

# Blackstone River



## Fisheries Restoration Plan

May, 2002

Developed by  
The Narragansett Bay Estuary Program  
and  
Division of Fish and Wildlife, R.I. Department of  
Environmental Management

With direction from  
The Blackstone River Fish Restoration Steering Committee

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Management*

***Narragansett Bay Estuary Program  
Report #02-120***

**Blackstone River Strategic  
Anadromous Fish Restoration Plan  
May, 2002**

**Developed by:**

- Narragansett Bay Estuary Program (coordinator)
- R.I. Division of Fish and Wildlife, Department of Environmental Management

**With direction from the Blackstone River Fish Restoration Steering Committee:**

- Elizabeth Webbing Mills
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- Pawtucket Hydro LLC
- National Grid
- Save The Bay, Inc.
- Trout Unlimited
- Slater Mill Historic Site, Inc.
- University of Rhode Island
- John H. Chafee Blackstone River Valley National Heritage Corridor Commission
- American Heritage Rivers Program
- Blackstone Valley Tourism Council
- Blackstone Valley Watershed Council
- U.S. Fish & Wildlife Service
- U.S. Environmental Protection Agency
- National Marine Fisheries Service
- Commonwealth of Massachusetts
- Audubon Society of Rhode Island
- New England Interstate Water Pollution Control Commission

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## EXECUTIVE SUMMARY

This Plan defines a strategy for restoring river herring and shad to the Blackstone River in Rhode Island. It focuses specifically on the lower four miles of the Blackstone River as the initial phase of restoration. However, it provides long-term fish population goals and objectives for the entire Blackstone River watershed in Rhode Island and Massachusetts.

The Plan was developed by the Narragansett Bay Estuary Program (NBEP) and the Rhode Island Division of Fish and Wildlife (RIDFW) with extensive input from the Blackstone River Fish Restoration Steering Committee (Steering Committee), a collaborative group involving state and federal agency representatives, hydroelectric power plant owners, and other local and regional stakeholders. The views and actions presented in this plan represent those of the NBEP and RIDFW and do not necessarily represent those of all Steering Committee members. While all members of the Steering Committee have expressed support for efforts to improve the fishery and environmental health of the Blackstone River, some members of the Steering Committee, particularly the hydroelectric operators on the Lower Blackstone River, have questioned the evidence of historical anadromous fish runs on the Blackstone River and have expressed concerns about the overall costs associated with restoration, including potentially significant costs in terms of lost electrical generation. The RIDEM, NEP, and other members of the Steering Committee acknowledge these concerns and have committed to working with the hydroelectric operators on the river to minimize the costs associated with successful implementation of this Plan.

One of the primary impediments to the restoration of anadromous (sea-run) fish such as herring and shad in the Blackstone watershed is the presence of numerous dams, which prevent fish from migrating from Narragansett Bay into the Blackstone River. In the lower four miles of the river, four existing dams block access to upstream habitat. The restoration strategy described in this Plan focuses specifically on providing upstream fish passage at these facilities as well as measures to protect out-migrating juvenile fish. Restoration of anadromous fish to the Blackstone River represents one component of a larger strategy to restore ecological functions and values to Narragansett Bay.

The primary function of this Plan is to describe the goals and objectives of restoration and to present an overall strategy for achieving these goals in the lower portion of the watershed, including cost estimates and a proposed timeframe for restoration. The Plan does not assign responsibility for specific actions or address who will pay for specific facilities. The Plan is designed to be flexible. It envisions an “adaptive management” approach, outlining a general strategy and broad goals which can, and should be, adjusted as necessary as the restoration proceeds. Due to the large size and scope of the proposed

restoration, the extended timeframes involved, and uncertainties related to funding, such an adaptive approach is necessary to insure success of the project.

Restoration of anadromous fish to the Blackstone River will provide substantial ecological benefits for the Blackstone River watershed and the Narragansett Bay Ecosystem, as well as economic benefits for the communities of the Blackstone Valley and beyond. Specifically, the re-established fish runs will:

- Benefit the marine ecosystem by providing forage for valuable commercial and recreational fish species such as bluefish and striped bass;
- Benefit the fresh water ecosystem by providing forage for recreational species such as bass and pickerel;
- Provide forage for predatory birds such as waterfowl, wading birds, and osprey;
- Provide and enhance fishing opportunities for urban anglers in Pawtucket, Central Falls, and other areas along the river;
- Provide educational opportunities and aesthetic benefits to visitors at Slater Mill and elsewhere;
- Help to re-establish an ecological connection between Narragansett Bay and the Blackstone Watershed that was lost with the decline of anadromous fish runs on the Blackstone River; and
- Enhance opportunities for tourism and recreation in the Blackstone River Valley Heritage Corridor.

The overall goal and specific objectives for the Plan are as follows:

**Goal:** Restore self-sustaining populations of shad and river herring to the Blackstone River basin, in order to provide benefits to the widest spectrum of users.

**Objectives:**

- A. Achieve and sustain an adult population of American shad returning to the Blackstone River annually;
- B. Achieve and sustain an adult population of river herring returning to the Blackstone River annually;
- C. Provide upstream passage to optimize utilization of available habitat;
- D. Promote outmigrant survival of juvenile shad and herring;
- E. Enhance and promote recreational opportunities associated with the shad and herring fisheries, including development of a sport fishery; and
- F. Provide opportunities for environmental education focussing on the restored fish runs.

The Plan will be carried out in four primary phases:

- Phase I: Mainstem Blackstone River from head of tide (Main Street, Pawtucket) to Ashton **(Map 2)**
- Phase IA: Abbot Run tributary **(Map 1)**
- Phase II: Mainstem Blackstone River from Ashton to the Rhode Island/Massachusetts Border **(Map 3)**
- Phase III: Branch River **(Map 4)**
- Phase IV: Mainstem Blackstone River in Massachusetts

Restoration of the entire Blackstone River in Rhode Island is expected to produce approximately:

- 1,400 acres of accessible fish habitat
- 1.1 million herring per year
- 22,000 shad per year

The Plan emphasizes Phase I of the restoration: the mainstem Blackstone River from head of tide (Main Street, Pawtucket) to Ashton. Four existing dams in this four-mile section of the river currently block upstream fish migration: Main Street Dam (FERC #3689), Slater Mill Dam, Elizabeth Webbing Dam (FERC #3037), and Valley Falls Dam (FERC #3063). All of these dams, with the exception of Slater Mill, are operating hydroelectric projects regulated by the Federal Energy Regulatory Commission (FERC).

The primary target of Phase I is an area above the Valley Falls Dam in the Lonsdale reach of the river, comprising more than 80 percent of the available spawning habitat in Phase I. This reach is bisected by Pratt Dam, which has been breached and is passable by anadromous fish under most flow conditions. Habitat and population estimates for Phase I of the restoration are as follows:

- 206 acres of habitat
- 202,000 herring per year
- 9,900 shad per year
- 5 years to implement
- 5-year population target: 40,500 herring (based on an assumed brood stock planting of 20,000 herring per year and assumes 20% of Phase I population goals met)

The restoration strategy for Phase I focuses primarily on providing upstream passage for adult fish, but will also seek to minimize downstream mortality of juvenile fish. Upstream passage will be accomplished through the construction of permanent passage facilities such as fish ladders and by-pass channels. A "Trap and Truck" operation is proposed to begin moving fish upstream in advance of completion of permanent facilities, with the goal of

eventually relying on the permanent facilities alone to provide passage at all four dams.

