the severity of degradation found on the site. The form has three components: 1) general site information, 2) a checklist of 12 sources of degradation commonly associated with the riparian waterbodies surveyed during this effort; and, 3) a list and scoring system for 14 degraded conditions that may result from the sources of degradation. During reconnaissance of waterbodies, field teams evaluated the stream and associated riparian and buffer areas for presence of degradation sources, in-field evidence of degradation, site characteristics, and assigned a score to indicate the level of degradation as described below.

General Site Information

Information in this section of the form includes a site-ID, survey date, location (i.e., state, county, town), latitude/longitude, length of evaluation area, and a description of the restoration problem, surrounding habitats and land/uses, and potential challenges to restoration. Teams documented the physical characteristics of the site with photographs and collected a GPS coordinate at approximately the center of each potential site. The length of evaluation area was recorded and represents the linear distance (in feet) of shoreline or waterbody that was in need of restoration. In areas where a similar condition occurs on both shoreline banks, the length of both banks was included in the length recorded for the evaluation area.

Sources (or causes) of Degradation

This section of the data form was used to document the sources, or causes, of degradation observed on each site. The field team documented any of the following 12 general sources of degradation that were observed by circling the source on the data form:

1) Rip-rap or other unnatural hard structure;
2) Fill/debris/trash;
3) Drainage issue;

4) All-terrain Vehicle (ATV) or off-road vehicle damage;
5) Culvert issue;
6) Invasive plants;
7) High densities of impervious surfaces;
8) Dams or other major obstructions;
9) Land clearing (differs from other categories in that the cleared areas were not permanently maintained in accordance with right-of-way management requirements);
10) Maintained right-of-way (ROW) clearing (power or gas utilities, roads, railroads where vegetation is permanently maintained in low herb/shrub cover as part of utility/infrastructure management requirements);
11) Unstable bank; and,
12) Land use activities with high potential to input nutrients or pollutants into the waterbody.

Indicators of Degradation and Degradation Score

This section of the data form was used to document the types and severity of degradation observed on each site. These indicators refer to the degraded environmental conditions that have resulted from the source(s) of degradation identified on the site. The field team documented presence of any of the 14 indicators by assigning a degradation score ranging from 0.01 to 1.0 that represented the degree of degradation for each indicator observed. A score of 1.0 represented the most degraded conditions and a value of 0.01 represented the least degraded. Scores for all indicators of degradation were combined to get a final degradation score. The maximum score any site could receive was 14.00, which could occur if all indicators of degradation were observed and each indicator had a degradation score of 1.0 (indicating severely degraded condition). Indicators of degradation include the following:

1) Low water quality/clarity;
2) Impediment to natural water flow;
3) Obstruction to fish passage;
4) Low bank stability/erosion;
5) Evidence of extreme flooding;
6) Concentrated high velocity runoff into waterbody;
7) Lack of, or impaired, riparian vegetation;
8) Unnatural channel;
9) Unnatural sediment accumulation;
10) Impaired aesthetic quality;
11) Inadequate buffer;
12) Close proximity to a nutrient/pollution source;
13) Wetland loss; and,
14) Direct disturbance to substrate.

Form 2: Conceptual Costs

The field team evaluated each site to determine the effort and costs likely to be associated with restoration of the site relative to other sites. The ***Conceptual Cost*** form provides a list of potential factors that may contribute to restoration cost. Team members checked all potential factors applicable to the site, added factors not on the list when observed, and assigned a cost rank based on the following broad categories: Low = < $25,000, Moderate = $25,000 to $75,000, High = $75,000 to $150,000, and Very High = > $150,000. This cost rank appears in the database and is one of the search options. The cost rank is very conceptual and is intended to provide an additional level of information to assist users in evaluating and selecting potential restoration sites relative to the other sites identified in this survey. More information would be necessary to fully and accurately evaluate restoration costs at each site.

Form 3: Potential Challenges

The field team used the ***Potential Challenges*** form to evaluate each site for potential factors that may pose challenges to the restoration effort. Team members checked all potential factors on the form that were applicable to the site and new factors were added to the list of potential challenges as they were encountered. This list of challenges is included in the database and appears as a list on the site summary forms. As with the cost rank, the list of potential challenges is intended to provide an additional level of information to assist users in evaluating and selecting potential restoration sites. Additional effort would be necessary to refine and document potential challenges to restoration at each site.

Form 4: Supplemental Site Evaluation

The ***Supplemental Site Evaluation*** form (Volume II, Appendix A) was used to document additional details regarding the environmental conditions of some sites with potential for restoration. Similar to the ***Site Identification and Degradation Scoring*** form, information from this form allows users of the database to evaluate the severity of degradation on a site. However, the ***Supplemental Site Evaluation*** form provides additional details within five broad environmental parameters (i.e., water quality, riparian habitat, human disturbance, channel morphology, and in-stream/fish habitat). For example, the ***Site Identification and Degradation Scoring*** form may provide documentation that an unstable bank exists at a site and that the level of degradation was high, but the ***Supplemental Site Evaluation*** form provides additional information for riparian habitat parameter such as the number of vegetative layers in the riparian area, the percent cover of vegetation in the riparian area, the percent cover of invasive plant species present, as well as additional information.

The ***Supplemental Site Evaluation*** output essentially provides more justification or explanation for degradation scores and is another way to look at the ecological conditions of a site. The information closely corresponds to the degradation score in that a site with a relatively low degradation score will also have a low overall score for the parameters evaluated during the supplemental site evaluation. Users of the database can assess the level of degradation at a site based on either the degradation score output from the ***Site Identification and Degradation Scoring*** form or the output score from the ***Supplemental Site Evaluation*** form. However, queries on the habitat inventory database are presented in order of the severity of degradation (highest scores) based on the degradation score from the ***Site Identification and Degradation Scoring*** form only.

When completing the ***Supplemental Site Evaluation*** form the field team answered a series of questions relating to environmental variables associated with the water quality, riparian habitat, human disturbance, channel morphology, and in-stream/fish habitat parameters. The response to each question had a value assigned to it that reflected a range of conditions (from ideal to degraded). For example, when evaluating the riparian habitat parameter, one question asks to record the percent cover of vegetation on the shoreline bank. Selecting a value of < 5% cover would receive an overall score of 1.0 (indicating the least desirable condition); a value of 60% cover would receive a score of 0.25 (reflecting the most desirable condition). Higher scores reflect a higher level of degradation than low scores. Scores for all parameters were combined and an average of the parameters evaluated was calculated to derive a supplemental evaluation score. This score provides an indicator of overall degradation and can be used to compare degradation scores among all sites. In some cases, not all parameters were applicable for the site. These parameters were excluded in the total score and when calculating the average score. The total score for each individual parameter provides information regarding the level of degradation for each specific parameter that was evaluated and is useful in comparing conditions among sites for a specific parameter of interest.

The ***Supplemental Site Evaluation*** form (Volume II, Appendix A) was completed for each potential restoration site, except in cases where the total degradation score from the ***Site Identification and Degradation Scoring*** form was $\leq$ 1.0, or, the only degradation indicators identified on the ***Site Identification and Degradation Scoring*** form were "inadequate buffer" and/or "adjacent to intensive land management activities with potential to input nutrients or pollutants". The form was not completed for sites meeting either of these criteria because relative to other potential restoration opportunities in the project area these sites had relatively straightforward degraded conditions that were adequately documented on the ***Site Identification and Degradation Scoring*** form.

2.3 DISSEMINATION OF INFORMATION

2.3.1 Habitat Restoration Inventory Database

An interactive database was created for the HRI in Microsoft Access 2000 (Microsoft Inc., Redmond, WA) data management software to facilitate data entry, storage, evaluation, and report generation for the project. The database was designed to receive and store all raw data in a limited number of master tables. A database Graphic User Interface (GUI), or data entry screen was created to facilitate entry of raw field data, query data and produce summary reports for each potential restoration site. The databases included password access measures to limit database access by un-authorized personnel.

The database offers a user-friendly format to query the database based on criteria such as town, waterbody, restoration type, restoration habitat, source(s) of degradation identified on site, size of restoration area, cost, challenges to restoration, and project status. The results of queries are presented in table format and each site entry within the table can be selected and all available information for the site can be viewed in a Restoration Site Summary Report. Examples of summary reports are available in (Volume II, Appendix B). The summary report provides detailed information regarding the environmental degradation observed on site, the severity of degradation, recommendations for restoration, estimated project cost, notable challenges to restoration, as well as information on land ownership, restoration project contacts, site location, surrounding land uses, project schedule, and potential funding sources. The summary report also includes a photograph of the site and the location of the site on 0.5-foot resolution digital orthoquads.

2.3.2 GIS Data

GIS technology was used to identify potential restoration sites prior to fieldwork. Base data layers, including 0.50-foot resolution aerial photography (MEGIS 2001), MEDOT roads, hydrography, dams, and town and county boundaries were obtained from the Maine Office of GIS. Additional base layers (i.e., watershed boundaries, and RTE species data) were provided by USFWS. Geographic coordinates for sites in the project area that had been previously identified as potential restoration sites by the Maine DEP were provided in the form of a spreadsheet. These coordinates were converted into a shapefile using ArcGIS 8.3 (ESRI 2002). All base layers were overlaid on the aerial photos and analyzed to select potential restoration sites using ArcGIS 8.3. The base layers were also used to create maps for field data collection.

GPS coordinates were collected for all potential restoration sites identified during the course of fieldwork using a Magellan Meridian Platinum handheld, WAAS enabled, GPS unit. Coordinates were collected in Geographic coordinate system, using WGS 84 datum, in decimal degrees, with 3-meter accuracy. Latitude and Longitude coordinates were collected in the center of each site and recorded on field data collection sheets.

Field data were processed in the office to aid in analysis, database development, and report preparation. GPS coordinates for all potential restoration sites were compiled and entered into a spreadsheet. Coordinates were converted to a shapefile using ArcGIS 8.3 and the shapefile was overlaid on aerial photos and other base layers. Coordinates were also entered into the HRI database. These data were also used to create all report figures, presentation images, and site images for the database.

3.0 RESULTS OF HABITAT RESTORATION INVENTORY

The following section provides a summary of the results of the HRI. All results presented here were based entirely on an evaluation of the information from data forms 1 (***Site Identification and Degradation Scoring***), 2 (Conceptual Cost), and 3 (Potential Challenges). Information from data form 4 (***Supplemental Site Evaluation***) is included in the database. However, analyses revealed that conclusions regarding the need for restoration and the severity of degradation at a given site obtained from data form 1 alone correlated closely with the conclusions from the more complex form 4. Therefore, as the name implies, information and scores from Form 4 remain in the database only to provide additional information that may assist parties in characterizing a site.

3.1 OVERALL RESULTS

One hundred fifty-four (154) potential restoration sites were identified throughout the 34.6 miles of waterbodies surveyed. A list of all sites and site summary reports for each site are provided in Volume II, Appendix B. The number included 27 sites along 5.6 miles of the East Branch, 27 sites along 5.6 miles of Mill Brook, 12 sites along the 6.4 mile perimeter of the Presumpscot Estuary, 45 sites along the 8.1 miles of the Presumpscot River, and 43 sites along 8.9 miles of the West Branch (Figure 3).

The Presumpscot River had the highest density of degraded sites observed with an average of 5.56 sites per mile. The West Branch had 4.83 sites per mile, the East Branch and Mill Brook each had 4.82 sites per mile, and the Presumpscot Estuary had the least number of sites per mile (1.88). The density of degraded sites per mile is a general characterization of how degraded the waterbodies were. However, density of sites per mile is somewhat misleading because one site may cover several thousand feet of the waterbody. In terms of actual linear distance of shoreline in need of restoration, the Presumpscot River had the most area of degraded habitat with 52% of its shoreline in need of some form of habitat restoration, followed by the Presumpscot Estuary (42%), East Branch (37%), West Branch (29%), and finally, Mill Brook (26%).

Table 2. Summary of Sources of Degradation Encountered.

Source of Degradation	% of Sites	Source of Degradation	% of Sites
Land clearing (cleared, but not maintained as open area as a result of right-of way management requirements)	48	Drainage issue	16
Maintained right-of way (cleared and permanently maintained as open area in accordance with right-of way management requirements)	38	Invasive plants	16
Rip-rap or other hard structure	25	Fill/debris/trash	12
Impervious surface	21	ATV/Off-road vehicles	12
Unstable bank	19	Culvert issue	8
Intensive land management (potential source of nutrients/pollution)	19	Dam/obstruction	5

