STRATEGIC PLAN FOR THE RESTORATION

OF ANADROMOUS FISHES TO

RHODE ISLAND COASTAL STREAMS

American Shad, *Alosa sapidissima* D. Raver, USFWS

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INTRODUCTION

This document represents a working draft of the strategic plan to restore anadromous fish species to Rhode Island coastal streams. The project was initiated thanks to a grant provided to the Department of Environmental Management, Division of Fish and Wildlife (DFW), by Luther Blount.

The dams of the Industrial Revolution were placed in rivers for an inexpensive and reliable source of power. Little thought was given to the effects on native fish populations. Fish passage efforts at the time met with little success. The end result was the extirpation of local populations of American shad, alewives, blueback herring, Atlantic salmon, and other species. As the Industrial Revolution waned, so has the need for the dams, yet they remain.

The concept of environmental responsibility is raised for readers of this report to consider. The dams of the Industrial Revolution in Rhode Island are the most numerous and problematic impediments to anadromous restoration. Additionally the dams have completely altered the characteristics of many streams, raising water temperatures, concentrating sediment and pollutants, buffering the normal and necessary water level fluctuations, and altering the species composition of flora and fauna. Most of the dams spill water from the top (where the water temperatures are the warmest). This may result in the equivalent of a series of warmwater ponds end to end rather a natural stream channel. As many of the dams have already provided their benefits to Rhode Island and outlived their useful live (as well as pose a hazard), it is suggested that dam removal be given due consideration as a fish passage alternative. Complete removal of a dam may benefit a host of fish and wildlife species in any system rather than simply providing fish passage for certain freshwater and anadromous species. More typical stream corridor vegetation (both wetland and upland) can become reestablished, ultimately lowering water temperatures through shading (with corresponding increases in dissolved oxygen), improving water quality through attenuation of contaminants, and reducing erosion and sedimentation. Where feasible, dam removal should be considered first.

A great deal of work toward the restoration of anadromous species in Rhode Island waters where extirpated, has been conducted with varying degrees of success. Little fish passage work has been done in recent years due to funding limitations. The bulk of RI Division of Fish and Wildlife, (DFW) effort has focused on transplanting river herring broodstock into areas where fish passage is already established, and the stocking of hatchery-reared Atlantic salmon fry, parr, and smolts into the Pawcatuck watershed. Monitoring of returning adults and out-migrating juveniles, is also conducted annually. Research initiatives on improving upstream and downstream fish passage from other states and at the federal level, (particularly at the USGS Conte Lab) may hold some promise for improving anadromous populations.

Rhode Island has direct control of anadromous species spawning areas and freshwater life stage juvenile habitats within its borders, but the marine life stages of Atlantic salmon, American shad, alewives, and blueback herring that are migratory and travel outside of Rhode Island territorial waters fall under multiple jurisdictions. Rhode Island can protect and enhance freshwater habitats through fish passage improvements, land acquisition, regulation, and increased public awareness. Marine life stages protection and enhancement will require interstate cooperation through the Atlantic States Marine Fisheries Commission (ASMFC), intercontinental cooperation through the North Atlantic Salmon Conservation Organization (NASCO), and federal oversight by the United States Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS).

This report identifies Rhode Island watersheds with the potential to restore, establish, or enhance anadromous fish populations through upstream passage for migrating adults and downstream passage for juveniles. In both cases the primary goals are to minimize passage induced mortality allowing expansion into unutilized and underutilized habitats with the most cost-effective passage method available. Reintroduction of spawning broodstock is another critical component of the restoration efforts.

Partnerships between the RI Department of Environmental Management (DEM), US Army Corps Of Engineers (USACE), NMFS, USFWS, Natural Resources Conservation Service (NRCS), local interest groups, and an informed constituency will be necessary to fund and implement the various fish passage methods recommended in this plan.

METHODS

Site inspections were conducted throughout Rhode Island to all streams and rivers discharging to Rhode Island Territorial Waters. Sections outside of the state boundary are not included as part of this plan. Site inspections were made on foot, from a canoe, or by boat. The Blackstone River Watershed was not included as part of this plan. Observations were made for the various types of spawning and juvenile habitat for the target anadromous species listed in Table 1. The following were noted during each site inspection:

- Measurements of the width of the stream were taken where appropriate to aid in habitat area size calculations.
- Obstructions to fish passage were located, measured for height and width (if appropriate), judged for the type of fish passage methods that might be effective, and their proximity to anadromous habitat noted.
- Characteristics to aid in judgement of anadromous suitability were noted during site inspections such as:
  - water levels

- water characteristics
- surrounding land use
- the presence or absence of anadromous species (when and where appropriate)
- other fish and wildlife species observed
- substrate types
- submerged aquatic vegetation types
- surrounding upland vegetation types
- surrounding wetland vegetation types
- surrounding land use types
- point sources of pollution or runoff
- anything else of significance

This data was stored in spreadsheet database format on a watershed by watershed and stream by stream basis.

Data from a number of sources was considered in preparation of this report:

- RIDEM Dam Safety Section Database
- Anadromous fisheries surveys (electrofishing, beach seineing, passive capture of both adult and juvenile migrants, electronic and visual observations and counts of migrating fish).
- DFW Unpublished stream and pond survey data (for indicator species of habitat suitability.
- DFW Federal Aid Performance Reports.
- RIDEM DFW Freshwater Fisheries Comprehensive Survey.
- The State of the State's Waters (Section 305(b)
- USFWS Fish Passage and Diversion Structures Course.
- USGS Topographic map set for Rhode Island.
- Aerial photo-interpretation of photos from RI photo sets.
- RIGIS/RIDEM shapefiles used with ArcView mapping software.
- MapTech Terrain Navigator topographic map software (RI, CT, MA).
- Planimeter and curvimeter.

For the purposes of this report, dissolved oxygen levels are a parameter used as an indicator of anadromous suitability.

To simplify the use of this plan, only watersheds judged to have some level of anadromous suitability for one or more of the target anadromous species are included. Recommendations for fish passage will range from individual dams all the way to more substantial multiple-fishway projects necessary to access large areas of habitat. Areas compromised by diminished water quality will be noted to aid in the restoration decision making process.

The state is broken down into individual watersheds as shown in the Map Legend and Table 1. Species Suitability Matrix. If any portion of an identified watershed can potentially support a self-sustaining population of a particular anadromous species, it is indicated by a black circle. If this is limited for a particular reason or there is anything else worthy of note, it its indicated by a white circle and comments are included.

One measure of anadromous suitability, for the purposes of this plan, is found in Table 2, Freshwater Fish Indicator Species For Anadromous Habitat Suitability. It is assumed that if a particular freshwater body can support the freshwater species in the list, the system has habitat characteristics suitable for the anadromous target species.

Maps A through O show all watersheds judged to have some level of anadromous restoration potential. Maps B, C, D, E, H, K, N, and O all have more than one watershed included on each map because the watersheds are in close proximity to each other. Obstructions to fish passage are indicated either by a red or green circle. A red circle indicates that the obstruction is impassible to one or more of the target anadromous species and either requires removal or a fish passage device to allow access to spawning habitat for the respective species. A green circle indicates that the obstruction either has a fish passage device or some other characteristic which allows upstream fish passage. The obstructions are numbered simply for identification purposes. The upstream limits of suitability as judged by this plan are indicated by the circle with a crosshair. On maps that include more than one watershed, obstruction numbers commence with “1” for each respective watershed.

Obstruction Tables 3 through 17 detail the characteristics of the watersheds identified with anadromous restoration potential. Each obstruction number corresponds with the obstruction numbers on the maps for the respective watersheds.

- The column in the tables entitled, “Passage Sequence to Reach Obstruction” identifies the route the fish will follow while ascending the stream to reach the respective obstruction.

- “Existing Anadromous Population” lists the target anadromous species known to be established immediately downstream of the obstruction.
- “Species Suitability Immediately Above Obstruction” indicates passage will allow access to suitable anadromous habitat for the respective species somewhere in that segment or in an accessible tributary.

- “The Habitat Size Above Obstruction (Acres)” indicates the combined total habitat size, made accessible by passage beyond the obstruction, for one or more of the target anadromous species.

- The “Obstruction Height (Feet)” is the vertical height the fish passage device must be designed for.

- The “Drainage Area - Miles^2” when known, is included to aid in the design of a fishway.

- The “Recommended Passage Method” if dam removal is not an option, is the suggested fish passage device based upon the target species, obstruction characteristics, water flow and watershed size.

- The “Restoration Factor (Acres / Foot)” is simply the acreage of anadromous habitat divided by the height in vertical feet of the obstruction. This number helps to determine which restored areas should produce the highest anadromous population size, with the least financial expenditure. Given as a factor, the number can be used with the most up-to-date anadromous population estimate methods and most up to date cost-per-vertical-foot fishway construction cost estimates.

- “River or Stream” is the name of the mainstem river, stream, brook, or pond in some cases, where the respective obstruction is located.

- “City or Town” is where the obstruction is located.

- “Dam / Obstruction Name” is the identified dam name from the RIDEM Dam Safety Section, the name listed in the appropriate USGS topographic map, or identified local name.

- “State ID No.” is the identified dam’s assigned number from the RIDEM Dam Safety Section.

- The latitude and longitude for the respective obstructions was determined with MapTech Terrain Navigator mapping software.

- The “Dam / Obstruction Type” is as described by the RIDEM Dam Safety Section combined with site inspection observations.

Table 18, Recommended Fish Passage Sites, lists suggested fish passage sites for a number of watersheds around the state. The projects range from simple projects like the Indian Lake Dam in the Point Judith Watershed to multiple fishway projects in the Pawtuxet River Watershed.

I. Plan Objective

"To provide a tool that will help identify where anadromous fisheries restoration activities should be conducted in Rhode Island coastal streams."

II. Expected Results or Benefits

A strategic plan will assist in the decision-making process regarding the scheduling of anadromous fisheries restoration in Rhode Island. It will provide an organized framework to identify and prioritize future work. It will evaluate feasibility of restoration to allow intelligent allocation of available funds. It will identify short-term and long-term goals that can serve as a reference to pursue state appropriations, local endowments, and grant opportunities that can be combined with US Fish and Wildlife Service, (FWS) and National Oceanographic and Atmospheric Administration, (NOAA) federal grants.

Anadromous restoration will enhance habitat values for a variety of species in both the marine and freshwater environments. Anadromous species provide both recreational and commercial fishing opportunities. If dam removal is used as a fish passage method, a more natural stream corridor may result with some semblance of pre-dam conditions. Aesthetic and educational opportunities also result from the anadromous restoration effort. People may observe fish passage, recovery, and monitoring at the respective fishways, observe sampling techniques, and assist with a variety of volunteer efforts as they become available.

III. Strategic Plan

1. BIOLOGICAL COMPONENT.

1.A. Stock anadromous species broodstock or juveniles in suitable freshwater habitats where extirpated, or reduced numbers exist in concert with fish passage mitigation.

1.A.1. River herring.
1.A.2. American shad.
1.A.3. Atlantic salmon
1.A.4. Others

1.B. Maintain or improve quality of freshwater habitats.

1.B.1. Continue to oppose hydroelectric development.
1.B.2. Continue opposition to water withdrawals.
1.B.3. Continue watershed acquisition initiatives.
1.B.4. Continue review and comment process with regulatory agencies.

2. FISH PASSAGE COMPONENT.

2.A. Identify where restoration and/or enhancement work is to be conducted.

2.A.1. Top ranked projects. (with unlimited funding)
2.A.2 Cost effective projects. (with limited funding)
2.A.3. Other projects. (prioritized by others-funding/constituency)

2.B. Improve upstream fish passage.

2.B.1 Maximize passage efficiency of existing fishways.
2.B.2. Investigate breaching or removal of dams.
2.B.3. Design and install suitable fishways where appropriate.
2.B.4. Remove culverts and restore stream channels where possible or replace culverts obstructing fish passage.
2.B.5. Maintain passage through routine scheduled removals of vegetative obstructions.
2.B.6. Remove debris in areas where passage is obstructed as needed.

2.C. Insure juvenile fish passage is unimpeded.

2.C.1. Maximize downstream passage efficiency at dams with existing fishways by retrofitting juvenile passage devices.
2.C.2. Incorporate juvenile passage devices in all new fish passage designs.

2.D. Other Enhancements.

2.D.1. Prioritize and incorporate catadromous (American eel, *Anguilla rostrata*) fish passage into any fish passage device where deemed appropriate.

2.D.2. Investigate and implement management policy for predators of anadromous species where appropriate.

3. FISH PASSAGE FUNDING

3.A. Funding Opportunities.

3.A.1. Develop and maintain a database of funding opportunities.

4. MONITORING.

4.A. Evaluate passage success through annual monitoring and research.

4.A.1. Monitor adult returns.
4.A.2. Monitor upstream passage efficiency.
4.A.3. Monitor downstream passage efficiency.

5. MARINE SURVIVAL.

5.A. Support U.S. and international efforts relating to anadromous fisheries in Atlantic waters.

5.A.1. Support the North Atlantic Salmon Conservation Organization (NASCO) and Atlantic States Marine Fisheries Commission (ASMFC) management efforts relating to anadromous fisheries harvest and bycatch.
5.A.2. Establish species specific regulations controlling harvest of anadromous fish during migration in both freshwater and marine environments.

6. PARTNERSHIPS.

6.A. Develop public support for restoration efforts.

6.A.1. Increase anadromous fisheries recreational and viewing opportunities.

6.B. Volunteer involvement.

6.B.1. Maximize participation in where feasible in restoration efforts through press releases and mailings to past participants.

6.C. Education and outreach.

6.C.1. Increase anadromous fisheries educational opportunities.
6.C.2. Incorporate weekly anadromous fisheries passage data into RIDEM web page.

6.D. Advisory Committees

6.D.1. Set up a watershed advisory committee of interested state, federal, private, and public partners to facilitate future restoration efforts.

7. UPDATES AND REVISIONS

7.A. Refine and update this plan as restoration efforts commence and as research dictates.

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Appendix A. Recommended Watershed Enhancements.

Obstruction locations and characteristics discussed in sections A. through O. In Appendix A. can be seen in the corresponding watershed map and respective watershed obstruction table.

A. Pawcatuck River Watershed

The Pawcatuck River Watershed (PRW), one of the three largest in Rhode Island, is located in the southwestern portion of Rhode Island and southeastern Connecticut. The watershed is approximately 308 square miles (80% within Rhode Island). Rhode Island portions include the towns of Westerly, Charlestown, South Kingstown, Richmond, Hopkinton, Exeter and West Greenwich. Connecticut portions include the towns of Stonington, North Stonington, Voluntown and Sterling. The basin is approximately 25 miles long north to south, and 24 miles wide east to west. The mainstem originates at Wordens Pond in South Kingstown, has a course of 31 miles, and ultimately discharges to Little Narragansett Bay in Westerly. The lower five miles of the river are tidal.

Aquatic habitats range from warmwater impoundments and flowing water to freestone streams in the Wood River and Usquepaug River watersheds. Warmwater areas are predominated by submerged aquatic vegetation, and have habitat suitable for American shad, alewives, and blueback herring. Coldwater sections in the are suitable for Atlantic salmon and anadromous trout. This is the only watershed identified by this plan with significant areas of salmon habitat.

Substantial water withdrawals occur to support turf growing and a number of golf courses. Significant impacts on resident and stocked fisheries have been observed by RIDFW staff.

R.I. Department of Environmental Management (2002), indicated that several sections of the river fell below the C classification (less than 5 mg/1 of dissolved oxygen). Most of the watershed has high water quality

While Denil fishways exist at Potter Hill Dam (Map A.3) and Bradford Dam (A.8), fish passage efficiency has been poor for shad and river herring. Water flow through broken gates in the dam on the opposite bank from the fishway draws shad and herring away from the fishway entrance. Correcting this problem should be given the highest priority. While many areas in the watershed have suitable anadromous habitat, the following areas are is identified by this plan as the focus for this watershed. There are eight dams on the mainstem of the Pawcatuck River. The first is breached and the next two have Denil fishways (Potter Hill A.3., and Bradford, A.8., respectively). The habitat suitable for Atlantic salmon, and made accessible by these fishways is confined to Tomaquag Brook. The most realistic fish passage work providing access to additional habitat should be directed to the mainstem and Usquepaug/Queen River. The following work would result in a significant expansion of potential river herring and American shad spawning habitat making this a more cost effective option than some of the other alternatives. The next dam upstream of Bradford on the mainstem (Richmond USGS Gaging Station - dam A.13.) is not an impediment to Atlantic salmon and needs only minor work to allow alosid passage. Carolina Dam (A.15) is breached and is not an obstruction to fish passage. Fishing Falls Dam (A.16.) will require removal or a Denil fishway. Horseshoe Falls Dam (A.17.) will require a Denil fishway. Kenyon Dam (A.18.) will require a Denil fishway. Usquepaug Dam (A.28.) on the Queen will require a Denil fishway. This fish passage expansion would provide access to over 1300 additional acres of habitat, portions of which are suitable for all the target species of this plan.

B.1. Mashaug Pond Watershed

B.1.1. Mashaug and Little Mashaug Ponds (suitable for river herring and white perch) are coastal barrier lagoons adjacent to Block Island Sound. Because there typically no saltwater intrusion, salinity levels range from brackish to fresh. Passage into barrier ponds requires either natural or manual breaching of the barrier beach at least twice annually at appropriate times. Springtime breaching will allow migrating adult alewives and white perch access to spawning areas and a fall breach will allow juveniles to exit the system. The technique of manual breaching has been used successfully for many years at Quicksand Pond in Little Compton. Adult fish stage just beyond the surf zone adjacent to the Quicksand barrier beach. Sufficient water leaches through the sand to give the necessary olfactory cues. If the barrier does not breach naturally by April 1st, DFW personnel have used a back-hoe and bull dozer to remove enough sand to allow the pond to breach. This manual breach method if employed during calm sea conditions has allowed the barrier beach to heal itself quickly because sand from the barrier travels only a short distance offshore. Fall breaching to allow juvenile passage has typically coincided wit fall rain events and should normally be undertaken by October 1st annually. Using DFW personnel and equipment, this is a cost-effective fish passage method for this system.

B.2. Ninigret Pond Watershed

Ninigret Pond is another coastal barrier lagoon with a permanent man-made breachway. A number of small tributaries in the watershed are suitable for anadromous restoration.

B.2.1. East Pond (suitable for river herring and white perch) is located at the southwest corner of Ninigret historically supported a substantial spawning population of white perch in the 1960's and early 1970's (pers. observation). Passage could be restored through culvert repair under East Beach road and stream restoration on either side of the culvert. The habitat is suitable for both river herring and white perch. Stocking of broodstock is necessary.

B.2.2. King Tom Pond (suitable for river herring and white perch) discharges to the northern part of Ninigret Pond. Fish passage through a steeppass is fishway placed in a trench in the earthen dam is recommended. The fishway should be closed seasonally and a method for juvenile out-migration should be employed. Stocking of broodstock is necessary.

B.2.3. Cross Mills Pond (suitable for river herring and white perch) discharges to the northern part of Ninigret Pond. Fish passage through a trench in the earthen dam and gravel parking lot adjacent to the dam, installation of a steeppass, and placement of a concrete box culvert under Old Post Rd. is recommended. This will bypass the existing spillway and culvert system. The fishway should be closed seasonally and a method for juvenile out-migration should be employed. Stocking of broodstock is necessary.

B.2.4. and B.2.5. Factory Brook/Pond (suitable for river herring and sea-run brook trout) discharges to the northern part of Green Hill Pond (connected to Ninigret). Recommended fish passage is via steeppass fishway, attached to existing concrete spillway in dam. The fishway should be closed seasonally and a method for juvenile out-migration should be employed. Upstream, earthwork is required to move boulders to establish more efficient fish passage. Vegetation/debris inspections and removal will be required regularly to maintain passage to Factory Pond. Stocking of broodstock is necessary.

B.3. Trustom Pond Watershed

Trustom and Cards Ponds are coastal barrier lagoons with minimally altered barrier beaches. The U.S. Fish and Wildlife Service (FWS) has control over a large percentage of land in the watershed as part of the Trustom Pond National Wildlife Refuge. Additionally Trustom Pond is manually breached regularly to improve water quality in the pond, enhance diversity, and provide habitat for piping plovers.

B.3.1. As Trustom Pond (suitable for river herring and white perch) is manually breached regularly by FWS, fish passage through the barrier beach simply requires coordination between the RIDEM Division of Fish and Wildlife (DFW) and FWS. Stocking of broodstock is necessary.

B.3.2. If access to Trustom Pond is available, passage to Mill Pond could provide a unique salmonid research opportunity. The DFW Perryville Trout Hatchery is immediately upstream of Mill Pond. Effluent from the trout hatchery results in a relatively stable flow into Mill Pond. Offspring of sea-run brook trout and Atlantic salmon reared to the smolt stage at Perryville hatchery and subsequently released into the system just prior to breaching of the barrier each spring could be evaluated as a source of potential broodstock. The preferred estuarine conditions identified as suitable for sea-run brook trout (by Bigelow and Schroeder 2002) are not present in the system, but the simplicity of the experiment makes it a cost-effective opportunity. Placement of a steeppass fishway in the dam would provide direct access to the hatchery. In the absence of the fishway, a weir-type trap could be placed downstream of the dam and checked regularly DFW hatchery personnel.

C.1. Point Judith Pond Watershed

Point Judith Pond is a tidal estuary with a permanent, man-made breachway. Salinity levels typically range from oligohaline to polyhaline conditions, with little anadromous habitat in the pond itself.

The Saugatucket River is the major tributary discharging to the northern end of the pond.

This river has been the primary focus for anadromous restoration in the watershed. Two Denil fishways exist in the system at present. Both fishways have characteristics that result in less-than-optimal upstream passage efficiency. The Main St. fishway C.1.2., (intended to allow American shad to pass) has a section steeper than the optimal 1:8 slope. Additionally, the overall fishway was constructed 6" too low for normal water levels during passage periods. The velocity of the water in the fishway is higher than optimal for alewife and blueback herring passage, and impassible for American shad. A downstream passage slot/ramp device is recommended to minimize juvenile passage mortality.

Downstream juvenile passage at the spillway adjacent to the Palisades fishway C.1.3., is necessary. An open sloped channel is recommended to minimize juvenile mortality. Upstream passage efficiency at the gatehouse in the spillway for Saugatucket Pond C.1.4., could be improved with minor modifications. A deeper and narrower slot would maintain water levels and improve passage.

Indian Lake would add a substantial amount of habitat with minimal cost. A simple rearrangement of stones in and below the dam C.1.8., combined with a series of pools (similar to conditions downstream of the steeppass fishway in the Gilbert Stuart) would allow upstream passage.

C.2. Narrow River Watershed

Narrow (Pettaquamscutt) River is a tidal estuary with a permanent inlet to Narragansett Bay. Salinity levels typically range from oligohaline to polyhaline conditions. Alewife spawning has been observed downstream of the first obstruction. The first obstruction C.2.1. at Gilbert Stuart Birthplace, is a dam with various water control structures serving the historic grist mill. Anadromous fish passage is via a man-made stream channel combined with a steeppass fishway. The system has self-sustaining populations of alewives and blueback herring. Diversions of water to run the mill for demonstrations and to reduce impoundment levels during periods of high water, create a significant fish passage and mortality worthy of attention. The diversion of water attracts upstream migrating fish away from the true fish passage channel into an enclosed area where the fish are susceptible to stranding, low dissolved oxygen, and predation. A steeppass fishway for this bypass channel is recommended to correct this problem.

