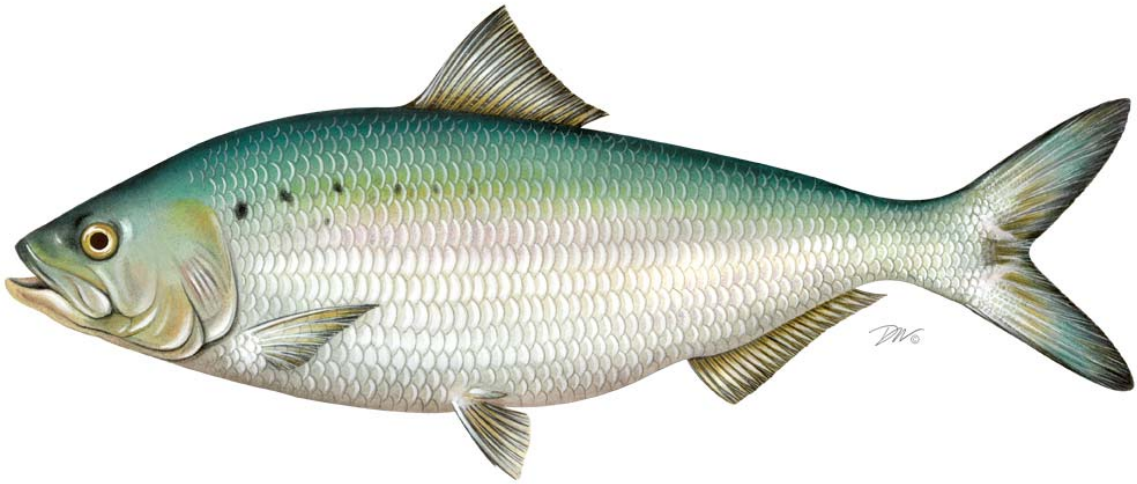
Connecticut Department of Energy and Environmental Protection
Inland Fisheries & Marine Fisheries Divisions

American Shad Habitat Plan



Submitted to the Atlantic States Marine Fisheries Commission as a requirement of Amendment 3 to the Interstate Management Plan for Shad and River Herring

Approved February 6, 2014

American Shad Habitat Plan

STATE OF CONNECTICUT

Connecticut Dept. Energy and Environmental Protection
Inland Fisheries Division
Marine Fisheries Division
Old Lyme, CT

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Introduction

The Atlantic States Marine Fisheries Commission (ASMFC) has a Fishery Management Plan for American shad and river herring and in February of 2010 adopted Amendment 3 to this plan. It requires all states so submit a Habitat Plan for American shad in their state. This document is that plan for Connecticut. It has three sections: (1) habitat assessment, (2) threats assessment, and (3) habitat restoration program. The report covers 16 rivers in Connecticut that are known to have supported American shad runs. It is possible that some additional smaller rivers may have supported small historic runs of American shad but for these rivers, historical documentation is lacking and present-day restoration opportunities are very limited. The list of the 16 rivers covered by this report is shown in Table 1.

Fisheries management in Connecticut is conducted by two divisions within the umbrella agency of the Department of Energy and Environmental Protection (CTDEEP). These are the Marine Fisheries Division and the Inland Fisheries Division. Both divisions have some responsibilities for managing anadromous fish populations. This document is a collaboration of the two divisions. For simplicity, the activities referred herein will be attributed to the CTDEEP, even though some are conducted by the Marine Fisheries Division, some by the Inland Fisheries Division, and some by non-fisheries-related divisions (e.g. divisions that regulate water quality).

Habitat Assessment

Objective: Assess the habitat (historic and currently available) and impediments to full utilization of the habitat.

Various sources of information including historical accounts, watershed management plans, maps, present-day fish survey data, and staff knowledge of the rivers and features (e.g. falls, dams, human infrastructure) were reviewed to identify downstream and upstream endpoints to historic and present-day shad runs and spawning and nursery habitat. The length of these

stream reaches were measured using GIS. Habitat categories were assigned broadly without any effort to identify and quantify small river stretches (e.g. 300 m plots). Moreover, there can be considerable overlap with shad spawning and rearing habitat but such overlap was not considered. All river stretches were categorized as either spawning or rearing habitat.