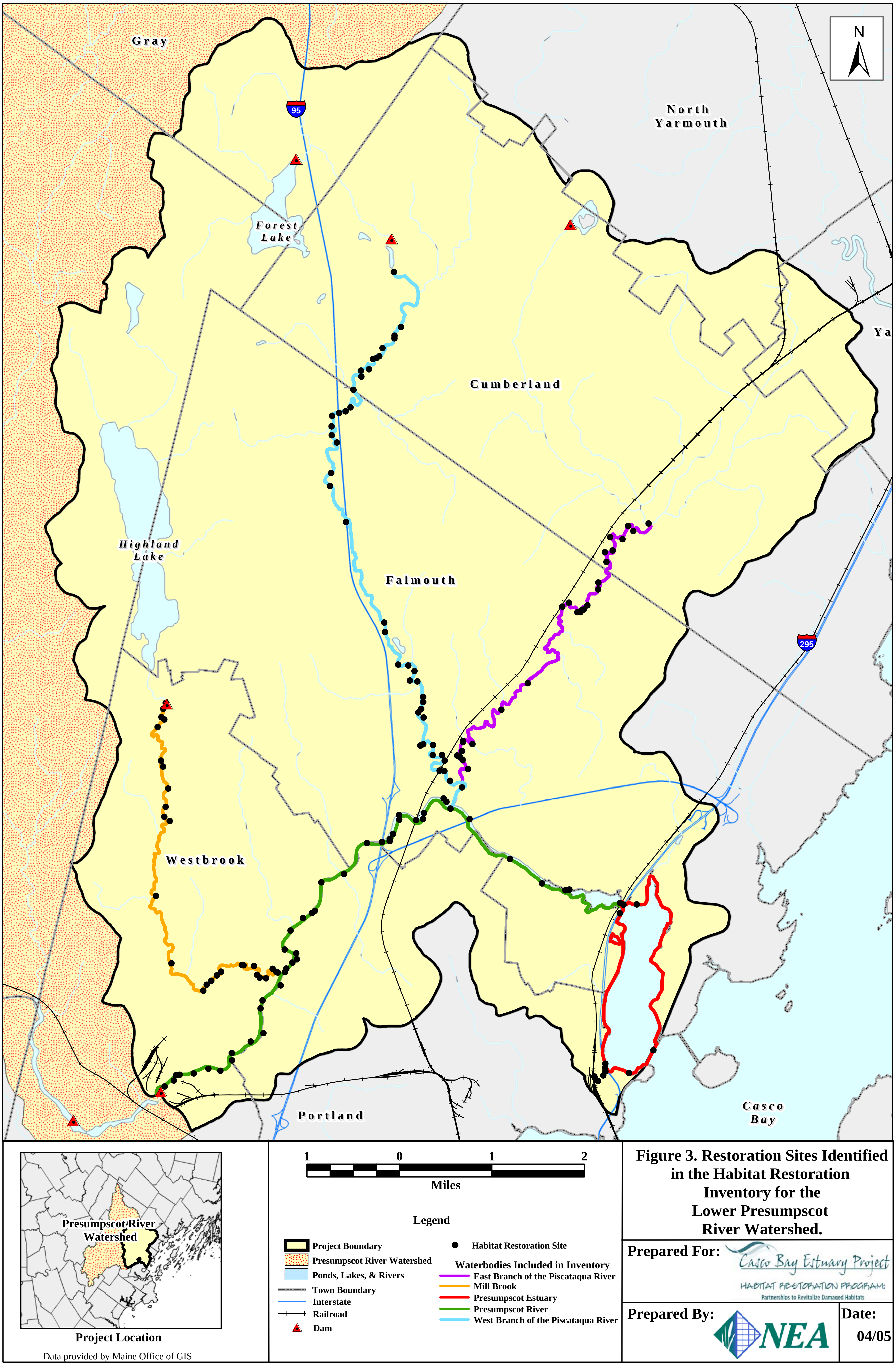


Figure 3. Restoration Sites Identified in the Habitat Restoration Inventory for the Lower Presumpscot River Watershed.

Prepared For: Casco Bay Estuary Project, Habitat Restoration Program: Partnerships to Revitalize Damaged Habitats

Prepared By: NEA

Date: 04/05

Twelve (12) sources of degradation were identified (Table 2). The most common sources of degradation were land clearing, which was an issue at 48% of all sites, and clearings associated with power line, road, or railroad ROWs, which was an issue at 38% of all sites (Table 2). Thirty (30) percent of sites (46 sites) had only one source of degradation.

Three hundred sixty-five (365) individual examples of sources of degradation were observed in the study area (Table 3). Seventy-four (74) occurrences of land clearing were documented throughout the study area and clearing was the number one source of degradation for three of the five waterbodies surveyed (Table 3). The next most common source (58 occurrences) was ROW corridors associated with road, railroad and utility crossings. Land clearing was the most common problem encountered along the east and west branches of the Piscataqua, and the Presumpscot River. ROW crossings and ATV damage were the most common sources of degradation found along Mill Brook, and rip-rap (or other hard structures) was most common along the Presumpscot Estuary.

Table 3. Number of Sources of Degradation Identified Along Each Waterbody.

Source of Degradation	EB[1]	MB[1]	PE[1]	PR[1]	WB[1]	Total
Land clearing (not right-of-way)	18	8	3	22	23	**74**
Maintained right-of-way clearings	6	13	6	14	19	**58**
Rip-rap (or other artificial hard structure)	3	3	8	14	10	**38**
Impervious surface	2	5	6	11	9	**32**
Intensive land management	9	2	0	8	10	**29**
Unstable bank	4	4	1	11	9	**29**
Invasive plant species	3	2	2	13	5	**25**
Drainage issue	2	2	0	11	9	**24**
Fill/debris/trash	1	5	4	6	3	**19**
ATV/off-road vehicle damage	0	10	0	1	7	**18**
Culvert issue	0	1	3	5	3	**12**
Dam/obstruction	1	1	0	2	3	**7**
Total Documented	**49**	**56**	**33**	**118**	**110**	**365**

[1] Key: EB = East Branch of the Piscatiqua, MB = Mill Brook, PE = Presumpscot Estuary, PR = Presumpscot River, WB = West Branch of the Piscatiqua.

Fourteen (14) different types of in-field indicators of degradation were observed (Table 4). Because most sites had multiple indicators of degradation, 433 individual examples of degraded conditions were documented (Table 4). In-field indicators of degradation refer to the degraded environmental conditions that had resulted from the source(s) of degradation identified on the site (listed in Tables 2 and 3). Lack of adequate vegetated buffer use was the most commonly encountered indicator of degradation with 138 occurrences throughout the study area (Table 4). Widening buffers to 250 feet and/or planting existing buffers to improve vegetative layers and density in buffers would improve the environmental conditions at 87% of the 154 potential restoration sites.

Table 4. Number of Sites with Degraded Conditions per Waterbody.

Degraded Condition	EB[1]	MB[1]	PE[1]	PR[1]	WB[1]	TOTAL
Buffer of well-vegetated shrubs and/or trees < 250 ft. wide (adjacent to waterbody and/or associated wetland)	25	23	11	38	41	**138**
Apparent lack of or impaired native vegetation along shoreline and/or bank (vegetation in freshwater and tidal systems)	9	24	11	35	22	**101**
Impaired aesthetic quality	5	9	11	19	14	**58**
Low bank stability/erosion (evidence of bank failure, fallen trees, undercutting, no overhanging vegetation on bank tops)	4	13	2	16	11	**46**
Unnatural channel (downcutting, widening, straightening, or evidence of manmade structures in or along channel that alter channel or reduce erosion of banks)	3	3	9	13	12	**40**
Adjacent to sources of potential high nutrient input or pollution (i.e., golf courses, agricultural areas, housing developments, large lawns) AND buffer < 250 ft	10	5	1	11	12	**39**
Impediment to natural water flow (constrictions, restrictions, redirection of flow)	4	3	5	13	10	**35**
Areas of concentrated high velocity runoff into waterbody (i.e., paved gullies, steep swales)	2	10	0	10	12	**34**
Evidence of unnatural sediment build-up/accumulation	0	11	0	8	5	**24**
In-stream impacts to substrate	0	6	0	1	5	**12**
Wetland loss (filled or hydrologic connection impaired)	0	0	6	0	0	**6**
Low water quality/clarity (turbid, muddy, surface sheen, algal growth, smell of pollutants)	0	1	0	3	0	**4**
Obstruction to fish passage (seasonal water withdrawal, dams, culverts that obstruct passage, diversions)	0	1	0	1	0	**2**
TOTAL	**62**	**109**	**56**	**168**	**144**	**433**

[1] Key: EB = East Branch of the Piscatiqua, MB = Mill Brook, PE = Presumpscot Estuary, PR = Presumpscot River, WB = West Branch of the Piscatiqua.

The next most common indicator of degradation was lack of, or impaired, shoreline vegetation with 101 occurrences (Table 4). Efforts to restore or improve shoreline bank vegetation would improve the environmental conditions at 66% of the sites. Degradation scores (i.e., the score that reflects overall how degraded a site was) ranged from 0.40 to 8.5. As discussed in Section 2.0, the highest score any site could have received was 14.00. Overall, the level of degradation for most sites was relatively low with 29% of sites scoring from 0.00 to 1.0 and 31% of sites scoring > 1.0 to 2.0. Twelve (12) percent of sites scored from > 2 to 3, 5% scored from > 3 to 4, 18% scored from > 4 to 5, and 5% scored > 5.

3.2 RESULTS FOR INDIVIDUAL WATERBODIES

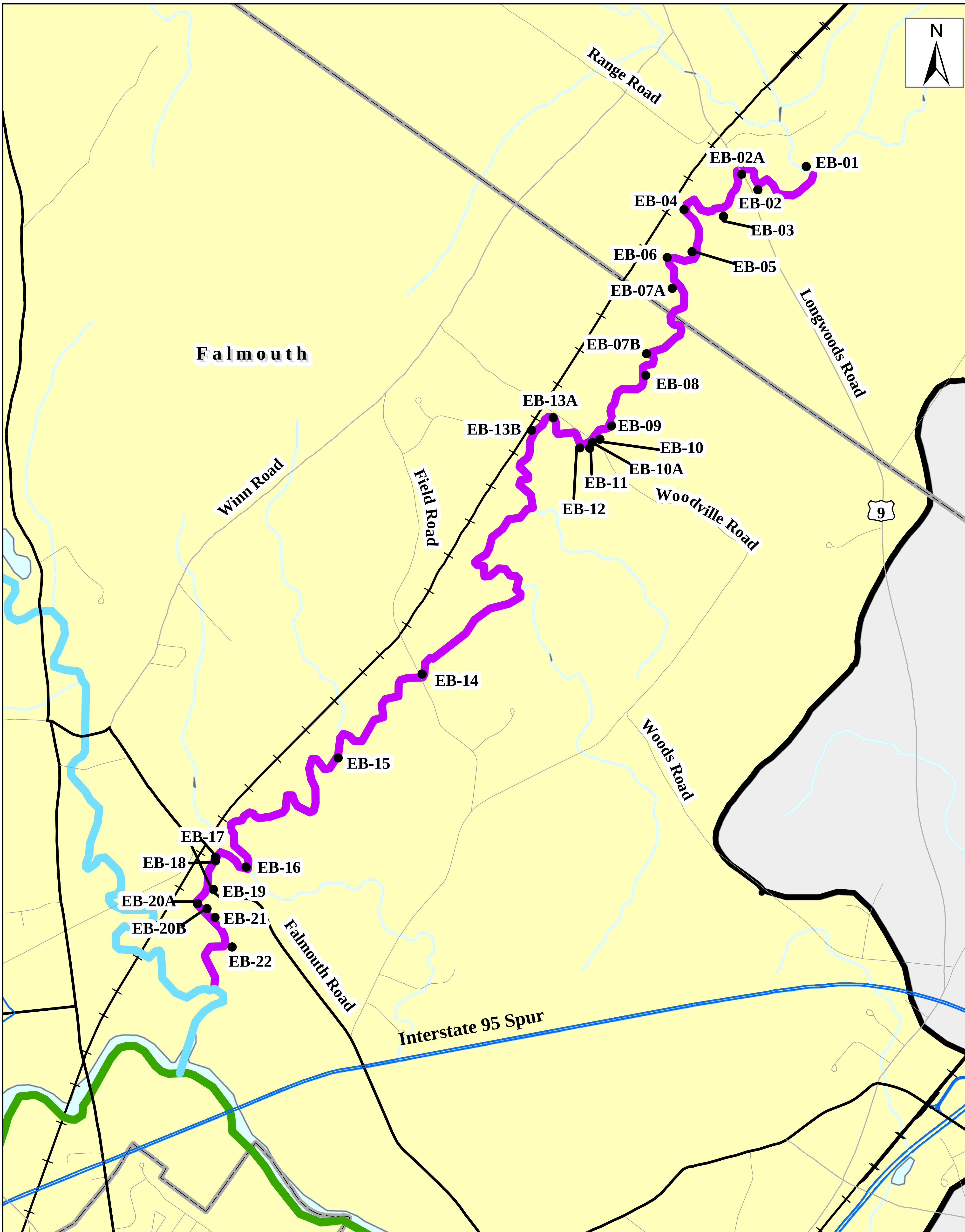
This section contains specific information on each of the waterbodies surveyed for this project. A general characterization of the physical characteristics and ecological setting of each waterbody and a summary of the restoration issues specific to each waterbody are provided.

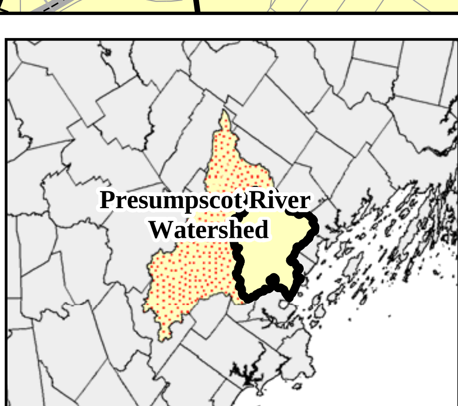
3.2.1 East Branch of the Piscataqua

Description of Waterbody and Surrounding Area

Surveys were conducted along approximately 5.6 miles of the East Branch of the Piscataqua. The survey covered 59,136 linear feet (11.2 miles) of shoreline along both banks (Figure 4). The survey area extended from the confluence of two small tributaries, located approximately 1,150 feet to the northeast of Route 9 and approximately 100 feet southeast of the railroad in Falmouth, toward the southwest to the confluence of the East Branch with the West Branch of the Piscataqua. At the time of the survey, flow in the stream generally was relatively slow. Average water depth in the upper 1/4 of the stream was about 1.5 feet. Throughout the remainder, average water depth ranged from about 2 feet to 3 feet. The drop in stream elevation from the start of the survey area to the end was < 5 feet (MEGIS 2005). Substrate throughout the length typically was sand and sand-silt mix, and only rarely was gravel and cobble present. Embeddedness tended to be moderate to high throughout the length of the stream. The stream can be characterized as fairly meandering for its entire length. Habitat was mostly pools and runs, and riffles and rapids were uncommon. Water color was generally clear. Deadfalls and logjams, some containing 10 or more trees, were common. Banks were generally moderately steep and fairly well-vegetated. Evidence of natural stream course migration was evident in scattered areas, with natural areas of bank erosion and tree falls. Suitability of the stream for salmonids was only fair, due to substrate, and no trout were observed during surveys.

Approximately 65% of the East Branch was surrounded by forest. Land cover in the immediate vicinity of the waterbody in the northern section of the site, from approximately Route 9 southwest to Woodville Road (1.7 miles) was characterized by approximately 40% forested area and 60% open area. Land use in open areas was dominated by a 300-foot wide ROW, a large golf course, residential development, numerous agricultural fields, two primary roads and several secondary roads associated with development. The middle section of the waterbody, from Woodville Road southeast to Falmouth Road (3.4 miles), was 85% forested and 15% open area, including primarily agricultural fields, a railroad, and two primary roads.