C.3. Wesquage Pond Watershed

Wesquage Pond (suitable for river herring and white perch) is a coastal barrier lagoon in close proximity to Narragansett Bay. Because there limited saltwater intrusion, salinity levels range from brackish to fresh. Passage into barrier ponds requires either natural or manual breaching of the barrier beach at least twice annually at appropriate times. Springtime manual breaching will allow migrating adult alewives and white perch access to spawning areas and a fall breach will allow juveniles to exit the system. A cooperative agreement with the Bonnet Shores Fire District is established to maintain this passage method and should be maintained.

D.1. Annaquatucket River Watershed

The Annaquatucket River has four Denil fishways. The Secret Lake Fishway (D.1.4) is a functional fishway, but few herring ascend the fishway and take advantage of the available habitat. Presumably, alewives and blueback herring which ascend fishway D.1.3. detect no attraction flow from the channel leading to Secret Lake and spawn in Belleville Pond. It is recommended that a steeppass fishway be placed in the bypass channel (D.1.4A.) adjacent to the Secret Lake Fishway. This will expose a percentage of fish ascending the Annaquatucket River to attraction flow resulting in passage into an underutilized habitat.

D.2. Cocumcussoc Brook Watershed

Cocumcussoc Brook simply needs stones removed at D.2.1 to facilitate passage for herring and rainbow smelt.

E.1. Hunt River Watershed

This watershed already has two fishways in the first two dams on the mainstem. Unfortunately the fishways have not allowed river herring passage in the past with maximum efficiency. As of 2002, these fishways are scheduled for retrofits to enhance river herring passage. This system has high quality habitat for American shad also, but the Denil fishways are incapable of passing shad, even with the proposed modifications. This system would be ideal however for anadromous brook trout if a suitable strain could be located.

E.2. Bleachery Pond Watershed

While this system has habitat suitable for river herring, the significant height of the first obstruction results in a low restoration factor as indicated in Table 7.2.1.

E.3. Apponaug Cove Watershed

This system has an existing herring run that could be enhanced by improved fish passage at the partially passable obstruction.

F. Conimicut Point Watershed

While this system has some water quality concerns, it still has a substantial herring run into Warwick Pond. The system needs scheduled debris and vegetative removal.

G. Pawtuxet River Watershed

The Pawtuxet Watershed at over 232 $miles^2$ has plenty of anadromous habitat, but the sheer number of dams combined with the poor water quality in the lower reaches of the mainstem result in a low overall ranking. One standout project however, despite the poor water quality would be to remove the first obstruction on the mainstem. This would be valuable for the stream corridor, and would enhance stream characteristics as described in the introduction of this report.

H.1. Woonasquatucket River Watershed and H.2. Moshassuck River Watershed

These urban watersheds have local interest in establishing fish passage but the poor water quality and high number of dams make other watersheds more attractive alternatives.

I. Ten Mile River Watershed

This watershed is a standout for anadromous restoration. Alewives and blueback herring have been observed spawning in the Seekonk River immediately downstream of the first dam at Omega Pond. I.1. Members of a local fishing club regularly net the herring and lift them over the dam. In the mid 1990's river herring broodstock were stocked into the Turner Reservoir above I.3. as an experiment to evaluate the spawning and rearing habitat. The juveniles were successfully observed an captured confirming the viability of the system. By putting in 2 fishways and breaching the dam at I.2. passage would be provided to over 300 acres of habitat.

J. Runnins River Watershed

The Runnins Watershed while small, has the last known native shad run in Rhode Island. Despite water quality issues in the urbanized watershed, the run persists. Cooperative arrangements with the state of Massachusetts should be made to protect and enhance the remaining population.

K.1. Mussachuck Creek Watershed

This watershed has a remnant population of anadromous herring that persist despite a collapsed culvert obstructing passage to formerly accessible habitat. Admirably, the RI Department of Transportation has made verbal commitments to correct this problem.

K.2. Prince Pond Watershed

A herring run persists in this system despite heavy recreational fishing pressure on a very small system. Watershed specific regulations need to be adopted to address this issue.

L. Kickamuit River Watershed

This is high ranking system for herring restoration despite being used as part of a local drinking water supply. A Denil fishway is already designed for the first obstruction.

M. Almy Brook Watershed

This system already has a herring run into Nonquit Pond. Another section of the system has a 380 acre reservoir suitable for herring. The dam is very large but the habitat size makes it an attractive alternative.

N.1. Quicksand Pond Watershed, N.2. Tunipus Pond Watershed, N.3. Briggs Marsh Watershed, and N.4. Long/Round Pond Watersheds are all coastal ponds in close proximity to tidal waters. An alewife population persists in Quicksand Pond and Tunipus Pond because natural breaches of the barrier allow spawning access. More attention should be given to Briggs Marsh which now also breaches regularly.

O.1. Sachuest Point Watershed, O.2. Easton Pond Watershed, O.3. Newport Watershed, and O.4. Lawton Valley Watershed

Gardiner Pond is a standout for anadromous restoration potential because of its size and close proximity to tidal waters.

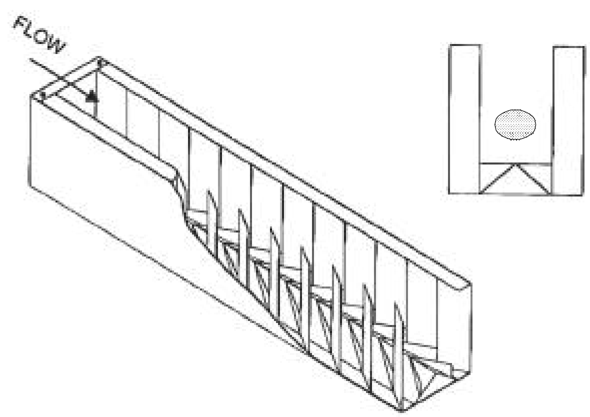
Appendix B. Fish Passage Methods

B.1. Fishways.

B.1.A. Alaska Steeppass Fishway.

An Alaska steeppass fishway is a cost effective method to provide anadromous fish passage. It is made of aluminum alloy and is designed to be constructed in a modular fashion. The device is usually set no steeper than a 1:6 slope in dams with relatively stable flow and relatively small watershed size. Steeppass fishways are typically used in obstructions with relatively stable water levels during migration periods. The zone for most efficient passage is indicated by the shaded ellipse in Figure 1. Costs are typically in the area of $15,000 per vertical foot of dam from design to completion as of the date of this report (R.Quinn, pers. comm.). If possible, the fishway should be used on dams with a minimum drainage area of 5 miles^2. Target species for passage are alewives and blueback herring.

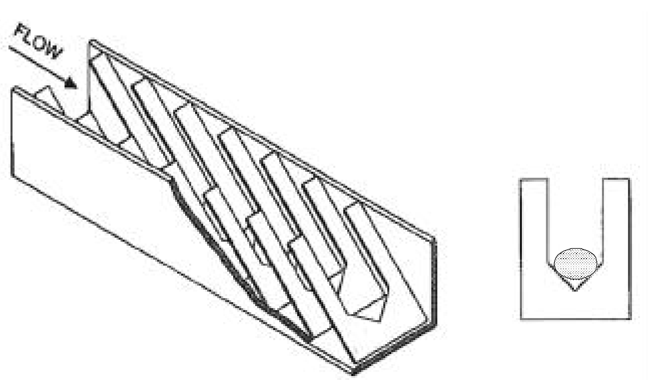
Figure 1.



B.1.B. Denil Fishway.

Two types of Denil fishway are considered in this plan. Both are constructed with concrete walls and floor. Slots are placed in the concrete allowing placement of wooden baffles in the fishway. The velocity of the water is dissipated sufficiently by the baffles to allow efficient upstream passage of fish. The zone for most efficient passage is indicated by the shaded ellipse in Figure 2. Denil fishways are typically used in obstructions with relatively stable water levels during migration periods. For streams suitable for alewives and blueback herring, a 3 foot wide, 1:6 slope Denil fishway is used. The minimum drainage area for this fishway is 16 miles^2. For streams suitable for American shad, typically a 4 foot wide, 1:8 slope Denil fishway is used. The minimum drainage are for this fishway is 20 miles^2. Costs are typically in the area of $30,000 per vertical foot of dam as of the date of this report.

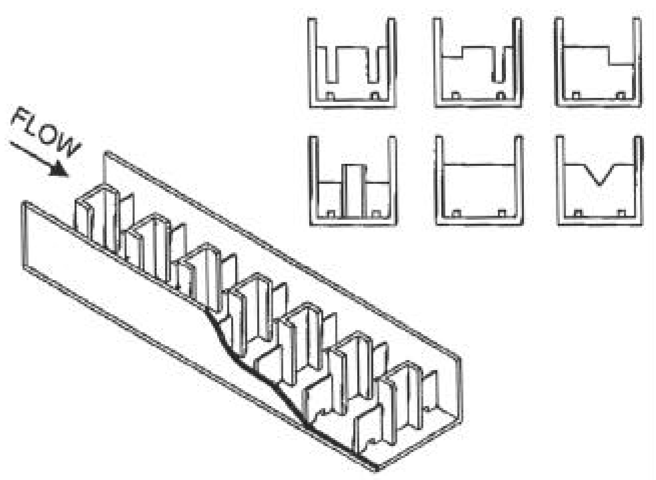
Figure 2.



B.1.C. Pool and Weir Fishway.

Pool and weir fishways for the purposes of this plan will be considered a specialty passage device to be used when other devices are deemed unacceptable during the design phase of a fish passage project.

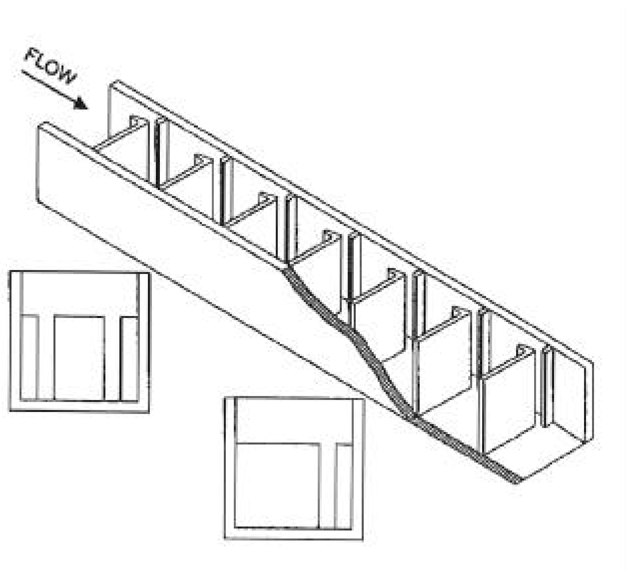
Figure 3.



B.1.D. Slot Fishway.

Slot fishways, for the purposes of this plan, will be considered a specialty passage device to be used when other devices are deemed unacceptable during the design phase of a fish passage project. They are designed for obstructions with high variations in flow.

Figure 4.



B.2. Breaching of Dams.

B.2.A. Complete removal.

In the absence of contaminated sediments behind a respective obstruction, this removal method is the preferred method of restoration by this plan. Complete removal of a dam may benefit a host of fish and wildlife species in any system rather than simply providing fish passage for certain freshwater and anadromous species. More typical stream corridor vegetation (both wetland and upland) can become reestablished, ultimately lowering water temperatures and improving water quality through shading and attenuation of contaminants respectively. Vegetation can stabilize floodplains with corresponding reductions in erosion, and sedimentation as well.

It is recognized that a host of socioeconomic and historic issues must be considered for any dam removal proposal yet these factors are outside the scope of this plan. *Recommendations for particular fishway designs in this plan are not intended to preclude the consideration of dam removal first in any restoration effort*.

B.2.B. Slots.

Some of the low dams which cannot be removed (i.e.: a U. S. Geologic Survey gauging station dam) may be appropriate for a permanent or manage fish passage slot. The slots are cut or constructed into dams to provide sufficiently non-turbulent, reduced velocity water for passage of fish that do not normally jump to ascend rivers such as shad and river herring. In cases where water levels are of concern during dry periods, stop logs, boards, and gate designs can be incorporated to reduce flow and maintain water levels.

B.2.C. Diversions.

In some cases diverting fish around an obstruction may be a reasonable passage alternative. Many of the historic dams in Rhode Island have abandoned diversion channels and water control structures which may be altered to pass fish upstream as is, or combined with one of the other passage methods. In some cases creating a new diversion around an obstruction may be a more cost effective alternative than some of the other methods.

B.3. Culverts.

Culverts can obstruct upstream and downstream fish passage in a variety of ways. If the downstream end of a culvert is high enough above the water during upstream migration periods, the roadway, trail, railroad bed, etcetera, becomes a barrier to passage no different than a dam. In other cases, culverts that are too small a diameter can increase the velocity of the water to levels that impact efficient fish passage. The restrictions can also serve to collect debris and concentrate predators. The darkness inside of culverts may also hinder fish upstream fish passage due to behavioral characteristics of the fish. The expense for culvert replacement or new installations should be borne by whomever needs the fill in and around the particular stream. The preferred alternative would be to remove the fill where possible.

B.3.A. In-kind replacement.

Method used when failure occurs and passage was not hindered prior to failure. Should only be used if complete removal or spanning the stream corridor are not available options.

B.3.B. Pre-cast box culverts.

To be used during new construction or when attempting to eliminate an obstruction. The culvert should be sized large enough to keep water velocities to minimum, and have sufficient depth to allow upstream and downstream movement of fish throughout the year. Should only be used if complete removal or spanning the stream corridor are not available options.

B.3.C. Spanning.

Spanning the stream, avoiding physical alterations to the channel, is the preferred method if a stream crossing is unavoidable.

B.4. Special Circumstances.

B.4.A. Barrier Beaches.

Passage through barrier beaches into barrier ponds requires either natural or manual breaching of the barrier beach at least twice annually at appropriate times. Springtime breaching allows migrating adult anadromous species access to spawning habitat and emigrating juvenile salmonids access to marine waters. Fall breaching allows emigrating juveniles alosids to exit the system.

B.4.A.1. Timed manual breaching.

The technique of manual breaching has been used successfully for many years at Quicksand Pond in Little Compton. Adult fish stage just beyond the surf zone adjacent to the Quicksand barrier beach. Sufficient water leaches through the sand to give the necessary olfactory cues. If the barrier does not breach naturally by April 1st, DFW personnel have used a back-hoe and bull dozer to remove enough sand to allow the pond to breach. This manual breach method if employed during calm sea conditions has allowed the barrier beach to heal itself quickly because sand from the barrier travels only a short distance offshore. Fall breaching to allow juvenile passage has typically coincided wit fall rain events and should normally be undertaken by October 1st annually.

Using DFW personnel and equipment, this is a cost-effective fish passage method for barrier beaches.

B.4.A.2. Natural breaching.

Natural breaching can occur after a heavy rainfall, during moon tides, during storms, or after any combination of these events. If the breach occurs at the appropriate time, anadromous species will take advantage of the fish passage opportunity.

B.4.B. Vegetation and Debris.

Existing anadromous runs and restored runs need regular inspections to address obstructions caused by vegetation and debris.

A.4.B.1. Shore-based.

Can be conducted by DFW personnel and volunteers.

A.4.B.2. Vessel-based.

Should only be undertaken by DFW personnel unless special arrangements are made.

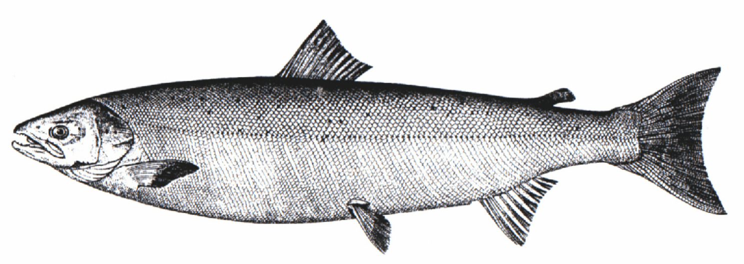
B.4.C. Fish Lifts.

No fish lifts have been recommended in this plan. In the event that an effort is initiated to restore the endangered shortnose sturgeon, *Acipenser brevirostrum* (Figure 12) in Rhode Island, a fishlift or some other type of fish passage method will be required in the absence of dam removal.

Appendix C. Life Histories and Habitat Requirements of Target Species

C.1. Atlantic Salmon.

Figure 5.



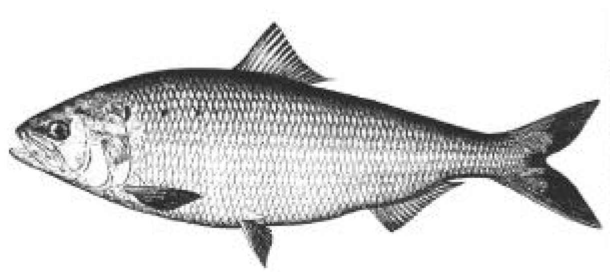
Atlantic salmon are anadromous, migrating from the ocean to fresh water specifically to reproduce. Most adults migrate from the ocean to the river in the spring. A smaller number migrate upriver in early fall. They stop eating when they enter fresh water, living off their body fat and tissues for up to a year. The adult salmon seek cold water areas to spend the summer. Spawning typically takes place in October and November. Eggs are buried in prepared gravelly-cobble areas in streams called redds. Most females lay a total of 7,000 to 8,000 eggs in two or more redds. Unlike Pacific salmon species, Atlantic salmon do not always die after spawning, and can return to the ocean. A steady supply of clean, well oxygenated water is critical to sustain the eggs. The eggs remain in the gravel throughout the winter before hatching in the spring. Newly hatched salmon, called sac fry, obtain food from their attached yolk sac. The salmon emerge from the redd, primarily from April to June, when the yolk sac has been completely absorbed. Feeding activities begin at this time. Salmon fry, approximately one and one quarter inches long at emergence, quickly set up feeding territories which they defend from other fish. Growing salmon prefer stream habitat lined with cobble-sized stone and clean, cool (60-70^{o} F) water that is free of sediment. Fish are found in riffles and along the interface of fast moving water, under overhanging cover and generally toward the bottom of the water column. Fry that have spent their first summer in the stream where they hatched are three to four inches long by fall and are called parr. After one full year in freshwater, the parr will have grown to a length of four to six inches. Parr remain in freshwater for a period of one to three years. The freshwater residence period is largely dependent on growth rate. The fastest growing parr, usually from warmer, more productive tributaries, spend only one year in freshwater. Slower growing parr, often from colder, less fertile tributaries, spend three, or rarely, four years in freshwater. Most parr in the Pawcatuck River basin spend two years in freshwater. During their first fall, parr may disperse widely from their first summer location to seek new habitat. Parr destined to leave the freshwater environment the following spring begin a process called smoltification during the preceding winter. Pronounced physical changes occur during the spring after salmon reach a size suitable for migration to the sea, six to eight inches or more. These changes allow juvenile salmon to adapt to life in marine waters. Throughout the smoltification process a series of behavioral, physiological, and morphological changes occur that transform young salmon from territorial, bottom-dwelling, freshwater fish to schooling, saltwater fish. Juvenile salmon leaving for the ocean are called smolts. Smolts lose the dark vertical stripes, parr marks, on their sides and become bright silver in color. Smolts migrate to Long Island Sound from April through June. Some smolts may commence pre-smolt movement in the fall to start their long migration.

Smolts move eastward and begin a long migration northward along the coast after reaching Block Island Sound. The salmon eventually arrive at waters off of the west coast of Greenland where they share feeding grounds with other Atlantic salmon from North America and Europe. Most Pawcatuck River salmon return to spawn after residing in the ocean through two sea winters (2SW). A few salmon, called grilse, return after spending only one winter at sea (1SW), and others wait until after their third sea winter to return (3SW). The average 2SW salmon grows from six inches long and weighing about two ounces as a smolt entering Block Island Sound to about 30 inches and 10 pounds as a returning mature salmon. Grilse (1SW) average about four pounds and 3SW salmon often weigh more than 15 pounds.

Adult salmon return to Rhode Island primarily in May and June. In the freshwater environment, the color of the adult salmon slowly changes from silver to a very dark color. The salmon attempt to reach their natal streams, where they spend the summer holding in deep, cold pools before spawning in the fall. From the time they enter the freshwater until spawning, often six months later, the salmon do not feed; feeding begins after they return to saltwater in the fall or spring. Atlantic salmon, unlike Pacific salmon, do not die after spawning, though many die as a consequence of the rigors of the upriver migration, the spawning effort itself, and not feeding for up to one year while in freshwater. Adults that survive the rigors of migration and spawning are called kelts. Kelts return to the ocean in late fall or early spring, at which time they regain their silver color. A small percentage of salmon survive several spawning runs, alternating between freshwater and marine environments. Repeat spawners and grilse are valuable to the salmon population for maintaining genetic variability and providing a buffer for all sources (fresh and salt water) of mortality affecting the predominant 2SW year class. Male parr becoming sexually mature (precocious) in the freshwater environment insure spawning will occur when sea-run females are present and sea-run males are absent.

C.2. American Shad, *Alosa sapidissima*.

Figure 6.



American shad spawning may occur in both tidal and non-tidal freshwater, and the spawning migration corresponds rising spring water temperatures over 50 degrees in the Pawcatuck Watershed. Shad spawning runs in the usually extend from the middle of April until early July. Spawning usually takes place between sunset and midnight Williams and Daborn 1984. Depending on size, female American shad produce up to 659,000 eggs (Roy 1969).
Shad spawn in river areas dominated by broad flats with relatively shallow water (1-6 m) with moderate (0.3-1.0 m/s) current (Munroe 2000). Highest survival rates of shad eggs reportedly occur in those settling over gravel and rubble substrates (Layzer 1974). Fish selected sandy or pebbly shallows for spawning grounds in the more slowly flowing section of the Annapolis River, NS (Williams and Daborn 1984). Depending on size, female American shad produce up to 659,000 eggs (Roy 1969). Spawning usually takes place in the evening after sundown (Williams and Daborn 1984). Eggs are released in open water, where they are fertilized by the males. The juveniles grow throughout the summer, and leave the watersheds in the fall in response to cooling water temperatures (Leggett and Whitney 1972).

Eight watersheds have been identified in this plan having areas suitable for American shad restoration. Of the eight, the Pawtuxet, Woonasquatucket, and Moshassuck Watersheds have significant water quality concerns. The Pawcatuck and Runnins Watersheds have existing shad runs with room for improvement. The Point Judith and Hunt Watersheds have existing fishways incapable of providing shad passage into the available habitat. The Ten Mile Watershed downstream of the Turner Reservoir is the clear choice for shad restoration.

C3. Alewife, Alosa pseudoharengus and Blueback Herring, *Alosa aestivalis*

Figure 7.

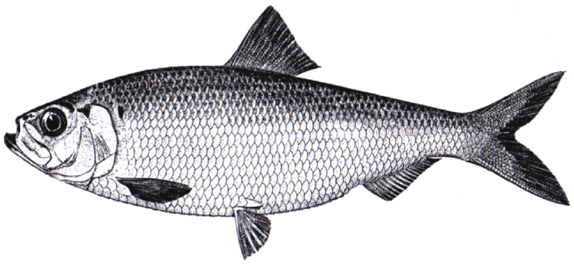
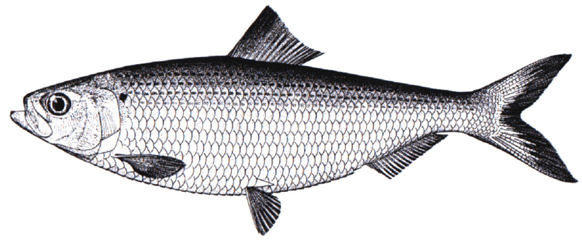


Figure 8.