It is relatively easy to determine the geographic extent of historical shad runs in Connecticut rivers due to our knowledge of natural waterfalls that would have blocked runs or abrupt changes in river gradient or habitat that would not have supported shad runs. However, it can be difficult to speculate what kind of habitat (i.e. spawning, rearing, or neither) existed in some river stretches that are now inundated by the headponds of dams. Most of these impounded river stretches are currently categorized as rearing habitat and for the sake of simplicity, these stretches were categorized as historic rearing habitat also. This might not be historically accurate. However, since most of the large dams are not likely to be removed, when shad runs are reconnected to their historic range, these impounded reaches will provide rearing habitat to the species and therefore the actual historic status of the habitat is irrelevant in a present-day context.

The results of these calculations are summarized in Table 2 for all 16 rivers. Historically, American shad had access to 642 km of riverine habitat in Connecticut. Currently, the species has access to 350 km. For spawning habitat, the historical habitat is estimated to have included 268 km while currently there are 125 km. For rearing habitat, the historical habitat is estimated to have included 311 km while currently there are 163 km.

Threats Assessment

Objective: Inventory and assess the critical threats to habitat quality, quantity, access, and utilization.

a. Barriers to migration- Dams and other structures are known to block shad migrations and limit the amount of accessible habitat. There are over 4,000 dams in Connecticut and there are dams built on all of the historic shad runs have dams. In order to restore shad runs, the fish must be able to get past these dams. It is the policy of the CTDEEP that dam removal is the most effective means to accomplish this. Shad are notoriously difficult to pass up fishways and when a dam is removed, the need for a fishway is avoided. Furthermore, dam removal restores historic habitat. Even with functional fishways, threats to shad remain. First, there are inevitable migratory delays associated with fishways: finding it, ascending it, resting after ascending it, and interruptions caused by debris in the fishway or flow rates above or below the prescribed range of flows for the fishway design. With rivers with multiple dams, delays can be additive, resulting in weeks of lost migratory time. Delays can limit the extent of upstream

migration, resulting in reduction of spawning in key upstream habitat. Some fishways injure migrants that result in pre-spawning mortality. There are significant threats to shad during the downstream migration. Spent adults may not be able to find or use downstream passageways, resulting in death and reduction of the repeat spawning rate for the population. Fish that use the spillway may suffer injury going over the spillway and may die.

The CTDEEP has an extensive inventory of dams in Connecticut. The agency has worked with The Nature Conservancy and the Northeast Association of Fish and Wildlife Administrators on the Northeast Aquatic Connectivity Project to analyze these dams for their impact on connectivity to anadromous fish habitat. These databases are beyond the scope of this document and are not included herein but they were assessed to document their potential impact on shad runs. The results of that assessment is a list of dams that block shad runs and impact CTDEEP plans to restore shad runs found in Table 3.

It is recognized that things other than dams can create migratory barriers to shad and ASMFC has requested an inventory of all such barriers. Culverts are a concern for fragmenting habitat for anadromous fish. However, impassable culverts are more common in headwater streams and smaller rivers, upstream of the range of American shad, which tends to stay in larger rivers. There are no impassable culverts in Connecticut that block shad migrations, either currently or along migratory corridors expected to be reconnected in the coming years. Therefore, no inventory is provided. River stretches containing degraded water quality can also be barriers to shad migrations. Such degradation can include low dissolved oxygen, low flow rates, or plumes of toxic or heated effluent. Each shad river was reviewed for the presence of such water quality barriers and none of significance was found. Therefore, no inventory is provided.

b. Impingment/entrainment at dams- This threat is related to the previously listed threat: dams. In addition to creating delays to the downstream migration or the existence of an ecological trap from which fish cannot escape, downstream migrants may be drawn into industrial intakes or impinged upon and killed. The most common is the turbine intake for hydroelectric projects. Most turbines will kill most adult shad that pass through. Turbine mortality of young-of-year shad is highly variable but potentially significant. Other intakes include pumped storage projects, irrigation, cooling water systems, and drinking water intakes. If fish are drawn into these intakes, mortality can be significant.

c. Water withdrawals- In addition to potentially killing migrants by mechanically damaging the fish or drawing them into industrial filters and processes, water withdrawals can also impact the habitat by reducing the available stream flow in the river. Withdrawals from a large river like the Connecticut are typically minor with low impacts. Withdrawals from small to medium sized rivers (e.g. Quinnipiac River) can be substantial and may drastically reduce the available

water during the summer rearing period. Water reduction can also result in the warming of the river water, as well.