Project Location

Data provided by Maine Office of GIS

0.5 0 0.5

Miles

Legend

- Project Boundary
- Presumpscot River Watershed
- Ponds, Lakes, & Rivers
- Town Boundary
- Interstate
- Local Road
- Primary Road
- Railroad
- Dam
- Habitat Restoration Site

Waterbodies Included in Inventory

- East Branch of the Piscataqua River
- Mill Brook
- Presumpscot Estuary
- Presumpscot River
- West Branch of the Piscataqua River

Figure 4. Restoration Sites along the East Branch of the Piscataqua River Identified in the Habitat Restoration Inventory for the Lower Presumpscot River Watershed.

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Prepared By: NEA

Date: 04/05

Land cover in the southernmost section, from Falmouth Road southwest to the confluence of the East Branch with the West Branch of the Piscataqua (0.5 miles), was 80% forest and 20% open area. Agricultural fields and a 125-foot wide ROW dominate the open areas. A relatively high density of agricultural fields also surround much of this section, but for the most part were located beyond the 250-foot buffer of the river.

Significant direct alterations to the channel include bridge abutments and culverts associated with four primary and secondary road crossings and one bridge associated with an unimproved road. These features have likely altered the velocity and flow of water in the East Branch from its natural condition, have impaired the natural shoreline bank, and roads associated with these areas promote runoff of pollutants from the road surface into the waterbody.

In 1998 the USEPA listed the East Branch as an impaired waterbody for point/non-point pollution (USEPA 2005). Impairments included excessive BOD, NH_3, and total phosphorous. The East Branch again was listed as impaired in 2002 for excessive levels of pathogens (USEPA 2005).

Summary of Field Evaluations

Twenty-seven (27) potential restoration sites were identified along the East Branch of the Piscataqua (Figure 4). A list of all sites and site summary reports for each site are provided in Volume II, Appendix B. Ten (10) of the 12 overall-identified sources of degradation were identified along the East Branch and 49 individual examples of these were observed (Table 3). The most common source of environmental degradation was land clearing, which was noted at 67% of all sites. The most common degraded condition encountered was the lack of adequate buffer (i.e., forested buffer $\geq$ 250 feet), which was noted at 93% of all restoration sites on the East Branch (Table 4).

Approximately 21,860 linear feet of habitat (37% of the linear distance of the shoreline) along the East Branch was in some state of environmental degradation and 21,810 linear feet (>99%) of the area in need of restoration had inadequate riparian buffer. Relative to the four other waterbodies inventoried during this survey, the East Branch had the third highest amount of linear distance of its shoreline that was in need of restoration. Of the 27 sites identified along the East Branch, 93% were in need of buffer restoration. Of the 21,810 feet of buffer restoration needed, 46% was associated with old fields/agricultural areas (9,945 feet), 32% was associated with golf courses (7,025 feet), 14% was associated with residential development (2,950 feet), 8% was associated with ROW corridors (1,940 feet), and < 1% was associated with commercial development and roads (175 feet). One or more of the other indicators of degraded conditions (i.e., sediment loading, potential nutrient loading, drainage issues, lack of riparian vegetation, impaired aesthetic quality, low bank stability and erosion) were also found within sites identified for buffer restoration.

Notable Sites or Issues

Degradation scores of restoration sites along the East Branch (i.e., degree of environmental degradation at each site) ranged from 0.50 to 4.05 and only three sites (11% of all sites) had degradations scores greater than 3.0 (Table 5). Based on the methods used in this survey these were the most severely degraded sites along the East Branch (Table 5). So, although the East Branch ranks third highest in terms of the amount of area in need of restoration, the number of sites that were at least moderately degraded (degradation scores $\geq$ 3.0 or higher) was lower than that found in all other waterbodies surveyed. For the range of conditions observed in the study area, a moderately degraded site had a degradation score of greater than 3.0.

Table 5. East Branch Restoration Sites with a Degradation Score of Greater than 3.0.

Site ID	Size (linear feet)	# of Indicators of Degradation	Degradation Score[1]	Primary Issues
EB-02A	50	5	4.05	Bridge associated with road crossing
EB-10A	60	5	4.05	Bridge associated with road crossing
EB-19	50	4	3.25	Bridge associated with road crossing

[1] Higher score indicates a higher level of habitat degradation.

Each of the 27 sites identified during this survey was deserving of further evaluation to determine suitability for restoration, and although determining site suitability for restoration is subjective and greatly dependant upon the budgets and objectives of the organizations interested in restoration, the following site/restoration issues observed along the East Branch were worth noting.

Sites EB-02A, EB-10A, and EB-19 (Impacts associated with bridge crossings)

These sites were associated with road crossings over the East Branch. In general, habitat degradation associated with road crossings includes hardened un-natural shorelines, impediments to natural flow due to abutments, lack of vegetation on shoreline banks and in the riparian buffer, and impaired aesthetic quality. There was also potential for runoff of sediment and pollutants from the impervious roadway surfaces. Issues at Site EB-19 also include rip-rap (originally placed at the crossing for bank stabilization) that had fallen into the stream channel and was somewhat constricting and redirecting flow. Bridge sites also typically include trace amounts of invasive species (i.e., purple loosestrife).

Conceptual costs to restore this bridge site are likely to be very high (> $150,000) and factors to consider in the costs associated with restoring the site include the need for the following: engineering surveys and hydrologic investigations prior to removal of hard structures on banks; bio-engineering stabilization of banks; traffic control; and major site grading, fill removal, removal of hard structures, erosion control, and planting. Some challenges associated with restoration of bridge sites include limited access, potential need to restrict public access on roadways during restoration, and limitations of planting and grading due to ROW restrictions on vegetation adjacent to road corridors. Some restoration benefit could be achieved at a low cost ($25,000) by removing rip-rap in the stream at Site EB-19, improving vegetation in riparian areas at all sites, or installing silt fence or other structures to redirect flow off roadways away from stream corridors.

Restoration recommendations for these sites include:

- Remove rip-rap and hard structures from within the natural channel;
- Remove rip-rap and bridge abutments along shoreline banks and stabilize banks using bioengineering techniques;
- Redirect runoff from roadways to ensure sediment/pollutants are filtered through detention basins;
- Remove invasive species; and,
- Plant trees/shrubs to improve the buffer.

Common Sources or Indicators of Degradation

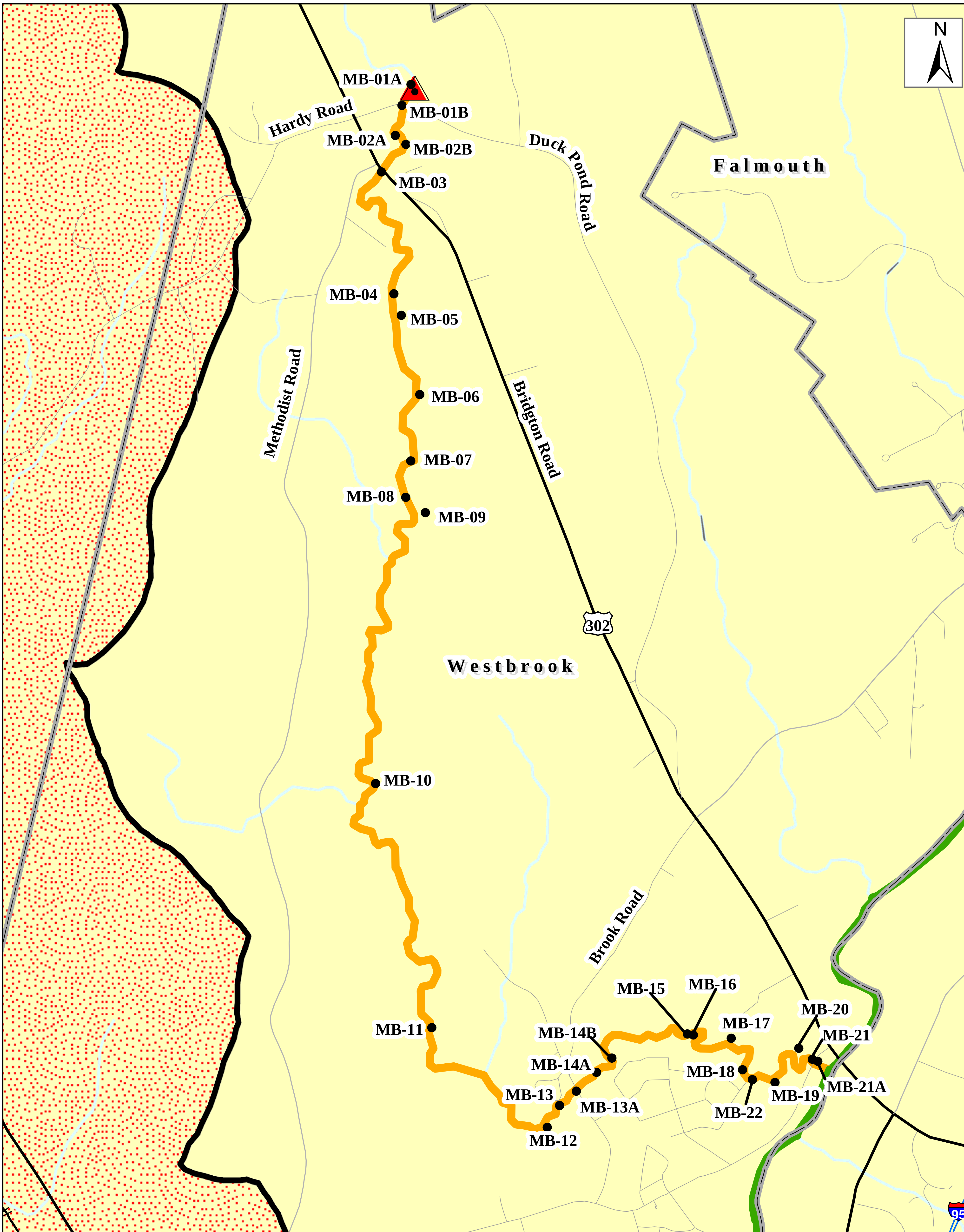
The most common degraded condition observed along the East Branch was lack of riparian buffer and the most common cause (or source) of this degradation was land clearing. Ninety-three percent (93%) of the restoration need along the East Branch was related to inadequate buffer coverage, most of which was associated with land clearing for agricultural areas and golf courses. Addressing the causes of land clearing would help to improve the long-term health of the East Branch. In addition, costs associated with improving buffer coverage can be minor and may simply involve working with landowners to remove a portion of the riparian area from active use. Based on documented trends in commercial and residential development in the Presumpscot Watershed, if left unchecked the trend in forest loss adjacent to waterbodies is likely to continue (CBEP 1996). As such, measures to promote high-quality habitat along the East Branch should include the following:

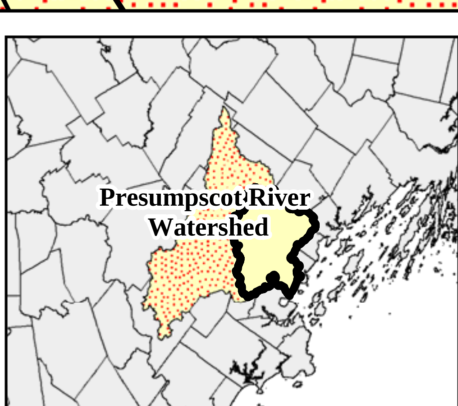
- Land preservation;
- Work with existing landowners to minimize activities that degrade buffers;
- Initiate community activities and landowner outreach programs that assist landowners with improving buffer conditions; and,
- Enforcement of rules and regulations imposed to restrict activities that degrade buffers.

3.2.2 Mill Brook

Description of Waterbody and Surrounding Area

Restoration inventory surveys were conducted along approximately 5.6 miles of Mill Brook. The survey covered 59,136 linear feet (11.2 miles) of shoreline along both banks. The survey area extended from the Highland Lake Dam in Falmouth southeast to the confluence of Mill Brook with the Presumpscot River in Westbrook (Figure 5). The northern half of the Mill Brook waterbody had an average slope of 1.3% and the substrate was derived primarily from glacial till material. The lower half had an average slope of 0.3% and the substrate was derived primarily from marine fines. Elevation change in this waterbody was significant with a change of approximately 160 feet from the start of the survey area to the end (MEGIS 2005). Water flow was typically moderate during the survey, although it can be controlled via the Highland Lake Dam.





Project Location

Data provided by Maine Office of GIS

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Miles

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- Project Boundary
- Presumpscot River Watershed
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- Town Boundary
- Interstate
- Local Road
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- Habitat Restoration Site

Waterbodies Included in Inventory

- East Branch of the Piscataqua River
- Mill Brook
- Presumpscot Estuary
- Presumpscot River
- West Branch of the Piscataqua River

Figure 5. Restoration Sites along Mill Brook Identified in the Habitat Restoration Inventory for the Lower Presumpscot River Watershed.

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Prepared By: NEA

Date: 04/05

The waterbody had a diverse assemblage of riffles, runs and pools and the channel bottom materials range from silt to large cobble. Overall, embedeness ranged from moderate to high, but aside from specific documented potential problem areas, embeddedness was attributed to natural conditions of the waterbody, particularly since the local surficial geology in the area had a high component of sands and clays. In general, embeddedness was lower in the northern half, and higher in the southern portion of the brook. The banks were relatively steep and stable throughout, except in areas modified by human activities and identified as potential restoration sites. Some bank erosion, fallen trees, woody debris jams, beaver dams and impoundments, were observed throughout the waterbody. However, unless otherwise noted (i.e., identified as a location in need of restoration), these features were determined to be naturally occurring features and an integral part of a typical dynamic stream system. This was particularly the case for streams such as Mill Brook, which is in a period of adjustment and recovering from significant flooding events of the 1990's (Jeff Varricchione, Maine DEP, personal communication).

Approximately 75% of Mill Brook was surrounded by forest (Volume II, Appendix C). Land cover in the northern section of Mill Brook, from the Highland Lake Dam southwest to the ROW crossing located just south of the gravel pit (1.4 miles), was approximately 50% forest and 50% open area. A large gravel mining operation, residential homes, farms and associated agricultural areas, a large approximately 600-foot wide ROW, and two 125-foot wide ROWs, dominate open areas. Open ROW corridors parallel over 3,100 feet of the river in this section and had significantly degraded the riparian buffer. Land cover in the middle section, located from the ROW crossing located just south of the gravel pit south and southeast to Austin Road (2.8 miles), was approximately 90% forest and 10% open area. Two 75-foot wide ROWs, a 150-foot wide ROW, residential development and a primary road dominate open areas.