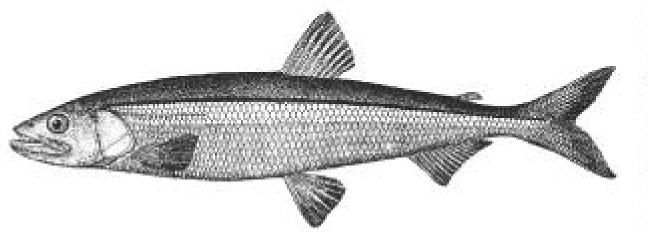


Spawning periods in Rhode Island typically range from March through June. Alewives generally spawn 3-4 weeks earlier than blueback herring, with peak spawning separated by 2-3 weeks (Jones et al. 1978).

In most Atlantic coast populations, juvenile river herring emigrate from freshwater-estuarine nursery areas between June and November of their first year of life (Richkus 1975). Fecundity estimates for alewives ranged from 48,000 to 360,000 in Bride Lake, Connecticut (Kissil 1974). Alewives spawn in large rivers, small streams, and ponds, including barrier beach ponds. Spawning substrates include gravel, sand, detritus, and submerged vegetation with sluggish water flows. Blueback herring spawn in swift-flowing, deeper stretches of rivers and streams with associated hard substrate (Loesch and Lund 1977) and in slower-flowing tributaries and flooded low-lying areas adjacent to main streams.

Rainbow Smelt, *Osmerus mordax*

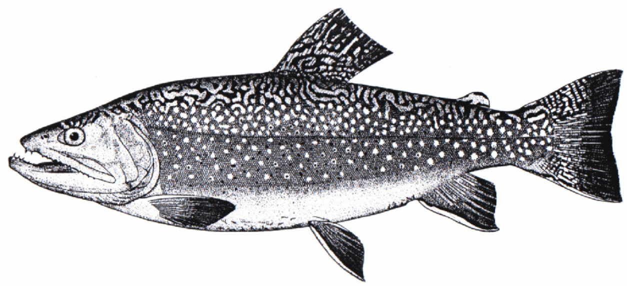
Figure 9.



Rainbow smelt are anadromous, spawning in freshwater and growing and maturing in estuaries and coastal waters. In coastal streams, most smelt spawn above the head of the tide. Spawners usually begin to move into spawning areas before the ice breakup. Spawning usually peaks with bimonthly spring tides. Peak spawning occurs in late March through mid April in RI. Along the east coast, smelt spawn at water temperatures of 4.0 to 9.0" C (Clayton 1976). Typically, the substrate in the spawning area of coastal streams is gravel, with water depths at low tide of 0.1 to 1.3 m (Murwski et al.1980). According to Clayton (1976), spawning site selection is influenced largely by water velocity rather than depth or substrate. Adapted from USFWS, 1983.

Sea-Run Brook Trout, *Salvelinus fontinalis.*

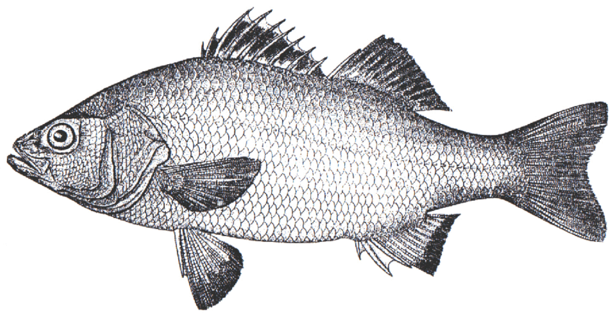
Figure 10.



Some strains of brook trout are adapted to survival in the estuarine portions of costal streams and rivers. Because the estuary is significantly more productive than typical freshwater brook trout habit, the fish can attain a much larger size an provide a significant recreational fishing opportunity.

White perch, Morone americana.

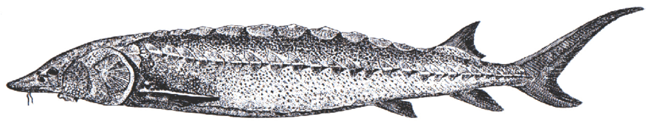
Figure 11.



White perch spawn from April through June in estuaries, rivers, lakes, and marshes. Spawning is usually in freshwater, but may occur in brackish water also. White perch are fecund compared to similar-sized fish. The large numbers of eggs enable the white perch to propagate rapidly in introduced areas.

Shortnose Sturgeon, *Acipenser brevirostrum*.

Figure 12.



Shortnose sturgeon are typically anadromous, migrating from the ocean to fresh water specifically to spawn in the spring. They broadcast their eggs in areas with rubble substrate. Once hatched, the young fish drift downstream and may eventually swim to brackish water. No specific watersheds are recommended for sturgeon restoration in this plan.

Appendix D. Description of Strategic Plan Strategies

D.1. Biological Component.

To conduct an anadromous fisheries restoration effort for alosids, broodstock must either be provided with passage to expand into unused habitat, or they must be physically transported in a tank and stocked into the new habitat while ready to spawn. This trap and transport method has been used successfully in Rhode Island for may years.

Anadromous salmonid broodstock are typically in short supply. The restoration method usually consists of spawning males and females at a hatchery, and stocking either eggs, fry, parr, or smolt stages into the watershed where restoration is desired. The juveniles imprint on the system and return as sexually mature adults which are either intercepted for broodstock purposes, or allow to continue their ascent to habitats where natural spawning can occur.

An additional consideration is finding a source of broodstock. Alosids must either be relocated from streams already having self-sustaining runs in Rhode Island or be relocated from outside the state, (usually from another New England state). Typically the fish are provided by the USFWS, state fisheries agency, or a power generating agency. Salmonids are usually supplied by a federal hatchery from outside of Rhode Island. Special effort is necessary to locate a strain of anadromous brook trout.

D.2. Fish Passage Component.

Maximizing fish passage efficiency of existing fishways in existing runs is considered one of the highest priorities in this plan. Efficient adult passage upstream will result in dispersal of juveniles over the entire available habit. This will help to maximize future adult returns, provided the juveniles can exit the streams to marine waters as quickly and safely as possible. It is suggested that corrections to existing fish passage devices including downstream passage of juveniles be given the highest priority. These suggestions should also be incorporated into any new design also.

As monies become available, this plan can be used to decide where work should be undertaken for new projects. Projects identified by this plan range from simple vegetative removal projects all the way to restorations of entire watersheds.

American eel, *Anguilla rostrata* upstream passage for juveniles should be considered in any anadromous fish passage project. Where possible, passage devices should a component of any project.

Predators of anadromous species have increased dramatically in recent years. Double-crested cormorants, Phalocrocorax auritus in particular aggregate near fishways where alosids are staging. In systems where restoration is underway, this may significantly impact anadromous populations. It is recommended that a predator management policy be developed and implemented particularly in those systems where restoration funding is being used.

It is recommended that recreational harvest of anadromous species be closed in any watershed which has a restoration effort underway for the respective species. For example: If herring broodstock are being transported into a particular system, no harvest of those fish or fish ascending the stream from marine waters should be permitted. The regulation change would simply require that those areas where it is permissible to harvest herring be listed and close all other areas.

D.3. Fish Passage Funding.

The following are some web sites of potential anadromous restoration funding.

NOAA Restoration Center - http://www.nmfs.noaa.gov/habitat/restoration/funding.html
National Fish and Wildlife Foundation - http://nfwf.org/programs/5star-rfp.htm
FishAmerica Foundation - http://www.fishamerica.org/content/conservation/fishamerica/
Ocean Trust - http://www.oceantrust.org/
Trout Unlimited - http://www.tu.org/index.asp
American Rivers - http://www.americanrivers.org/
CICEET - http://ciceet.unh.edu/index_new.html
Natural Resources Conservation Service - http://www.nrcs.usda.gov/programs/whip/

D.4. Monitoring.

Monitoring of exiting and new anadromous runs is necessary to evaluate success and diagnose problems, particularly given the costs of restoration. A restoration project needs to be set up so decisions can be made using data rather than "tradition" and modifications made in a timely manner to address problems.

D.5. Marine Survival.

Because American shad, Atlantic salmon, alewives, and blueback herring are migratory, U.S. and international efforts relating to anadromous fisheries in Atlantic waters need to be supported and quotas and regulations adhered to.

Regulations need to be established for anadromous species in Rhode Island while in marine waters, staging for a spawning run. Currently alewives and blueback herring are unprotected downstream of the “defined freshwater/marine boundary”, but have stringent harvest restrictions upstream of the defined boundary. This paradox has persisted for years, preventing runs from reaching their potential.

It is recommended that the recreational harvest of anadromous species be based upon monitoring data rather than having a statewide blanket regulation. Many of the larger systems could potentially support a higher recreational harvest, while some of the smaller systems may be having a large percentage of the total spawning population removed.

D.6. Partnerships.

Many partnerships have developed in recent years with the goal of restoring anadromous species. This includes a number of federal partners, neighboring states, local interest groups, and private individuals. These partnerships need to continue and be expanded in order to maximize the effectiveness of the restoration effort and facilitate the restoration effort. The extreme cost of even a single fishway warrants commitments of broodstock, design, funding, permitting, dam owner cooperation, construction performance, volunteer monitoring, and more.

Fishways provide outstanding educational opportunities. It is recommended that some of the new Denil fishways that are constructed in the future incorporate viewing windows in the turning/resting pool when safely accessible for viewing by the public either supervised or unsupervised. The windows could also be used for upstream passage counts either visually or remotely with an infrared camera/video monitoring device.

D.7. Updates and Revisions.

This plan needs to be continually refined and updated as time passes as restoration efforts commence and as research dictates and watershed characteristics change.

TABLE 1. FRESHWATER FISH INDICATOR SPECIES FOR ANADROMOUS HABITAT SUITABILITY

Anadromous Target Species	Freshwater Indicator Species
alewife, *Alosa pseudoharengus*	largemouth bass, *Micropterus salmoides* smallmouth bass, *Micropterus dolomieui* bluegill sunfish, *Lepomis macrochirus* pumpkinseed sunfish, *Lepomis gibbosus* common shiner, *Luxilus cornutus* golden shiner, *Notemigonus crysoleucas* redfin pickerel, *Esox americanus* chain pickerel, *Esox niger* blueback herring, *Alosa aestivalis* yellow perch, *Perca flavescens*
blueback herring, *Alosa aestivalis*	largemouth bass, *Micropterus salmoides* smallmouth bass, *Micropterus dolomieui* bluegill sunfish, *Lepomis macrochirus* pumpkinseed sunfish, *Lepomis gibbosus* common shiner, *Luxilus cornutus* golden shiner, *Notemigonus crysoleucas* redfin pickerel, *Esox americanus* chain pickerel, *Esox niger* alewife, *Alosa pseudoharengus* yellow perch, *Perca flavescens*
American shad, *Alosa sapidissima*	largemouth bass, *Micropterus salmoides* smallmouth bass, *Micropterus dolomieui* bluegill sunfish, *Lepomis macrochirus* pumpkinseed sunfish, *Lepomis gibbosus* common shiner, *Luxilus cornutus* golden shiner, *Notemigonus crysoleucas* redfin pickerel, *Esox americanus* chain pickerel, *Esox niger* alewife, *Alosa pseudoharengus* blueback herring, *Alosa aestivalis* yellow perch, *Perca flavescens*
Atlantic salmon, *Salmo salar*	brook trout, *Salvelinus fontinalis* fallfish, *Semotilus corporalis*
Sea-run brook trout, *Salvelinus fontinalis*	brook trout, *Salvelinus fontinalis* fallfish, *Semotilus corporalis*
rainbow smelt, *Osmerus mordax*	largemouth bass, *Micropterus salmoides* smallmouth bass, *Micropterus dolomieui* bluegill sunfish, *Lepomis macrochirus* pumpkinseed sunfish, *Lepomis gibbosus* common shiner, *Luxilus cornutus*

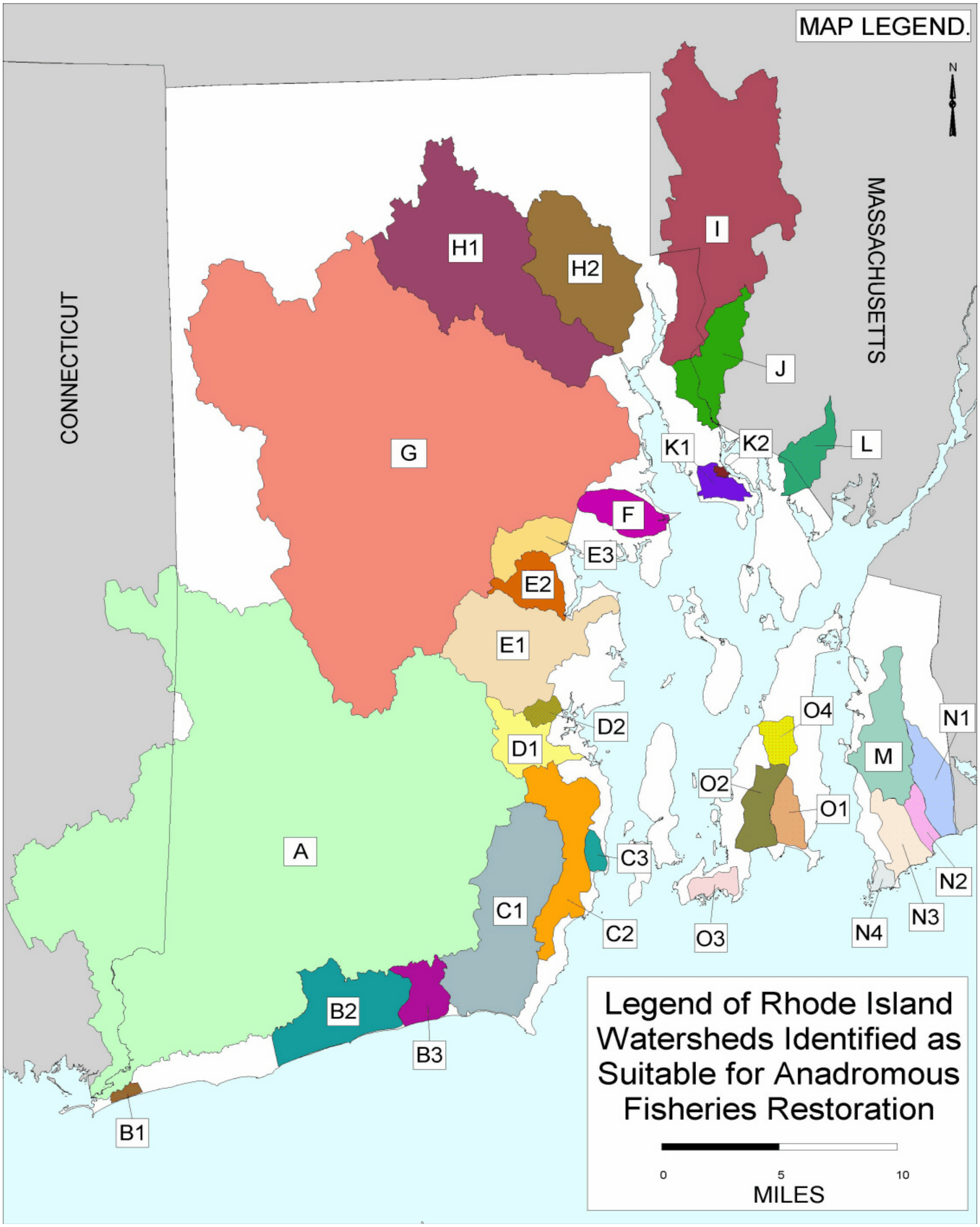
	golden shiner, *Notemigonus crysoleucas* redfin pickerel, *Esox americanus* chain pickerel, *Esox niger* alewife, *Alosa pseudoharengus* blueback herring, *Alosa aestivalis* yellow perch, *Perca flavescens*
white perch, *Morone americana*	largemouth bass, *Micropterus salmoides* smallmouth bass, *Micropterus dolomieui* bluegill sunfish, *Lepomis macrochirus* pumpkinseed sunfish, *Lepomis gibbosus* common shiner, *Luxilus cornutus* golden shiner, *Notemigonus crysoleucas* redfin pickerel, *Esox americanus* chain pickerel, *Esox niger* alewife, *Alosa pseudoharengus* blueback herring, *Alosa aestivalis* yellow perch, *Perca flavescens*

Table 2. Species Suitability Matrix

Suitability

Map/Table Reference	Identified System Name	Atlantic Salmon, *Salmo salar*	American Shad, *Alosa sapidissima*	Alewife, *Alosa pseudoharengus*	Blueback Herring, *Alosa aestivalis*	White Perch, *Morone americana*	Rainbow Smelt, *Osmerus mordax*	Sea-Run Brook Trout, *Salvelinus fontinalis*	Comments
A.	Pawcatuck River Watershed	**!**	**!**	**!**	**!**	**!**	**!**	**!**	
B.1.	Mashaug PondWatershed			**!**	**!**	**!**			
B.2.	Ninigret Pond Watershed			**!**	**!**	**!**	**!**	**!**	
B.3.	Trustom Pond Watershed	!		**!**	**!**	**!**		!	Salmon and trout for research/broodstock purposes.
C.1.	Point Judith Pond Watershed		**!**	**!**	**!**		!		Smelt habitat below first obstruction.
C.2.	Narrow River Watershed			**!**	**!**	**!**			
C.3.	Wesquage Pond Watershed			**!**	**!**	**!**			
D.1.	Annaquatucket River Watershed		**!**	**!**	**!**		!		
D.2.	Cocumcussoc Brook Watershed			**!**	**!**		!		Past smelt work had limited success.
E.1.	Hunt/Potowomut River Watershed	!	**!**	**!**	**!**	!		**!**	Salmon for potential broodstock. Placement of trap in fishway for recovery.
E.2.	Bleachery Pond Watershed			**!**	**!**				
E.3.	Apponaug Cove Watershed			**!**	**!**		!		
F.	Conimicut Point Watershed			!	!		!		Introduced carp have been observed feeding on eggs of spawning herring. WQ issues.
G.	Pawtuxet River Watershed		!	!	!	!	!	!	Water quality issues.
H.1.	Woonasquatucket River Watershed		!	!	!				Water quality issues.
H.2.	Mosshasuck River Watershed		!	!	!				Water quality issues.
I.	Ten Mile River Watershed	!	**!**	**!**	**!**			!	Trout and salmon included for research purposes. N. Attleboro National Fish Hatchery located in MA section of watershed.
J.	Runnins River Watershed		**!**	**!**	**!**	**!**			
K.1.	Mussachuck Creek Watershed			**!**	**!**	**!**	**!**		
K.2.	Prince Pond Watershed			**!**	**!**	**!**	**!**		
L.	Kickamuit River Watershed			**!**	**!**	!			
M.	Almy Brook Watershed			**!**	**!**		!		
N.1.	Quicksand Pond Watershed			**!**	**!**	**!**			
N.2.	Tunipus Pond Watershed			**!**	**!**	**!**			
N.3.	Briggs Marsh Watershed			**!**	**!**	**!**			
N.4.	Long / Round Pond Watersheds			**!**	**!**	**!**			
O.1.	Sachuest Point Watershed			**!**	**!**	**!**			
O.2.	Easton Pond Watershed			**!**	**!**	**!**			
O.3.	Newport Watersheds			**!**	**!**	**!**			
O.4.	Lawton Valley Watershed			**!**	**!**	**!**			

!	Conditional Suitability
!	Suitable


MAP LEGEND.
N
CONNECTICUT
MASSACHUSETTS
A
B1
B2
B3
C1
C2
C3
D1
D2
E1
E2
E3
F
G
H1
H2
I
J
K1
K2
L
M
N1
N2
N3
N4
O1
O2
O3
O4
Legend of Rhode Island Watersheds Identified as Suitable for Anadromous Fisheries Restoration
0
5
10
MILES