d. Climate change- Climate change will result in changes to the ecosystems of Connecticut but severe impacts are not anticipated for the American shad populations. There are many existing shad runs south of Connecticut where water temperatures are warmer so there appears not to be an obvious threat from increasing temperature. However, the rate of post-spawning mortality and subsequently repeat spawning rate (iteroparity) is known to have a clinal trend and may be related to water temperature in the rivers. Therefore, as the water temperature in Connecticut rivers increase, a reduction in the rate of repeat spawning is a possibility. That could result in an altered population structure, reduction in total annual egg deposition, and subsequent decline in run size.

e. Threats not highlighted- There are many other threats that are on a list from ASMFC as potential threats to American shad. We will briefly review some of these and explain why they are not included in the list above.

Toxic and thermal discharges- None of the stream sections identified as critical shad habitat suffer from toxic discharges. Such discharges are carefully regulated by the CTDEEP. Both the Connecticut and Quinebaug rivers receive thermal discharges but past research on the Connecticut has shown these to have no impact on the shad run and previous assessments of the discharges in the Quinebaug River have concluded that they will also not impact shad.

Channelization- Channelization, stream straightening, burying sections of streams, and other projects that alter the morphology of streams are rarely proposed in Connecticut anymore and such activities are strictly regulated. The Inland Fisheries Division has ample opportunity to comment on permit applications and would recommend denial of any permits that would impact American shad habitat.

Competition and predation by invasive and managed species- There are many non-native fish species in Connecticut, including non-native predators in the Connecticut River where there is a strong sustained shad run. While these species may cause some diminishment in numbers of shad, it does not appear to be significant in light of the other listed threats and the opportunity to extirpate these non-native species is extremely limited.

Habitat Restoration Program

Objective: For threats deemed to be of critical importance to the restoration of American shad, each state should develop a program of actions to improve, enhance, and /or restore habitat quality and quantity, habitat access, habitat utilization and migration pathways.

Narrative: The CTDEEP is aggressively pursuing the restoration of shad runs in a number of Connecticut streams. The Connecticut River is the best known shad river in the state and hosts one of the largest and most stable American shad runs on the East Coast. It supports both recreational and commercial fisheries for shad. The CTDEEP has submitted and the ASMFC has accepted a Sustainability Plan for this population. There are no barrier dams on the Connecticut River in Connecticut, the water quality is quite good, and the harvest is sustainable. The opportunity to expand this population exists in upstream states with improvements to upstream and downstream fish passage at three mainstem dams and some tributary dams. CTDEEP is engaged in this effort through its participation on the Connecticut River Atlantic Salmon Commission, a multi-state/federal partnership that manages restoration and enhancement of diadromous species in the Connecticut River basin. The CTDEEP is also actively working to restore shad runs to three Connecticut River tributaries within Connecticut: the Farmington, Mattabessett, and Scantic rivers. These rivers are reported in this document separate from the Connecticut River.

In addition to the Connecticut River, the CTDEEP seeks to restore and enhance runs of American shad in a number of other rivers that flow into Long Island Sound. Each of these rivers is reported in this document. The CTDEEP has not submitted a sustainability plan for any of these other rivers and has initiated a process to close all harvest of shad in all of these other rivers until which time the population has grown to the level where a sustainability plan can be developed. In all cases, the impediment to full utilization of historic habitat is the presence of barrier dams. Improvements to water quality in Connecticut streams have progressed in the past 30 years to the point where it is not an impediment to restoring American shad runs. It is accurate to state that some streams could benefit from further improvement of water quality and such improvements could increase survival of young-of-year shad. However, our assessment concludes that such reduced water quality is not a significant obstacle to shad in re-colonizing historic habitat. Connecticut is a heavily dammed state with over 4,000 dams within its borders—the exact number is unknown. These dams were the major factor of the demise of all diadromous fish runs in the state and remain the most significant challenge in restoring these runs. Some runs of American shad have been totally eliminated or reduced to a very few fish so that some re-introduction of the species is necessary. The text that follows describes the main features of the agency's plan to protect and reconnect habitat for shad in Connecticut. The geographic scope of Connecticut's American shad restoration efforts is summarized in Table 4, which lists the rivers, the targeted habitat and quantifies projected spawning and nursery habitat by river. Currently, shad have access to 360 miles of habitat. The CTDEEP plan for restoration seeks to reconnect habitat and increase that to 610 miles of habitat. The amount of historic habitat is estimated to have been 640 miles.