The southern most section, from Austin Road west and southwest to the confluence of the Presumpscot River (1.4 miles), was 85% forested and 15% open. Residential development, commercial development, an old field, a primary road, and secondary roads associated with development, dominate open areas. In addition, a relatively high density of residential development surrounds this section, but occurs beyond the 250-foot buffer along the river.

Significant direct alterations to the channel include a complete waterbody obstruction (dam) located at Highland Lake, and bridge abutments/culverts associated with four primary/secondary road crossings and one bridge associated with an unimproved road. These features have altered the velocity and flow of water in Mill Brook from its natural condition, have impaired the natural shoreline bank, and roads associated with these areas promote runoff of pollutants from the road surface into the waterbody.

In 1998 and again in 2002, the USEPA listed Highland Lake as an impaired waterbody for excessive levels of total phosphorous (USEPA 2005). Highland Lake provides source water to Mill Brook. Based on surveys conducted by MEDEP, water temperatures in the upper portion of Mill Brook (near Highland Lake) have been documented as sub-optimal for most trout species (Jeff Varricchione, Maine DEP, personal communication).

Summary of Field Evaluations

Twenty-seven (27) potential restoration sites were identified for Mill Brook (Figure 5). A list of all sites and site summary reports for each site are provided in Volume II, Appendix B. All 12 sources of degradation were documented along Mill Brook and 56 individual examples of these were observed (Table 3). The most common sources of environmental degradation were ROWs (observed at 41% of sites) and ATV/off-road vehicle use (observed at 37% of sites). These sources of degradation were closely tied to one another in that most areas of ATV damage occur within utility and natural gas ROW corridors. The most common degraded condition encountered was impaired shoreline bank vegetation (at 89% of sites) and lack of adequate buffer (at 85% of sites) (Table 4). These conditions were the direct result of ATV use of riparian areas and ROW management practices that maintain vegetation in ROW's as low herb and/or shrub cover.

Approximately 15,510 linear feet of habitat (26% of the linear distance of the shoreline) along Mill Brook was in some state of environmental degradation and 4,895 linear feet (32%) of the area in need of restoration had inadequate riparian buffer. Relative to the four other waterbodies inventoried during this survey, Mill Brook had the lowest amount of linear distance of its shoreline that is in need of restoration. Eighty-five percent (85%) of all restoration sites along Mill Brook were in need of some buffer restoration. Of the 4,895 feet of buffer restoration needed, 7% was associated with old fields/agricultural areas (1,000 feet), 15% was associated with commercial development and roads, <1% was associated with residential development (125 feet), 8% was associated with ROW corridors (1,200 feet), and 2% was associated with ROW corridors combined with ATV use areas. One or more of the other indicators of degraded conditions (i.e., sediment loading, potential nutrient loading, drainage issues, lack of riparian vegetation, impaired aesthetic quality, low bank stability and erosion) were also found within sites identified for buffer restoration.

Notable Sites or Issues

Nine (33%) of the 27 sites along Mill Brook have a degradation score of greater than 3.0 (Table 6). Although Mill Brook ranks the lowest in terms of the amount of area in need of restoration, the number of sites that were at least moderately degraded (degradation scores $\geq$ 3.0 or higher) was higher than that found in all other waterbodies except the Presumpscot Estuary. In addition, the Highland Lake Dam had permanently altered the natural flow of water in this entire waterbody. The dam had a fish passage structure, but the structure was compromised during a 1997 flood and the dam now completely obstructs passage for anadromous species to points upstream of the dam. Degradation scores of restoration sites along Mill Brook (i.e., degree of environmental degradation at each site) ranged from 0.40 to 6.05 (Table 6).

Each of the 27 sites identified during this survey is deserving of further evaluation to determine suitability for restoration, and although determining site suitability for restoration is subjective and greatly dependant upon the budgets and objectives of the organizations interested restoration, the following site/restoration issues observed along Mill Brook are worth noting.

Table 6. Mill Brook Restoration Sites with a Degradation Score of Greater than 3.0.

Site ID	Size (linear feet)	# of Indicators of Degradation	Degradation Score[1]	Primary Issues
MB-10	75	6	3.50	ATV use and ROW
MB-09	75	6	3.70	ATV use and ROW
MB-07	30	6	4.00	ATV use and ROW
MB-13A	80	5	4.05	Bridge associated with road crossing
MN-21A	120	5	4.05	Bridge associated with road crossing
MB-05	30	6	4.15	ATV use and ROW
MB-04	30	6	4.25	ATV use and ROW
MB-06	1500	6	4.90	Gravel mining operation
MB-01A	400	7	6.05	Dam, industrial use

[1] Higher score indicates a higher level of habitat degradation.

Site MB-01A (Highland Lake Dam)

This dam site was located in a relatively forested area at the southern end of Highland Lake. This was the most environmentally degraded site on Mill Brook and poses the most significant long-term negative impacts to the river, particularly to anadromous fish species. The dam had limited fish access structures and therefore posed a significant obstruction to fish passage. Other habitat degradation at the site included lack of buffer and riparian vegetation, hard structures (walls and rip-rap) that have replaced former shoreline banks, invasive species (i.e., loosestrife), and complete alteration of natural river flow.

Restoration costs are expected to be extremely high due to costs associated with major construction activities, need for considerable survey work, fill/structural removal and disposal, to name a few. Challenges may include access issues, landowner cooperation, and funding.

Sites MB-4, MB-5, MB-7, MB-9, and MB-10 (ROW Corridors and ATV Use)

Approximately 98% of the length of Mill Brook had inadequate buffers and much of this area also had impaired shoreline vegetation. Ten percent (10%) of the areas with inadequate buffer and impaired shoreline vegetation were associated with utility ROWs. ROWs pose a unique restoration challenge, because these areas were typically well-vegetated but were permanently maintained as herbaceous/low-growing shrub cover due to utility corridor maintenance practices. In addition, ATV use in many of the ROWs also contributes significantly to overall stream degradation. Degradation commonly observed at ROW crossings and areas with ATV impacts include inadequate vegetation on banks and in the buffer, direct erosion of shoreline banks and vegetation in ATV trails, extreme rutting and runoff from trails into waterbody, sediment loading in the waterbody, and impacts to in-stream substrate. In addition, the lack of dense, tall vegetative cover along waterbodies through ROWs also likely contributes to the sub-optimal water temperatures documented within Mill Brook.

Restoration costs at these sites generally are low (< $25,000), but restoration challenges include ROW maintenance restrictions on vegetation density and height, and the likelihood that following restoration, sites will be re-used, or ATV riders will create new access areas through waterbodies. Site-specific restoration of ATV damaged sites should be combined with methods to educate riders and reduce the use and impacts in waterbodies, to improve likelihood of successful restoration of ATV sites.

Restoration recommendations for ROWs and sites impacted by ATV's include:

- Stabilize and plant overhanging vegetation along shoreline banks within ROW;
- Coordinate with landowner to promote the highest density and layers of vegetation allowable in ROW;
- Improve conditions within ATV trails by restoring shoreline banks and vegetation, redirecting runoff, stabilizing trails, and reducing in-channel impacts using bridges or redirecting ATVs to alternate trails; and,
- Work with local ATV organizations to promote awareness of ATV impacts and to enlist assistance in restoration efforts.

Sites MB-13A and MB 21A (Impacts associated with bridge crossings)

These sites were associated with road crossings over Mill Brook. In general, habitat degradation associated with road crossings includes hardened un-natural shorelines, impediments to natural flow due to abutments, lack of vegetation on shoreline banks and in the riparian buffer, and impaired aesthetic quality. There was also potential for runoff of sediment and pollutants from the impervious roadway surfaces.

Conceptual costs to restore bridge site are likely to be very high (> $150,000) and factors to consider in the costs associated with restoring the site include the need for the following: engineering surveys and hydrologic investigations prior to removal of hard structures on banks; bio-engineering stabilization of banks; traffic control; and major site grading, fill removal, removal of hard structures, erosion control, and planting. Some challenges associated with restoration of bridge sites include limited access, potential need to restrict public access on roadways during restoration, and limitations of planting and grading due to ROW restrictions on vegetation adjacent to road corridors. Some restoration benefit could be achieved at a low cost ($25,000) by improving vegetation in riparian areas at all sites, or installing silt fence or other structures to redirect flow off roadways away from stream corridors.

Restoration recommendations for these sites include:

- Remove bridge abutments along shoreline banks and stabilize banks using bioengineering techniques;
- Redirect runoff from roadways to ensure sediment/pollutants are filtered through detention basins; and,
- Plant trees/shrubs to improve the buffer.

Site MB-06 (Gravel Pit)

Site MB-06 is a gravel pit located on Bridgton Road in Westbrook. Numerous examples of environmental degradation were observed at the gravel pit site, including lack of buffer, poor water quality, sediment loading, invasive plant species, obstructions to growth of shoreline vegetation, and potential sources of nutrient/pollution input into Mill Brook. Costs and effort associated with restoration efforts could be significant depending on the source and nature of the problems. However, conditions could be significantly improved with relatively reasonable cost and effort.

Restoration recommendations for this site include:

- Install sediment/erosion control devices;
- Redirect runoff from site into detention ponds;
- Discontinue active use of buffer areas and replant to 250-foot width;
- Conduct water quality sampling to evaluate water input into Mill Brook from pit area;
- Stabilize areas of erosion/slumping on shoreline banks; and,
- Remove concentrated areas of rock disposal along shoreline bank and in buffer.

Common Sources or Indicators of Degradation

The most common restoration issues facing Mill Brook were associated with ROW corridors damaged by ATV use. Sites associated with these sources of degradation typically rank relatively high in terms of severity of degradation, therefore many were identified as notable sites. However, ATV damages have been documented throughout the area surrounding this waterbody and many were not associated with ROWs. Damages to waterbodies and adjacent riparian areas from ATV use can be significant. Therefore, in addition to addressing issues at sites with high degradation scores, restoration efforts in general should focus on addressing ATV use and impacts throughout the watershed, and particularly on ROWs.

Restoration recommendations include the following:

- Regrade and restore shoreline banks and areas of extreme rutting;
- Replant vegetation;
- Redirect runoff from trail away from waterbodies;
- Stabilize trails;
- Reduce in-channel impacts using bridges or redirecting ATVs to alternate trails; and,
- Work with local ATV organizations and the public to promote awareness of ATV impacts and to elicit assistance in restoration efforts.

Also, an extensive system of ATV trails (documented as site MB-22) was observed in various areas along both the east and west banks of the river. Direct degradation to the stream as a result of trail use was relatively minor. However, there were minor localized areas of vegetation loss, bank slumping, erosion, and sediment runoff from trails that could be improved throughout the waterbody.

3.2.3 Presumpscot Estuary

Description of Waterbody and Surrounding Area

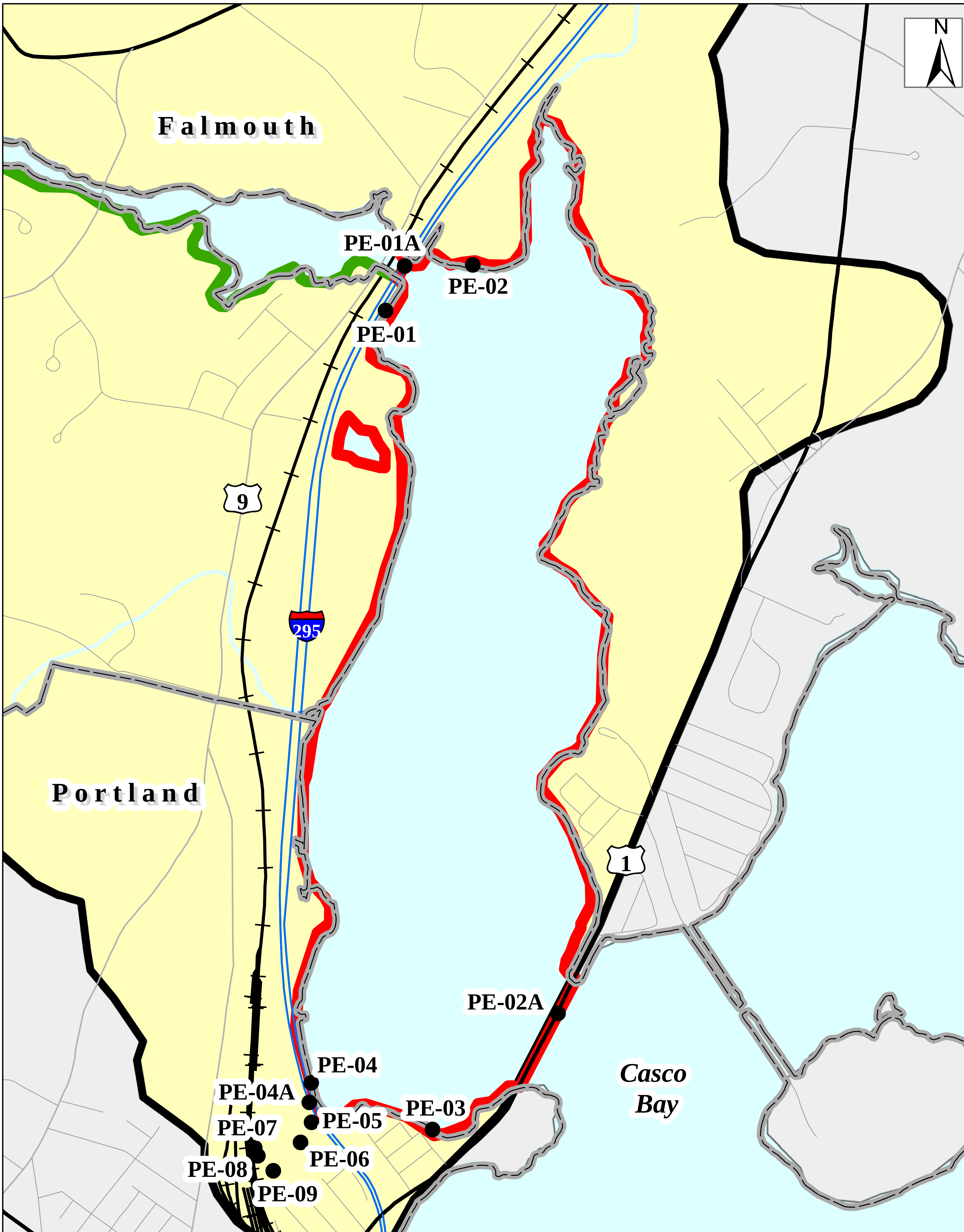
Restoration inventory surveys were conducted along approximately 6.4 miles (33,845 feet) of the perimeter of the Presumpscot Estuary (Figure 6). The survey area extended from the I-295 bridge in Portland (where waters of the Presumpscot River and estuary meet) and followed along the estuary perimeter to the Route 1 Bridge in Portland. The survey area included several coves and impoundments that were hydrologically connected to the estuary.