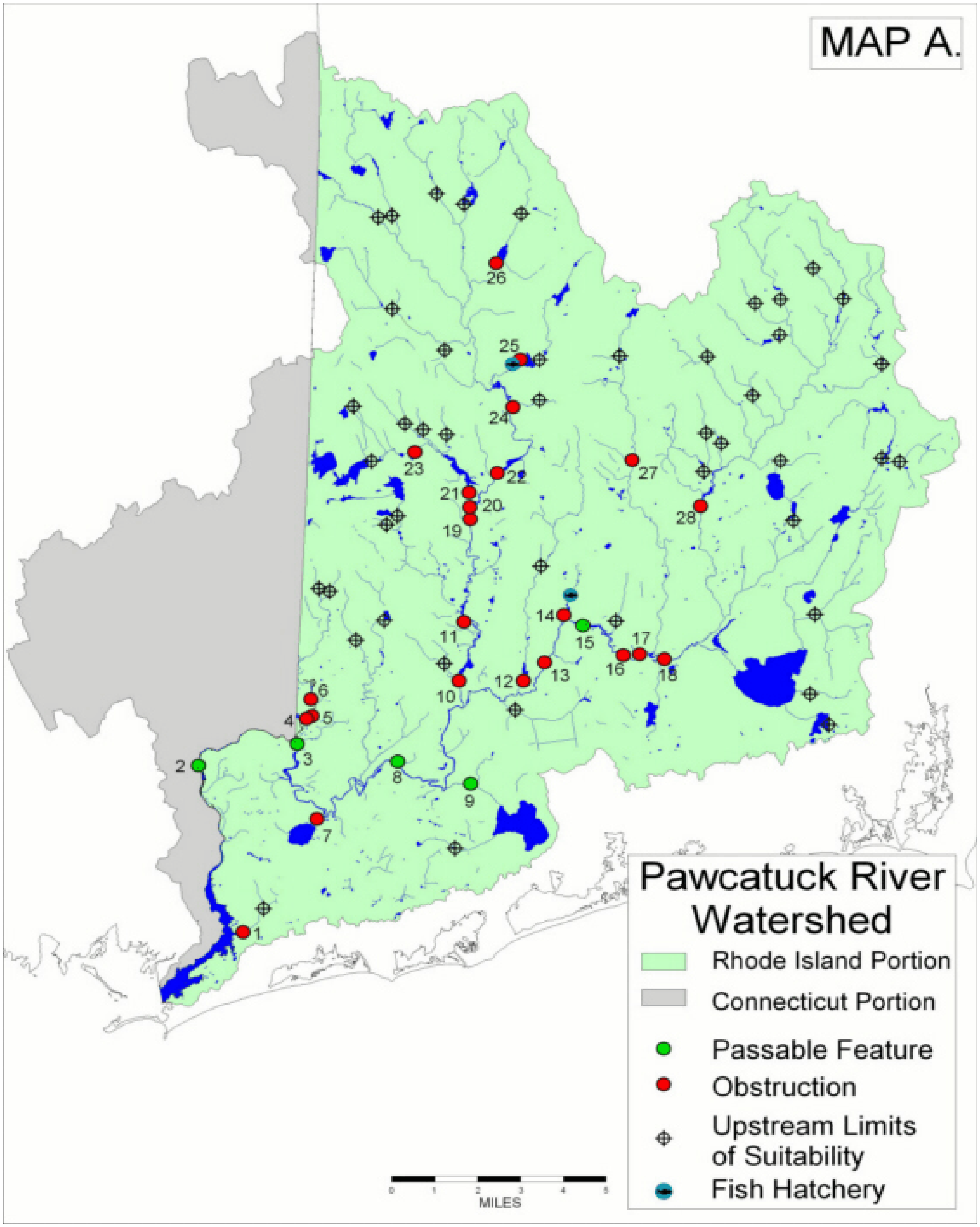

MAP A.
Pawcatuck River Watershed
Rhode Island Portion
Connecticut Portion
Passable Feature
Obstruction
Upstream Limits of Suitability
Fish Hatchery
MILES
1
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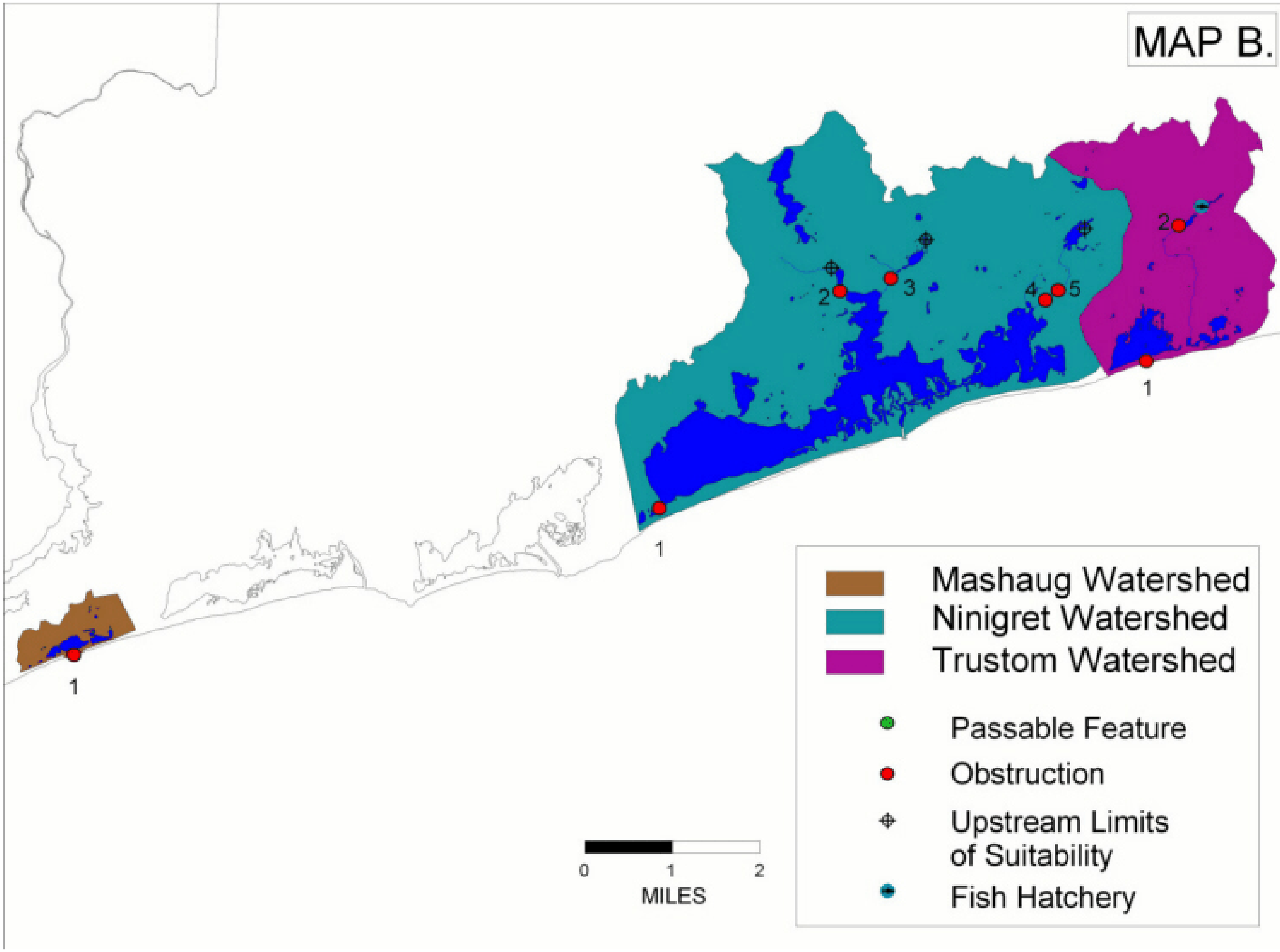
TABLE 3. FOR MAP A.

SYSTEM NAME	OBSTRUCTION NUMBER	PASSAGE SEQUENCE TO REACH OBSTRUCTION	EXISTING ANADROMOUS POPULATION?	SPECIES SUITABILITY IMMEDIATELY ABOVE OBSTRUCTION	HABITAT SIZE ABOVE OBSTRUCTION (ACRES)	OBSTRUCTION HEIGHT (FEET)	DRAINAGE AREA - MILES^2	RECOMMENDED PASSAGE METHOD	RESTORATION FACTOR (ACRES/FOOT)	RIVER OR STREAM	CITY-TOWN	DAM / OBSTRUCTION NAME	STATE ID NO.	LATITUDE DEGREES	LATITUDE MINUTES	LATITUDE SECONDS	LONGITUDE DEGREES	LONGITUDE MINUTES	LONGITUDE SECONDS	DAM / OBSTRUCTION TYPE
PAWCATUCK RIVER WATERSHED	1	1	NO	A/T	0.61	2	U	SLOT	0.31	MASTUXET BROOK	WESTERLY	UNKNOWN	N/A							MASONRY,STONES
	2	2	A/B/S/AS	A/B/S/T	N/A	6.5	292	SLOT	N/A	PAWCATUCK RIVER	WESTERLY	WHITE ROCK DAM	255	41	24	18	71	50	42	EARTH,CONCRETE
	3	2-3	A/B/S	A/B/S/AS/T	82.81	8	204	DENIL	~~10.351~~	PAWCATUCK RIVER	HOPKINTON	POTTER HILL DAM	254	41	24	48	71	47	54	EARTH,MASONRY
	4	2-3-4	NO	A/B/S/T	0.71	4.2	29.6	STEEPPASS	0.169	ASHAWAY RIVER	HOPKINTON	ASHAWAY LINE POND DAM	266	41	25	24	71	47	36	EARTH,CONCRETE
	5	2-3-4-5	NO	A/B/S/T	3.39	6.5	29.6	STEEPPASS	0.522	ASHAWAY RIVER	HOPKINTON	ASHAWAY MILL POND DAM	265	41	25	34	71	47	30	EARTH,MASONRY
	6	2-3-4-5-6	NO	A/B/S/AS/T	18.06	6	29.4	STEEPPASS	3.010	ASHAWAY RIVER	HOPKINTON	BETHEL POND DAM	264	41	25	50	71	47	30	EARTH,MASONRY
	7	2-3-7	A/B/S/AS	A/B	171.95	N/A	U	REGULAR REMOVAL	N/A	CHAPMAN POND	WESTERLY	VEGETATION/DEBRIS	N/A	41	23	9	71	47	13	VEGETATION/DEBRIS
	8	2-3-8	A/B/S/AS	A/B/S/AS/T	82.12	6	219	BREACH/DIVERSION	~~13.687~~	PAWCATUCK RIVER	WESTERLY	BRADFORD POND DAM	253	41	24	28	71	45	0	EARTH,CONCRETE
	9	2-3-8-9	A/B	A/B	563.73	N/A	U	REGULAR REMOVAL	N/A	POQUIANT BROOK	CHARLESTOWN	BUCKEYE BROOK RD. CULVERT/VEGETATION	N/A	41	23	45	71	42	30	VEGETATION/DEBRIS
	10	2-3-8-10	NO	A/B/S/AS/T	71.60	12	87.2	POOL/WEIR/SLOT	5.967	WOOD RIVER	RICHMOND	ALTON POND DAM	247	41	26	18	71	43	24	ROCKFILL,EARTH
	11	2-3-8-10-11	NO	A/B/S/AS/T	50.53	7	85.3	DENIL	7.219	WOOD RIVER	HOPKINTON	WOODVILLE POND DAM	246	41	27	36	71	43	12	ROCKFILL,EARTH
	12	2-3-8-13-14	NO	A/B/AS/T	33.99	7	5.6	STEEPPASS	4.856	MEADOW BROOK	RICHMOND	WOOD RIVER JUNCTION DAM	273	41	26	12	71	41	30	EARTH,ROCKFILL,CONCRETE
	13	2-3-8-13	NO	A/B/S/AS/T	21.82	3	U	SLOT	7.273	PAWCATUCK RIVER	RICHMOND	ROUTE 91 GAUGING STA. DAM	N/A	41	26	43	71	40	52	EARTH,CONCRETE
	14	2-3-8-13-14	NO	A/B/S/AS/T	6.41	4.5	2.6	STEEPPASS	1.424	WHITE BROOK	RICHMOND	WHITE BROOK POND	280	41	27	49	71	40	18	EARTH,MASONRY
	15	2-3-8-13-15	NO	A/B/S/AS/T	N/A	7	96.6	DAM REMOVAL	N/A	PAWCATUCK RIVER	CHARLESTOWN	CAROLINA POND DAM	252	41	27	30	71	39	54	EARTH,MASONRY
	16	2-3-8-13-15-16	NO	A/B/S/AS/T	4.05	7	93.3	DAM REMOVAL	0.579	PAWCATUCK RIVER	RICHMOND	SHANNOCK MILL POND DAM	250	41	26	48	71	38	36	EARTH,MASONRY
	17	2-3-8-13-15-16-17	NO	A/B/S/AS/T	12.00	16	92.7	DENIL/DIVERSION	0.750	PAWCATUCK RIVER	RICHMOND	HORSESHOE FALLS DAM	249	41	26	48	71	38	12	ROCKFILL,MASONRY,EARTH
	18	2-3-8-13-15-16-17-18	NO	A/B/AS/T	1191.20	7	80.2	DENIL	170.171	PAWCATUCK RIVER	RICHMOND	KENYON MILL POND DAM	248	41	26	44	71	37	32	EARTH,MASONRY
	19	2-3-8-10-11-19	NO	A/B/S/AS/T	3.00	3	87.3	SLOT	1.000	WOOD RIVER	RICHMOND	SWITCH RD. GAUGING STA. DAM	N/A	41	29	54.5	71	42	58	EARTH,CONCRETE
	20	2-3-8-10-11-19-20	NO	A/B/S/AS/T	18.02	12	72.8	DENIL	1.502	WOOD RIVER	HOPKINTON	HOPE VALLEY MILL POND DAM	245	41	30	12	71	43	4	EARTH,MASONRY,CONCRETE
	21	2-3-8-10-11-19-20-21	NO	A/B/AS/T	84.30	14	11.3	STEEPPASS	6.021	BRUSHY BROOK	HOPKINTON	LOCUSTVILLE POND DAM	262	41	30	30	71	43	0	OTHER,EARTH
	22	2-3-8-10-11-19-20-22	NO	A/B/S/AS/T	53.15	14	58.6	DENIL	3.796	WOOD RIVER	HOPKINTON	WYOMING POND UPPER DAM	216	41	30	54	71	42	18	MASONRY,GRAVITY,EARTH
	23	2-3-8-10-11-19-20-21-23	NO	A/B/AS/T	18.20	5.5	5.6	STEEPPASS	3.309	BRUSHY BROOK	HOPKINTON	MOSCOW POND DAM	222	41	31	24	71	44	31	EARTH,MASONRY
	24	2-3-8-10-11-19-20-22-24-25	NO	A/B/S/AS/T	59.56	5	87.2	SLOT	11.912	WOOD RIVER	RICHMOND	BARBERVILLE DAM	220	41	32	26	71	41	46	EARTH,CONCRETE
	25	2-3-8-10-11-19-20-22-24-25	NO	A/B/S/AS/T	50.66	10	6.3	STEEPPASS	5.066	ROARING BROOK	HOPKINTON	BROWNING MILL POND DAM	221	41	33	30	71	41	36	EARTH,MASONRY
	26	2-3-8-10-11-19-20-22-24-26	NO	AS/T	44.20	12	6	STEEPPASS	3.683	BREAKHEART BROOK	EXETER	BREAKHEART POND DAM	214	41	35	42	71	42	12	EARTH,GRAVITY,CONCRETE
	27	2-3-8-13-15-16-17-27	NO	AS/T	3.73	4	5.7	STEEPPASS	0.933	BEAVER RIVER	RICHMOND	DECAPPETT POND DAM	230	41	31	15	71	38	48	EARTH
	28	2-3-8-13-15-16-17-18-28	NO	A/B/S/AS/T	73.76	6	33.4	DENIL	12.293	USQUEPAUG RIVER	S. KINGSTOWN	GLEN ROCK RESERVOIR DAM	236	41	30	13	71	36	29	ROCKFILL,EARTH

A= alewife
B= blueback herring
S= American shad
AS= Atlantic salmon
T= sea-run brook trout
RS= rainbow smelt
W= white perch

U= UNKNOWN

Strikethrough text is used in the "Restoration Factor" column where upstream passage is not necessary. The restoration factor for passable dams is included for comparison purposes.


MAP B.
2
3
2
4
5
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1
1
0
1
2
MILES
Mashaug Watershed
Ninigret Watershed
Trustom Watershed
Passable Feature
Obstruction
Upstream Limits of Suitability
Fish Hatchery

TABLE 4. FOR MAP B.

SYSTEM NAME	OBSTRUCTION NUMBER	PASSAGE SEQUENCE TO REACH OBSTRUCTION	EXISTING ANADROMOUS POPULATION?	SPECIES SUITABILITY IMMEDIATELY ABOVE OBSTRUCTION	HABITAT SIZE ABOVE OBSTRUCTION (ACRES)	OBSTRUCTION HEIGHT (FEET)	DRAINAGE AREA - MILES^2	RECOMMENDED PASSAGE METHOD	RESTORATION FACTOR (ACRES/FOOT)	RIVER OR STREAM	CITY-TOWN	DAM/OBSTRUCTION NAME	STATE ID NO.	LATITUDE DEGREES	LATITUDE MINUTES	LATITUDE SECONDS	LONGITUDE DEGREES	LONGITUDE MINUTES	LONGITUDE SECONDS	DAM / OBSTRUCTION TYPE
1) MASHAUG POND WATERSHED	1	1	NO	A/B	45.87		U	MANUAL BREACH	N/A	MASHAUG POND	WESTERLY	MASHAUG BARRIER BEACH	547	41	20	28	71	50	6	BARRIER BEACH
2) NINIGRET POND WATERSHED	1	1	NO	A/B/W	2.39		U	CULVERT REPLACEMENT	N/A	EAST POND	CHARLESTOWN	EAST BEACH RD. CULVERT	N/A	41	20	32.5	71	41	42	CULVERT/SAND
	2	2	NO	A/B/W	9.56	4	3	STEEPPASS	2.390	KING TOM	CHARLESTOWN	KING TOM POND DAM	576	41	22	56	71	39	13	EARTH, CONCRETE MASONRY
	3	3	NO	A/B/W	19.38	5	U	STEEPPASS/CULVERT	3.876	CROSS MILLS POND	CHARLESTOWN	CROSS MILLS DAM	N/A	41	22	59	71	38	31	CONCRETE/EARTH
	4	4	A?	A/B/T	0.67	5	U	STEEPPASS	0.134	FACTORY BROOK/POND	S. KINGSTOWN	FACTORY BROOK DAM	N/A	41	22	46	71	36	22	EARTH, CONCRETE MASONRY
	5	4-5	NO	A/B/T	28.54		U	ROCK REMOVAL	N/A	FACTORY BROOK	S. KINGSTOWN		N/A	41	22	52	71	36	12	ROCKS
3) TRUSTOM POND WATERSHED	1	1	NO	A/B/T/AS*	224.32		U	MANUAL BREACH	N/A	TRUSTOM/CARDS PONDS	S. KINGSTOWN	TRUSTOM BARRIER BEACH	N/A	41	22	10	71	34	48	BARRIER BEACH
	2	1-2	NO	A/B/T/AS*	8.57	5	U	STEEPPASS OR CHANNEL	1.714	MILL POND	S. KINGSTOWN	MILL POND DAM/BYPASS	N/A	41	23	33	71	34	31.5	CONCRETE/EARTH

A= alewife
B= blueback herring
S= American shad
AS= Atlantic salmon
T= sea-run brook trout
RS= rainbow smelt
W= white perch

U= UNKNOWN

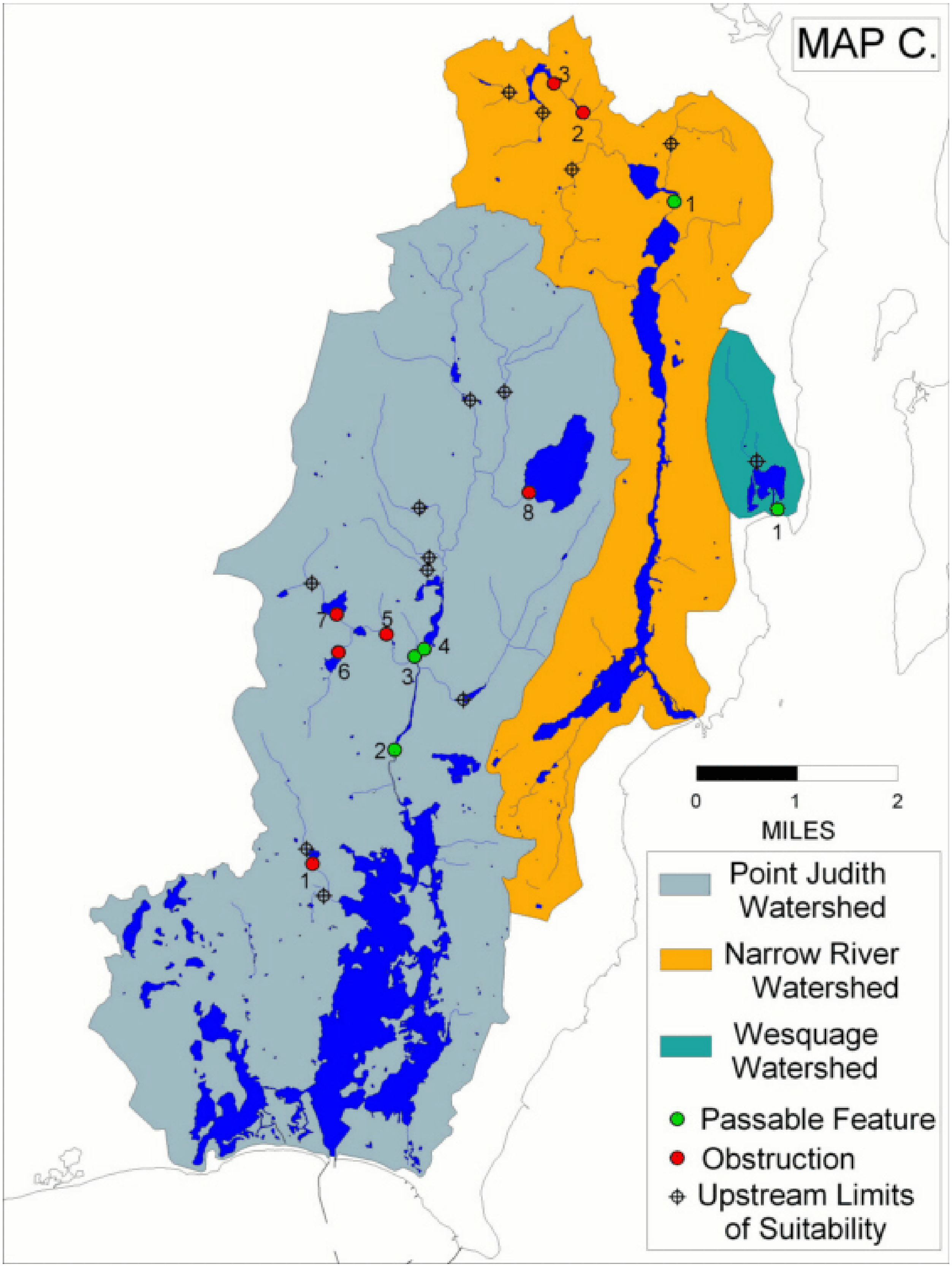

MAP C.
0
1
2
MILES
Point Judith Watershed
Narrow River Watershed
Wesquage Watershed
Passable Feature
Obstruction
Upstream Limits of Suitability

TABLE 5. FOR MAP C.

SYSTEM NAME	OBSTRUCTION NUMBER	PASSAGE SEQUENCE TO REACH OBSTRUCTION	EXISTING ANADROMOUS POPULATION?	SPECIES SUITABILITY IMMEDIATELY ABOVE OBSTRUCTION	HABITAT SIZE ABOVE OBSTRUCTION (ACRES)	OBSTRUCTION HEIGHT (FEET)	DRAINAGE AREA - MILES^2	RECOMMENDED PASSAGE METHOD	RESTORATION FACTOR (ACRES/FOOT)	RIVER OR STREAM	CITY-TOWN	DAM/OBSTRUCTION NAME	STATE ID NO.	LATITUDE DEGREES	LATITUDE MINUTES	LATITUDE SECONDS	LONGITUDE DEGREES	LONGITUDE MINUTES	LONGITUDE SECONDS	DAM / OBSTRUCTION TYPE
1) POINT JUDITH POND WATERSHED	1	1	NO	A/B	8.17	5*	U	STEEPPASS COMBINED WITH POOL AND WEIR	1.634	SMELT BK./RUM POND	S. KINGSTOWN	RUM POND DAM	N/A	41	25	12	71	31	4	ROCKFILL,EARTH
	2	2	A/B	A/B/S	11.26	5	16.1	EXISTING FISHWAY-REDESIGN FOR SHAD -JUVENILE NEEDED	~~2.252~~	SAUGATUCKET R.	S. KINGSTOWN	WAKEFIELD POND DAM	425	41	26	12	71	30	6	EARTH,MASONRY
	3	2-3	A/B	A/B	41.72	8	10.7	EXISTING FISHWAY-JUVENILE NEEDED	~~5.215~~	SAUGATUCKET R.	S. KINGSTOWN	PALLISADES SPILLWAY	N/A	41	27	2	71	29	46	ROCKFILL,EARTH
	4	2-3-4	A/B	A/B	45.35	3	10.7	SLOT/REDESIGN OF GATES	~~15.117~~	SAUGATUCKET R.	S. KINGSTOWN	SAUGATUCKET POND DAM (GATEHOUSE)	426	41	27	8	71	29	43	ROCKFILL,EARTH
	5	2-5	NO	A/B	1.25	6	2.1	STEEPPASS	0.208	ROCKY BROOK	S. KINGSTOWN	HEFLER FARM POND DAM	525	41	27	14	71	30	12	EARTH,MASONRY
	6	2-5-6	NO	A/B	12.06	3	1.5	STEEPPASS	4.020	ROCKY BROOK	S. KINGSTOWN	PEACEDALE RESERVOIR DAM	578	41	27	4	71	30	48	EARTH
	7	2-5-7	NO	A/B	24.27	3	5	STEEPPASS	8.090	ROCKY BROOK	S. KINGSTOWN	ASA POND DAM	549	41	27	27	71	30	48	EARTH,CONCRETE
	8	2-3-4-8	NO	A/B	263.34	4	8.4	POOL AND WEIR OR STEEPPASS	65.835	SAUGATUCKET R.	S. KINGSTOWN	INDIAN LAKE DAM	537	41	28	34	71	28	27	ROCKFILL,EARTH
2) NARROW RIVER WATERSHED	1	1	A/B	A/B	56.61	8	4	ADDITIONAL STEEPPASS NEEDED	~~7.076~~	MATTATUXET R.	N. KINGSTOWN	CARR POND DAM	513	41	31	13	71	26	41	ROCKFILL,EARTH
	2	1-2	NO	A/B	1.06	4	2.5	REMOVAL OR STEEPPASS	0.265	MATTATUXET R.	N. KINGSTOWN	SHADY LEA DAM	N/A	41	32	1.5	71	27	49	EARTH,MASONRY,CONCRETE
	3	1-2-3	NO	A/B	18.35	10	2	STEEPPASS	1.835	MATTATUXET R.	N. KINGSTOWN	SILVER SPRING LAKE DAM	444	41	32	18	71	28	10	EARTH,MASONRY,CONCRETE
3) WESQUAGE POND WATERSHED	1	1	NO	A/B/W	56.09	N/A	U	MANUAL BREACH-TWICE ANNUALLY	N/A	WESQUAGE POND	NARRAGANSETT	WESQUAGE BARRIER BEACH	N/A	41	28	24	71	25	29	BARRIER BEACH

A= alewife
B= blueback herring
S= American shad
AS= Atlantic salmon
T= sea-run brook trout
RS= rainbow smelt
W= white perch

U= UNKNOWN

Strikethrough text is used in the "Restoration Factor" column where upstream passage is not necessary.
The restoration factor for passable dams is included for comparison purposes.