a. Barrier removal and fish passage program- Migratory barriers are the most important threat to American shad runs in Connecticut. The CTDEEP has an aggressive fish passage program that seeks to either remove a dam or build a fishway around it. The first choice is always to remove the dam. American shad are notorious for not using fishways very well, particularly at dam higher than 25 feet. The removal of a dam precludes the need for a fishway. It also eliminates problems with downstream passage. Furthermore, it restores native habitat (perhaps historic spawning habitat long since inundated) and reduces impoundments that often favor non-native predators. However, many dams cannot be removed for a variety of reasons, most notably because they are still valued (e.g. hydroelectric projects). For these dams, the CTDEEP seeks the provision of fishways, either through a voluntary process or through regulatory processes. The CTDEEP is acutely engaged in all licensing and re-licensing procedures for hydroelectric projects in Connecticut by the Federal Energy Regulatory Commission (FERC). The CTDEEP works very closely with the U.S. Fish & Wildlife Service in these procedures. In addition, the State of Connecticut has well-used statues that authorize the CTDEEP to require a fishway at dams not regulated by FERC. However, most fish passage projects in Connecticut are not pursued through any regulatory process but instead follow a voluntary process. The CTDEEP works with many municipalities and non-governmental organizations (NGOs) like watershed groups, land trusts, fishing clubs, and larger conservation organizations in a coordinated regional approach in which the NGO sponsors the project, crafts all the necessary agreements, applies for grants to pay for design and construction, and oversees the construction while the CTDEEP provides continuous technical oversight. In a typical year, two or three fish passage projects are implemented in Connecticut and many of them benefit American shad.

b. Impingment/entrainment at dams- This problem is also addressed through the regulatory process. The most common source of this threat comes from hydroelectric projects and lack of suitable downstream passage. The CTDEEP works with the U.S. Fish & Wildlife Service and FERC, and licensees to ensure the best state-of-the-art downstream fishway facilities are installed at hydroelectric dams. Intakes for other industrial uses are assessed during the permitting process and the CTDEEP dictates the design and operation of these intakes to minimize impact on American shad.

c. Water withdrawals- All water withdrawals from Connecticut streams of significant size must be permitted by the CTDEEP. The two fisheries divisions routinely comment on permit applications and judge such applications on their potential impact on diadromous fish runs, including American shad. Connecticut has just passed new streamflow regulations that will tighten the regulation of water withdrawals. In some cases, an assessment of the proposed withdrawal is conducted. An old canal system off the Connecticut River was recently converted to a co-generation plant and there were concerns that some young-of-year shad were being both drawn into the cooling system and trapped in the terminal end of the canal. An analysis

showed that the numbers of lost young-of-the-year shad equated to less than 10 adult shad back to the river in subsequent years. In a run that numbers between 300,000 and 1,000,000, this level of loss was deemed to be too insignificant to require engineering solutions. Similar analyses are performed for other withdrawals and if the losses are potentially harmful to the run, engineering or operational solutions are required. In the Quinnipiac River, existing water withdrawals have begun to impact the minimum flow levels during the summer rearing period. The CTDEEP has taken steps to eliminate some withdrawals and limit future withdrawals to protect fish habitat.

d. Climate change- Climate change is a larger problem than can be effectively addressed by fisheries management agencies. However, the CTDEEP was recently transformed into an energy agency (Department of Environmental Protection to the Department of Energy and Environmental Protection) and part of its mission it to guide the state into a more environmentally-responsive approach to generating and using energy. However, the main impact of climate change to American shad runs has been identified as increased water temperature possibly reducing the rate of repeat spawning in the state, impacting the stock's population structure and resiliency. Although this impact cannot be entirely avoided if the streams in the state experience temperature increases, the actions taken under items (a), (b) and (c) will mitigate to some extent this impact. By increasing survival at dams and reducing migratory delays, we will counteract the trend being imposed by climate change.