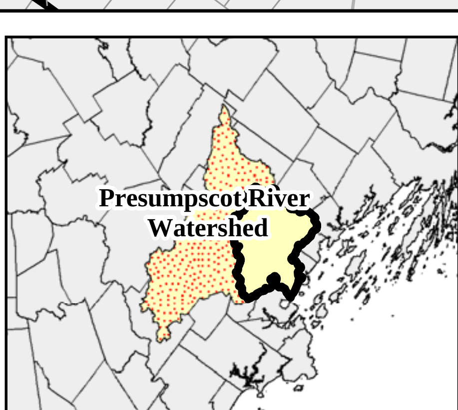
The estuary was characterized by deep silty sediment, and mussels were common throughout the estuary, particularly growing on rocky outcroppings in intertidal areas that were exposed during low-low tides. The shoreline of the estuary was heavily disturbed and developed, and most of it was lined with rip-rapped banks, vegetated with an invasive plant species (*Phragmites australis*), or was disturbed or sometimes "manicured" by residential or commercial development.

Land cover surrounding the estuary was 25% forest, 60% open and 15% salt marsh. Approximately 50% of the open area was dominated by residential/commercial development that includes an interstate, a railroad, two primary roads and numerous secondary roads associated with developed areas. The remaining 10% of open area was old field (primarily protected conservation land) (Volume II, Appendix C).

Significant direct alterations to the estuary include bridge abutments/culverts associated with two interstate crossings and one primary/secondary road crossing. In addition, a significant part of the perimeter of the estuary directly abuts the ROW for I-295 and an active railroad line. These features have altered the velocity and flow of tidal water in the estuary from its natural condition, have impaired the natural estuarine shoreline and tidal flats, and roads associated with these areas promote runoff of pollutants from the road surface into the waterbody. In addition, I-295 and other roads have been placed directly through the former estuary. Culverts in these areas allow for tidal flow, but may be impeding flow enough to promote significant changes within the marsh perimeter and associated salt marsh areas that were separated from the former estuary via I-295.

Salinity levels near the Route 9 bridge over the Presumpscot River range from 0.3 to 9.2 parts per thousand (ppt) (Friends of Casco Bay 2005). Excluding outliers, typical salinities range from 0.5 to 6.0 ppt. Temperature at this location ranges from 4.0 to 26.5 °C, and pH ranges from 6.5 to 8.6. Salinity levels at the Macworth causeway range from 7.9 to 30.3 ppt. Excluding outliers, typical salinities at this location range from 18 to 30 ppt. Temperature at this location ranges from 3.0 to 22.5 °C, and pH ranges from 7.5 to 8.2.





Project Location

Data provided by Maine Office of GIS

0.25 0 0.25

Miles

Legend

- Project Boundary
- Presumpscot River Watershed
- Ponds, Lakes, & Rivers
- Town Boundary
- Interstate
- Local Road
- Primary Road
- Railroad
- Dam
- Habitat Restoration Site

Waterbodies Included in Inventory

- East Branch of the Piscataqua River
- Mill Brook
- Presumpscot Estuary
- Presumpscot River
- West Branch of the Piscataqua River

Figure 6. Restoration Sites along the Presumpscot Estuary Identified in the Habitat Restoration Inventory for the Lower Presumpscot River Watershed.

Prepared For: Casco Bay Estuary Project HABITAT RESTORATION PROGRAM: Partnerships to Restore Damaged Habitats

Prepared By: NEA

Date: 04/05

As recently as the 1960's, the Presumpscot Estuary reportedly contained eelgrass beds, and historically had abundant clam flats, fish and bird species, and a diversity of desirable salt marsh plant species including *Spartina alterniflora* and *Spartina patens* (CBEP 1996, PRMPSC 2003). However, the estuary currently had minimal coverage of *Spartina* species, clams were located only in the middle section of the estuary, and no eelgrass was observed during surveys for this study. Furthermore, eelgrass mapping efforts by the Maine Department of Marine Resources between 1993 and 1995 reported no eelgrass beds in the Presumpscot Estuary (PRMPSC 2003). Current conditions (i.e., substrate type, salinity, pH) were not favorable for these desirable species. Conditions were, however, favorable for the undesirable invasive species common reed, and this species was common throughout the estuary.

The Presumpscot Estuary had an extensive history of water quality impairments that were primarily the result of land development, intensive industrial activities, and damming of the Presumpscot River. Relatively recent examples of impaired conditions include elevated levels of metals and high levels of PAH's (linked to impaired reproduction and cancer in animals) in the estuary sediment, elevated levels of furans and dioxins (toxic chemicals that were a by-products from paper production) in estuary sediment (CBEP 1994), closing of former clam flats and shellfish consumption advisories (1990), and an increase in fine (sand, silt, clay) sediment load in the estuary than would occur naturally. However, the removal of Smelt Hill Dam, elimination of paper production at the Cumberland Mill site, and other improvements to water quality of source water leading into the estuary have resulted in improved conditions within the estuary. Studies conducted by the Friends of Casco Bay in 2000 found that dissolved oxygen levels (often an indicator of system health) exceeded Class SC DO standards with samples reaching a 95% saturation level (PRMPSC 2003).

Summary of Field Evaluations

Twelve (12) potential restoration sites were identified within the estuary (Figure 6). A list of all sites and site summary reports for each site are provided in Volume II, Appendix B. Eight (8) of the 12 sources of degradation were identified along the estuary and 33 individual examples of these problems were observed (Table 3). The most common source of degradation along the estuary was rip-rap or other hard structures (observed at 8 of the 12 sites). These sources of degradation resulted in 56 indicators of degraded environmental conditions (Table 4). The most common degraded conditions were the lack of adequate buffer, lack of or impaired shoreline vegetation, and impaired aesthetic quality (Table 4).

Approximately 14,152 linear feet of habitat (42% of the linear distance of the shoreline) along the estuary was in some state of environmental degradation. Thirty-six percent (36%) of the area in need of restoration lacks sufficient buffer and 64% of the restoration area was in a degraded condition due to the prevalence of the invasive species common reed. Relative to the other waterbodies inventoried during this survey, the estuary had the second highest linear distance of its shoreline that was in need of restoration. Of the 5,102 feet of the area in need of buffer restoration, 86% was associated with the I-295 highway corridor and commercial development (4,392 feet) and 14% was associated with residential development (710 feet).

Notable Sites or Issues

Degradation scores of restoration sites along the Presumpscot Estuary (i.e., degree of environmental degradation at each site) ranged from 1.3 to 5.25. Nine of the 12 sites (75%) in the estuary have a degradation score of greater than 3.0 (Table 7). The estuary ranks second highest in terms of the amount of area in need of restoration, and the number of sites that were at least moderately degraded (degradation scores $\geq$ 3.0 or higher) was higher than that found in all other waterbodies surveyed.

Each of the 12 sites identified during this survey is deserving of further evaluation to determine suitability for restoration, and although determining site suitability for restoration is subjective and is greatly dependant upon the budgets and objectives of the organizations interested in restoration, the following site/restoration issues observed along the Presumpscot Estuary are worth noting.

Table 7. Presumpscot Estuary Restoration Sites with a Degradation Score of Greater than 3.0.

Site ID	Size (linear feet)	# of Indicators of Degradation	Degradation Score[1]	Primary Issues
PE-08	180	5	3.95	Filling of salt marsh
PE-07	100	5	4.00	Poor culvert/bank design
PE-03	635	6	4.25	Development in the intertidal zone
PE-01A	250	5	4.05	Bridge associated with road crossing
PE-02A	250	5	4.05	Bridge associated with road crossing
PE-04A	250	5	4.05	Bridge associated with road crossing
PE-01	887	5	4.50	I-295 ROW
PE-04	1550	6	5.25	I-295 ROW
PE-05	925	6	5.25	I-295 ROW

[1] Higher score indicates a higher level of habitat degradation.

Sites PE-01, PE-04, and PE-05 (Rip-rap embankments and no buffer)

These sites were located along the ROW embankments for I-295 and in terms of habitat, were the most environmentally degraded sites in the estuary. Specific issues include lack of riparian vegetation due to rip-rap on the estuary perimeter, restriction of tidal flow due to culverts beneath the interstate, steep grade to embankments with no intertidal salt marsh fringe, presence of invasive species, filling of salt marsh, and lack of forested buffer due to the highway ROW.

Cost to restore these sites is expected to be very high (> $150,000 per site) due to costs associated with survey work, redirection of traffic, bioengineering, and major land grading and fill/structural removal, to name a few. Challenges to restoration include highway ROW restrictions on vegetative growth along roadways, modification to rip-rap may compromise the highway, access and construction issues (work would need to be done from estuary or highway edge), and the velocities of tidal flow and current water quality conditions may not be conducive to salt marsh restoration.

Sites PE-01A, PE-02A, and PE-04A (Impacts associated with bridge crossings)

These sites were associated with road crossings over the Presumpscot Estuary. In general, habitat degradation associated with road crossings includes hardened un-natural shorelines, impediments to natural flow due to abutments, lack of vegetation on shoreline banks and in the riparian buffer, and impaired aesthetic quality. There was also potential for runoff of sediment and pollutants from the impervious roadway surfaces.

Conceptual costs to restore bridge site are likely to be very high (> $150,000) and factors to consider in the costs associated with restoring the site include the need for engineering surveys and hydrologic investigations prior to removal of hard structures on banks, bio-engineering stabilization of banks, traffic control, and major site grading, fill removal, removal of hard structures, erosion control, and planting. Some challenges associated with restoration of bridge sites include limited access, potential need to restrict public access on roadways during restoration, and limitations of planting and grading due to ROW restrictions on vegetation adjacent to road corridors. Some restoration benefit could be achieved at a low cost ($25,000) by installing silt fence or other structures to redirect flow off roadways away from the waterbody.

Restoration recommendations for these sites include:

- Remove bridge abutments along shoreline banks and stabilize banks using bioengineering techniques;
- Remove rip-rap from intertidal zone and regrade to a depth suitable for salt marsh vegetation;
- Redirect runoff from roadways to ensure sediment/pollutants are filtered through detention basins; and,
- Plant trees/shrubs to improve the buffer.

Site PE-08 (Filled Salt Marsh)

This site contains evidence of salt marsh filling. However, the size of this restoration area likely extends far beyond the area noted in the database. Much of the former salt marsh throughout the estuary had been filled, but this site includes only a relatively small area where fill material was exposed in tidal channels and shoreline banks. Degraded conditions at this location include fill materials that were visible in channel banks (i.e., concrete, lumber, waste metal, tires, trash, and construction debris), low bank stability, evidence of erosion, inadequate buffer, impacts from commercial development, unnatural channel structure due to presence of fill material, wetland filling, and impaired aesthetics.

Restoration costs are anticipated to be very high (> $150,000) due to the need for engineering surveys and hydrologic investigations prior to removal of fill material, bio-engineering stabilization of banks, and major site grading, fill removal, removal of hard structures, erosion control, and planting. Challenges to restoration include access restrictions and the need for heavy equipment, potential hazardous material issues, and restrictions to restoration efforts due to adjacent residential development. Restoration recommendations for this site include:

- Improve buffer density and width to greatest extent possible;
- Remove fill material and dispose at suitable site;
- Regrade site; and,
- Restore tidal hydrology and replant salt marsh.

Site PE-03 (Development in the Intertidal Zone)

Site PE-03 was located at the interface of residential properties and the shoreline of the Presumpscot River Estuary. The intertidal zone and shoreline had been significantly altered and as a result degraded conditions include the following: placement of rip-rap and other hard structures within intertidal, shoreline bank, and buffer areas; presence of outfall pipes that appear to dump stormwater runoff from roads directly into the estuary; lack of/impaired shoreline vegetation and buffer; fill material in shoreline bank; and, the presence of trash/debris and invasive species.

Some restoration benefit can be achieved at this site through relatively low cost and effort including the removal of some hard structures, clean up trash/debris, plant vegetation to improve buffer density and removal of invasive species. However, the extent of restoration is somewhat limited by existing residential properties, permanent structures, and paved areas. Costs associated with the removal of rip-rap and those associated with potential water quality issues related to the stormwater outfall pipe are likely to be very high. In addition, the likelihood of successful replanting of *Spartina* species in the intertidal zone may be limited because the redirection of stormwater flow from outfall pipes (to divert freshwater influx) would require significantly more costs.

Site PE-07 (Poor Culvert Design)

This site was located behind a commercial property and was paralleled by a railroad. Much of the area had been historically filled. Issues on the site were primarily related to poor culvert design that was forcing high velocity flow into an 8-foot unstable embankment. Other issues on site include an unvegetated bank that was severely slumping, rip-rap was impeding vegetation growth at the culvert, inadequate buffer, and impervious surfaces nearby. Evidence surrounding the site (i.e., recent excavation, new culvert, new rip-rap at culvert, erosion mat on nearby embankments) suggests that construction may have recently occurred on site and that restoration had been attempted in this area.

Costs are expected to be moderate ($25,000 to $75,000) due to the need for engineering surveys, culvert redirection, bank stabilization and erosion control, and bioengineering. Buffer restoration will be somewhat limited due to existing commercial properties and the railroad. Actual culvert replacement could be costly, but in-channel modifications and bank stabilization may resolve the problem. Challenges associated with this site include existing fill, steep topography of the bank.