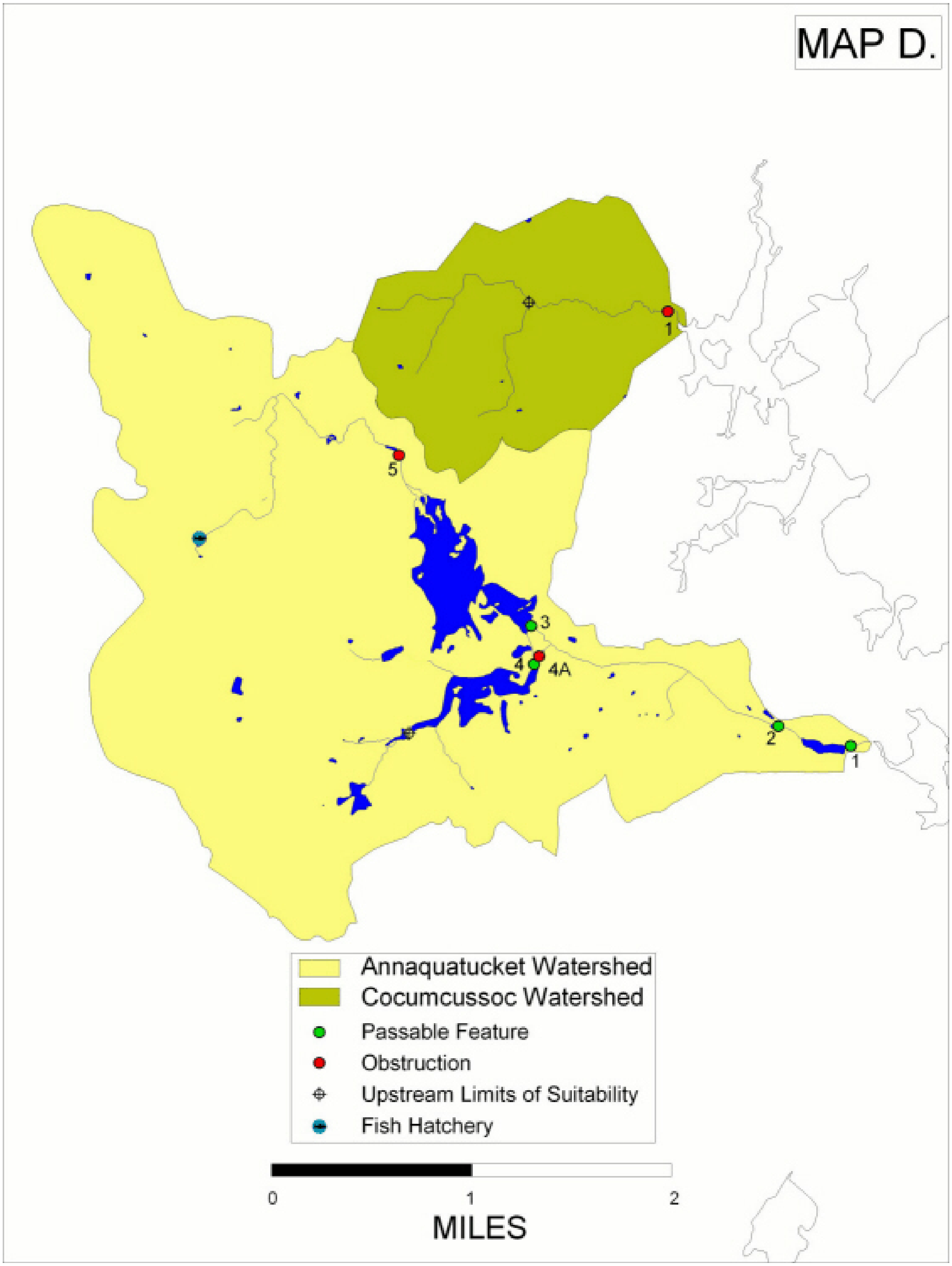

MAP D.
1
5
3
4
4A
2
1
Annaquatucket Watershed
Cocumcussoc Watershed
Passable Feature
Obstruction
Upstream Limits of Suitability
Fish Hatchery
0
1
2
MILES

TABLE 6. FOR MAP D.

SYSTEM NAME	OBSTRUCTION NUMBER	PASSAGE SEQUENCE TO REACH OBSTRUCTION	EXISTING ANADROMOUS POPULATION?	SPECIES SUITABILITY IMMEDIATELY ABOVE OBSTRUCTION	HABITAT SIZE ABOVE OBSTRUCTION (ACRES)	OBSTRUCTION HEIGHT (FEET)	DRAINAGE AREA - MILES^2	RECOMMENDED PASSAGE METHOD	RESTORATION FACTOR (ACRES/FOOT)	RIVER OR STREAM	CITY-TOWN	DAM/OBSTRUCTION NAME	STATE ID NO.	LATITUDE DEGREES	LATITUDE MINUTES	LATITUDE SECONDS	LONGITUDE DEGREES	LONGITUDE MINUTES	LONGITUDE SECONDS	DAM / OBSTRUCTION TYPE
1) ANNAQUATUCKET RIVER WATERSHED	1	1	A/B	A/B/W	6.64	8	U	NONE	~~0.830~~	ANNAQUATUCKET R.	N. KINGSTOWN	HAMILTON RESERVOIR DAM	550	41	33	0	71	26	30	EARTH,CONCRETE
	2	1-2	A/B	A/B	3.37	5	U	JUVENILE	~~0.674~~	ANNAQUATUCKET R.	N. KINGSTOWN	FEATHERBED DAM	N/A	41	33	7.5	71	26	53	ROCKFILL,MASONRY,EARTH
	3	1-2-3	A/B	A/B	115.5	7	8	JUVENILE	~~16.499~~	ANNAQUATUCKET R.	N. KINGSTOWN	BELLEVILLE POND DAM	553	41	33	35	71	28	23	ROCKFILL,MASONRY,EARTH
	4	1-2-3-4	A/B	A/B	45.43	5	U	NONE	~~9.086~~	ANNAQUATUCKET R.	N. KINGSTOWN	SECRET LAKE DAM	N/A	41	33	24.5	71	28	21	ROCKFILL,MASONRY,EARTH
	4A	1-2-4A-4	A/B	A/B	45.43	8	U	STEEPPASS	5.679	ANNAQUATUCKET R.	N. KINGSTOWN	(BELLEVILLE BYPASS)	N/A	41	33	25	71	28	20	ROCKFILL,MASONRY,EARTH
2) COCUMCUSSOC BROOK WATERSHED	1	1	RS	A/B/RS/T	1.41	N/A	U	ROCK REMOVAL	N/A	COCUMCUSSOC BK.	N. KINGSTOWN	UNNAMED (ROCKS)	N/A	41	34	59	71	27	29	ROCKS

A= alewife
B= blueback herring
S= American shad
AS= Atlantic salmon
T= sea-run brook trout
RS= rainbow smelt
W= white perch

U= UNKNOWN

Strikethrough text is used in the "Restoration Factor" column where upstream passage is not necessary.
The restoration factor for passable dams is included for comparison purposes.

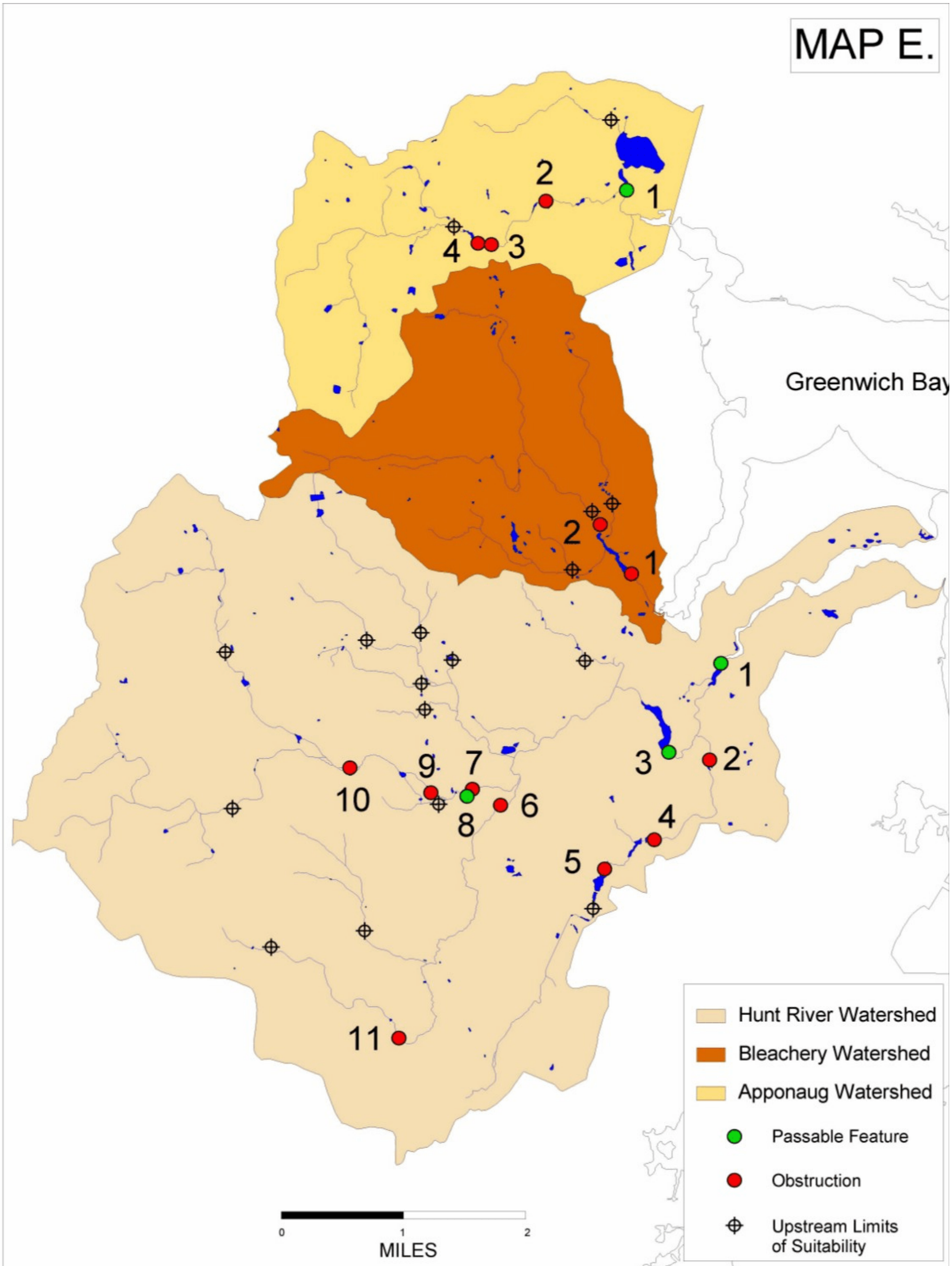

MAP E.
Greenwich Bay
2
1
4
3
2
1
1
9
7
3
2
10
6
8
4
5
11
Hunt River Watershed
Bleachery Watershed
Apponaug Watershed
Passable Feature
Obstruction
Upstream Limits of Suitability
0
1
2
MILES

TABLE 7. FOR MAP E.

SYSTEM NAME	OBSTRUCTION NUMBER	PASSAGE SEQUENCE TO REACH OBSTRUCTION	EXISTING ANADROMOUS POPULATION?	SPECIES SUITABILITY IMMEDIATELY ABOVE OBSTRUCTION	HABITAT SIZE ABOVE OBSTRUCTION (ACRES)	OBSTRUCTION HEIGHT (FEET)	DRAINAGE AREA - MILES^2	RECOMMENDED PASSAGE METHOD	RESTORATION FACTOR (ACRES/FOOT)	RIVER OR STREAM	CITY-TOWN	DAM/OBSTRUCTION NAME	STATE ID NO.	LATITUDE DEGREES	LATITUDE MINUTES	LATITUDE SECONDS	LONGITUDE DEGREES	LONGITUDE MINUTES	LONGITUDE SECONDS	DAM / OBSTRUCTION TYPE
1) HUNT/POTOWOMUT RIVER WATERSHED	1	1	A/B	A/B/S/T	13.78	5	U	DOWNSTREAM NEEDED/DENIL REDESIGN FOR SHAD	~~2.756~~	HUNT RIVER	EAST GREENWICH	FORGE DAM	N/A	41	38	21.5	71	26	43	EARTH,MASONRY,CONCRETE
	2	1-2	NO	A/B	2.13	3.3	2.9	STEEPPASS	0.645	SAND HILL BROOK	NORTH KINGSTOWN	TAYLOR POND DAM	552	41	37	44	71	26	54	EARTH
	3	1-3	A/B	A/B/S/T	31.13	8	23	DOWNSTREAM NEEDED/DENIL REDESIGN FOR SHAD	~~3.891~~	HUNT RIVER	NORTH KINGSTOWN	POTOWOMUT POND DAM	551	41	37	48	71	27	18	EARTH,MASONRY,CONCRETE
	4	1-2-4	NO	A/B	4.79	4	U	STEEPPASS	1.198	SAND HILL BROOK	NORTH KINGSTOWN	SANDHILL POND DAM	N/A	41	37	9	71	27	23	EARTH,MASONRY,CONCRETE
	5	1-2-4-5	NO	A/B	10.03	1	U	SLOT	10.030	SAND HILL BROOK	NORTH KINGSTOWN	DAVISVILLE (SAWMILL) MILL POND DAM	569	41	36	56	71	27	55	EARTH
	6	1-3-6	NO	A/B/S/T	7.92	3	U	STEEPPASS/SLOT	2.640	HUNT RIVER	NORTH KINGSTOWN	AUDUBON DAM	N/A	41	37	25	71	28	54	EARTH,MASONRY,CONCRETE
	7	1-3-7	NO	A/B/T	0.09	3	U	REDISTRIBUTE STONES	0.030	FRENCHTOWN BROOK	EAST GREENWICH	DOT DAM 1	N/A	41	37	32	71	29	11	STONES
	8	1-3-7-8	NO	A/B/T	0.72	8	U	DOWNSTREAM NEEDED	~~0.090~~	FRENCHTOWN BROOK	EAST GREENWICH	DOT DAM 2	N/A	41	37	32	71	29	11	EARTH,MASONRY,CONCRETE
	9	1-3-7-8-9	NO	A/B/T	5.53	8	U	STEEPPASS OR DIVERSION	0.691	FRENCHTOWN BROOK	EAST GREENWICH	GREENHOUSE DAM	N/A	41	37	29.5	71	29	33	EARTH,MASONRY,CONCRETE
	10	1-3-7-8-9-10	NO	T	0.7	6.5	6.4	STEEPPASS	0.108	FRENCHTOWN BROOK	EAST GREENWICH	FRENCHTOWN PARK POND #1 DAM	557	41	37	42	71	30	24	EARTH,MASONRY
	11	1-3-6-11	NO	A/B/T	1.73		U	REDISTRIBUTE STONES	N/A	SCRABBLETOWN BROOK	NORTH KINGSTOWN	STONES-ROUTE 2	N/A	41	35	38.5	71	29	53	STONES
2) BLEACHERY POND WATERSHED	1	1	NO	A/B	9.83	16	3.5	STEEPPASS	0.614	MASKERCHUGG RIVER	EAST GREENWICH	GREENWICH BLEACHERY POND DAM	403	41	39	9.5	71	27	36	EARTH,MASONRY
	2	1-2	NO		1.32	3.5	3	STEEPPASS	0.377	MASKERCHUGG RIVER	EAST GREENWICH	LAS BRISAS PARK POND DAM	515	41	39	31	71	27	54	EARTH
3) APPONAUG COVE WATERSHED	1	1	A/B	A/B	57.89	7	2	**STEEPPASS** OR EARTHWORK	8.270	HARDIG BROOK	WARWICK	GORTON POND DAM	559	41	42	6	71	27	42	EARTH
	2	2	NO	A/B	1.35	6	U	SLOT/STEEPPASS	0.225	HARDIG BROOK	WARWICK	DOT DAM	N/A	41	41	57	71	28	27	EARTH,MASONRY,CONCRETE
	3	2-3	NO	A/B	1.36	3	U	POOL-WEIR	0.453	HARDIG BROOK	WARWICK	CONDOMINIUM DAM 1	N/A	41	41	37.5	71	29	0	EARTH,CONCRETE
	4	2-3-4	NO	A/B	1.41	3	U	POOL-WEIR	0.470	HARDIG BROOK	WARWICK	CONDOMINIUM DAM 2	N/A	41	41	39	71	29	8	EARTH,CONCRETE

A= alewife
B= blueback herring
S= American shad
AS= Atlantic salmon
T= sea-run brook trout
RS= rainbow smelt
W= white perch

U= UNKNOWN

Strikethrough text is used in the "Restoration Factor" column where upstream passage is not necessary. The restoration factor for passable dams is included for comparison purposes.

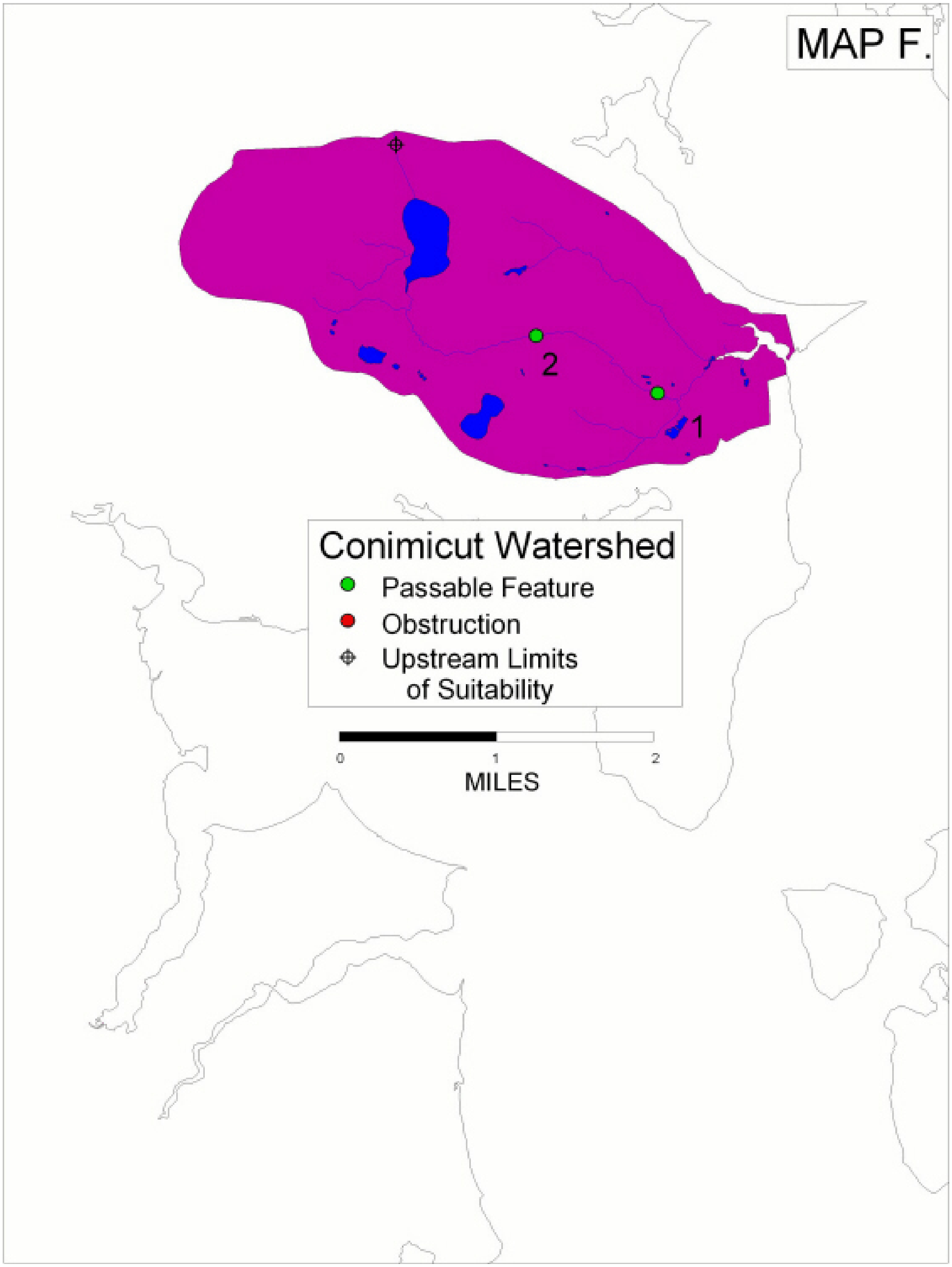

MAP F.
2
1
Conimicut Watershed
Passable Feature
Obstruction
Upstream Limits
of Suitability
0
1
2
MILES

TABLE 8. FOR MAP F.