Preliminary cost estimates indicate that Phase I of the restoration plan will require between \$1.9 and \$2.4 million to complete. A three-stage approach is proposed for completing Phase I, as outlined with cost estimates for each stage in Table 1. Opinions of probable costs were developed for preliminary planning and evaluation purposes only and represent “order of magnitude” estimates. They are subject to change based on more detailed engineering. Monitoring and research programs are required to evaluate the success of the restoration program, and should be conducted as part of a unified program that includes pertinent studies, management actions and public information.

The Blackstone River and its watershed have changed greatly in the past 300 years. The natural resources of the river—its habitats and biological communities—have been altered by the effects of agriculture, industrialization and urbanization. Restoration of the Blackstone’s natural resources will require a long-term commitment on the part of citizens, governments and non-governmental organizations. Many parts of that commitment are already in place, through the work of the Blackstone Valley Watershed and Tourism Councils, the Blackstone River Valley National Heritage Corridor, Trout Unlimited and Save The Bay, to name a few.

Public access is also an important aspect of fisheries restoration on the Blackstone River. There is great demand for fishing access in urban areas, as demonstrated by the frequent use of unsafe and inconvenient areas, for example on the floodwalls below Main Street in Pawtucket . Design work for fish passage facilities on the Blackstone should consider public access improvements where practicable. Such improvements would enhance the safety and convenience of the public in gaining access to the fisheries of the Blackstone River and will build support for the restoration by allowing people to view and make use of restored runs of anadromous fish.

**Table 1 - Phase I Cost Estimates<sup>1</sup> and Timeframes**

<b>Restoration Action</b>	<b>Cost Estimate</b>	<b>Timeframe</b>
<b>Stage 1</b>		
1. Secure project funding	NA	2002 - 2006
2. Conduct site surveys, prepare final engineering designs, and obtain permits	\$ 97,000 <sup>2</sup>	2002 – 2004
3. Plant brood stock in Lonsdale area of the river	\$ 100,000 <sup>3</sup>	2005—2010
4. Monitor outmigrating juveniles	\$ 100,000	2005 – 2010
<b>Subtotal</b>	<b>\$ 297,000</b>	
<b>Stage 2</b>		
5. Construct Denil ladder at Main Street Dam	\$ 523,000	2008
6. Construct bypass and collection facility at Slater Mill	\$ 325,000 <sup>4</sup>	2008
7. Trap returning fish at Slater Mill and truck upstream	\$ 125,000 <sup>5</sup>	2008 – 2013
<b>Subtotal</b>	<b>\$ 973,000</b>	
<b>Stage 3</b>		
8. Conduct site surveys, prepare final engineering designs, and obtain permits	\$ 70,000 <sup>6</sup>	2008
9. Construct Denil ladder at Elizabeth Webbing Dam	\$ 326,000	2010
10. Construct Denil ladder at Valley Falls Dam	\$ 293,000	2010
<b>Subtotal</b>	<b>\$ 689,000</b>	
<b>Total</b>	<b>\$1,959,000</b>	
<b>Potential Downstream Protection<sup>7</sup></b>		
Construct Downstream Protection Hardware at Main Street Dam	<b>\$ 125,000</b>	
Construct Downstream Protection Hardware at Elizabeth Webbing Dam	<b>\$ 201,000</b>	
Construct Downstream Protection Hardware at Valley Falls Dam	<b>\$ 123,000</b>	
<b>Total</b>	<b>\$2,408,000</b>	

<sup>1</sup> All estimates in 2001 dollars

<sup>2</sup> For Main Street and Slater Mill sites

<sup>3</sup> Estimate for 5 years of operation.

<sup>4</sup> Includes restructured intake and floodwall work

<sup>5</sup> Estimate for 5 years of operation.

<sup>6</sup> For Elizabeth Webbing and Valley Falls

<sup>7</sup> As designed by the USFWS for the ACOE reconnaissance report



## 1.0 INTRODUCTION

This Plan defines a strategy for restoring river herring and shad to the Blackstone River in Rhode Island. It focuses specifically on the lower four miles of the Blackstone River as the initial phase of restoration. However, it provides long-term fish population goals and objectives for the entire Blackstone River watershed in Rhode Island and Massachusetts, recognizing that any facilities constructed in the lower watershed should be designed to accommodate the ultimate population targets. Ongoing river restoration activities in Massachusetts, briefly summarized in Section 2 of this Plan, will complement the actions described in this Plan.

The Plan was developed by the Narragansett Bay Estuary Program (NBEP) and the Rhode Island Division of Fish and Wildlife (RIDFW) with extensive input from the Blackstone River Fish Restoration Steering Committee (Steering Committee), a collaborative group involving state and federal agency representatives, hydroelectric power plant owners, and other local and regional stakeholders. The views and actions presented in this plan represent those of the NBEP and RIDFW and do not necessarily represent those of all Steering Committee members. While all members of the Steering Committee have expressed support for efforts to improve the fishery and environmental health of the Blackstone River, some members of the Steering Committee, particularly the hydroelectric operators on the Lower Blackstone River, have questioned the evidence of historical anadromous fish runs on the Blackstone River and have expressed concerns about the overall costs associated with restoration, including potentially significant costs in terms of lost electrical generation. The RIDFW, NEP, and other members of the Steering Committee acknowledge these concerns and have committed to working with the hydroelectric operators on the river to minimize the costs associated with successful implementation of this Plan.

One of the primary impediments to anadromous fish restoration in the watershed is the presence of numerous dams which prevent the movement of fish from Narragansett Bay into the Blackstone River. In the lower four miles of the river, four existing dams block access to upstream habitat. The restoration strategy described in this Plan focuses specifically on providing upstream fish passage at these facilities as well as measures to protect out-migrating juvenile fish. Restoration of anadromous fish to the Blackstone River represents one component of a larger strategy to restore ecological functions and values to Narragansett Bay.

The primary function of this Plan is to describe the goals and objectives of restoration and an overall strategy for achieving these goals in the lower portion of the watershed, including cost estimates and a proposed timeframe for restoration. The Plan does not assign responsibility for specific actions or address who will pay for specific facilities. The Plan is designed to be flexible. It envisions an "adaptive management" approach, outlining a general strategy and broad goals which can, and should be, adjusted as necessary as the restoration proceeds. Due to the large size and scope of the proposed restoration, the extended timeframes involved, and uncertainties related to funding, such an adaptive approach is necessary to insure success of the project.

In 1997, the U.S. Army Corps of Engineers completed the Blackstone River Watershed Reconnaissance Investigation, which examined opportunities for ecological restoration, including anadromous fish passage (ACOE 1997). The Reconnaissance Investigation identified the first four dams on the lower Blackstone as an appropriate Phase I for the restoration, and noted the feasibility of restoring fish runs further up the main stem Blackstone and Branch Rivers. For the Reconnaissance, the Corps worked with the R.I. Division of Fish and Wildlife (RIDFW) and U.S. Fish and Wildlife Service (USFWS) to develop conceptual designs for fish ladders on the first four dams. Much of the information in this Plan is based on the descriptive and design work produced by the RIDFW and USFWS for the Corps Reconnaissance.