In addition, the site appears to have been previously restored. However, the restoration has not been successful (for reasons unknown).
Recommendations for this site include:

- Contact previous contractor that worked on this site to identify why restoration efforts may have failed;
- Regrade site;
- Remove fill material if appropriate;
- Stabilize and replant bank (will likely require bioengineering);
- Plant shrubs and trees to restore buffer;
- Redesign culvert or use water diversion structure to redirect flow and reduce erosion of bank;
- Replace rip-rap at culvert with bioengineering/plantings.

Common Sources or Indicators of Degradation

Common problems associated with the estuary include the lack of buffer due to development and the widespread presence of the invasive species, common reed. Sixty-seven (67) percent of the perimeter of the Presumpscot Estuary was degraded due to the presence of common reed (the entire area was documented as Site PE-02) and 37% of the perimeter had inadequate buffer. Restoration sites with invasive species tend to score relatively low in terms of severity of degradation, and in fact, there is considerable debate as to the overall contribution of the common reed to estuary health. But, the prevalence of common reed and its potential to continue to spread is of concern. Degradation from common reed can include restriction to fish passage to foraging areas, loss of desirable native vegetation, and there is some evidence to suggest that common reed is indicative of poor water quality conditions.

Costs to address invasive species throughout the Presumpscot Estuary are expected to be very high due to the widespread coverage of the species and the need for long-term management to ensure eradication of the species. Restoration efforts could target localized areas of common reed growth along the estuary perimeter at a relatively low cost, but the overall restoration benefit in addressing small areas along the estuary perimeter is questionable. Buffer restoration along the perimeter is restricted in most areas due to development. However, the width and density of species in riparian areas could be improved at specific areas for < $25,000.

3.2.4 Presumpscot River

Description of Waterbody and Surrounding Area

Restoration inventory surveys were conducted along approximately 8.1 miles of the Presumpscot River, which included 85,536 linear feet (16.2 miles) of shoreline along both banks of river (Figure 7). The survey area extended from the Cumberland Mill Dam in Westbrook roughly eastward to the mouth of the Presumpscot River Estuary located at the I-295 Bridge in Portland. The Presumpscot ranges from approximately 75 feet to 250 feet wide, with an average width of approximately 125 feet. Elevation in the Presumpscot drops 27.4 feet from the Cumberland Mill Dam to sea level at the mouth of the estuary. The most significant elevation changes occur in the

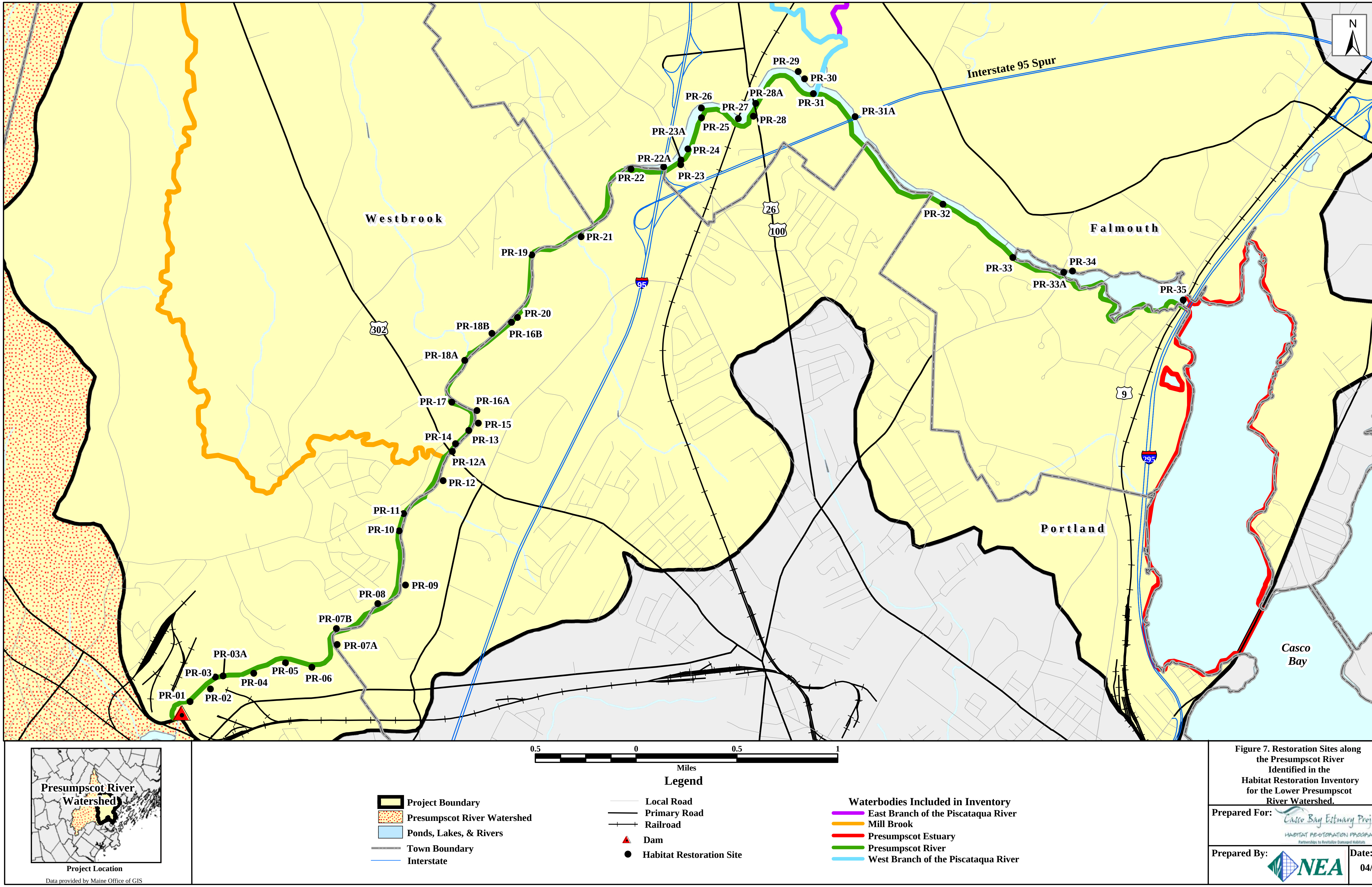


Figure 7. Restoration Sites along the Presumpscot River Identified in the Habitat Restoration Inventory for the Lower Presumpscot River Watershed.

72 vicinity of Cumberland Mills Dam and the former location of Smelt Hill Dam that was removed in 1997 (PRMPSC 2003).

Water flow in the vicinity of the dam and former dam was fast (as evidenced by rapids), substrate was primarily cobble, rubble and exposed bedrock, water was clear, and the average water depth was 1 to 2 feet. Aside from these areas, 90% of the river was characterized by long runs of slow to moderate flowing water, substrate of silts and sands, and an average water depth of 10 feet. Banks throughout the waterbody were steep (average height of 10 feet) and had abundant overhanging vegetation. Bank undercutting and root exposure were common, but unless identified as a restoration site, were attributed to "naturally" occurring changes of a dynamic riverine system. Woody debris, in-stream organic material, and pools/eddys, were common and well distributed throughout the survey area. Currently the dominant fish species in the river include warm-water species such pumpkinseed (*Lepomis gibbosus*), yellow perch (*Perca flavescens*), and American eel (*Anguilla rostrata*).

Approximately 40% of the area immediately surrounding the Presumpscot River was forest (Volume II, Appendix C). Land cover in the westernmost section of the river, from Cumberland Mill Dam northeast to Route 302 (2.3 miles), was 80% open and 20% forested. Open areas were dominated by commercial/industrial and multi-home residential development, two 175-foot ROWs, a primary road crossing, and many secondary roads associated with developed areas (Volume II, Appendix C). The next section, from Route 302 northeast to Interstate 495 (2.3 miles) was 65% open and 45% forested. A large golf course, a landfill, a 125-foot wide ROW, and several agricultural areas/old fields dominate open areas. Ninety (90) percent of the southeast shoreline of the Presumpscot River in this section had a buffer less than 25 feet wide. The section from Interstate 495 to Interstate 95 (1.5 miles) was 65% open and 35% forested. Agricultural fields, a gravel mining operation, two interstate roads, two primary roads, and two 125-foot wide ROWs dominate open areas. The last section of the Presumpscot extends 2.0 miles from Interstate 95 to Route 9. The area surrounding the river was 90% forested, 8% open and 2% brackish marsh. Agricultural fields and some residential development dominate open areas.

Significant direct alterations to the channel include a complete waterbody obstruction (dam) located at Cumberland Mills, and bridge abutments/culverts associated with three interstate crossings, seven primary/secondary road crossings, and two railroad crossing. These features had altered the velocity and flow of water in the Presumpscot from its natural condition, had impaired the natural shoreline bank, and roads associated with these areas promote runoff of pollutants from the road surface into the waterbody.

The main branch of the Presumpscot had a significant history of poor water quality conditions, primarily due to intensive industrial activities and damming of the river. Relatively recent examples are a 1990 freshwater fish consumption advisory; a 1993 study that found elevated levels of mercury in blue mussels; temperatures in excess of those allowable under MEDEP Rule Chapter 582 (i.e., no more than 0.5° F above EPA national ambient water quality criteria of 66° F; low reproductive rate for cold water fish species such as trout; and as recently as 1998, the Presumpscot (below the Cumberland Mill Dam site) was in non-attainment of Class C water quality standards (CBEP 1996, PRMPSC 2003). Water quality conditions have improved significantly in the river, particularly since the elimination of pulping activities at the Cumberland Mill in 1999.

There were no EPA-listed water quality impairments for the main branch of the Presumpscot River (USEPA 2005). However, waterbodies that flow into the main branch (i.e., the East Branch of the Piscataqua and Highland Lake) were listed as impaired by the USEPA in 2002 (USEPA 2005). Recent water quality data were not currently available, but results from 1998 research on macroinvertebrates in the Presumpscot estimate that the river below Westbrook has a 60% chance of meeting class B water quality standards for aquatic life (PRMPSC 2003).

Summary of Field Evaluations

Forty-five (45) potential restoration sites were identified for the Presumpscot River (Figure 7). A list of all sites and site summary reports for each site are provided in Volume II, Appendix B. Examples of all 12 sources of degradation were identified along the Presumpscot and 118 individual examples of these problems were observed (Table 3). The most common source of degradation was land clearing (observed at 22 of the 37 sites), which was directly associated with commercial development and roadways. The sources of degradation observed along the river resulted in 168 indicators of degraded environmental conditions (Table 4). The most common indicators of degraded conditions were the lack of adequate buffer and impaired shoreline vegetation (Table 4).

Approximately 44,295 linear feet of habitat (52% of the linear distance of the shoreline) along the Presumpscot was in some state of degradation and 67% of the area in need of restoration had inadequate buffer. Inadequate buffer and impaired shoreline vegetation were primarily the direct result of land clearing and land use activities close to riparian areas. Of the 29,705 feet of buffer restoration needed, 31% was associated with old fields/agricultural areas (9,380 feet), 30% was associated with golf courses (8,815 feet) and 28% was associated with commercial/industrial development and roads (8,215 feet). ROW corridors (1,725 feet) contribute to 6% of the buffer restoration need and residential development (1,570 feet) contributes to 5% of the buffer restoration need.

Notable Sites or Issues

Degradation scores of restoration sites along the Presumpscot River (i.e., degree of environmental degradation at each site) ranged from 0.55 to 6.5. Thirteen (13) sites (29% of sites) had degradation scores greater than 3.0; a score that indicates relatively degraded conditions (Table 8). Forty-five (45) restoration sites were identified along this waterbody, ranking the river as the waterbody with the highest number of restoration sites and the highest density of sites per mile of river surveyed. However, although the Presumpscot River ranks highest in terms of the amount of area in need of restoration, and had the highest density of restoration sites, the number of sites that were at least moderately degraded (degradation scores $\geq$ 3.0 or higher) was lower than that found in all other waterbodies surveyed except the East Branch and West Branch. In addition, the Cumberland Mills Dam has permanently altered the natural flow of water in this entire waterbody and completely obstructs passage for anadromous species to points north of the dam.

Each of the 45 sites identified during this survey is deserving of further evaluation to determine suitability for restoration, and although determining site suitability for restoration is subjective and is greatly dependant upon the budgets and objectives of the organizations interested restoration, the following site/restoration issues observed along Presumpscot River are worth noting.

Table 8. Presumpscot River Restoration Sites with a Degradation Score of Greater than 3.0.

Site ID	Size (linear feet)	# of Indicators of Degradation	Degradation Score[1]	Primary Issues
PR-03A	120	5	4.05	Bridge associated with road crossing
PR-12A	160	5	4.05	Bridge associated with road crossing
PR-22A	210	5	4.05	Bridge associated with road crossing
PR-23A	80	5	4.05	Bridge associated with road crossing
PR-28A	100	5	4.05	Bridge associated with road crossing
PR-13A	220	5	4.05	Bridge associated with road crossing
PR-33A	100	5	4.05	Bridge associated with road crossing
PR-35	95	5	4.05	Bridge associated with road crossing
PR-33	250	8	5.1	Former dam site
PR-16A	300	7	5.25	Landfill
PR-06	50	9	5.75	Exposed pipe and high velocity flow in tributary
PR-26	850	7	6	Gravel mining operation
PR-01	1900	9	8.5	Dam and industrial development

[1] Higher score indicates a higher level of habitat degradation.

Site PR-01 (Cumberland Mill Dam)

This dam site was located within an industrial area/paper mill. This was the most environmentally degraded site identified during this survey effort. This site poses the most significant long-term negative impacts to the Presumpscot River, particularly to anadromous fish species. The dam had no fish access structures and therefore was a complete obstruction to fish passage. Other examples of habitat degradation includes complete lack of buffer and riparian vegetation, hard structures (walls and buildings) have replaced former river banks, invasive species (i.e., loosestrife), high density of impervious surface in the area, rip-rap on shoreline banks, complete alteration of natural river flow, and outfall pipes dump directly into the Presumpscot.

Restoration costs are expected to be extremely high due to costs associated with major construction activities, need for considerable survey work, fill/structural removal and disposal, to name a few. Challenges may include access issues, potential hazardous materials issues in the substrate, landowner cooperation, fill disposal, and funding.