SYSTEM NAME	OBSTRUCTION NUMBER	PASSAGE SEQUENCE TO REACH OBSTRUCTION	EXISTING ANADROMOUS POPULATION?	SPECIES SUITABILITY IMMEDIATELY ABOVE OBSTRUCTION	HABITAT SIZE ABOVE OBSTRUCTION (ACRES)	OBSTRUCTION HEIGHT (FEET)	DRAINAGE AREA - MILES^2	RECOMMENDED PASSAGE METHOD	RESTORATION FACTOR (ACRES/FOOT)	RIVER OR STREAM	CITY-TOWN	DAM/OBSTRUCTION NAME	STATE ID NO.	LATITUDE DEGREES	LATITUDE MINUTES	LATITUDE SECONDS	LONGITUDE DEGREES	LONGITUDE MINUTES	LONGITUDE SECONDS	DAM / OBSTRUCTION TYPE
CONIMICUT POINT WATERSHED	1	1	A/B	A/B/W	0.00	N/A	U	REGULAR REMOVAL	N/A	BUCKEYE BK.	WARWICK	WEST SHORE RD. CULVERT	N/A	41	42	31	71	22	58	VEGETATION/DEBRIS
	2	1-2	A/B	A/B/W	80.89	N/A	U	REGULAR REMOVAL	N/A	BUCKEYE BK.	WARWICK	WARWICK AVE. CULVERT	N/A	41	42	51	71	23	58	VEGETATION/DEBRIS

A= alewife
B= blueback herring
S= American shad
AS= Atlantic salmon
T= sea-run brook trout
RS= rainbow smelt
W= white perch

U= UNKNOWN

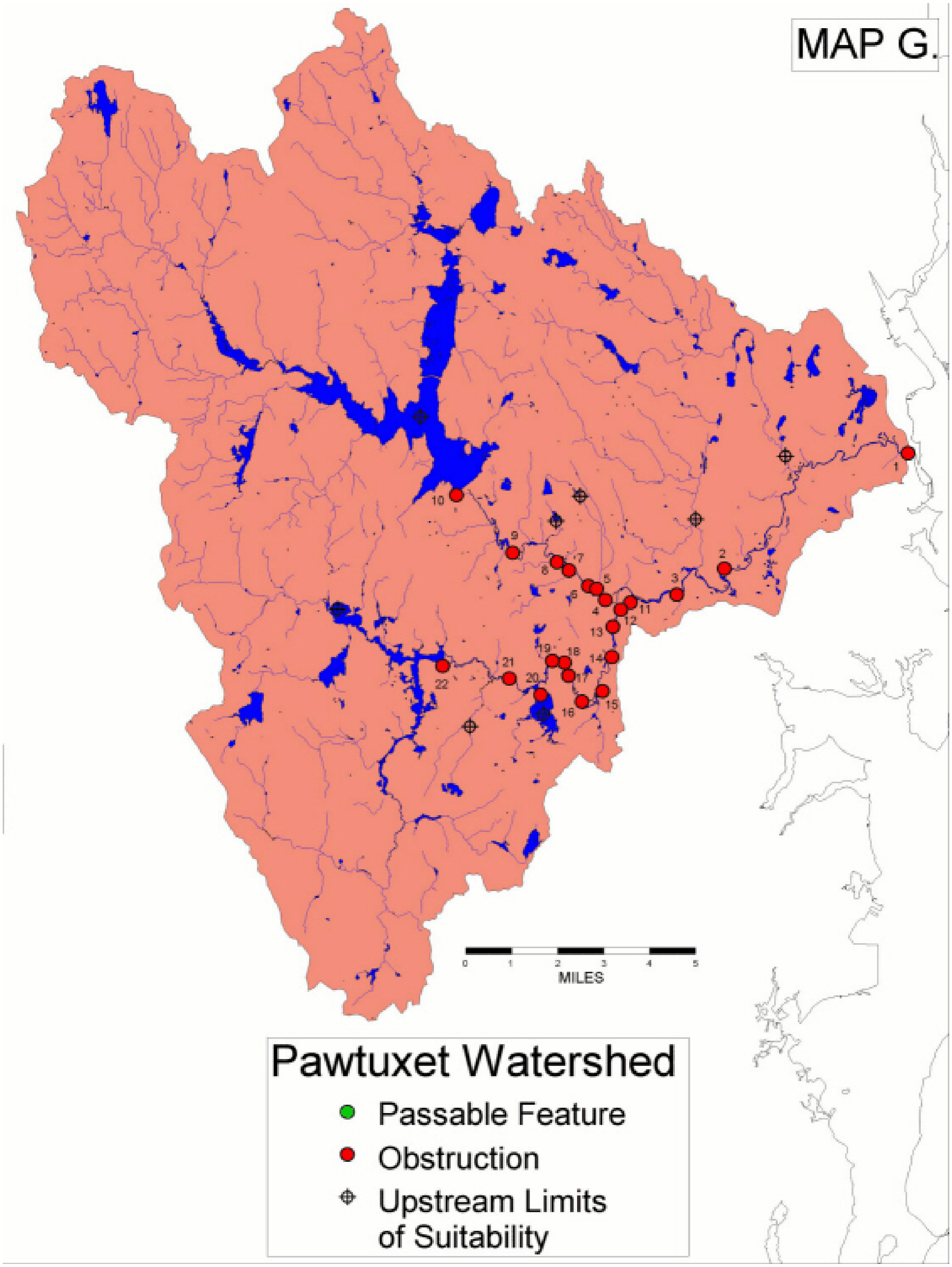
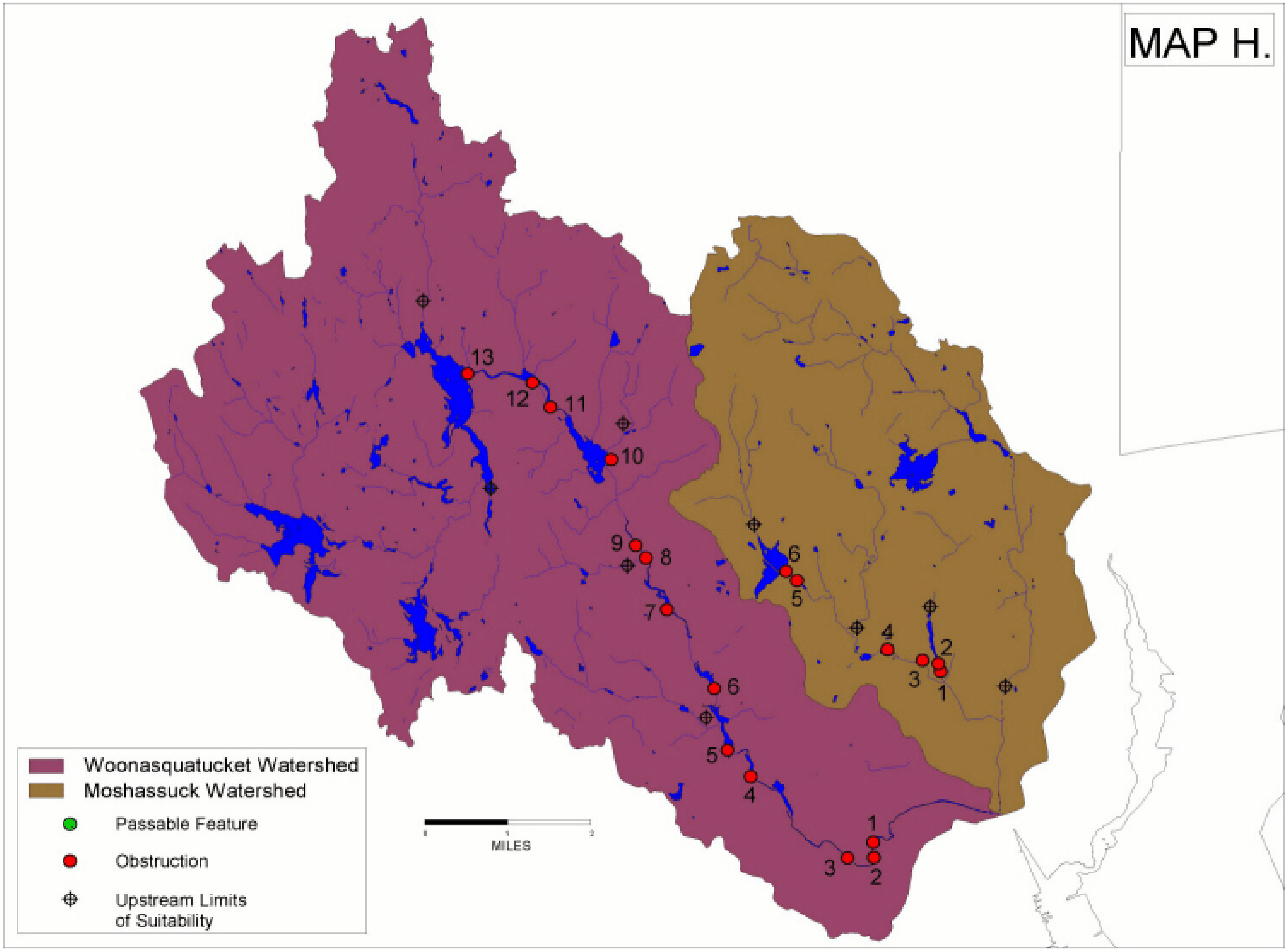

MAP G.
Pawtuxet Watershed
Passable Feature
Obstruction
Upstream Limits
of Suitability
MILES
0
1
2
3
4
5
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

TABLE 9. FOR MAP G.

SYSTEM NAME	OBSTRUCTION NUMBER	PASSAGE SEQUENCE TO REACH OBSTRUCTION	EXISTING ANADROMOUS POPULATION?	SPECIES SUITABILITY IMMEDIATELY ABOVE OBSTRUCTION	HABITAT SIZE ABOVE OBSTRUCTION (ACRES)	OBSTRUCTION HEIGHT (FEET)	DRAINAGE AREA - MILES^2	RECOMMENDED PASSAGE METHOD	RESTORATION FACTOR (ACRES/FOOT)	RIVER OR STREAM	CITY-TOWN	DAM/OBSTRUCTION NAME	STATE ID NO.	LATITUDE DEGREES	LATITUDE MINUTES	LATITUDE SECONDS	LONGITUDE DEGREES	LONGITUDE MINUTES	LONGITUDE SECONDS	DAM / OBSTRUCTION TYPE
PAWTUXET	1	1	NO	A/B/S/W	53.80	3	232.6	REMOVAL OR SLOT	17.93	PAWTUXET R.	WARWICK	PAWTUXET RESERVOIR LOWER DAM	143	41	45	51	71	23	27.5	CONCRETE
RIVER	2	2	NO	A/B/S	34.85	6	197.1	DENIL	5.808	PAWTUXET R.	WARWICK	PONTIAC MILL DAM	144	41	43	34	71	28	17	CONCRETE,GRAVITY,EARTH
WATERSHED	3	2-3	NO	A/B/S	38.10	20	181.8	DENIL	1.905	PAWTUXET R.	W. WARWICK	NATICK POND DAM	145	41	43	2.5	71	29	33	ROCKFILL,MASONRY
	4	1-2-3-4	NO	A/B/S	4.91	7	106.6	DENIL	0.701	N. BRANCH	W. WARWICK	CLYDE POND DAM	154	41	42	57	71	31	26	EARTH,MASONRY
	5	1-2-3-4-5	NO	A/B/S	1.59	10	105.6	DENIL	0.159	N. BRANCH	W. WARWICK	RIVER POINT MILL POND DAM	155	41	43	11.5	71	31	40	EARTH,MASONRY
	6	1-2-3-4-5-6	NO	A/B/S	3.81	15	104.4	DENIL	0.254	N. BRANCH	W. WARWICK	PHENIX MILL POND DAM	156	41	43	13	71	31	52	EARTH,MASONRY
	7	1-2-3-4-5-6-7	NO	A/B/S	7.05	17	102.5	DENIL	0.415	N. BRANCH	W. WARWICK	HARRIS POND DAM - (COV.)	157	41	43	31.5	71	32	23	ROCKFILL,EARTH
	8	1-2-3-4-5-6-7-8	NO	A/B/S	12.03	16	101.5	DENIL	0.752	N. BRANCH	W. WARWICK	ARKWRIGHT POND DAM	158	41	43	46.5	71	32	44	EARTH,MASONRY
	9	1-2-3-4-5-6-7-8-9	NO	A/B/S/T	2.38	12	98.2	DENIL	0.198	N. BRANCH	SCITUATE	HOPE DAM	160	41	43	51.5	71	33	51.5	MASONRY,GRAVITY,EARTH
	10	1-2-3-4-5-6-7-8-9-10	NO	A/B	3200.00	96	92.8	DENIL	33.33	N. BRANCH	SCITUATE	GAINER MEMORIAL DAM	161	41	45	0	71	35	20	EARTH,GRAVITY,CONCRETE
	11	1-2-3-11	NO	A/B/S	2.33	9	73.8	DENIL	0.259	S. BRANCH	W. WARWICK	RIVER POINT POND LOWER DAM	146	41	42	53	71	30	45	EARTH,MASONRY
	12	1-2-3-11-12	NO	A/B/S	5.84	20	73.7	DENIL	0.292	S. BRANCH	W. WARWICK	RIVER POINT POND UPPER DAM	147	41	42	46	71	31	0	EARTH,MASONRY
	13	1-2-3-11-12-13	NO	A/B/S	14.27	26	73.4	DENIL	0.549	S. BRANCH	W. WARWICK	ARCTIC DAM	148	41	42	24.5	71	31	14	ROCKFILL,MASONRY,EARTH
	14	1-2-3-11-12-13-14	NO	A/B/S	10.54	16	73.4	DENIL	0.659	S. BRANCH	W. WARWICK	CENTERVILLE POND DAM	149	41	41	49	71	31	16	MASONRY,GRAVITY,EARTH
	15	1-2-3-11-12-13-14-15	NO	A/B/S	19.45	8	71.7	DENIL	2.431	S. BRANCH	W. WARWICK	CROMPTON LOWER DAM	150	41	41	8	71	31	30	MASONRY,GRAVITY,EARTH
	16	1-2-3-11-12-13-14-15-16	NO	A/B/S	5.07	7.5	69.6	DENIL	0.676	S. BRANCH	W. WARWICK	CROMPTON POND/UPPER/DAM	194	41	40	57	71	32	2	MASONRY,EARTH
	17	1-2-3-11-12-13-14-15-16-17	NO	A/B/S	1.18	6	69	DENIL	0.197	S. BRANCH	W. WARWICK	QUIDNICK POND/LOWER/DAM	195	41	41	26	71	32	23.5	EARTH,MASONRY
	18	1-2-3-11-12-13-14-15-16-17-18	NO	A/B/S	2.95	14	68.8	DENIL	0.211	S. BRANCH	COVENTRY	QUIDNICK POND/UPPER/DAM	151	41	41	42	71	32	30	EARTH,MASONRY
	19	1-2-3-11-12-13-14-15-16-17-18-19	NO	A/B/S	45.89	14	68	DENIL	3.278	S. BRANCH	COVENTRY	ANTHONY MILL POND DAM	152	41	41	44	71	32	49.5	GRAVITY,EARTH
	20	-2-3-11-12-13-14-15-16-17-18-19-2	NO	A/B	224.81	7	2.5	STEEPPASS	32.12	TIOGUE R.	COVENTRY	TIOGUE LAKE DAM	177	41	41	6	71	33	6	MASONRY,GRAVITY,EARTH
	21	-2-3-11-12-13-14-15-16-17-18-19-2	NO	A/B/S	35.54	12	68.3	DENIL	2.962	S. BRANCH	COVENTRY	WASHINGTON POND UPPER DAM	153	41	41	24	71	34	3	ROCKFILL,MASONRY,GRAVITY,EARTH
	22	-3-11-12-13-14-15-16-17-18-19-21	NO	A/B	620.85	9	58	DENIL	68.98	S. BRANCH	COVENTRY	FLAT RIVER RESERVOIR DAM	167	41	41	38	71	35	42	GRAVITY,EARTH

A= alewife
B= blueback herring
S= American shad
AS= Atlantic salmon
T= sea-run brook trout
RS= rainbow smelt
W= white perch



MAP H.
13
12
11
10
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2
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6
5
4
3
2
1
Woonasquatucket Watershed
Moshassuck Watershed
Passable Feature
Obstruction
Upstream Limits of Suitability
MILES

TABLE 10. FOR MAP H.

SYSTEM NAME	OBSTRUCTION NUMBER	PASSAGE SEQUENCE TO REACH OBSTRUCTION	EXISTING ANADROMOUS POPULATION?	SPECIES SUITABILITY IMMEDIATELY ABOVE OBSTRUCTION	HABITAT SIZE ABOVE OBSTRUCTION (ACRES)	OBSTRUCTION HEIGHT (FEET)	DRAINAGE AREA - MILES^2	RECOMMENDED PASSAGE METHOD	RESTORATION FACTOR (ACRES/FOOT)	RIVER OR STREAM	CITY-TOWN	DAM/OBSTRUCTION NAME	STATE ID NO.	LATITUDE DEGREES	LATITUDE MINUTES	LATITUDE SECONDS	LONGITUDE DEGREES	LONGITUDE MINUTES	LONGITUDE SECONDS	DAM / OBSTRUCTION TYPE
1) WOONASQUATUCKET RIVER WATERSHED	1	1	NO	A/B/S	1.5	9	49.4	DENIL	0.17	WOONASQUATUCKET R.	PROVIDENCE	RISING SUN POND DAM	140	41	49	18	71	26	34	CONCRETE
	2	1-2	NO	A/B/S	2.6	5.5	49.3	DENIL	0.47	WOONASQUATUCKET R.	PROVIDENCE	PARAGON POND DAM	139	41	49	4	71	26	36	EARTH,CONCRETE
	3	1-2-3	NO	A/B/S	13.30	9.5	48	DENIL	1.40	WOONASQUATUCKET R.	PROVIDENCE	ATLANTIC MILLS POND DAM	138	41	49	6	71	26	56	EARTH,MASONRY
	4	1-2-3-4	NO	A/B/S	6.90	6	46	REMOVAL	1.15	WOONASQUATUCKET R.	PROVIDENCE	MANTON MILL POND DAM	135	41	50	6	71	28	20	CONCRETE
	5	1-2-3-4-5	NO	A/B/S	25.20	10	44.7	DENIL	2.52	WOONASQUATUCKET R.	N. PROVIDENCE	LYMANSVILLE DAM	134	41	50	24	71	28	36	ROCKFILL,EARTH
	6	1-2-3-4-5-6	NO	A/B/S	18.80	10	40.2	DENIL	1.88	WOONASQUATUCKET R.	JOHNSTON	ALLENDALE POND DAM	133	41	51	6	71	28	54	EARTH,OTHER
	7	1-2-3-4-5-6-7	NO	A/B/S	12.30	6	39	REMOVAL	2.05	WOONASQUATUCKET R.	JOHNSTON	GREYSTONE DAM	131	41	51	56	71	29	30	ROCKFILL,MASONRY,EARTH
	8	1-2-3-4-5-6-7-8	NO	A/B/S	0.70	3	36.1	REMOVAL	0.23	WOONASQUATUCKET R.	SMITHFIELD	ESMOND MILL LOWER POND DAM	130	41	52	30	71	29	54	MASONRY
	9	1-2-3-4-5-6-7-8-9	NO	A/B/S	1.24	3	36.1	REMOVAL	0.41	WOONASQUATUCKET R.	SMITHFIELD	ESMOND MILL MIDDLE POND DAM	129	41	52	37	71	30	2	EARTH,CONCRETE
	10	1-2-3-4-5-6-7-8-9-10	NO	A/B/S	6.90	3	36.1	REMOVAL	2.30	WOONASQUATUCKET R.	SMITHFIELD	ESMOND MILL UPPER POND DAM	128	41	52	44	71	30	9	EARTH,CONCRETE,MASONRY
	11	1-2-3-4-5-6-7-8-9-10-11	NO	A/B/S	100.00	27	33.6	DENIL	3.70	WOONASQUATUCKET R.	SMITHFIELD	GEORGIAVILLE POND DAM	126	41	53	30	71	30	30	GRAVITY,EARTH
	12	1-2-3-4-5-6-7-8-9-10-11-12	NO	A/B/S	7.10	8.2	30.2	DENIL	0.87	WOONASQUATUCKET R.	SMITHFIELD	CAPRON POND DAM	110	41	54	10	71	31	18	EARTH,MASONRY,CONCRETE
	13	1-2-3-4-5-6-7-8-9-10-11-12-13	NO	A/B/S	26.20	14	29.8	DENIL	1.87	WOONASQUATUCKET R.	SMITHFIELD	STILLWATER POND DAM	109	41	54	30	71	31	36	GRAVITY,EARTH
	14	-2-3-4-5-6-7-8-9-10-11-12-13-1	NO	A/B/S	302.00	16	26.2	DENIL	18.88	WOONASQUATUCKET R.	SMITHFIELD	STILLWATER RESERVOIR DAM	108	41	54	30	71	32	30	CONCRETE,EARTH,OTHER
2) MOSHASSUCK RIVER WATERSHED	1	1	NO	A/B/S	1.02	3	2.15	REMOVAL	0.34	WEST RIVER	PROVIDENCE	CANADA LOWER POND DAM	094	41	51	10	71	25	34	EARTH,CONCRETE
	2	1-2	NO	A/B/S	18.48	17	2.1	DENIL	1.087	WEST RIVER	PROVIDENCE	CANADA UPPER POND DAM	093	41	51	16	71	25	35	EARTH,ROCKFILL,CONCRETE
	3	3	NO	A/B/S	4.81	10	7.7	DENIL	0.481	WEST RIVER	PROVIDENCE	WANSKUCK POND DAM	091	41	51	18	71	25	52	EARTH,MASONRY
	4	3-4	NO	A/B/S	13.98	9	7.4	DENIL	1.553	WEST RIVER	PROVIDENCE	WHIPPLE POND DAM	090	41	51	26	71	26	21	EARTH,MASONRY
	5	3-4-5	NO	A/B/S	1.05	3	3.2	REMOVAL	0.35	WEST RIVER	N. PROVIDENCE	GENEVA SPORTSMEN'S CLUB POND DAM	085	41	52	13	71	27	41	EARTH,ROCKFILL
	6	3-4-5-6	NO	A/B/S	49.00	8	3.2	DENIL	6.125	WEST RIVER	N. PROVIDENCE	WENSCOTT RESERVOIR DAM	084	41	52	18	71	27	48	ROCKFILL,MASONRY,EARTH

A= alewife
B= blueback herring
S= American shad
AS= Atlantic salmon
T= sea-run brook trout
RS= rainbow smelt
W= white perch

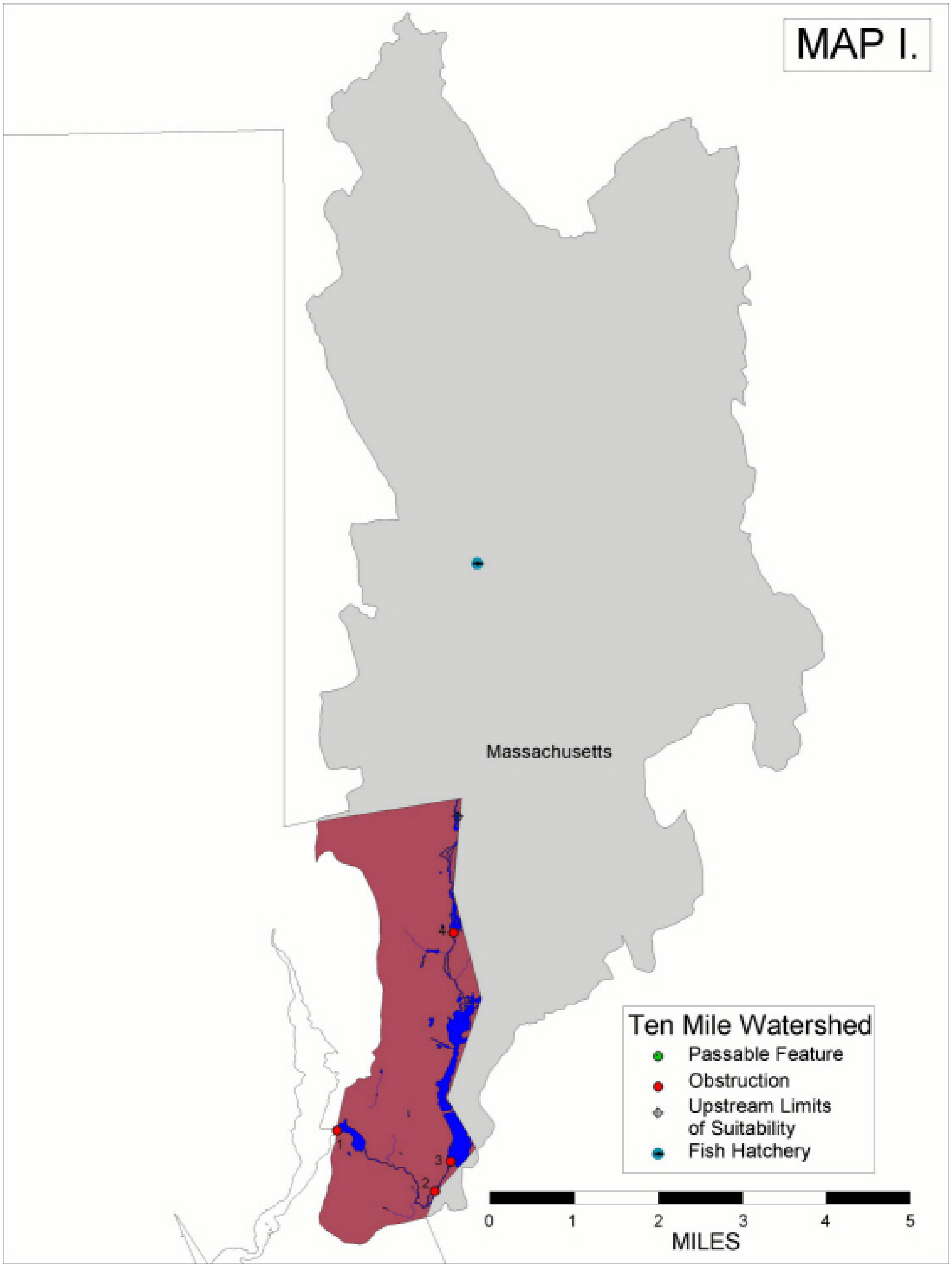
MAP I.
Massachusetts
Ten Mile Watershed
Passable Feature
Obstruction
Upstream Limits
of Suitability
Fish Hatchery
1
2
3
4
0
1
2
3
4
5
MILES

TABLE 11. FOR MAP I.

