American Shad

Alosa sapidissima

Federal Listing	
State Listing	SC
Global Rank	
State Rank	S3
Regional Status	V. High

Photo by NHFG

Justification (Reason for Concern in NH)

American shad still run up the rivers of the east coast, but abundance levels are significantly reduced when compared to early colonial times. While over fishing likely impacted abundance levels, dam construction blocked access to spawning areas and decimated the abundant runs of shad and other migratory fish (Limburg and Waldman 2009). Prior to a dam constructed on the Connecticut River at Turners Falls in 1798, American shad reached Bellows Falls and the Ashuelot River in great numbers. The Essex dam, in Lawrence, Massachusetts, built on the Merrimack River in 1847, extirpated the Atlantic salmon population and crippled the American shad run. American shad are among the fish managed by the Atlantic States Marine Fisheries Commission (ASMFC). The Fisheries Management Plan for Shad and River Herring states that by 1993, commercial landings of American shad were estimated at 1.5 million pounds, down from 50 million pounds landed in the early 1900's (ASMFC 2010). A coastwide American shad stock assessment, conducted in 2007, found that shad populations are currently at an all-time low and do not appear to be recovering (ASMFC 2007).

Distribution

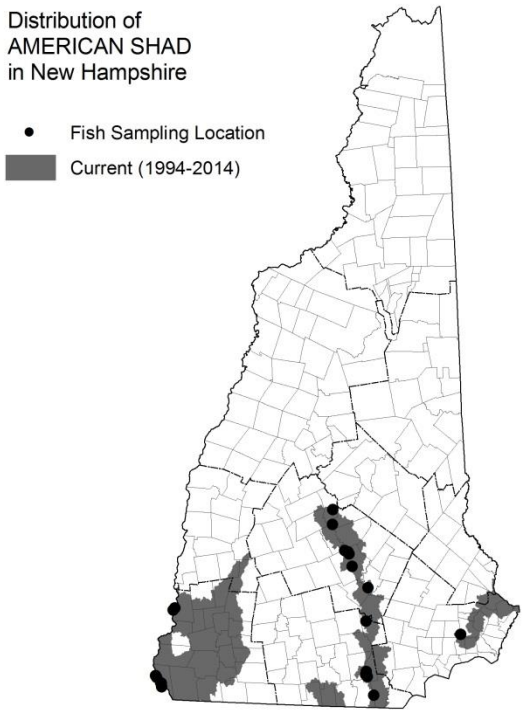
American shad spawn in rivers from Florida to Newfoundland, though they are most abundant from Connecticut to North Carolina. In New Hampshire, the largest historic populations spawned in the Connecticut and Merrimack Rivers. The distribution of historical shad spawning areas in New Hampshire coastal rivers is not well documented.

Habitat

American shad are anadromous fish that spawn in moderate to large freshwater rivers along the Atlantic coast. Spawning occurs between 12-200C and flows of 10-132 cm2/sec. The nonadhesive eggs drift in the current until they hatch. Dissolved oxygen levels below 5 mg/l are detrimental to shad at all life stages. In the ocean, shad prefer temperatures between 7-130C and migrate to deeper water during winter. During summer and fall, adult shad congregate in the Gulf of Maine and the Bay of Fundy (Bigelow and Schroeder 1953). Juvenile shad will remain in freshwater habitats until they descend to saltwater in the fall.

NH Wildlife Action Plan Habitats

- Large Warmwater Rivers
- Marine
- Estuarine



Distribution Map

Current Species and Habitat Condition in New Hampshire

Connecticut River:
The Connecticut River shad population has increased in recent years, but it is still below restoration targets. The Fisheries Management Plan for American Shad in the Connecticut River sets a restoration target of between 1.5 and 2 million shad returning to the mouth of the Connecticut River each year (CRASC 1992). It also establishes a fish passage efficiency target of 40 - 60% passage at each upstream fishway (5 year running average). These targets allow for a wide range of variability in annual return numbers. At the lower end of the range (1,500,000 at the river mouth and 40% passage at each upstream fishway) the target translates into a minimum passage number of 600,000 shad at the Holyoke Dam, 240,000 shad at the Turners Falls Dam, and 96,000 shad at the Vernon Dam. The shad count at the Holyoke Dam has only exceeded 600,000 once, with 720,000 shad recorded in 1992.