## 1.1 Project Purpose

The purpose of this Restoration Plan is to identify specific steps necessary to restore anadromous fish to the Blackstone River, and to provide a foundation for design, funding and construction of the project. The Plan focuses specifically on restoration of anadromous fish to the Blackstone River in Rhode Island, but provides goals and objectives for the watershed as a whole, including those portions in Massachusetts. The Plan focuses on providing fish passage in the lower four miles of the river as Phase I of the restoration, with the expressed intent of providing access to suitable habitat in the Lonsdale area, upstream of the Valley Falls dam.

## 1.2 Plan Development Process

In order to restore anadromous fish to the Blackstone River, the Narragansett Bay Estuary Program saw a need to involve river stakeholders—state, federal and municipal governments; business interests; and non-governmental agencies—in the process. In 2000, the Bay Program, in partnership with the R.I. Division of Fish and Wildlife, Save The Bay, and Slater Mill, wrote and received a grant from the Rhode Island Aqua Fund to develop a collaborative restoration plan for the fisheries of the Blackstone. In January, 2001, the Bay Program began assembling the Blackstone River Fish Restoration Steering Committee, a group intended to guide development of the restoration plan, representing the broadest possible array of river interests. Over a period of several months the Steering Committee came to include the following organizations:

- Narragansett Bay Estuary Program (coordinator)
- R.I. Division of Fish and Wildlife, Department of Environmental Management
- Elizabeth Webbing Mills
- Blackstone Falls Hydro
- Pawtucket Hydro LLC
- National Grid
- Save The Bay, Inc.
- Trout Unlimited

- Slater Mill Historic Site, Inc.
- University of Rhode Island
- John H. Chafee Blackstone River Valley National Heritage Corridor Commission
- American Heritage Rivers Program
- Blackstone Valley Tourism Council
- Blackstone Valley Watershed Council
- U.S. Fish & Wildlife Service
- U.S. Environmental Protection Agency
- National Marine Fisheries Service
- Commonwealth of Massachusetts
- Audubon Society of Rhode Island
- New England Interstate Water Pollution Control Commission

Kleinschmidt Associates, Inc. was hired to provide the Steering Committee with technical and administrative support in developing the restoration plan.

The Steering Committee agreed to undertake several specific roles:

- To assist in the formulation of a consensus-based restoration plan;
- To provide knowledge and expertise relevant to Plan development;
- To provide input from different stakeholder perspectives; and
- To assist with public outreach and education regarding the Plan.

After an initial organizational meeting on February 28<sup>th</sup>, 2001, the full Steering Committee met in Pawtucket on April 26<sup>th</sup>, August 20<sup>th</sup>, October 11<sup>th</sup> and December 18<sup>th</sup> to guide the development of this Restoration Plan. Each draft of the Plan was shared with the Committee, and the Committee's comments used to revise subsequent drafts. The Committee hosted public meetings in Pawtucket on May 24<sup>th</sup> and November 14<sup>th</sup>, 2001. The Narragansett Bay Estuary Program briefed the Blackstone River Valley National Heritage Corridor Commission on the restoration plan on June 21<sup>st</sup>, and kept the Rhode Island Habitat Restoration Team updated on the plan throughout the process of its development. Members of the public, Corridor Commission members, and technical experts on the Restoration Team expressed a great deal of support for the project, and provided a wealth of comments and information which were incorporated into this final draft of the Plan.

## 2.0

## THE BLACKSTONE RIVER

The Blackstone River is the largest tributary of Narragansett Bay and a major component of the Narragansett Bay Ecosystem (**Map 1**). From its headwaters in Worcester, Massachusetts, the river flows southeasterly for about 48 miles, meeting salt water at Main Street in Pawtucket, Rhode Island, where it becomes the tidal Pawtucket River, then the Seekonk River, which together form an estuarine arm of Narragansett Bay. The Blackstone drains a watershed of 475 square miles, of which roughly 30% is in Rhode Island. The watershed includes highly urbanized areas around Worcester and along the lower river in Woonsocket, Central Falls and Pawtucket, Rhode Island, as well as large undeveloped areas. There are six principal tributaries to the Blackstone, the largest of which is the Branch River, just south of the Massachusetts border in Glocester, Burrillville and North Smithfield, Rhode Island (ACOE 1997).

The Blackstone River Valley is often called the birthplace of the American Industrial Revolution, and certainly this legacy is important to the culture of the region as well as the physical condition of the river today. Industrial modification of the river began in the late 1600's or early 1700's. The first dam across the river at Pawtucket Falls (now Main Street) appears to have been built circa 1718. Many more dams were built throughout the watershed in the 18<sup>th</sup> and 19<sup>th</sup> Centuries. The mouth of Blackstone was narrowed considerably with the development of downtown Pawtucket (**Appendix 3**). By the late 19<sup>th</sup> Century, much of the river and many of its tributaries were either impounded by dams or channelized for transportation, urban development and flood control. **Appendix 1** is a list of existing dams on the main stem of the Blackstone.

Development of the Blackstone watershed also led to pollution of the river by industrial discharges and human waste. While the water quality of the Blackstone has improved greatly in recent years, the State of Rhode Island classes various areas as "impaired" by elevated levels of human pathogens (fecal coliform), copper, lead, nutrients, and ammonia; reduced biodiversity; and low levels of dissolved oxygen (RIDEM 2001). A number of major efforts are under way to address these problems, including:

- A Blackstone River Feasibility Study for habitat and water quality restoration in the Massachusetts portion of the watershed, under development by the Commonwealth of Massachusetts and the U.S. Army Corps of Engineers;
- Development of a water quality restoration plan or TMDL (Total Maximum Daily Load) for the Rhode Island section of the river by the Rhode Island Department of Environmental Management (RIDEM);
- Elimination of Combined Sewer Overflows (CSOs) in Pawtucket and Central Falls as part of the Narragansett Bay Commission's Comprehensive CSO Program;
- Clean-up of the Peterson/Puritan, Inc. Superfund Site, situated on both banks of the Blackstone River from the Pratt Dam northward to the Ashton Dam in the Lonsdale area; and
- Development of a Watershed Action Plan for the Rhode Island portion of the watershed by RIDEM.

Over the next decade or two, these projects should result in significant further improvements to the water quality of the Blackstone River. Coordination of fisheries restoration work with other environmental activities on the river should be accomplished through the Watershed Action Plan.



**The Blackstone River above Central Falls, R.I.**

In developing this Plan, the Steering Committee considered potential impacts of water pollution on the restoration effort, including implications for the reproductive success of anadromous fishes as well as potential human health risks caused by consumption of fish from the restored runs. The presence of successfully reproducing resident fishes in the river, as well as the successful spawning and reproduction of herring introduced to the river in 1993, indicates that current water quality conditions are not a constraint to restoration. In addition, because anadromous fish spend only a limited amount of time in freshwater, their exposure to any contaminants in the river would be low and any bioaccumulation in fish tissues would be minimal. For this reason, human consumption is not expected to pose a future health hazard. Section 3.0 provides additional information on this issue.