Sites PR-3A, PR-12A, PR-22A, PR-23A, PR-28A, PR-13A, PR-33A, and PR-35A (Impacts associated with bridge crossings)

These sites were associated with road crossings over the Presumpscot River. In general, habitat degradation associated with road crossings includes hardened un-natural shorelines, impediments to natural flow due to abutments, lack of vegetation on shoreline banks and in the riparian buffer, and impaired aesthetic quality. There was also potential for runoff of sediment and pollutants from the impervious roadway surfaces.

Conceptual costs to restore bridge site are likely to be very high (> $150,000) and factors to consider in the costs associated with restoring the site include the need for the following: engineering surveys and hydrologic investigations prior to removal of hard structures on banks; bio-engineering stabilization of banks; traffic control; and major site grading, fill removal, removal of hard structures, erosion control, and planting. Some challenges associated with restoration of bridge sites include limited access, potential need to restrict public access on roadways during restoration, and limitations of planting and grading due to ROW restrictions on vegetation adjacent to road corridors. Some restoration benefit could be achieved at a low cost ($25,000) by installing silt fence or other structures to redirect flow off roadways away from the waterbody.

Restoration recommendations for these sites include:

- Remove bridge abutments along shoreline banks and stabilize banks using bioengineering techniques;
- Remove rip-rap from intertidal zone and regrade to a depth suitable for salt marsh vegetation;
- Redirect runoff from roadways to ensure sediment/pollutants are filtered through detention basins; and,
- Plant trees/shrubs to improve the buffer.

PR-06 (Exposed Pipe in Degraded Tributary)

This 20-foot wide degraded tributary was located down slope from a utility ROW. The site was characterized by significant scouring and erosion of tributary banks, sediment loading in the tributary and at the confluence with the Presumpscot River, trash and concrete blocks in the tributary, and an exposed pipe that crosses the tributary and parallels the river. A trail also crosses the tributary via a makeshift bridge crossing. The buffer was well-vegetated, forested, but only 150-feet wide due to the utility ROW.

Costs for restoration of this site are expected to be moderate ($25,000 to $75,000), primarily due to the need to remove large cobble and debris from the tributary, bank stabilization, and the need to stabilize and/or remove the exposed pipe. Costs could be very high depending on issues associated with exposed pipe and fill removal. Challenges include the possible need to access the site with heavy equipment from the river, and potential issues surrounding the exposed pipe (i.e., is the pipe needed and what does the pipe carry).

Restoration recommendations for this site include the following:

- Remove trash/boulders to restore natural flow;
- Stabilize banks;
- Control runoff;
- Re-vegetate slumping banks;
- Explore nature of exposed pipe and stabilize or remove;
- Improve or remove trail crossing; and
- Investigate ROW as possible contributor to problems in the tributary (i.e., possible excessive runoff, diversion bars needed).

PR-16A (Landfill)

This site was located near the base of a landfill and was associated with the Riverton Trolley Park. Degraded conditions on the site include inadequate buffer, gullies from steep slopes off the landfill were carrying landfill runoff into the river, erosion, trash and household debris, and sediment loading in river. The area also had been impacts by foot traffic from a trail that crosses through the area from the Riverton Trolley Park.

Restoration costs are expected to be moderate ($25,000 to $75,000), and based on current knowledge of the site there were no major limitations to restoration. Possible challenges could include high costs if water diversion or detention structures are needed or severe water quality issues were identified. Also, because of steep slopes, access to this site could be an issue if heavy equipment is needed. However, much of the restoration could be conducted by hand.

Restoration recommendations for this site include:

- Replant buffer;
- Conduct water quality testing to evaluate runoff from landfill;
- Redirect runoff (may require detention basins or diversion structures);
- Investigate source of sediment loading an eliminate;
- Remove trash; and,
- Re-route and/or improve trail.

PR-26 (Gravel Mining Operation)

This site includes a tributary from a gravel mining operation that dumps into the Presumpscot. Environmental degradation issues include sediment loading in the tributary and at the confluence of the tributary with the Presumpscot, high turbidity, undercut banks, cobble/rock from mine in tributary channel, lack of riparian vegetation, invasive plant species (i.e., loosestrife and knotweed), an inadequate buffer consisting of shrubs and < 25 feet wide along tributary, and an inadequate buffer consisting of trees and < 200 feet wide along the river.

Costs and effort to restore this site could be well over $250,000 depending on the source and nature of the problems (not fully investigated as part of this survey effort). However, significant restoration gain can be achieved at this site at a low cost (< $25,000) and relatively minimal effort. For example, addressing the issue of runoff of sediment into the tributary alone can result in significant environmental improvement for the site.

Restoration recommendations for this site include:

- Install sediment/erosion control devices;
- Widen buffer along 800 feet of river;
- Widen buffer along 1,150 feet of tributary from gravel pit;
- Stabilize banks; and,
- Investigate potential water quality issues.

PR-33 (Former Smelt Hill Dam Site)

Degradation at this site was primarily the result of placement of large cobble/rip-rap on the western bank of the river at the former location of the Smelt Hill Dam. Degradation on site includes rip-rap and gravel on shoreline bank, herbaceous buffer cover only from river edge to 50 ft from bank top, aesthetic issues due to rip-rap and cribbing in channel, invasive purple loosestrife, sediment loading, erosion, and channelization from a residential development located upslope of the site.

Costs to restore this site are expected to be very high (> $150,000) and restoration challenges are likely to include access restrictions by adjacent landowners, the magnitude of the endeavor to remove and dispose of rip-rap, efforts will require heavy equipment, bio-engineering will likely be needed to stabilize at least part of the steep embankment, and restoration will require engineering and hydrologic surveys. In addition, this site serves as an example for future dam removal projects; its condition and characteristics may influence future decisions regarding dam removal.

Restoration recommendations include:

- Remove rip-rap and dispose at a suitable location;
- Stabilize shoreline bank, particularly areas of significant erosion;
- Restore vegetation on shorline bank;
- Redirect channelized flow from development;
- Remove cribbing (although structure may serve as fish/wildlife habitat); and,
- Plant trees/shrubs to extend buffer from shoreline bank to existing forest edge.

Common Sources or Indicators of Degradation

In addition to the sites described above, the most prevalent habitat restoration issues facing the Presumpscot River were associated with land clearing, much of which was the direct result of clearing for agricultural uses, golf courses, and commercial/industrial development. In addition, costs associated with improving buffer coverage can be minor and may simply involve working with landowners to remove a portion of the riparian area from active use. Addressing these common sources of the habitat degradation would help to improve conditions and ensure the long-term health of the Presumpscot River.

Restoration recommendations include:

- Land preservation;
- Work with existing landowners to minimize activities that degrade buffers;
- Initiate community activities and landowner outreach programs that assist landowners with improving buffer conditions; and,
- Enforcement of rules and regulations imposed to restrict activities that degrade buffers.

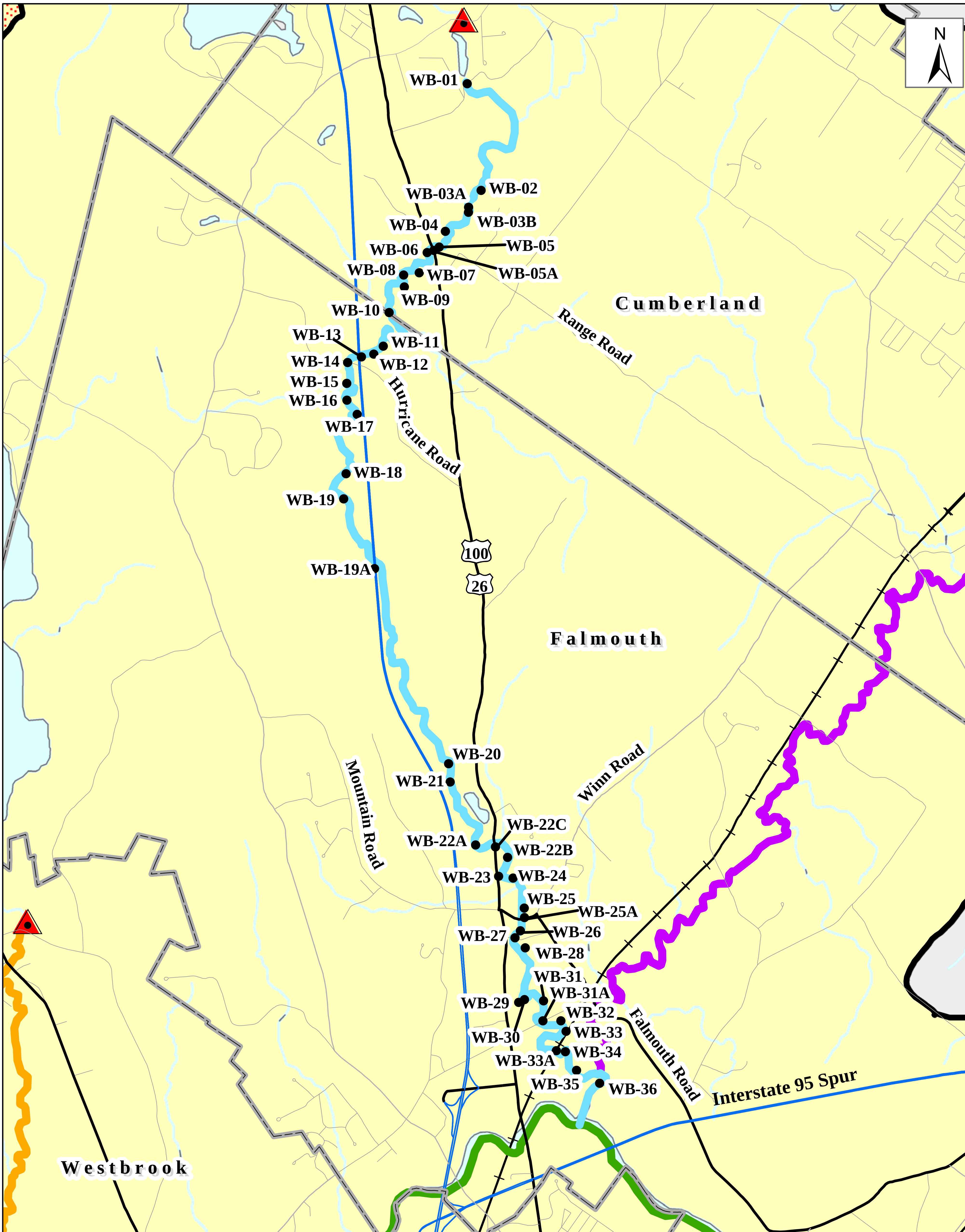
Also, a non-maintained system of trails (documented as site PR-12) was observed in various areas along both the north and south banks of the river. Degradation resulting from trail use was relatively minor. However, there were some localized areas of vegetation loss, banks slumping, erosion, and sediment runoff from trails that could be improved. Also, improvements to these trails may offer a significant opportunity to increase public recreational use of and access to the river.

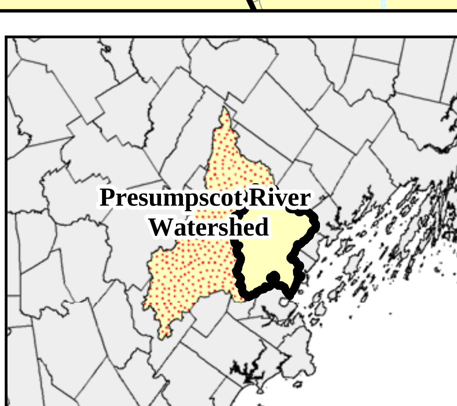
3.2.5 West Branch of the Piscataqua River

Description of Waterbody and Surrounding Area

Restoration inventory surveys were conducted along approximately 8.9 miles, which included 93,984 linear feet (17.8 miles) of shoreline along both banks of the West Branch of the Piscataqua (Figure 8). The survey area extended from the dam at Mill Pond in Falmouth southeast to the Presumpscot River in Falmouth. The West Branch traverses more elevation drop than the East Branch, in particular in the southern-middle portion downstream of the most southerly crossing of Route 100. From the start of the survey area to the end, the river drops approximately 60 feet (MEGIS 2005). At the time the survey, flow in the stream generally ranged from slow in wider and deeper portions to fast in constricted portions. Average water depth in the upper 1/4 of the stream was about 0.5 to 1.0 foot. Throughout the remainder, average water depth ranged from about 1.5 feet to 3 feet.

Substrate throughout the length typically was gravel and sand; portions of the southern-middle were ledge and exposed bedrock. Sand and silt were the dominant substrate for approximately the final 0.5-mile upstream of the confluence with the East Branch. Embeddedness tended to be low to moderate throughout the length of the stream. Logjams were less abundant than in the East Branch, but were still fairly common, and sometimes quite large. Two fairly sizable beaver dams were located along this river. Banks typically were moderately steep, and tended to be moderately well-vegetated. The stream can be characterized as meandering for most of its length, although there were significant "straight-run" sections in the middle portion. Despite the





Project Location

Data provided by Maine Office of GIS

0.5 0 0.5 1

Miles

Legend

- Project Boundary
- Presumpscot River Watershed
- Ponds, Lakes, & Rivers
- Town Boundary
- Interstate
- Local Road
- Primary Road
- Railroad
- Dam
- Habitat Restoration Site

Waterbodies Included in Inventory

- East Branch of the Piscataqua River
- Mill Brook
- Presumpscot Estuary
- Presumpscot River
- West Branch of the Piscataqua River

Figure 8. Restoration Sites along the West Branch of the Piscataqua River Identified in the Habitat Restoration Inventory for the Lower Presumpscot River Watershed.

Prepared For: Casco Bay Estuary Project HABITAT RESTORATION PROGRAM: Partnerships to Revitalize Damaged Habitats

Prepared By: NEA

Date: 04/05

fact that there were more road and utility crossings per unit distance along the West Branch, the general habitat for salmonids was good to very good, due to substrate, and numerous trout were observed in upper and middle sections of this waterbody.

Approximately 70% of the area immediately surrounding the West Branch of the Piscataqua was forested (Volume II, Appendix C). Land cover in the north section, from Mill Pond south and southwest to Interstate 95 (2.2 miles), was 50% forest and 50% open area. Farms and associated agricultural fields, two primary roads, a 125-foot ROW, and a 250-foot wide ROW were the dominant land uses in open areas (Volume II, Appendix C). Approximately 50% of the waterbody in this section occurs within or directly adjacent to ROW openings. The section from Interstate 95 south and southeast to Gray Road/Route 100 (4.0 miles) was approximately 90% forest and 10% open. A 500-foot wide ROW and a large agricultural field dominate open areas. A pond also abuts the east bank of the waterbody in the southernmost portion of this section.