The Turners Falls Dam and the Vernon Dam have a large influence on the number of shad that are able to reach their historic range in New Hampshire. Passage efficiency has been historically poor at these dams, although there have been some recent improvements. Since 2004, the number of shad counted at the Turners Falls Dam has averaged only 5% of the number of shad counted at Holyoke, with a high of 11% in 2014. At Vernon, passage efficiency averaged 8% until 2012, when some repairs at the fishway increased passage efficiency to 40%. Passage efficiency at the Vernon Dam over the last three years has been within restoration target levels (40%, 51%, and 69% respectively). With the Vernon Dam Fishway functioning relatively well, the poor passage efficiency at the Turners Falls Dam is the main limiting factor on the number of shad that reach the upper Connecticut River.

Merrimack River:

The Merrimack River shad population averages 23,529 adult returns per year, based on counts at the Essex Dam fishway in Lawrence, MA between 1983 and 2014. The greatest number of shad counted at the Essex Dam fishway was 76,717 in 2001. Historically, the Merrimack River shad population likely numbered over a million returns per year. The shad population remains well below its potential in the Merrimack River. Restoration targets for shad passage set in the Shad Restoration Plan for the Merrimack River (MRTC 2010) call for shad counts of over 740,000 fish at the Essex Dam and 650,000 fish at the next upstream dam in Lowell (The Pawtucket Dam). These are ambitious restoration targets, but they are based on the large amount of suitable shad spawning habitat in the upper Merrimack River watershed. Shad numbers to the upper Merrimack River in New Hampshire are currently limited by poor fish passage efficiency at the Pawtucket Dam in Lowell. Shad counts at in Lowell average about 10% of counts at the Essex Dam (Sprankle 2005). Despite above average shad returns in recent years, the total number of fish counted at Lowell has not exceeded 10,000 in over 10 years. Shad are rarely observed at the Amoskeag Dam fishway in Manchester.

Coastal Rivers:

Shad are occasionally observed in coastal river fish ladders, but spawning populations have been virtually extirpated from the watersheds that drain into Great Bay. Anecdotal observations of shad have also been reported in the Salmon Falls River, but the fishway on this river is in Maine and is not monitored regularly by NHFG staff.

Population Management Status

Connecticut River

Up to 750 shad are trucked each spring to the Ashuelot River (a tributary of the Connecticut River in New Hampshire) to help restore the shad migration in the upper Connecticut River.

Merrimack River

Each spring the NHFG trucks shad from the Essex Dam fishway to inaccessible spawning habitat in the upper Merrimack River watershed. The Merrimack River Shad Restoration Plan calls for a target of 5,000 shad to be transferred annually. Currently, shad transfers typically range between 1,000 and 2,000 fish per year.

Adult shad are captured at the Essex Dam fishway and transported to the Nashua National Fish Hatchery, where they spawn in circular tanks. The resulting shad fry are then stocked to support shad restoration efforts in the Merrimack and other rivers. Typical shad fry numbers stocked into the Merrimack River have ranged between 1 million and 6 million per year since the project was initiated in 2009. All fry are immersed in an oxytetracycline bath to mark otoliths prior to release (Brooks et al. 1994). Sampling of returning adult shad at the Essex Dam has documented shad with marked otoliths, but a larger sample size will be needed to determine the overall contribution of hatchery shad to the restoration effort.

Coastal Watersheds:

Attempts to establish a shad population in the Exeter River by stocking adult shad from the Merrimack and Connecticut River populations were discontinued in 2008 due to poor return rates. Passage issues in the fish ladder at the Great Works Dam, in Exeter, and low dissolved oxygen levels in the impoundment upstream are two factors that may have limited the recovery (Mike Dionne, NHFG Biologist, personal communication).