In spite of the Blackstone's water quality problems, the river, its wetlands, tributaries and impoundments offer significant habitat value. Fifty-two percent of the watershed is forested while nearly 10% is wetland, including the largest freshwater wetland in Rhode Island, the Lonsdale Marsh in Lincoln, Cumberland and Central Falls. The Lonsdale Marsh is an important stop for migratory birds along the Eastern Flyway and is nesting habitat for several rare species of birds, including the least bittern, sora and marsh wren (RIDEM 2001). There are about 350 lakes and ponds in the Blackstone River basin (ACOE 1997), many of which were created as mill ponds during the 18<sup>th</sup> and 19<sup>th</sup> Centuries or as drinking water reservoirs during the 20<sup>th</sup>.

The Blackstone River system—main stem, tributaries and impoundments—is home to more than 30 species of fresh-water fish, including alewives (**Appendix 2**). The diversity of resident species and the presence of alewives are indicators of water quality and habitat sufficient to support restoration of shad and herring.

The estuarine portion of the Blackstone, known as the Pawtucket and Seekonk Rivers, is habitat for estuarine fish such as striped bass, bluefish, and menhaden, as well as the variety of invertebrates and birds characteristic of the upper reaches of Narragansett Bay. Old State Pier #2 in Pawtucket, about a mile downstream from the head of tide at Main Street, is the location of a public boat ramp and a favorite local fishing spot for striped bass and other salt-water species.



**Mills along the lower Blackstone River**

In addition to its natural values, the Blackstone River has had a great influence on the human environment of northern Rhode Island and south central Massachusetts. Beginning in the 18<sup>th</sup> Century, the Blackstone provided power, process water and waste disposal for the development of America's textile industry. Eventually there were hundreds of mills in the Blackstone Valley, and thousands of families moved

from French Canada and elsewhere to work in them. Even today, the built environment of the Blackstone River Valley reflects 19<sup>th</sup> Century patterns of development established in the era of waterpower, with mills and dense residential areas clustered along the river and lower-density development on the hillsides. According to the 2000 U.S. Census, Central Falls has the highest population density in Rhode Island, with approximately 15,000 persons per square mile.

The decline of the New England textile industry in the early and mid-20<sup>th</sup> Century, coupled with the "urban flight" of the post-war era, has created significant economic challenges for the milltowns of the Blackstone River Valley. Today, the urban communities in the Rhode Island portion of the Valley are among the most disadvantaged in the state.

According to the 1990 U.S. Census (the most recent for which complete figures are available), Pawtucket, Central Falls, and Woonsocket each showed median family income well below that for the state as a whole, while nearly a third of children in Central Falls lived in poverty—the highest rate in the state. Large proportions of residents in each of these cities are recent immigrants from Latin America or Southeast Asia.

In recognition of the natural and cultural heritage of the Blackstone Valley, Congress in 1986 created the John H. Chafee Blackstone River Valley National Heritage Corridor, "a special type of national park...to preserve and interpret...the unique and significant value of the Blackstone Valley" in Massachusetts and Rhode Island ([www.nps.gov/blac/](http://www.nps.gov/blac/)). In 1998, President Clinton designated the Blackstone an American Heritage River under a federal program intended to "preserve, protect, and restore rivers and their associated resources important to our history, culture, and natural heritage" (Executive Order 13061, 1997).

## 2.1 Anadromous Fish in the Blackstone River

There is considerable evidence that anadromous, or migratory sea-run, fish once ascended the Blackstone River to spawn in the watershed above Pawtucket Falls, and that the construction of bridges, dams and other infrastructure in the early 1700's as well as industrial pollution led to the extirpation of these fish runs. The species for which this evidence exists are Atlantic salmon (*Salmo salar*), river herring (alewife, *Alosa pseudoharengus* and blueback herring, *Alosa aestivalis*), and American shad (*Alosa sapidissima*). **Appendix 3** provides a detailed review of historic literature commissioned by the Narragansett Bay Estuary Program and undertaken by the University of Rhode Island, Graduate School of Oceanography.

The evidence for the presence of historic runs of salmon, herring and shad on the Blackstone River can be summarized as follows:

- *Geographic place names*: Place names indicative of fish runs, such as Spring Lake in Burrillville, which is called "Herring Pond" on 19<sup>th</sup> Century maps. This is buttressed by an 1856 account which states that "alewives and herring" historically spawned in the pond (see **Appendix 3**).
- *Published References*: There are numerous published references from the 18<sup>th</sup>, 19<sup>th</sup> and 20<sup>th</sup> Centuries to the historic presence of salmon, herring and shad in the Blackstone above Pawtucket Falls, and many more references to an abundant fishery for these species at or below the Falls. It is highly unlikely that large populations of anadromous fish would seasonally approach Pawtucket Falls if the fish were unable to access spawning habitat above the falls (see **Appendix 3**).
- *Acts of the General Assembly*: During the 18<sup>th</sup> Century, the R.I. General Assembly passed a number of Acts concerning fish passage. The first of these of these appears to have been passed in 1719, one year after construction of the Main Street Dam in Pawtucket, although it did not make specific reference to the Blackstone. Another, passed in 1792, did make reference to the "Pawtucket River," but seemed aimed at preserving Moses Brown's right to operate the dam at Slater Mill at the expense of upriver fishermen. The latter act is reproduced in **Appendix 4**.
- *Petitions to the General Assembly*: Also during the 18<sup>th</sup> Century—coincident with the heyday of dam building on the Blackstone—numerous petitions were filed by upriver residents, complaining of obstructions to fish passage created by dam construction. Several of these are also reproduced in **Appendix 4**.

On the basis of this body of evidence, it is the position of the Narragansett Bay Estuary Program, the R.I. Department of Environmental Management and others that the Blackstone River historically supported annual runs of anadromous fish, specifically, salmon, herring and shad. The Bay Program and the Department recognize, however, that it is impossible to ascertain with certainty



**Blueback Herring and Alewife taken from the Pawtucket River**

the condition of the river 300 years ago, and that the process by which the runs declined during the era of dam building is somewhat unclear. The Bay Program and the Department recognize as well that opinions differ as to the meaning of the documentary evidence. **Appendix 4** provides an alternative review and analysis of the historic record, which contrasts that presented in the URI research.

In 1993, the R.I. Division of Fish and Wildlife (RIDFW) completed a study to assess the suitability of habitat in the lower Blackstone River for anadromous fish restoration. In the Spring of that year, RIDFW released 3000 blueback herring into the river below the Albion Dam—the area of habitat that would be made accessible by Phase I of the restoration project detailed below. Sampling in August of that year, using electrofishing, found that the fish had reproduced successfully. The progeny of the released fish, 2½" to 3¼" in length, appeared to be abundant and healthy. The study confirmed the suitability of available habitat to support herring restoration on the lower Blackstone River (ACOE 1996).

In May, 2001, RIDFW undertook gillnet sampling at the head of the Pawtucket River, immediately below Main Street Dam, to ascertain whether native populations of anadromous fish were present at the mouth of the Blackstone during the spring run. The study found American shad, blueback herring, alewife, white perch and striped bass; all but the latter species included gravid (egg-bearing) females. Of the fish caught, alewife and white perch were the most numerous.