e. Adult Shad Transplantation program- Some runs have been extirpated but fish passage projects have now or will soon re-connect critical shad habitat to Long Island Sound. This represents an opportunity to restore a shad run. Once 'opened', a stream may receive stray shad from the Connecticut River, which will then slowly re-colonize the river. However, the pace of such a re-colonization may proceed at a socially-unacceptably slow rate. To accelerate the pace of restoration, the stream must be 're-seeded'. This has been done via hatchery rearing and stocking in other states. The CTDEEP does not endorse this approach for its streams. Hatcheries are expensive to operate and may introduce undesirable genetic and phenotypic traits. Due to the strong run size of shad to the Connecticut River and the presence of modern, efficient trapping facilities at the first dam at Holyoke, MA, the CTDEEP has implemented an active transplantation program in which pre-spawned adults from the Connecticut River are collected at the Holyoke Dam Fishlift, placed in a specially-designed transport tank truck, and driven to the restoration rivers where they are released into suitable habitat, typically upstream of dams that either have a fishway or is expected to have a fishway in the near future. Assessments of this technique have always shown that young-of-year American shad are found in the receiving habitat, attesting to the efficacy of the method. Based upon the genetic data available as well as the fact that some of these streams are currently devoid of any remnant native run of shad, it is believed that such a program does not

have negative impacts on native shad stocks. The Connecticut River provides most of the donor fish but the Shetucket River run has grown to a sufficient size and there are suitable trapping facilities at the first dam on that river (Greeneville Dam) so that currently all shad that are transplanted into the Shetucket-Quinebaug river basin originate from the Shetucket River. The amount of fish transplanted into each river varies from year-to-year but typically ranges between 80 and 200 adult shad per river. The CTDEEP conducts all of these transplantation activities except for some transplantation in the Shetucket River that is conducted by the City of Norwich, Department of Public Utilities, which operates two hydroelectric projects with fishways. They transplant some shad using their own truck under the guidance of the CTDEEP. A list of rivers with active transplantation programs is shown in Table 5.

f. Habitat Improvement program- The Inland Fisheries Division includes a Habitat Conservation and Enhancement program that seeks to protect and restore fish habitat statewide. This includes staff assigned to review permit applications for marine activities, such as dredging, dock construction, etc. This program has close ties to the Diadromous Fish Program and routinely reviews permit applications with the impacts to American shad in mind. Not only are conditions placed in permits to avoid or reduce any impacts to American shad habitat and runs but sometimes habitat can be improved beyond its current condition due to mitigation agreements. Staff also proactively works on restoration projects to improve habitat for American shad, often with municipalities and NGOs. Once example is the Moosup River Project in which six migratory barriers to American shad will be addressed in this former shad river. This project is funded through a mitigation fund provided by an upstream power plant and is supported by a partnership between the CTDEEP, three federal agencies, a municipality and an NGO.

Table 1. List of rivers in Connecticut known to have supported historical runs of American shad.

	Name of stream*	**Name of present-day Connecticut town(s) at mouth of river**
1	Housatonic River	Stratford & Milford
2	Naugatuck River	Derby
3	Pomperaug River	Southbury
4	Shepaug River	Southbury and Bridgewater
5	Quinnipiac River	New Haven
6	Hammonassett River	Madison & Clinton
7	Connecticut River	Old Saybrook & Old Lyme
8	Mattabesset River	Middletown & Cromwell
9	Farmington River	Windsor
10	Pequabuck River	Farmington
11	Scantic River	East Windsor
12	Shetucket River	Norwich
13	Willimantic River	Windham
14	Natchaug River	Windham
15	Quinebaug River	Preston
16	Moosup River	Plainville

*left justified streams flow into Long Island Sound; indented streams are tributaries of the left justified stream listed above

Table 2. Assessment of historic and current habitat for American shad in Connecticut.