SYSTEM NAME	OBSTRUCTION NUMBER	PASSAGE SEQUENCE TO REACH OBSTRUCTION	EXISTING ANADROMOUS POPULATION?	SPECIES SUITABILITY IMMEDIATELY ABOVE OBSTRUCTION	HABITAT SIZE ABOVE OBSTRUCTION (ACRES)	OBSTRUCTION HEIGHT (FEET)	DRAINAGE AREA - MILES^2	RECOMMENDED PASSAGE METHOD	RESTORATION FACTOR (ACRES/FOOT)	RIVER OR STREAM	CITY-TOWN	DAM/OBSTRUCTION NAME	STATE ID NO.	LATITUDE DEGREES	LATITUDE MINUTES	LATITUDE SECONDS	LONGITUDE DEGREES	LONGITUDE MINUTES	LONGITUDE SECONDS	DAM / OBSTRUCTION TYPE
TEN MILE RIVER WATERSHED	1	1	NO	A/B/S	44.8	13	50.3	DENIL	3.446	TEN MILE RIVER	EAST PROVIDENCE	OMEGA POND DAM	406	41	50	20	71	22	8	MASONRY,GRAVITY,EARTH
	2	1-2	NO	A/B/S	4.6	8	48	BREACH	0.575	TEN MILE RIVER	EAST PROVIDENCE	HUNTS MILL POND DAM	405	41	49	40	71	20	44	MASONRY,GRAVITY,EARTH
	3	1-2-3	NO	A/B/S	265.6	17	48	DENIL	15.624	TEN MILE RIVER	EAST PROVIDENCE	TURNER RESERVOIR DAM	407	41	49	59.5	71	20	31.5	EARTH,GRAVITY,CONCRETE
	4	1-2-3-4	NO	A/B/S	28.6 * to MA border	5	45.3	DENIL	5.720	TEN MILE RIVER	PAWTUCKET	TEN MILE RESERVATION DAM	294	41	52	28	71	20	27.5	EARTH,GRAVITY,CONCRETE

A= alewife
B= blueback herring
S= American shad
AS= Atlantic salmon
T= sea-run brook trout
RS= rainbow smelt
W= white perch

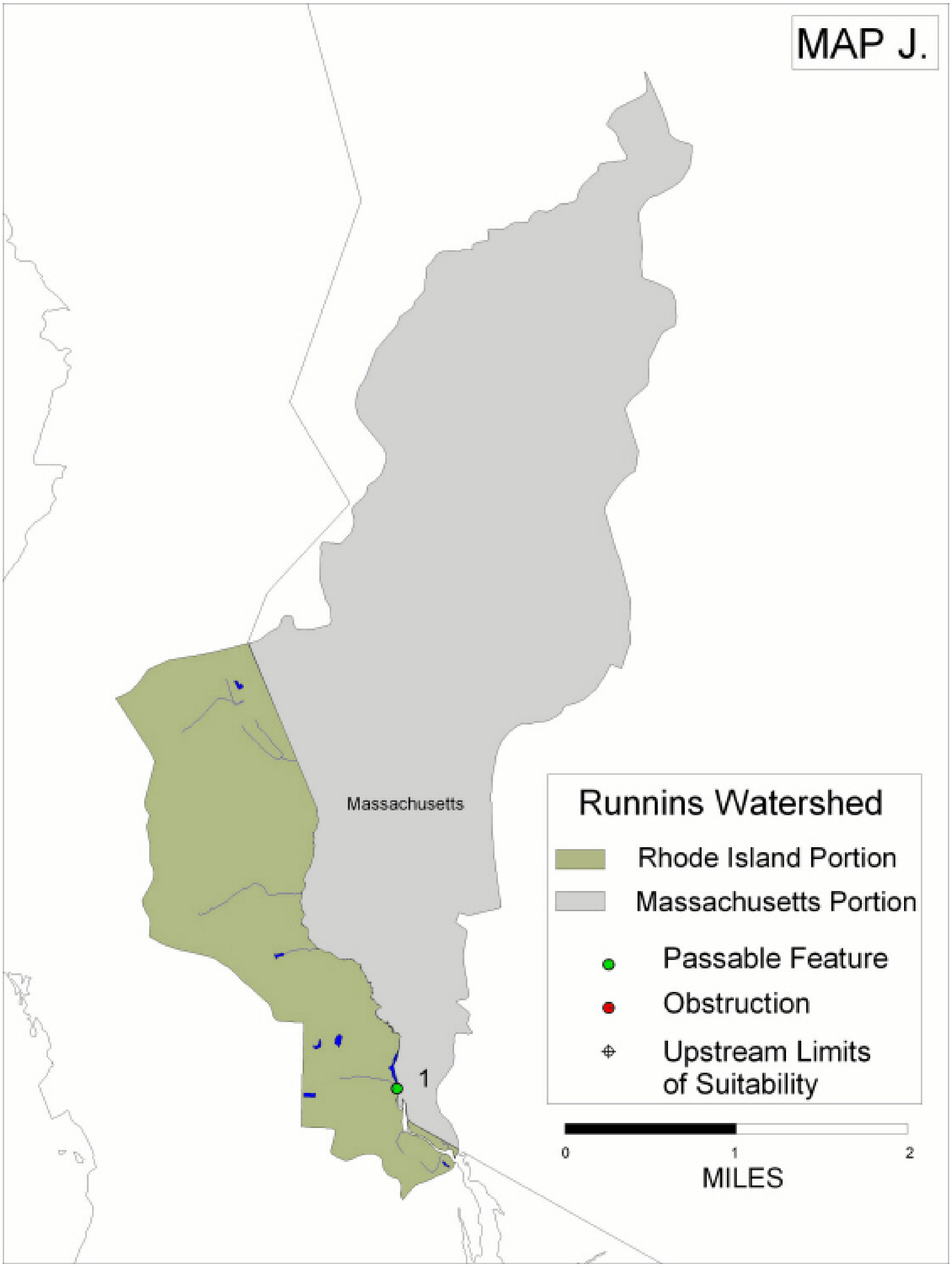
MAP J.
Massachusetts
1
Runnins Watershed
Rhode Island Portion
Massachusetts Portion
Passable Feature
Obstruction
Upstream Limits of Suitability
0
1
2
MILES

TABLE 12. FOR MAP J.

SYSTEM NAME	OBSTRUCTION NUMBER	PASSAGE SEQUENCE TO REACH OBSTRUCTION	EXISTING ANADROMOUS POPULATION?	SPECIES SUITABILITY IMMEDIATELY ABOVE OBSTRUCTION	HABITAT SIZE ABOVE OBSTRUCTION (ACRES)	OBSTRUCTION HEIGHT (FEET)	DRAINAGE AREA - MILES^2	RECOMMENDED PASSAGE METHOD	RESTORATION FACTOR (ACRES/FOOT)	RIVER OR STREAM	CITY-TOWN	DAM/OBSTRUCTION NAME	STATE ID NO.	LATITUDE DEGREES	LATITUDE MINUTES	LATITUDE SECONDS	LONGITUDE DEGREES	LONGITUDE MINUTES	LONGITUDE SECONDS	DAM / OBSTRUCTION TYPE
RUNNINS RIVER WATERSHED	1	1	YES	A/B/S/W	9.7	5	U	SLOT	~~1.94~~	RUNNINS RIVER	E. PROVIDENCE	STANDARD OIL POND DAM	410	41	47	0	71	19	50	EARTH,CONCRETE,MASONRY

A= alewife
B= blueback herring
S= American shad
AS= Atlantic salmon
T= sea-run brook trout
RS= rainbow smelt
W= white perch

U= UNKNOWN

Strikethrough text is used in the "Restoration Factor" column where upstream passage is not necessary. The restoration factor for passable dams is included for comparison purposes.

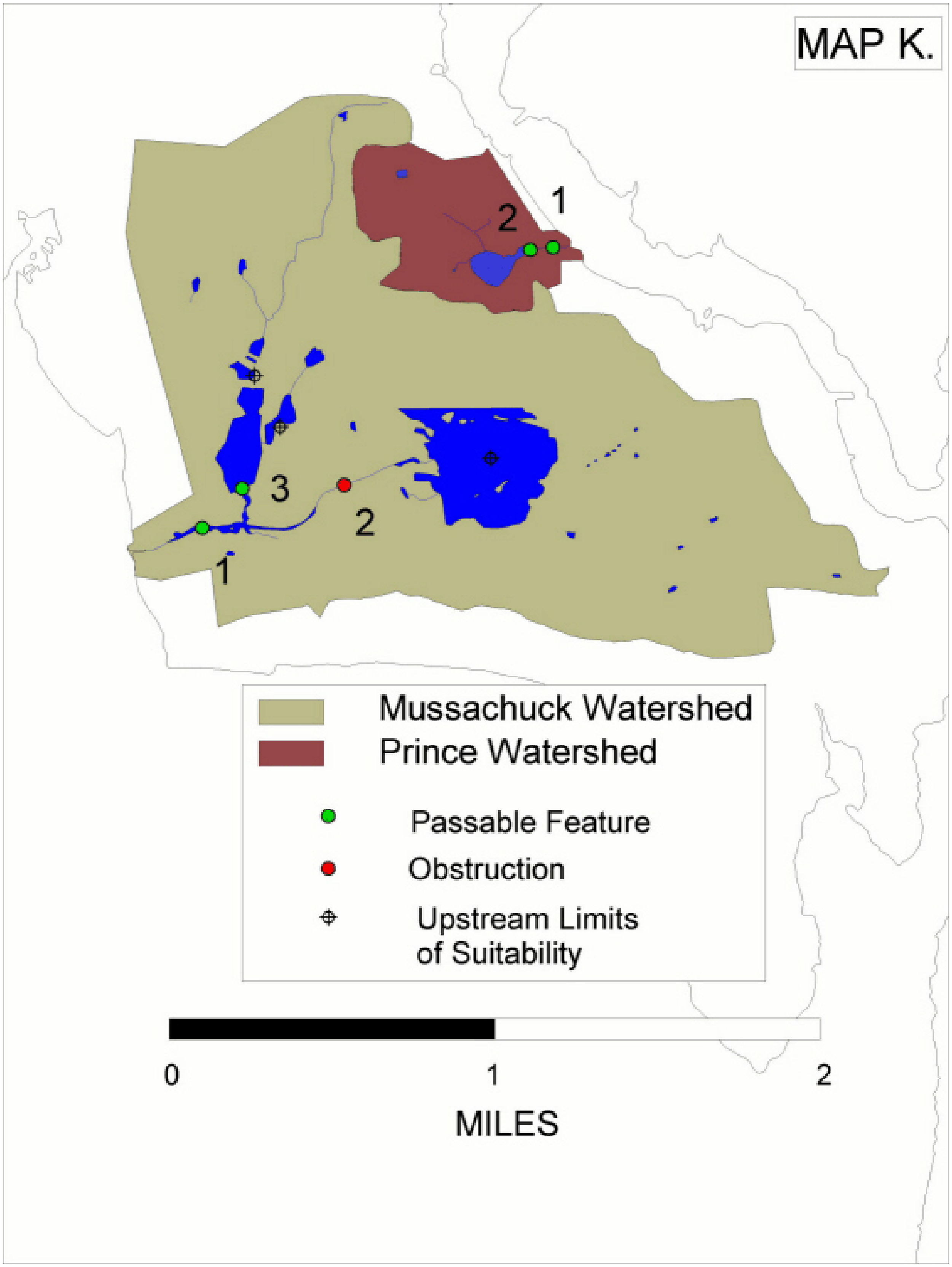
MAP K.
1
2
3
2
1
Mussachuck Watershed
Prince Watershed
Passable Feature
Obstruction
Upstream Limits of Suitability
0
1
2
MILES

TABLE 13. FOR MAP K.

SYSTEM NAME	OBSTRUCTION NUMBER	PASSAGE SEQUENCE TO REACH OBSTRUCTION	EXISTING ANADROMOUS POPULATION?	SPECIES SUITABILITY IMMEDIATELY ABOVE OBSTRUCTION	HABITAT SIZE ABOVE OBSTRUCTION (ACRES)	OBSTRUCTION HEIGHT (FEET)	DRAINAGE AREA - MILES^2	RECOMMENDED PASSAGE METHOD	RESTORATION FACTOR (ACRES/FOOT)	RIVER OR STREAM	CITY-TOWN	DAM/OBSTRUCTION NAME	STATE ID NO.	LATITUDE DEGREES	LATITUDE MINUTES	LATITUDE SECONDS	LONGITUDE DEGREES	LONGITUDE MINUTES	LONGITUDE SECONDS	DAM / OBSTRUCTION TYPE
1) MUSSACHUCK CREEK WATERSHED	1	1	A?	A/B/W	0.00	N/A	U	REMOVE OR MANAGE GATE	N/A	MUSSACHUCK CR.	BARRINGTON	WASHINGTON RD. TIDE GATE	N/A	41	43	53.5	71	20	13	BROKEN TIDE GATE/DEBRIS
	2	1-2	A?	A/B/W	84.62	N/A	U	CULVERT REPLACEMENT	N/A	MUSSACHUCK CR.	BARRINGTON	MIDDLE HIGHWAY CULVERT	N/A	41	44	0.5	71	19	40.5	COLLAPSED CULVERT
	3	1-3	A	A/B/W	19.67	3	U	EXISTING POOL AND WEIR	~~6.557~~	ECHO LAKE	BARRINGTON	ECHO LAKE DAM	N/A	41	44	0	71	20	4	ROCKFILL,MASONRY,EARTH
2) PRINCE POND WATERSHED	1	1	A	A/B/W	0.00	N/A	U	DEBRIS REMOVAL	N/A	PRINCE POND	BARRINGTON	RT. 114 CULVERT	N/A	41	44	40.5	71	18	54	CULVERT/DEBRIS
	2	1-2	A	A/B/W	7.86	N/A	U	DEBRIS REMOVAL	N/A	PRINCE POND	BARRINGTON	TRAIL CROSSING	N/A	41	44	40	71	18	59	VEGETATION/DEBRIS

A= alewife
B= blueback herring
S= American shad
AS= Atlantic salmon
T= sea-run brook trout
RS= rainbow smelt
W= white perch

U= UNKNOWN

Strikethrough text is used in the "Restoration Factor" column where upstream passage is not necessary. The restoration factor for passable dams is included for comparison purposes.

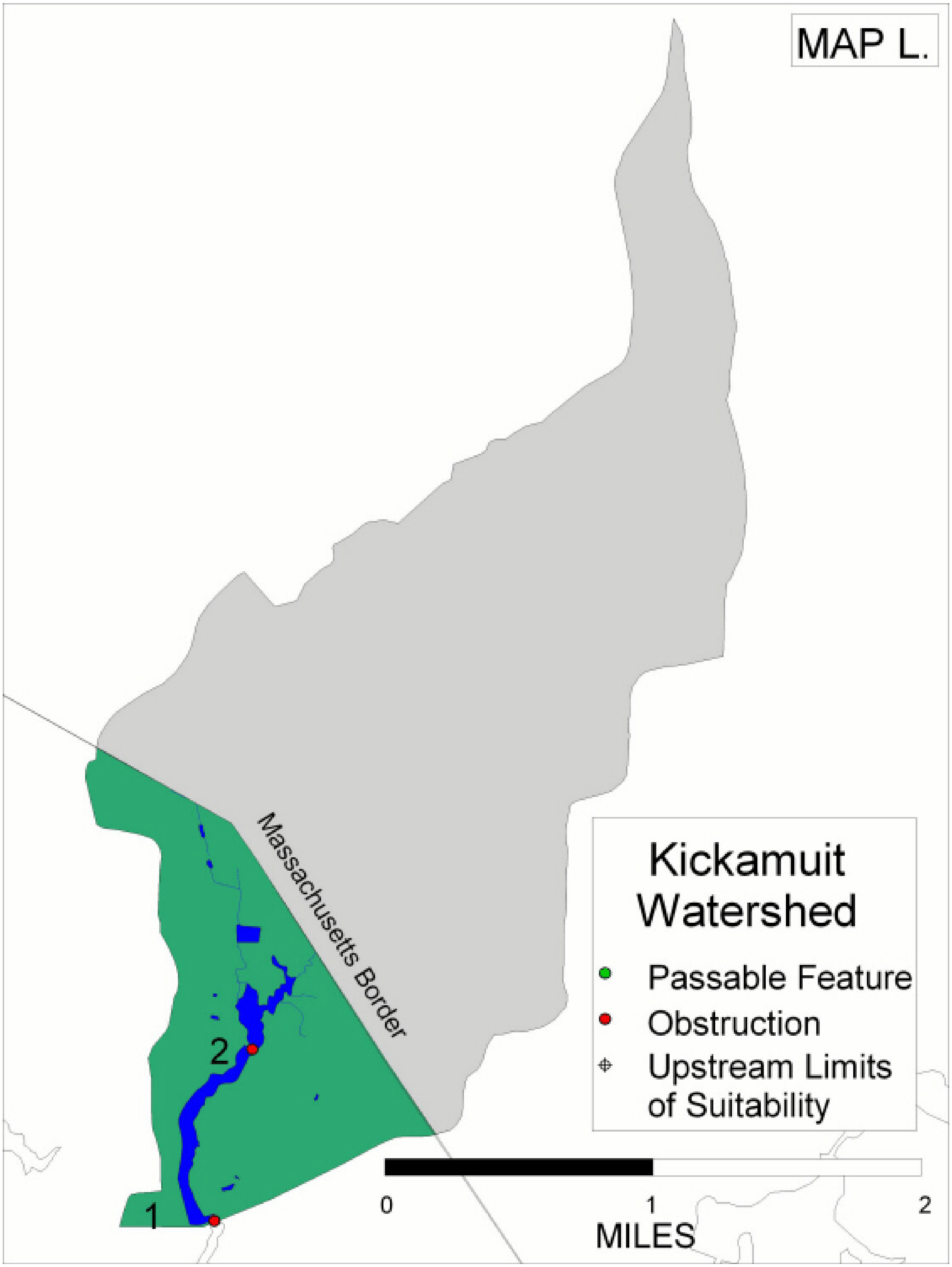
MAP L.
Massachusetts Border
Kickamuit Watershed
Passable Feature
Obstruction
Upstream Limits of Suitability
1
2
0
1
2
MILES

TABLE 14. FOR. MAP L.

SYSTEM NAME	OBSTRUCTION NUMBER	PASSAGE SEQUENCE TO REACH OBSTRUCTION	EXISTING ANADROMOUS POPULATION?	SPECIES SUITABILITY IMMEDIATELY ABOVE OBSTRUCTION	HABITAT SIZE ABOVE OBSTRUCTION (ACRES)	OBSTRUCTION HEIGHT (FEET)	DRAINAGE AREA - MILES^2	RECOMMENDED PASSAGE METHOD	RESTORATION FACTOR (ACRES/FOOT)	RIVER OR STREAM	CITY-TOWN	DAM/OBSTRUCTION NAME	STATE ID NO.	LATITUDE DEGREES	LATITUDE MINUTES	LATITUDE SECONDS	LONGITUDE DEGREES	LONGITUDE MINUTES	LONGITUDE SECONDS	DAM / OBSTRUCTION TYPE
KICKAMUIT RIVER	1	1	NO	A/B	26.59	7	4.6	DENIL	3.799	KICKAMUIT RIVER	WARREN	WARREN RESERVOIR LOWER DAM	479	41	43	47	71	15	47	EARTH,ROCKFILL,CONCRETE
WATERSHED	2	1-2	NO	A/B	14.36	8	4.6	STEEPPASS	1.795	KICKAMUIT RIVER	WARREN	WARREN RESERVOIR UPPER DAM	480	41	44	23.5	71	15	34	EARTH,MASONRY

A= alewife
B= blueback herring
S= American shad
AS= Atlantic salmon
T= sea-run brook trout
RS= rainbow smelt
W= white perch

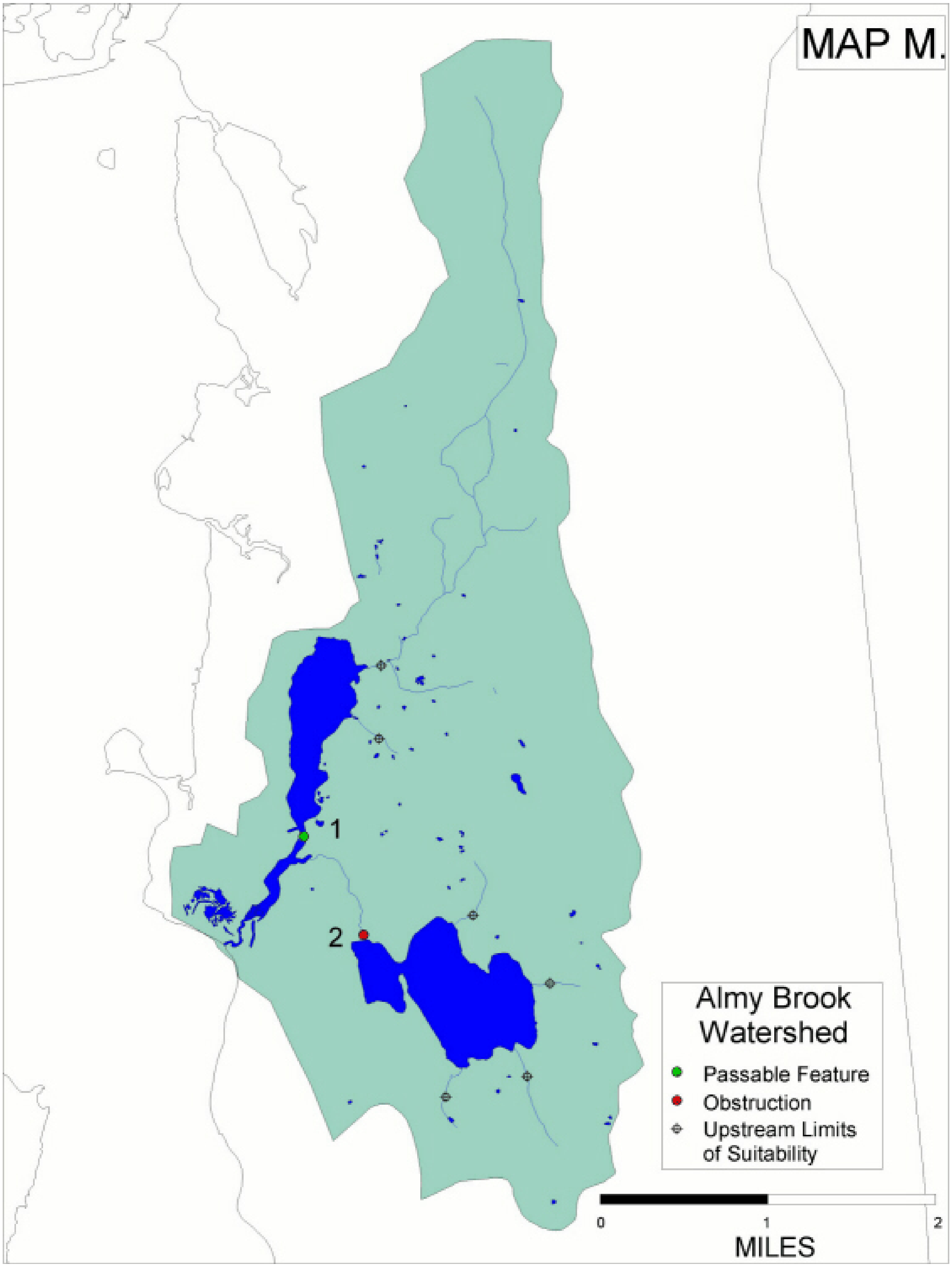
MAP M.
1
2
Almy Brook Watershed
Passable Feature
Obstruction
Upstream Limits of Suitability
0
1
2
MILES

TABLE 15. FOR MAP M.