## **2.2 Benefits of Restoration**

Restoration of anadromous fish to the Blackstone River would provide substantial ecological benefits for the Blackstone River watershed and the Narragansett Bay Ecosystem, as well as economic benefits for the communities of the Blackstone Valley and beyond. Specifically, the re-established fish runs would:



- Benefit the marine ecosystem by providing forage for valuable commercial and recreational fish species such as bluefish and striped bass;
- Benefit the fresh water ecosystem by providing forage for recreational species such as bass and pickerel;
- Provide forage for predatory birds such as wading birds and osprey;
- Provide and enhance fishing opportunities for urban anglers in Pawtucket, Central Falls, and other areas along the river;
- Provide educational opportunities and aesthetic benefits to visitors at Slater Mill and elsewhere;
- Help to re-establish an ecological connection between Narragansett Bay and the Blackstone Watershed that was lost with the decline of anadromous fish runs on the Blackstone River; and
- Enhance opportunities for tourism and recreation in the Blackstone River Valley Heritage Corridor.

It is difficult to estimate the potential direct and indirect economic benefits of restoration to the local area and the region. However, it is reasonable to expect that restoration would enhance commercial and recreational fisheries in the Blackstone River and Narragansett Bay. It is also reasonable to expect that restoration of anadromous fish to the river could attract additional tourism activity above and beyond that directly related to fishing activities.

In recent years, anadromous fish passage has been restored on rivers larger and smaller than the Blackstone. By constructing fish passage facilities such as ladders or elevators, or by removing dams, herring and shad runs have been restored to the Penobscot, the Merrimac, the Connecticut, the Delaware and many other rivers throughout the Northeast. New restoration projects are ongoing in Maine, New Hampshire,



**Fish Ladder on the Nemasket River, Middleborough, Mass.**

Massachusetts, Rhode Island and Connecticut. Two successful restorations in Rhode Island are the Pawcatuck River, where a fish ladder at Potter Hill passes herring and shad, and Pettaquamscutt River, where a ladder at the Gilbert Stuart Historic Site has passed more than 300,000 herring in a single season.

### 2.3 Restoration Activities in Massachusetts

Numerous restoration activities are taking place in the Massachusetts portion of the Blackstone watershed, including the Blackstone River Feasibility Study of habitat and water quality restoration under development by the Commonwealth of Massachusetts and the U.S. Army Corps of Engineers. The Commonwealth was actively involved in the development of this Restoration Plan and will increasingly be involved in its implementation as anadromous fish restoration proceeds toward Phase IV, the Blackstone River in Massachusetts.

### 3.0 RESTORATION GOALS AND OBJECTIVES

The Steering Committee established an over-arching goal as well as specific objectives for the Blackstone River Fisheries Restoration Plan:

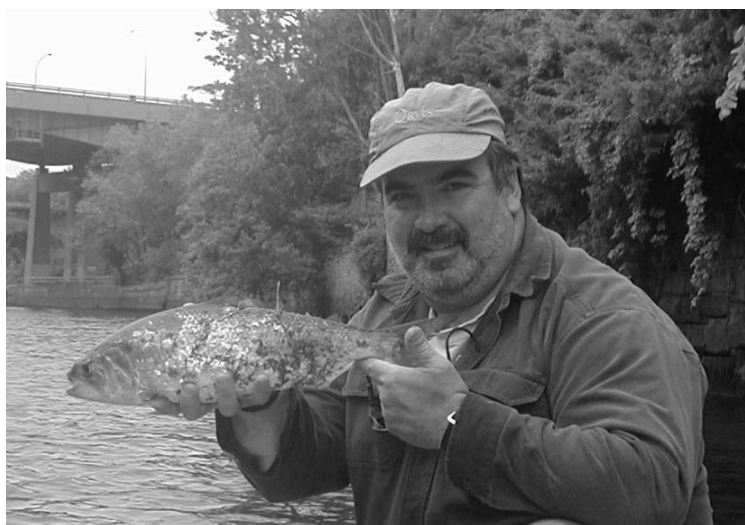
**Goal:** Restore self-sustaining populations of shad and river herring to the Blackstone River basin to provide benefits to the widest spectrum of users.

**Objectives:**

- A. Achieve and sustain an adult population of American shad returning to the Blackstone River annually;
- B. Achieve and sustain an adult population of river herring returning to the Blackstone River annually;
- C. Provide upstream passage to optimize utilization of available habitat;
- D. Promote outmigrant survival of juvenile shad and herring;
- E. Enhance and promote recreational opportunities associated with the shad and herring fisheries, including development of a sport fishery; and
- F. Provide opportunities for environmental education focussing on the restored fish runs.

On the advice of federal and state biologists, the Steering Committee determined that Atlantic salmon should be excluded at present as a target species for restoration on the Blackstone, because it is uncertain that there is enough suitable habitat to sustain a viable population. Since salmon are capable of climbing ladders designed for herring and shad, the Steering Committee believes that, should salmon restoration on the Blackstone become feasible in the future, the program outlined herein can be easily expanded to include that species.

American eel is a sea-run species that is already present in the Blackstone River. Eels are catadromous: spawning in salt water, living as adults in fresh. They are able to slither over obstacles, such as wet dams, that few other fish can negotiate, and seem to already be doing so to some extent in the Blackstone (see **Appendix 2**). In the design and installation of fish passage facilities for herring and shad, however, there are expected to be opportunities to enhance eel passage at minimal additional cost. The Steering Committee determined that such opportunities should be pursued where practicable.



**American Shad from the Pawtucket River below Main Street**

In general, relatively few people eat river herring or shad. Herring, in particular, are commonly used for bait. The fishery benefits of the project are expected to result primarily from enhancement of the salt- and fresh-water ecosystem, rather than consumption, as herring in particular are an important prey species for many salt and fresh-water gamefish. Nevertheless, the Steering Committee recognizes that, once runs are restored, some of the fish may be eaten.

There is a health advisory in place in Rhode Island, suggesting that people limit consumption of fish caught in the wild (for more specifics, see the website of the R.I. Dept. of Health, <http://www.healthri.org/environment/risk/fish.htm>). There is no specific advisory for the Blackstone River in Rhode Island, but there is an advisory against consumption in the Massachusetts portion of the river due to high levels of PCBs. Anadromous fish have been successfully restored in a number of other, comparably urban rivers in the Northeast, such as the Charles and Merrimac Rivers in Massachusetts and the Hudson River in New York, where there is a commercial fishery for American shad.

The Steering Committee expects that herring and shad, once restored to the Blackstone River, will have levels of contamination comparable to other wild fish in Rhode Island, and will not create a new hazard to public health. Because anadromous fish spend only a limited amount of time in freshwater, their exposure to contaminants in the Blackstone River would be low and any bioaccumulation in fish tissues is expected to be minimal. However, the Steering Committee recommends that fish-tissue samples be taken from the first returning fish of the restoration. Once the presence of any contaminants of concern has been ascertained, harvest of the restored fish runs can be managed accordingly.