	Historic			Present day			total kilometers of habitat by type					
							spawning		rearing-estuarine**		rearing- in-river	
River*	upstream end point	Town	Total km	Upstream end point	Town	Total km	historic^	current	historic	current	historic^	current
Housatonic	Great Falls	New Milford	46.9	Derby Dam	Shelton	21.1	21.7	1.4	19.4	19.4	21.6	0.9
Naugatuck	jct of E & W branches	Torrington	63.7	Tingue Dam	Seymour	9.7	24.3	3.5	0	0	19.6	6.2
Pomperaug	confluence w/Nonewaug R.	Woodbury	26.3	no run to mouth	n.a.	0	9.2	0	0	0	17	0
Shepaug	Roxbury Falls	Roxbury	6.4	no run to mouth	n.a.	0	1	0	0	0	5.4	0
Quinnipiac	Interstate 84	Southington	47.8	Carpenters Dam	Cheshire	37	14.2	8.8	10.9	10.9	22.7	17.3
Hammonassett	CT Route 80	Madison	18.1	Old Papermill Dam	Madison	12.8	5.6	1.6	6.5	6.5	6	4.7
Connecticut	MA state line	Enfield	108	MA state line	Enfield	108	32.3	32.3	24.3	24.3	51.4	51.4
Mattabesset	CT Route 71	Berlin	36.3	Kensington Dam	Berlin	36.3	15.65	15.65	0	0	20.65	20.65
Farmington	MA state line	Colebrook	94.1	Lower Collinsville Dam	Avon	60.3	59.7	29.8	0	0	33.4	29
Pequabuck	Dutton Ave. Bridge	Bristol	15.9	Middle Street Dam	Bristol	12.4	4.9	3.1	0	0	11	9.3
Scantic	MA state line	Somers	34.8	Springborn Dam	Enfield	22.4	14.75	11.2	0	0	21.95	11.2
Shetucket	Willi-Natchaug conf.	Windham	28	Scotland Dam	Windham	17.9	12.9	8.2	24.1	24.1	15.6	10.2
Willimantic	source	Staffford Springs	37.7	no run to mouth	n.a.	0	20.8	0	0	0	18.1	0
Natchaug	falls at Mansfield Hollow	Mansfield	5.8	no run to mouth	n.a.	0	2.5	0	0	0	3.3	0
Quinebaug	Cargill Falls	Putnam	57.5	Aspinook Dam	Griswold	11.9	21.2	9.8	0	9	36.3	2.1
Moosup	confluence w/Quanduck Bk	Sterling	14.5	no run to mouth	n.a.	0	7	0	0	0	7.5	0
totals			641.8			349.8	267.7	125.35	85.2	94.2	311.5	162.95

*left justified streams flow into Long Island Sound; indented streams are tributaries of the left justified stream listed above

**estuarine habitat is only listed for the river in which it is located even though runs in upstream tributaries (e.g. the Naugatuck) may benefit from such habitat. However, estuarine habitat within the Thames River (all estuary) are included under the Shetucket River, its main freshwater tributary.

^ "historic" habitat refers to existing habitat within the historic range. For example, historically a 5 mile stretch may have included free-flowing habitat that might have included spawning habitat but now that habitat is inundated by a dam which is unlikely to be removed and that habitat is now classified as rearing. When shad are reconnected to this habitat in the future, it will be in the historic range but will now be considered rearing habitat not spawning habitat. In any case, it is hard to categorize what kind of habitat existed historically under a dam's present-day impoundment.

Table 3. An inventory of key dams that block existing or planned runs of American shad in Connecticut.

River	dam*	purpose	current fish passage	plan for future fish passage	comments
Housatonic	Derby	hydroelectric	none	fishway	under design, currently
	Stevenson	hydroelectric	none	fishlift	FERC required timetable
	Shepaug	hydroelectric	none	fishlift	FERC required timetable
Naugatuck	Kinneytown	hydroelectric	Denil	continued monitoring	passes shad currently
	Tingue	none	none	fish bypass channel	under construction, currently
	Plume-Atwood	none	none	removal	near top of targeted watershed
Pomperaug	Trap Factory	none	none	removal	owner considering hydro
Quinnipiac	Wallace	industrial water	Denil	continued monitoring	passes shad currently
	Hanover Pond	town park	Denil	continued monitoring	may pass shad currently
	Carpenters	none	none	removal	project under development
	Clark Brothers	none	none	removal	project under development
Hammonassett	Old Papermill	none	partial barrier?	removal	dam is breached
Connecticut	Enfield	none	full passage w/o fishway	none	dam was naturally breached
Mattabesset	StanChem	fire protection	Denil	continued monitoring	passes shad currently
Farmington	Rainbow	hydroelectric	vertical slot	fish lift	fishway performs poorly; fishlift under design
	Spoonville	none	full passage w/o fishway	none	dam removed in 2012
	Winchell-Smith	none	partial barrier?	removal or fishway	project under development
	Lower Collinsville	future hydro	none	Denil	part of FERC licensing
	Upper Collinsville	future hydro	none	Denil	part of FERC licensing
Pequabuck	Middle Street	none	none	removal	awaiting full funding, aka Bristol Brass
Scantic	Springborn	none	none	removal	under design
	Somersville	none	none	Denil	after Springborn is removed; state-owned

Table 3
(continued)