SYSTEM NAME	OBSTRUCTION NUMBER	PASSAGE SEQUENCE TO REACH OBSTRUCTION	EXISTING ANADROMOUS POPULATION?	SPECIES SUITABILITY IMMEDIATELY ABOVE OBSTRUCTION	HABITAT SIZE ABOVE OBSTRUCTION (ACRES)	OBSTRUCTION HEIGHT (FEET)	DRAINAGE AREA - MILES^2	RECOMMENDED PASSAGE METHOD	RESTORATION FACTOR (ACRES/FOOT)	RIVER OR STREAM	CITY-TOWN	DAM/OBSTRUCTION NAME	STATE ID NO.	LATITUDE DEGREES	LATITUDE MINUTES	LATITUDE SECONDS	LONGITUDE DEGREES	LONGITUDE MINUTES	LONGITUDE SECONDS	DAM / OBSTRUCTION TYPE
ALMY BROOK	1	1	A/B	A/B/W	197.35	7	6	EXISTING DENIL/JUVENILE NEEDED	~~28.193~~	BORDEN BK.	TIVERTON	NONQUIT POND DAM	396	41	33	12	71	11	48	ROCKFILL,EARTH
WATERSHED	2	2	NO	A/B	380.19	34	3.7	STEEPPASS	11.182	PACHET BK.	LITTLE COMPTON	WATSON RESERVOIR DAM	485	41	32	30	71	11	6	EARTH

A= alewife
B= blueback herring
S= American shad
AS= Atlantic salmon
T= sea-run brook trout
RS= rainbow smelt
W= white perch

Strikethrough text is used in the "Restoration Factor" column where upstream passage is not necessary. The restoration factor for passable dams is included for comparison purposes.

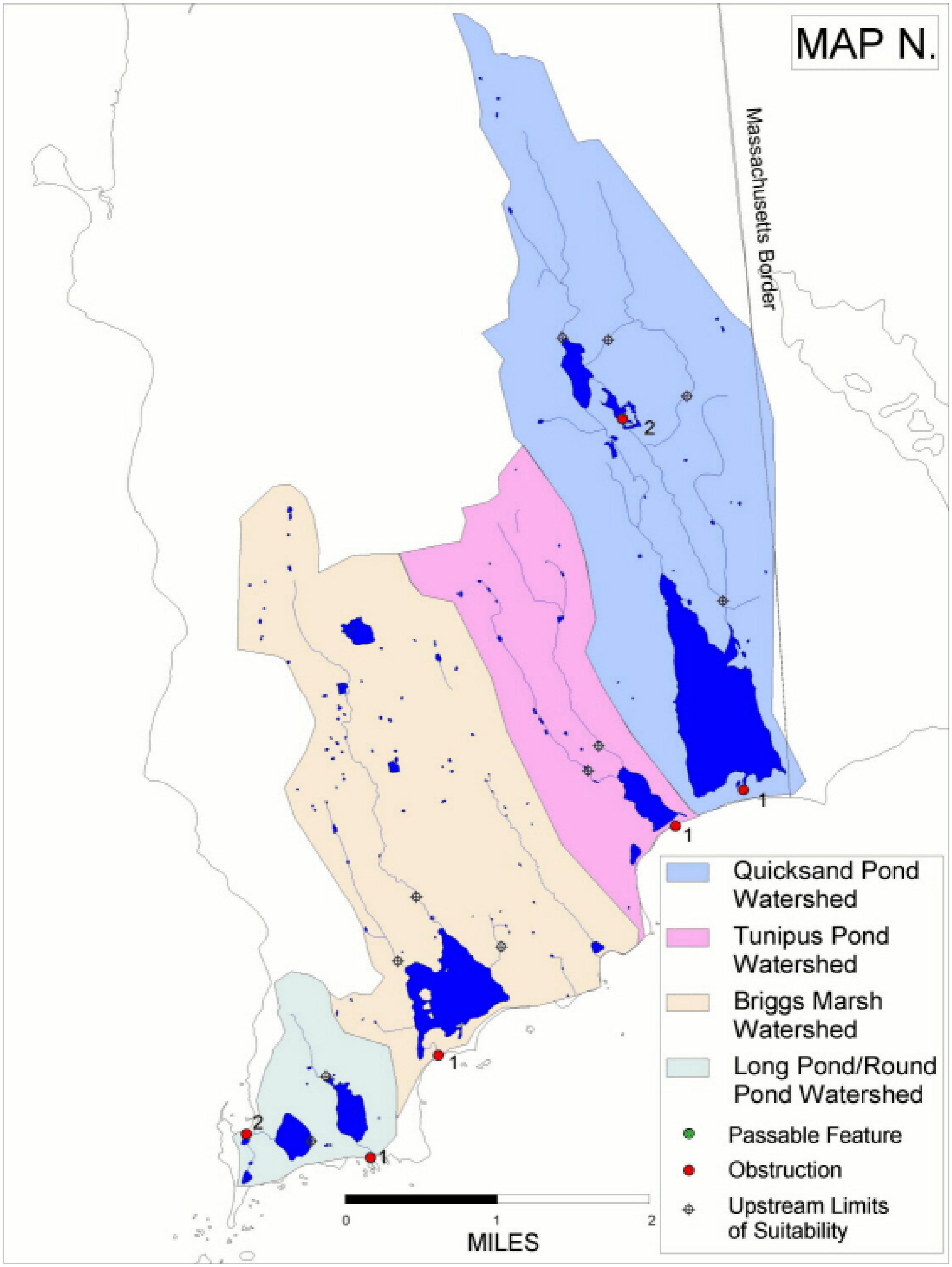
MAP N.
Massachusetts Border
2
1
1
1
2
1
0
1
2
MILES
Quicksand Pond Watershed
Tunipus Pond Watershed
Briggs Marsh Watershed
Long Pond/Round Pond Watershed
Passable Feature
Obstruction
Upstream Limits of Suitability

TABLE 16. FOR MAP N.

SYSTEM NAME	OBSTRUCTION NUMBER	PASSAGE SEQUENCE TO REACH OBSTRUCTION	EXISTING ANADROMOUS POPULATION?	SPECIES SUITABILITY IMMEDIATELY ABOVE OBSTRUCTION	HABITAT SIZE ABOVE OBSTRUCTION (ACRES)	OBSTRUCTION HEIGHT (FEET)	DRAINAGE AREA - MILES^2	RECOMMENDED PASSAGE METHOD	RESTORATION FACTOR (ACRES/FOOT)	RIVER OR STREAM	CITY-TOWN	DAM/OBSTRUCTION NAME	STATE ID NO.	LATITUDE DEGREES	LATITUDE MINUTES	LATITUDE SECONDS	LONGITUDE DEGREES	LONGITUDE MINUTES	LONGITUDE SECONDS	DAM / OBSTRUCTION TYPE
1) QUICKSAND POND WATERSHED	1	1	A/B	A/B/W	405.52		U	MANUAL BREACH TWICE ANNUALLY	N/A	QUICKSAND POND	LITTLE COMPTON	QUICKSAND BARRIER BEACH	N/A	41	29	49	71	7	38	BARRIER BEACH
	2	1-2	NO	A/B/W	28.36	5.5	1.3	STEEPPASS	5.156	COLD BK.	LITTLE COMPTON	SIMMONS POND DAM	474	41	32	12	71	8	48	ROCKFILL,EARTH
2) TUNIPUS POND WATERSHED	1	1	YES	A/B/W	49.59		U	MANUAL BREACH TWICE ANNUALLY	N/A	TUNIPUS POND	LITTLE COMPTON	TUNIPUS BARRIER BEACH	N/A	41	29	43	71	8	3	BARRIER BEACH
3) BRIGGS MARSH WATERSHED	1	1	NO	A/B/W	185.63		U	MANUAL BREACH TWICE ANNUALLY	N/A	BRIGGS MARSH	LITTLE COMPTON	BRIGGS MARSH BARRIER BEACH	N/A	41	28	19	71	10	2	BARRIER BEACH
4) LONG POND/ROUND POND WATERSHED	1	1	NO	A/B/W	45.09		U	MANUAL BREACH TWICE ANNUALLY	N/A	LONG POND	LITTLE COMPTON	LONG POND BARRIER BEACH	N/A	41	27	40	71	10	35	BARRIER BEACH
	2	2	NO	A/B/W	34.47		U	CULVERT OR BREACH	N/A	ROUND POND	LITTLE COMPTON	ROUND POND CULVERT	N/A	41	27	48	71	11	39	CULVERT

A= alewife
B= blueback herring
S= American shad
AS= Atlantic salmon
T= sea-run brook trout
RS= rainbow smelt
W= white perch

U= UNKNOWN

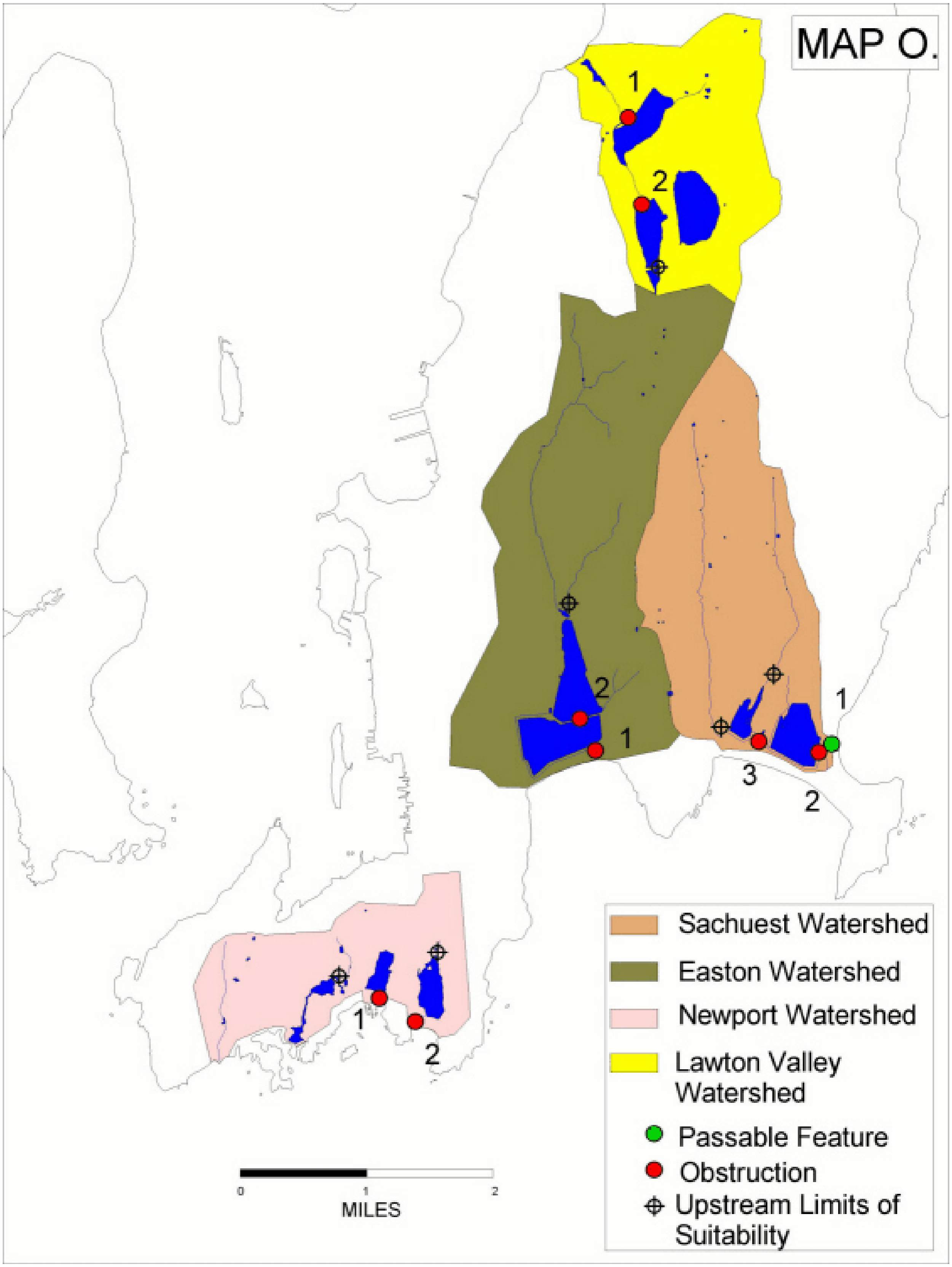
MAP O.
1
2
2
1
1
3
2
1
2
Sachuest Watershed
Easton Watershed
Newport Watershed
Lawton Valley Watershed
Passable Feature
Obstruction
Upstream Limits of Suitability
0
1
2
MILES

TABLE 17. FOR MAP O.

SYSTEM NAME	OBSTRUCTION NUMBER	PASSAGE SEQUENCE TO REACH OBSTRUCTION	EXISTING ANADROMOUS POPULATION?	SPECIES SUITABILITY IMMEDIATELY ABOVE OBSTRUCTION	HABITAT SIZE ABOVE OBSTRUCTION (ACRES)	OBSTRUCTION HEIGHT (FEET)	DRAINAGE AREA - MILES^2	RECOMMENDED PASSAGE METHOD	RESTORATION FACTOR (ACRES/FOOT)	RIVER OR STREAM	CITY-TOWN	DAM/OBSTRUCTION NAME	STATE ID NO.	LATITUDE DEGREES	LATITUDE MINUTES	LATITUDE SECONDS	LONGITUDE DEGREES	LONGITUDE MINUTES	LONGITUDE SECONDS	DAM / OBSTRUCTION TYPE
1) SACHUEST POINT WATERSHED	1	1	NO	A/B/W	N/A	N/A	2.2	SAND REMOVAL/CULVERT MAINTENANCE	N/A	MAIDFORD BROOK	MIDDLETOWN	THIRD BEACH RD. CULVERT	N/A	41	29	24.5	71	14	55	CULVERT
	2	1-2	NO	A/B/W	91.35	17	2.2	STEEPPASS	5.374	MAIDFORD BROOK	MIDDLETOWN	GARDINER POND DAM	583	41	29	25.5	71	15	1.5	ROCKFILL,EARTH
	3	2-3	NO	A/B/W	29.53	15	0.6	STEEPPASS	1.969	PARADISE BK.	MIDDLETOWN	NELSON POND DAM	582	41	29	32	71	15	40	ROCKFILL,EARTH
2) EASTON POND WATERSHED	1	1	NO	A/B/W	132.2	13	3.8	BREACH/CULVERT/STEEPPASS	10.17	BAILEY BROOK	NEWPORT	EASTON POND NORTH DAM	584	41	29	25.5	71	17	13.5	ROCKFILL,EARTH
	2	1-2	NO	A/B/W	109.3	12	3.9	STEEPPASS	9.105	BAILEY BROOK	MIDDLETOWN	EASTON POND SOUTH DAM	585	41	29	37.5	71	17	19	ROCKFILL,EARTH
3) NEWPORT WATERSHED	1	1	NO	A/B/W	132.2	N/A	U	CULVERT/TRENCH	N/A	LILY POND	MIDDLETOWN	CULVERT/EARTH	N/A	41	27	39	71	19	21	N/A
	2	2	NO	A/B/W	28.72	N/A	U	CULVERT/TRENCH	N/A	ALMY POND	NEWPORT	CULVERT/EARTH	N/A	41	27	26.5	71	18	54.5	N/A
4) LAWTON VALLEY WATERSHED	1	1	NO	A/B/W	80.9	33	2.9	STEEPPASS	2.452	LAWTON VALLEY BK.	PORTSMOUTH	LAWTON VALLEY RESERVOIR DAM	395	41	33	54	71	16	48	EARTH,CONCRETE
	2	1-2	NO	A/B/W	61	12	0.4	STEEPPASS	5.083	LAWTON VALLEY BK.	PORTSMOUTH	SISSON POND DAM	580-B	41	33	18	71	16	42	ROCKFILL,EARTH

A= alewife
B= blueback herring
S= American shad
AS= Atlantic salmon
T= sea-run brook trout
RS= rainbow smelt
W= white perch

U= UNKNOWN

TABLE 18. RECOMMENDED FISH PASSAGE SITES FROM VARIOUS WATERSHEDS

SYSTEM NAME	OBSTRUCTION NUMBER	PASSAGE SEQUENCE TO REACH OBSTRUCTION	HABITAT SIZE ABOVE OBSTRUCTION (ACRES)	OBSTRUCTION HEIGHT	RECOMMENDED PASSAGE METHOD	RESTORATION FACTOR (ACRES/FOOT)	DAM / OBSTRUCTION NAME
PAWCATUCK RIVER WATERSHED	13	2-3-8-13	21.82	3	SLOT	7.273	ROUTE 91 GAUGING STA. DAM
	16	2-3-8-13-15-16	4.05	7	DAM REMOVAL	0.579	SHANNOCK MILL POND DAM
	17	2-3-8-13-15-16-17	12.00	16	DENIL/DIVERSION	0.750	HORSESHOE FALLS DAM
	18	2-3-8-13-15-16-17-18	1191.20	7	DENIL	170.171	KENYON MILL POND DAM
	28	2-3-8-13-15-16-17-18-28	73.76	6	DENIL	12.293	GLEN ROCK RESERVOIR DAM
		FOR DAMS 13-16-17-18	1229.07	33		37.245	
		FOR DAMS 13-16-17-18-28	1302.83	39		33.406	
NINIGRET POND WATERSHED	3	3	19.38	5	STEEPPASS/CULVERT	3.876	CROSS MILLS DAM
POINT JUDITH POND WATERSHED	8	2-3-4-8	263.34	4		65.835	INDIAN LAKE DAM
NARROW RIVER	1	1	56.61	8	STEEPPASS	7.076	CARR POND DAM (G. STUART)
ANNAQUATUCKET RIVER WATERSHED	4A	1-2-4A-4	45.43	8	STEEPPASS	5.679	(BELLEVILLE BYPASS)
HUNT/POTOWOMUT RIVER WATERSHED	6	1-3-6	7.92	3	STEEPPASS/SLOT	2.640	AUDUBON DAM
APPONAUG COVE WATERSHED	1	1	57.89	7	STEEPPASS	8.270	GORTON POND DAM
PAWTUXET RIVER WATERSHED	1	1	53.80	3		17.933	PAWTUXET RESERVOIR LOWER DAM
	2	2	34.85	6		5.808	PONTIAC MILL DAM
	3	2-3	38.10	20		1.905	NATICK POND DAM
	11	1-2-3-11	2.33	9		0.259	RIVER POINT POND LOWER DAM
	12	1-2-3-11-12	5.84	20		0.292	RIVER POINT POND UPPER DAM
	13	1-2-3-11-12-13	14.27	26		0.549	ARCTIC DAM
	14	1-2-3-11-12-13-14	10.54	16		0.659	CENTERVILLE POND DAM
	15	1-2-3-11-12-13-14-15	19.45	8		2.431	CROMPTON LOWER DAM
	16	1-2-3-11-12-13-14-15-16	5.07	7.5		0.676	CROMPTON POND/UPPER/DAM
	17	1-2-3-11-12-13-14-15-16-17	1.18	6		0.197	QUIDNICK POND/LOWER/DAM
	18	1-2-3-11-12-13-14-15-16-17-18	2.95	14		0.211	QUIDNICK POND/UPPER/DAM
	19	1-2-3-11-12-13-14-15-16-17-18-19	45.89	14		3.278	ANTHONY MILL POND DAM
	20	1-2-3-11-12-13-14-15-16-17-18-19-20	224.81	7		32.116	TIOGUE LAKE DAM
	21	1-2-3-11-12-13-14-15-16-17-18-19-21	35.54	12		2.962	WASHINGTON POND UPPER DAM
	22	1-2-3-11-12-13-14-15-16-17-18-19-21-22	620.85	9		68.983	FLAT RIVER RESERVOIR DAM
		FOR DAM 1	53.80	3		17.933	
		FOR DAMS 1-2-3-11-12-13-14-15-16-17-18-19-2(	459.08	157		2.933	
		FOR DAMS 1-2-3-11-12-13-14-15-16-17-18-19-21-:	890.66	171		5.224	
TEN MILE RIVER WATERSHED	1	1	44.8	13	DENIL	3.446	OMEGA POND DAM
	2	1-2	4.6	8	BREACH*	0.575	HUNTS MILL POND DAM
	3	1-2-3	265.6	17	DENIL	15.624	TURNER RESERVOIR DAM
		FOR DAMS 1-2-3	315	38		8.289	
RUNNINS RIVER WATERSHED	1	1	9.7	5	SLOT	1.940	STANDARD OIL POND DAM
KICKAMUIT RIVER WATERSHED	1	1	26.59	7	DENIL	3.799	WARREN RESERVOIR LOWER DAM

Appendix E. Glossary of Terms.

alosid	For the purposes of this report, any of the genus *Alosa*, including American shad, alewife, and blueback herring.
anadromous	Fish that begin their juvenile life in freshwater, emigrate to marine waters to complete their adult growth, and migrate back to freshwater to spawn (i.e. shad, salmon).
attraction flow	Moving water allowing migrating adult fish to achieve proper orientation in the water column for upstream passage. Fish passage devices typically provide means of attraction flow to help fish locate the entrance. It's possible to have counterproductive attraction flow which draws migrating fish away from fish passage devices.
baffle	Device used in fishway structures to reduce velocities of flowing water to levels sufficient to allow upstream passage of fish.
broodstock	Adult, sexually mature fish used to produce eggs and milt or in the case of stocking efforts, trapping and transporting adult fish engaged in a spawning migration and relocating them in suitable habitats in another area. Juveniles produced from transplanted broodstock will imprint on the new system, and return as spawning adults.
catadromous	Fish that complete their adult growth in freshwater, but migrate to saltwater to spawn (i.e. American eel).
extirpation	Local extinction of a population.
juvenile	For the purposes of this plan: The freshwater life stage of any anadromous species and is not yet sexually mature.
mesohaline	Moderately brackish water with low range salinities (from 5-18 parts per thousand).
migratory	Movement of anadromous species from one habitat to another on a seasonal basis at a particular life stage..
oligohaline	Moderately brackish water with low range salinities (from .5-5 parts per thousand).

ppt	Parts per thousand (used as a measurement of salinity).
polyhaline	Pertaining to waters with salinities of 18-30 parts per thousand.
salinity	The salt concentration of water, measured in parts per thousand (ppt).
salmonid	From the family Salmonidae. For the purposes of this report, any Atlantic salmon, anadromous brook trout, anadromous brown trout, and wild freshwater populations of brook trout.
smoltification	Physiological changes in juvenile Atlantic salmon allowing survival in saline water.
spawning habitat	Areas with characteristics sufficient to induce adult anadromous species to spawn and conditions suitable for egg survival and incubation.
rearing habitat	Areas sufficient to provide juvenile anadromous species with conditions necessary to survive downstream migratory life stage.
watershed	Zone defined at the periphery by topography or physical barriers that cause surface water and ground water to drain to a particular body of water.

SPORT FISH RESTORATION

WILDLIFE RESTORATION