## 4.0 RESTORATION STRATEGY

The following presents a broad overall strategy for restoring anadromous fish to the Blackstone River as well as a more detailed strategy for implementing the initial phase of restoration (Phase I), which focuses on the lower four miles of the river. The primary focus of the restoration strategy is to address existing barriers to anadromous fish migration within the watershed, particularly dams that currently block upstream fish migration in Rhode Island. Full implementation of the strategy is expected to take 20 to 30 years.

### 4.1 Overall Strategy

The overall strategy for restoring anadromous fish to the Blackstone River will follow a phased approach. The Steering Committee agreed that restoration should be carried out in four phases, an approach in keeping with the recommendations of the Army Corps' Blackstone River Reconnaissance report. The four phases of restoration are:



Pawtucket Falls and Main Street Dam, Pawtucket, R.I.

- Phase I: Mainstem Blackstone River from head of tide (Main Street, Pawtucket) to Ashton\_ **(Map 2)**
- Phase II: Mainstem Blackstone River from Ashton to the Rhode Island/Massachusetts Border **(Map 3)**
- Phase III: Branch River **(Map 4)**
- Phase IV: Mainstem Blackstone River in Massachusetts

The Abbott Run tributary to the Blackstone River in Rhode Island has also been identified as a restoration target for herring **(Map 1)**. For the purposes of this Plan, Abbott Run is referred to as Phase IA because the tributary enters the mainstem of the river in Phase I, above the Elizabeth Webbing Dam.

Restoration of the Blackstone River in Rhode Island (Phases I, II, III, and IA) is expected to ultimately provide approximately:

- 1,400 acres of accessible habitat
- 1.1 million herring per year
- 22,000 shad per year

Each proposed phase of restoration is briefly described below along with a summary listing of target population numbers and a timeframe for implementation. The target population numbers represent an expectation of habitat carrying capacity—that is, the average annual fish run that would be expected after several generations of returns, 25 years after installation of fish passage facilities on the Blackstone River. Population growth will vary year to year as a result of habitat quantity and quality, natural and fishing mortality, water quality conditions including river flow and water temperature, fish passage effectiveness and other factors.

In order to achieve 5, 10, and 15 year restoration targets for each phase of the restoration, the plan assumes that 20,000 herring will be stocked into each area for five years, for a total of 300,000 herring during all three phases. The “five year restoration target” for Phase 1

assumes that 20% of the ultimate herring population goal, or annual run size, will be reached after five years. If the restoration fails to achieve this level of return, the Steering Committee should attempt to ascertain why this is so, and adjust the strategy as necessary to achieve these interim targets.



**Slater Mill Dam, Pawtucket, R.I.**

It is important to note that the population targets presented here are preliminary estimates only of actual run sizes based on the literature cited. In actuality, fish runs naturally vary somewhat from year to year, and limitations in the availability of fish for stocking as well as environmental variables may slow the rate at which the newly-restored runs grow towards carrying capacity.

Anadromous fish population dynamics are typically influenced by a variety of factors, which have been broadly divided into density dependent and density independent components (Ricker 1954, Beverton and Holt 1957, Cushing 1981). A number of analyses have been conducted on the stock-recruit relationship for shad (Freiden 1954, Talbot 1954, Walberg 1963, Legget 1976, Marcy 1976, St. Pierre, 1979, Crecco and Savoy 1984, and ASMFC 1985) and alewife (Harvey, 1973, Walton 1981, 1983, and Gibson 1984).

For the purposes of this restoration plan, population estimates for shad are based on stock recruitment relationships developed using data from the Susquehanna River, which estimates a restoration potential of 48 shad/acre (St. Pierre, 1979). It should be noted that this is a relatively conservative production rate. Observed production rates are markedly higher for shad on the



Elizabeth Webbing Mills Dam, Central Falls, R.I.

Connecticut River, equating to 111 shad/acre (Legget 1976 and ASMFC 1985). Population estimates for alewife are based on research conducted by the R.I. Division of Fish and Wildlife, which relies on data from a variety of rivers in New England to develop a model that predicts potential alewife run size based on surface acreage (Gibson 1984). Actual returns will

undoubtedly differ somewhat from these expectations; nevertheless, these figures should be useful in a general way for assessing the progress of the restoration. **Appendix 5** details the annual returns of herring and shad expected to result from the restoration.

Again, this plan envisions a flexible approach to restoration, focussing initially on Phase I, with the intention that, once this phase has been completed, fish are returning and the population appears to be on a positive trajectory toward self-sustaining runs, the Steering Committee can consider Phase II, subject to funding and other logistical factors.

### Phase I: Main stem Blackstone River from head of tide (Main Street, Pawtucket) to Ashton

On this section of the river there are four existing dams that currently block upstream fish migration: Main Street Dam, Slater Mill Dam, Elizabeth Webbing Dam, and Valley Falls Dam. All of these dams, with the exception of Slater Mill, are operating hydroelectric projects regulated by the Federal Energy Regulatory Commission (FERC). The primary habitat in this section of river is located above the Valley Falls Dam in the Lonsdale area, which represents over 80 percent of the total available spawning habitat in the Phase I area. The Lonsdale reach of the river is bisected by Pratt Dam, which has been breached and is passable by anadromous fish under most flow conditions. Habitat and population estimates for Phase I are as follows:

- 206 acres of habitat
- 202,000 herring per year
- 9,900 shad per year
- 5 years to implement
- 5-year population target: 40,500 herring (based on an assumed brood stock planting of 20,000 herring per year and assumes 20% of Phase I population goals met)

### Phase II: Main stem Blackstone River from Ashton to the Rhode Island/Massachusetts Border

On this section of the river there are five existing dams that currently block upstream fish migration: Ashton Dam, Albion Dam, Manville Dam, Woonsocket Falls Dam, and Bridge Street Dam. The Blackstone Canal runs parallel to the river for most of this reach and may offer additional fish habitat opportunity, particularly for outmigrating juvenile fish; however additional field work is necessary to ascertain its suitability. The canal does not appear to offer opportunities for upstream migration because of its elevation above the river, which would require some form of upstream fishway. Habitat and population estimates for Phase II are as follows:

- 255 acres of habitat
- 256,000 herring per year
- 12,000 shad per year
- 10 years to implement
- 5-year population target: 132,300 herring (based on an assumed brood stock planting of 20,000 herring per year for 5 years into Phase II habitat, and assumes 40% of Phase I, and 20% of Phase II population goals met).

### Phase III: Branch River

The Branch River is the largest tributary to the Blackstone River in Rhode Island. The Branch River enters the Blackstone River upstream of the Bridge Street Dam and includes the Slatersville Reservoirs. There are three existing dams that currently block upstream fish migration: Slatersville Upper, Middle, and Lower Dams. Restoration of the Branch River is expected to provide



habitat for herring, but not shad. Habitat and population estimates for Phase III are as follows:

- 238 acres of habitat
- 172,000 herring per year
- 15 years to implement
- 5-year population target: 258,600 herring (based on an assumed brood stock planting of 20,000 herring per year for 5 years into Phase III habitat, and assumes 60% of Phase I, 40% of Phase II, and 20% of Phase III population goals met).

#### Phase IV: Mainstem Blackstone River in Massachusetts

There are currently eight existing dams on the mainstem of the Blackstone River in Massachusetts. Estimated habitat and population numbers are provided below, based on assumptions regarding the average width of the river, but omitting passable tributaries. More accurate estimates should be developed prior to implementing Phase IV of the Plan.