Shetucket	Greeneville	hydroelectric	fishlift	continued monitoring	passes shad currently
	Taftville	hydroelectric	Denil	continued monitoring	passes shad currently
	Occum	hydroelectric	Denil	continued monitoring	passes shad currently
	Scotland	hydroelectric	none	fish lift	undergoing relicensing
Willimantic	4 willimantic dams	hydroelectric	none	none	will consider restoring if other parties remove dams
Natchaug	Willimantic Water Works	water supply	none	none	restoration plans end at base of dam
Quinebaug	Tunnel	hydroelectric	fishlift	continued monitoring	passes shad currently
	Aspinook	hydroelectric	none	Denil	will press during future relicensing
	Rajak	hydroelectric	none	uncertain	will press during future relicensing
	Rogers	uncertain	none	uncertain	will investigate after Rajak
Moosup	Lower Kaman	none	none	removal	project underway
	Upper Kaman	none	none	removal	project underway
	Griswold Rubber	comic relief	none	removal	project underway
	Brunswick #1	none	none	removal	project underway
	Brunswick #2	none	none	Denil	future hydro development?

Table 4. Summary of plans to restore and enhance runs of American shad in Connecticut with quantification of habitat types.

	Existing			Targeted for Restoration			total kilometers of habitat by type			
							spawning		rearing- in-river	
River*	Upstream end point	Town	Total km	upstream end point	Town	Total km	current	targeted	current	targeted
Housatonic	Derby Dam	Shelton	21.1	Bulls Bridge Dam	New Milford	68.5	1.4	33.4	0.9	25.1
Naugatuck	Tingue Dam	Seymour	9.7	Thomaston F.C.D.	Thomaston	49.1	3.5	24.3	6.2	19.6
Pomperaug	no run to mouth	n.a.	0	mouth of Nonewaug	Woodbury	26.3	0	9.2	0	17
Shepaug	no run to mouth	n.a.	0	Roxbury Falls	Roxbury	6.4	0	5.4	0	6.15
Quinnipiac	Carpenters Dam	Cheshire	37	Plantsville	Southington	47.8	8.8	14.2	17.3	22.7
Hammonassett	Old Papermill Dam	Madison	12.8	CT Rt. 80	N. Madison	18.1	1.6	5.6	1.7	6
Connecticut	state line	Enfield	108	state line	Enfield	108	32.3	32.3	51.4	51.4
Mattabesset	Kensington Dam	Berlin	36.3	Kensington Dam	Berlin	36.3	15.65	15.65	20.65	20.65
Farmington	Lower Collinsville Dam	Avon	60.3	Colebrook Dam	Hartland	94.1	29.8	59.7	29	33.4
Pequabuck	Middle Street Dam	Bristol	12.4	Dutton St.	Bristol	15.9	3.1	4.9	9.3	11
Scantic	Springborn Dam	Enfield	22.4	MA state line	Somers	34.8	11.2	14.75	11.2	21.95
Shetucket	Scotland Dam	Windham	28	Willi-Natchaug conf.	Windham	28	8.2	12.9	10.2	15.6
Willimantic	no run to mouth	n.a.	0	first dam	Windham	1.2	0	1.2	0	0
Natchaug	no run to mouth	n.a.	0	Willimantic Reservoir	Windham	3.4	0	1.5	0	1.9
Quinebaug	Aspinook Dam	Griswold	11.9	Cargill Falls	Putnam	57.5	9.8	21.2	2.1	36.3
Moosup	no run to mouth	n.a.	0	confluence w/Quanduck Bk	Sterling	14.5	0	7	0	7.5
totals			359.9			609.9	125.35	263.2	160	296.25

*left justified streams flow into Long Island Sound; indented streams are tributaries of the left justified stream listed above

Table 5. Connecticut rivers that receive transplanted American shad as part of the restoration effort.

River	Source of fish	Comments
Naugatuck	Connecticut River	Released above two dams
Quinnipiac	Connecticut River	Released above two dams
Mattabessett	Connecticut River	To begin in 2014
Farmington	Connecticut River	Released above Rainbow Dam
Scantic	Connecticut River	Not yet implemented
Shetucket	Shetucket River	Fish from Greeneville Dam
Quinebaug	Shetucket River	Fish from Greeneville Dam
Moosup	Shetucket River	Not yet implemented

Figure 1. Map of existing runs of American shad, Connecticut. Numbers correspond to the numbers next to river names in Table 1. Solid red lines represent the extent of existing runs (including those extended by fishways) and dashed lines represent river stretches targeted for future restoration.