Land cover in the final section of this waterbody, from Gray Road to the confluence of the West Branch with the Presumpscot River (2.7 miles), was 60% forest and 40% open. Agricultural fields, old fields, commercial and residential development, four primary roads, a railroad, and secondary roads associated with development, dominate open areas in this section. In addition, a relatively high density of additional large agricultural fields and residential/commercial development surround much of the West Branch, but these additional land uses were located beyond the 250-foot buffer of the river.

Significant direct alterations to the channel include a complete waterbody obstruction (dam) located at Mill Pond, and bridge abutments/culverts associated with two interstate crossings, seven primary/secondary road crossings, one railroad crossing, and two bridges associated with unimproved roads. These features have altered the velocity and flow of water in the West Branch from its natural condition, have impaired the natural shoreline bank, and roads associated with these areas promote runoff of pollutants from the road surface into the waterbody.

There were no EPA-listed water quality impairments for the West Branch (USEPA 2005).

Summary of Field Evaluations

Forty-three (43) potential restoration sites were identified for the West Branch (Figure 8). A list of all sites and site summary reports for each site are provided in Volume II, Appendix B. All 12 sources of degradation were identified along the West Branch and 109 individual examples of these were observed (Table 3). The most common source of degradation included land clearing (observed at 23 of the 36 sites) and ROW issues (observed at 19 sites). Ninety-nine (99) percent of sites with ATV impacts were located within utility ROW corridors. These sources of degradation resulted in 144 indicators of degraded environmental conditions (Table 4). The most common degraded condition was the lack of adequate buffer (Table 4).

Approximately 26,970 linear feet of habitat (29% of the linear distance of the shoreline) along the West Branch was in some state of environmental degradation and > 99% of the restoration need was associated with riparian buffer (26,935 feet). The lack of adequate buffer was primarily the direct result of land clearing and land uses such as ROW corridors and agricultural areas. Of the 26,935 feet of buffer restoration needed, 39% was associated with ROW corridors (7,765 feet), 30% was associated with old fields/agricultural areas (8,135 feet), 17% was associated with residential development (4,030 feet), 15% was associated with commercial/industrial development, and 9% was associated with combined ROW/ATV uses (2,310 feet).

Notable Sites or Issues

Of the 43 sites in the West Branch, 10 sites (23%) had a degradation score of greater than 3.0 (Table 9). Degradation scores of restoration sites along the West Branch (i.e., degree of environmental degradation at each site) ranged from 0.50 to 4.9. Although the West Branch ranks second highest in terms of the number of sites in need of restoration, compared to other sites, the amount of shoreline in need of restoration was relatively low and the number of sites that were at least moderately degraded (degradation scores $\geq$ 3.0 or higher) was lower than that found in all other waterbodies surveyed except the East Branch.

Each of the 43 sites identified during this survey is deserving of further evaluation to determine suitability for restoration, and although determining site suitability for restoration is subjective and is greatly dependant upon the budgets and objectives of the organizations interested restoration, the following site/restoration issues observed along the West Branch are worth noting.

Table 9. West Branch Restoration Sites with a Degradation Score of Greater than 3.0.

Site ID	Size (linear feet)	# of Indicators of Degradation	Degradation Score[1]	Primary Issues
WB-19	20	4	3.20	ATV use
WB-03A	25	6	3.70	ATV use and ROW
WB-05A	70	5	4.05	Bridge associated with road crossing
WB-19A	200	5	4.05	Bridge associated with road crossing
WB-22C	80	5	4.05	Bridge associated with road crossing
WB-25A	80	5	4.05	Bridge associated with road crossing
WB-31A	50	5	4.05	Bridge associated with road crossing
WB-33A	60	5	4.05	Bridge associated with railroad crossing
WB-12	550	7	4.35	Farm road through stream
WB-03B	40	6	4.90	ATV use and ROW

[1] Higher score indicates a higher level of habitat degradation.

Sites WB-03A and WB-03B (ATV use of ROW Corridors)

Approximately 98% of the length of the West Branch had inadequate buffer coverage. Thirty-six (36) percent of the areas with inadequate buffer were associated with utility ROWs. In addition, ATV use of ROWs had contributed to overall stream degradation by reducing shoreline banks, eliminating vegetation, increasing erosion and sediment loading, and by causing repeated direct impacts to the substrate of the channel.

Although restoration efforts in ROW corridors were somewhat limited due to ROW restrictions on vegetation density and height, fish habitat and water quality conditions could be improved at a relatively low cost and effort (< $25,000). Significant restoration benefit also would result from a reduction in impacts associated with ATV use of ROW corridors. Site-specific restoration of ATV damaged sites should be combined with methods to reduce use and impacts, in order to reduce the likelihood that sites will be re-used or that new access areas will be created by riders following restoration. The major challenge at these sites will be the ability to limit future use of the areas by ATV riders.

Restoration recommendations for ROWs impacted by ATV's include:

- Stabilize and plant overhanging vegetation along shoreline banks within ROW;
- Coordinate with landowner to promote the highest density and layers of vegetation allowable in ROW;
- Improve conditions within ATV trails by restoring shoreline banks and vegetation, redirecting runoff, stabilizing trails, and reducing in-channel impacts using bridges or redirecting ATVs to alternate trails; and,
- Work with local ATV organizations to promote awareness of ATV impacts and to elicit assistance in restoration efforts.

Site and WB-19 (ATV use)

Site-specific restoration of ATV damaged sites should be combined with methods to reduce use and impacts, in order to reduce the likelihood that sites will be re-used or that new access areas will be created by riders following restoration. Costs to address ATV issues were likely to be less than $25,000. However, challenges include the ability to limit future use of the areas by ATV riders.

Restoration recommendations for sites impacted by ATV's include:

- Improve conditions within ATV trails by restoring shoreline banks and vegetation, redirecting runoff, stabilizing trails, and reducing in-channel impacts using bridges or redirecting ATVs to alternate trails; and,
- Work with local ATV organizations to promote awareness of ATV impacts and to elicit assistance in restoration efforts.

Sites WB-05A, WB-19A, WB-22C, WB-25A, WB-31A, and WB-33A (Impacts associated with bridge crossings)

These sites were associated with road crossings and a railroad crossing (WB-33A) over the West Branch. In general, habitat degradation associated with road crossings includes hardened unnatural shorelines, impediments to natural flow due to abutments, lack of vegetation on shoreline banks and in the riparian buffer, and impaired aesthetic quality. There was also potential for runoff of sediment and pollutants from the impervious roadway surfaces.

Conceptual costs to restore bridge site are likely to be very high (> $150,000) and factors to consider in the costs associated with restoring the site include the need for the following: engineering surveys and hydrologic investigations prior to removal of hard structures on banks; bio-engineering stabilization of banks; traffic control; and major site grading, fill removal, removal of hard structures, erosion control, and planting. Some challenges associated with restoration of bridge sites include limited access, potential need to restrict public access on roadways during restoration, and limitations of planting and grading due to ROW restrictions on vegetation adjacent to road corridors. Some restoration benefit could be achieved at a low cost ($25,000) by installing silt fence or other structures to redirect flow off roadways away from the waterbody.

Restoration recommendations for these sites include:

- Remove bridge abutments along shoreline banks and stabilize banks using bioengineering techniques;
- Remove rip-rap from intertidal zone and regrade to a depth suitable for salt marsh vegetation;
- Redirect runoff from roadways to ensure sediment/pollutants are filtered through detention basins; and,
- Plant trees/shrubs to improve the buffer.

Site WB-12 (Farm Road)

This site was an unimproved farm road that crosses the West Branch. Habitat degradation issues include alteration of channel substrate (i.e., rock placed in channel to harden crossing), impediment to natural stream flow, diminished shoreline banks, lack of riparian vegetation, ruts/gullies in farm road, runoff from road into the waterbody, sediment loading, inadequate buffer (i.e., forested but 100 feet wide), and the area was located adjacent to potential sources of nutrient load and pollution (i.e., adjacent to a paved road and agricultural field).

Costs associated with restoration of this site are expected to be low (< $25,000) and there were no obvious limitations to restoration. However, costs could be moderate ($25,000 to $75,000) to restore the entire buffer to a 250-foot width and will depend on the type of road crossing installed.

Restoration recommendations for this site include:

- Remove hardened crossing in stream;
- Regrade and restore shoreline banks;
- Stabilize and replant banks;
- Replace crossing with bridge if needed; and,
- Widen stream buffer to 250 feet.

Common Sources or Indicators of Degradation

Similar to the East Branch, the most prevalent restoration issues facing the West Branch were associated with land clearing. Ninety-eight (98) percent of the restoration needs along the West Branch were related to inadequate buffer coverage, most of which were associated with ROWs and agricultural areas. Efforts to address these sources of degradation would help to improve the long-term health of the West Branch. In addition, costs associated with improving buffer coverage can be minor and may simply involve working with landowners to remove a portion of the riparian area from active use. The long-term health of the West Branch will likely be compromised if trends in land clearing and associated buffer loss continues unchecked. To improve conditions and ensure the long-term health of this waterbody, restoration efforts for the West Branch should focus on the following:

- Land preservation;
- Work with existing landowners to minimize activities that degrade buffers;
- Stabilize and plant overhanging vegetation along shoreline banks within ROWs;
- Coordinate with landowners and ROW managers to educate and promote the highest density and layers of vegetation allowable in ROW;
- Initiate community activities and landowner outreach programs that assist landowners with improving buffer conditions; and,
- Enforcement of rules and regulations imposed to restrict activities that degrade buffers.

4.0 RECOMMENDATIONS

Overall the lower Presumpscot River Watershed can be characterized as being in moderately good condition for a watershed that was partly in and adjacent to an urban area. This study documented a number of restoration needs and opportunities that have the potential to significantly improve water quality and habitat, both for aquatic species such as anadromous fish species and freshwater fish, but also for terrestrial wildlife species that inhabit riparian buffers. Specifically, this study has identified the following:

1) One hundred fifty-four (154) sites were in need of some form of restoration;
2) The most widespread sources (or causes) of degradation were land clearing (areas where land is cleared, but is not maintained as part of ROW management requirements), ROW's (areas that were cleared and were maintained as open areas due to management requirements), and ATV use; and,
3) The most common degradation was lack of adequate riparian buffer, and impaired/inadequate shoreline bank vegetation.

Notable widespread issues identified during this survey include the following:

ATV Impacts

Overall, ATV impacts were overwhelmingly most severe on Mill Brook, and this is where efforts could be concentrated. Despite the challenges associated with controlling ATV use and damage, there is significant potential for improvement at individual restoration sites. Significant restoration benefit can be achieved for relatively little cost by restricting or limiting access to degraded areas. In addition, because there were active ATV organizations in Maine, there is the potential for education and cooperative approaches.

Inadequate Riparian Buffers

As documented in this report, the lack of adequate riparian buffers was the most common restoration need in the Lower Presumpscot River watershed, and therefore this is where the greatest opportunity for improvement exists, particularly in areas where inadequate buffers abut large agricultural areas, golf courses, or other potential sources of nutrient/pollution load. Significant improvements could be achieved even through passive methods such as allowing natural regrowth of woody vegetation within openings that occur within the 250-foot buffer. The two golf courses adjacent to waterbodies in the watershed present a special challenge with regard to the buffer issue. Each had sections that directly abut a river, and therefore would require some type of redesign of some fairways or greens to accommodate wider buffers. However, there would be significant benefit of having a wider buffer (or a buffer at all in some cases) in terms in improved water quality (e.g., buffering from the use of fertilizers and pesticides), and reducing direct sun exposure on the water. Costs associated with improving buffer coverage can be minor and may simply involve working with landowners to remove a portion of the riparian area from active use and encouraging involvement in "Green-Acres" and "Golf-Green" programs.

Invasive Species

Invasive species such as Japanese knotweed, purple loosestrife, and common reed were found throughout the waterbodies in this survey, but were most common in the Presumpscot Estuary, where common reed had formed monocultures along most of the perimeter of the estuary. Numerous management options were available, however, the tradeoffs between cost, likelihood of success, and potential impacts to desirable species as a result of management activities must be carefully considered when selecting a management strategy. The species composition, extent of coverage, change in the extent of coverage over time, and an assessment of any negative impacts to other communities and wildlife from the invasive species, should be carefully evaluated prior to implementing management strategies, particularly those strategies that may broadly affect other species and communities. Restoration options may include removal of root stock, burning, cutting, herbicide application, and/or the use of biological controls.

Erosion, Undercutting and Root Exposure

These issues were observed at various locations throughout all waterbodies. In general, it was difficult to evaluate if this was occurring at a rate that was above that which occurs "naturally", especially when this study involved assessment at only a single point in time. Most likely, land development and land clearing in the watershed had resulted in somewhat higher pulses of flow in the waterbodies, which may result in increased rate of undercutting and channel migration. However, except for those eroding/undercut areas identified as restoration sites, the results of this study did not reveal that bank erosion was occurring at an unusual rate or causing unusually degraded conditions. A more intensive, watershed-scale study would be required to make determinations about natural-vs. unnatural causes of bank instability.

Summary of Waterbody Issues and Opportunities

Overall, the Presumpscot River had the highest number of restoration sites, the highest density of sites per mile of area surveyed, and the highest percent of area in need of restoration Table 10.

Table 10. Summary of Restoration Inventory by Waterbody.

	East Branch	Mill Brook	Presumpscot Estuary	Presumpscot River	West Branch
Total number of degraded sites per waterbody	27	27	12	45	43
Density of sites per mile of waterbody surveyed	4.82	4.82	1.80	5.56	4.83
Percent of waterbody in need of restoration	37	26	42	52	29
Percent of sites per waterbody with degradation scores > 3.0	11	33	75	29	23
Percent of sites per waterbody with inadequate buffer	>99	32	36	67	>99
Most common sources of riparian buffer degradation	Land clearing for ag fields/golf courses	Land clearing for ROWs/commercial development, and ATV use	Invasive species, land clearing for commercial development	Land clearing for ag fields/golf courses/commer cial development	Land clearing for ROWs and ATV use

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