- 221 acres of habitat
- 147,000 herring per year
- 11,000 shad per year

#### Phase IA.: Abbott Run

Abbott Run is a tributary which enters the Blackstone River in the Phase I area, between the Elizabeth Webbing and Valley Falls Dams. It is managed by the Pawtucket Water Supply Board (PWSB) and provides drinking water to the City of Pawtucket and neighboring communities. There are six dams on Abbott Run that block upstream fish migration. Of these, the first four could accomodate fish passage facilities fairly easily. The two uppermost reservoirs, Arnold Mills and Diamond Hill, present considerable obstacles to fish passage, due to the design of the dams and fluctuating water levels. Due to the small size of the tributary, it is not expected to provide any useable habitat for shad. Restoration of Abbott Run could be implemented at any point after completion of Phase I. Habitat and population estimates for Phase IA are as follows:

##### *Option 1: Passage at all impoundments:*

- 744 acres of habitat
- 345,712 herring per year

##### *Option 2: Passage at first four impoundments:*

- 99 acres of habitat
- 83,739 herring per year

Under Option 2, three fishways would be needed (at Happy Hollow, Abbott Run and Rawson's Pond). Howard Pond is already partially breached and would only require minor channel modifications. Option 2 would be less costly than Option 1 but would still generate a substantial alewife run, as well as possibly providing spawning and rearing habitat for blueback herring in tributaries such as Curran Brook and Miller's River. Ultimately, the feasibility of including Abbott Run in the restoration program will depend on PWSB's water management. In order for Abbott Run to be considered a suitable anadromous fish system, the PWSB would need to ensure that sufficient water will be released

from Arnold's Mill Reservoir down to the confluence with the Blackstone River during upstream and downstream migration periods.

#### 4.2 Phase I Strategy

Within Phase I, which focuses on the lower four miles of river, the strategy will involve actions to build the population of herring and shad in the river by providing passage at the four existing dams in the lower river, thus providing access to upstream habitat in the Lonsdale area of the river.

The restoration strategy for Phase I focuses primarily on providing upstream passage for adult fish, but will also seek to minimize downstream mortality of juvenile fish. Upstream passage will be accomplished through the construction of permanent passage facilities such as fish ladders and by-pass channels. A "Trap and Truck" operation is proposed to begin moving fish upstream in advance of completion of permanent facilities, with the goal of eventually relying on the permanent facilities alone to provide passage at all four dams.

Protection of outmigrating juveniles will focus on monitoring and research to evaluate the need for appropriate types of downstream protection measures. If through monitoring it is determined that projected population targets are not being met, then specific measures will be considered to improve protection of outmigrants, including juveniles and adults.

Several alternative fish passage options and strategies were considered for the four lower dams. After reviewing the various options, the Steering Committee selected a "Staged Development" strategy for Phase I of the restoration plan.

Staged Development represents an incremental approach to fish passage, with investments increasing over time commensurate with demonstrated restoration of herring and shad populations. As the population increases in response to stepwise interventions, additional interventions will be applied to the system. This strategy allows for a high degree of flexibility with costs staged over time, dependent on the response of the fishery. Inherent in this strategy is a commitment to monitor the population response and adjust the Plan accordingly. Specific monitoring requirements are described in more detail in Section 5 of this plan.

The Staged Development strategy for Phase I restoration of anadromous fish to the Blackstone River will involve three primary stages as follows:

##### Stage 1 - Implementation Planning and Funding

- Raise funds
- Secure and plant brood stock in the Lonsdale area
- Implement public outreach
- Prepare conceptual design engineering for passage and monitoring facilities
- Monitor and conduct research on outmigrating juveniles

### Stage 2 – Main Street and Slater Mill

- Construct a Denil fish ladder at Main Street Dam
- Construct a bypass channel at Slater Mill
- Construct a collection facility at Slater Mill to facilitate a Trap and Truck operation.
- Monitor returns

### Stage 3 – Elizabeth Webbing and Valley Falls

- Construct Denil fish ladder at Elizabeth Webbing Dam
- Construct Denil fish ladder at Valley Falls Dam.

All Denil fish ladders noted above are based on conceptual designs developed by the USFWS as part of the ACOE Reconnaissance report. The bypass channel at Slater Mill will be designed to allow fish to migrate upstream around the Slater Mill dam as well as for the collection of fish to support the Trap and Truck operation. Planting of brood stock is assumed to occur at a rate of 20,000 fish per year (10 percent of the ultimate population).

Specific components of the Phase I restoration strategy and their sequencing over time will be as follows:

Restoration Action	Timeframe
<b>Stage 1</b>	
1. Secure project funding	2002 – 2006
2. Conduct site surveys, prepare final engineering designs, and obtain permits	2002 – 2004
3. Plant brood stock in Lonsdale area of the river	2005—2010
4. Monitor outmigrating juveniles	2005 – 2010
<b>Stage 2</b>	
5. Complete Denil ladder at Main Street Dam	2008
6. Complete bypass and collection facility at Slater Mill	2008
7. Trap returning fish at Slater Mill and truck to upstream areas	2008 – 2013
<b>Stage 3</b>	
8. Conduct site surveys, prepare final engineering designs, and obtain permits	2008
9. Complete Denil ladder at Elizabeth Webbing Dam	2010
10. Complete Denil ladder at Valley Falls Dam	2010

Based on the results of downstream monitoring and research studies, the need for downstream protection measures will be evaluated. If necessary, such measures could range from voluntary hydroelectric power shutdowns to construction of downstream protection facilities at existing power intakes. There will also be an ongoing need to monitor and ensure that clear passage is maintained at the breached Pratt Dam and that activities are coordinated with ongoing clean-up activities associated with the Peterson/Puritan site. The existing breach appears passable and recent volunteer efforts to clear vegetation will likely improve passage opportunities. However, debris and other

material could accumulate at the dam over time and impede effective upstream fish passage.

## 5.0 COST ESTIMATES

Preliminary cost estimates indicate that Phase I of the restoration plan will require between \$1.9 and \$2.4 million to complete, depending on the need for downstream protection measures. This assumes all three stages of the development strategy are implemented as described in Section 3 above, including site surveys, engineering, and permitting that would be required prior to actual construction. For the purpose of cost estimating, it is assumed that downstream protection measures will require construction of hardware at power intake facilities.

A summary of the cost estimates for each stage of the restoration strategy is presented below. A more detailed breakdown of probable costs for each dam site (including potential downstream facility cost estimates) is presented in **Appendix 6**. These opinions of probable costs were developed for preliminary planning and evaluation purposes only and represent “order of magnitude” estimates. They are subject to change based on more detailed engineering. Estimates of upstream fish ladders and downstream protection hardware are based on conceptual designs developed by the USFWS.

In addition to the costs detailed here, the project will entail costs for operation and maintenance (O&M). Fish ladders generally require maintenance during the fish run as well as occasional annual maintenance. This Plan has not estimated operation and maintenance costs, nor has the responsibility for such work been determined. An O&M plan should be developed as part of the engineering design for the fishways. Some additional maintenance work elsewhere on the river may also be necessary to ensure unobstructed fish passage—for example at the breached Pratt Dam, where the Blackstone flows through several stone archways. As archways become clogged with flotsam, the increased water velocity in the remaining openings has the potential to hinder fish passage. Finally, the operation of fish ladders, as well as potential downstream protection measures may result in reduced generating capacity for hydroelectric facilities on the Blackstone. Cost estimates presented in this plan are for the construction of fishways, operation of a trap and truck operation, and potential downstream protection facilities. They do not include estimates for O&M, monitoring beyond the first five years, or estimates of potential lost generation. Final engineering plans for fish passage facilities should strive to minimize operational impacts on the hydros to the extent that this can be done while meeting overall project goals of establishing sustainable annual returns of herring and shad.

## Phase I Cost Estimates<sup>1</sup>

Restoration Action	Cost Estimate
<b>Stage 1</b>	
1. Secure project funding	NA
2. Conduct site surveys, prepare final engineering designs, and obtain permits	\$ 97,000 <sup>2</sup>
3. Plant brood stock in Lonsdale area of the river	\$ 100,000 <sup>3</sup>
4. Monitor outmigrating juveniles	\$ 100,000 <sup>3</sup>
<b>Subtotal</b>	<b>\$ 297,000</b>
<b>Stage 2</b>	
5. Construct Denil ladder at Main Street Dam	\$ 523,000
6. Construct bypass and collection facility at Slater Mill	\$ 325,000 <sup>4</sup>
7. Trap returning fish at Slater Mill and truck to Lonsdale area	\$ 125,000 <sup>5</sup>
<b>Subtotal</b>	<b>\$ 973,000</b>
<b>Stage 3</b>	
8. Conduct site surveys, prepare final engineering designs, and obtain permits	\$ 70,000 <sup>6</sup>
9. Construct Denil ladder at Elizabeth Webbing Dam	\$ 326,000
10. Construct Denil ladder at Valley Falls Dam	\$ 293,000
<b>Subtotal</b>	<b>\$ 689,000</b>
<b>Total</b>	<b>\$1,959,000</b>
<b>Potential Downstream Protection<sup>7</sup></b>	
Construct Downstream Protection Hardware at Main Street Dam	<b>\$ 125,000</b>
Construct Downstream Protection Hardware at Elizabeth Webbing Dam	<b>\$ 201,000</b>
Construct Downstream Protection Hardware at Valley Falls Dam	<b>\$ 123,000</b>
<b>Total</b>	<b>\$2,408,000</b>

<sup>1</sup> All estimates in 2001 dollars

<sup>2</sup> For Main Street and Slater Mill sites

<sup>3</sup> Estimate for 5 years of operation.

<sup>4</sup> Includes restructured intake and floodwall work

<sup>5</sup> Estimate for 5 years of operation.

<sup>6</sup> For Elizabeth Webbing and Valley Falls

<sup>7</sup> Blackstone River Fishery Restoration Plan, May 2002

## 6.0 MONITORING AND RESEARCH

Monitoring and research programs are required to evaluate the success of the restoration program, and should be conducted as part of a unified program of pertinent studies, management actions and public information. The following lists annual population monitoring requirements and several potential research items that may be pursued on an as-needed basis. For the purposes of this Plan, and the cost estimates presented in Section 5, it is assumed that the first five years of implementation (beginning with the first year of planted brood stock) would include careful monitoring of outmigrating juvenile fish (particularly the timing of outmigration), and research on potential turbine mortality at the Main Street, Elizabeth Webbing, and Valley Falls hydroelectric facilities. Monitoring of outmigrants would be based primarily on visual observations, and possibly some netting. Turbine mortality studies would include “desk-top” analyses of potential mortality based on the existing hydroelectric equipment and operational patterns, as well as the possibility of some limited turbine survival testing using tagging studies. Results of these monitoring and research studies would be used in combination with observed return rates to determine the need for specific downstream protection measures.

### Annual Population Monitoring Requirements

- Report numbers of upstream migrating adults by species at Main Street ladder and Slater Mill bypass. This should include collection and reporting of pertinent age structure and sex ratio information.
- Develop an estimate of relative abundance of juvenile shad and herring produced in the Blackstone River. This would include monitoring the timing of juvenile emigration.

### Potential Research Items

- Determine population estimates for numbers of shad and river herring entering the Blackstone River. Conduct upstream fish passage effectiveness studies as warranted.
- As appropriate, develop estimates of shad and herring sport harvest in the Blackstone River basin and commercial harvest in salt water.
- Develop a unified cooperative stakeholder program which provides guidance for restoration issues including juvenile and adult downstream mortality, habitat assessment and protection, instream flow needs, and others as identified.
- Fish health (including tissue samples for toxins).



Fishing from the Flood Wall above the Pawtucket River (Tidal Blackstone) in Pawtucket, R.I.

## **7.0 PUBLIC INVOLVEMENT AND ACCESS**

The Blackstone River and its watershed have changed greatly in 300 years. The natural resources of the river—its habitats and biological communities—have been altered by the effects of agriculture, industrialization and urbanization. Restoration of the Blackstone's natural resources will require a long-term commitment on the part of citizens, governments and non-governmental organizations. Many parts of that commitment are in place already, through the work of the Blackstone River Valley Watershed and Tourism Councils, the Blackstone River Valley Heritage Corridor, Trout Unlimited and Save The Bay, to name a few.

The fisheries restoration project proposed in this Plan is a major component of the wider Blackstone restoration and a large undertaking in itself. In order to ensure the commitment necessary to complete the restoration, members of the Blackstone River Fish Restoration Steering Committee and other advocates for the natural resources of the Blackstone should work to raise awareness of the restoration among members of the public and their elected officials. In the near term, outreach efforts can focus on the ecological history of the Blackstone River and its fisheries, and on the Blackstone River Strategic Fish Restoration Plan. As the restoration project proceeds, outreach should include progress reports on the work. In all cases, outreach products should be designed to appeal to all ages and levels of education and should be distributed to the widest audience possible. The experience of the interagency Rhode Island Habitat Restoration Team has found that there is great public interest in this kind of project. The challenge for outreach is to communicate scientific and bureaucratic information in a way that is meaningful to non-specialists.

Public access is also an important aspect of fisheries restoration on the Blackstone River. There is great demand for fishing access in urban areas, as evidenced by frequent use of unsafe and inconvenient areas, for example on the flood walls below Main Street in Pawtucket. Design work for fish passage facilities on the Blackstone should consider public access improvements where practicable. Such improvements would enhance the safety and convenience of the public in accessing the fisheries of the Blackstone River and will build support for the restoration by allowing people to view and make use of restored runs of anadromous fish. Efforts should also be made to coordinate and explore opportunities to provide canoe portage in association with the development of fishways on the river.

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## ACKNOWLEDGEMENTS

The idea of restoring anadromous fish on the Blackstone River has been around for many years. This Blackstone Fisheries Restoration Plan represents, however, the first attempt to bring a real diversity of river interests into the discussion, in order to develop an approach to restoration that addresses economic as well as environmental concerns in the Blackstone River Valley. The Narragansett Bay Estuary Program hopes and believes that the involvement of Valley communities in Massachusetts and Rhode Island will produce tangible results toward restoring river fisheries.

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