Regulatory Protection (for explanations, see Appendix I)

- Anadromous Fish ConservaTIon Act
- Harvest permit - season/take regulations

Quality of Habitat

Connecticut River:
The Connecticut River is known for its highly productive American shad habitat from the river mouth to Bellows Falls in New Hampshire. Shad numbers are currently limited more by fish passage issues and factors influencing survival at sea than by habitat quality in the Connecticut River (Sprankle, Connecticut River Program Coordinator, personal communication). Shad currently have access to the majority of their historic spawning habitat in the upper Connecticut River, but fish passage efficiency could be improved at each dam. Fluctuating water levels and increased summer water temperatures at dams may negatively influence juvenile survival.

Merrimack River:
According to the Merrimack River American Shad Management Plan, there are approximately 6,512 acres of potential spawning habitat in the upper Merrimack River, 2,205 acres of which are currently accessible (MRTC 2010). These are rough estimates. The relative importance of spawning areas within each section of river is unknown, but the estimates provide a general idea of the amount of habitat that would be available to shad in the absence of dams. Much of the mainstem of the Merrimack is considered excellent shad habitat in terms of depth, substrate, and flow rate. American shad technically have access from the mouth of the Merrimack River to the Hooksett Dam in New Hampshire and a small portion of the Nashua River. The actual numbers of shad reaching the upper Merrimack river is limited by poor fish passage efficiency at the Pawtucket Dam in Lowell (Sprankle 2005).

Coastal Rivers
Suitable spawning habitat for shad has been identified in the Exeter River and the Lamprey River (NHFG 2014). Fish ladder construction at the Wiswall Dam has provided access to 18.4 river km (68 hectares) of the Lamprey River for anadromous fish. The relative accessibility of the Lamprey River may offer the best chance for shad restoration on the New Hampshire seacoast. The proposed removal of the Great Works Dam may also make shad restoration feasible in the Exeter River.

Habitat Protection Status

Habitat Management Status

Shad habitat management activities focus primarily on managing river flow upstream and downstream of dams to maximize the efficiency of fishways. Fishways require constant maintenance and monitoring to be effective. They must be adjusted or redesigned to ensure successful fish passage over the widest range of flow conditions possible. The fishways in the most need of improvement are at the Turners Falls Dam on the Connecticut River and the Pawtucket Dam on the Merrimack River. Dam removals have the greatest potential for restoring American shad populations, but dam removals are unlikely on the larger rivers in New Hampshire and Massachusetts. The potential removal of the Great Works Dam creates an opportunity for natural shad recolonization of the freshwater portion of the Exeter River.

Threats to this Species or Habitat in NH

Threat rankings were calculated by groups of taxonomic or habitat experts using a multistep process (details in Chapter 4). Each threat was ranked for these factors: Spatial Extent, Severity, Immediacy, Certainty, and Reversibility (ability to address the threat). These combined scores produced one overall threat score. Only threats that received a "medium" or "high" score have accompanying text in this profile. Threats that have a low spatial extent, are unlikely to occur in the next ten years, or there is uncertainty in the data will be ranked lower due to these factors.

Disturbance from dams that block species from spawning areas or other important habitat (Threat Rank: High)

Dams block access to freshwater spawning habitat.

Dams have greatly reduced the amount of freshwater habitat available to American shad and other diadromous species (Limburg and Waldman 2009).

Mortality from hydropower turbines (Threat Rank: Medium)

Fish are killed during downstream migration when they pass through hydropower turbines.

Dead or injured fish are observed downstream of hydropower turbines each year at dams throughout the state. The level of mortality varies significantly by site.

Disturbance from dams causing delayed migration (Threat Rank: Medium)

Delays in migration occur at dams as fish try to successfully navigate fish passage facilities. These delays may become energetically costly to the point where they impact spawning behavior.

Studies of shad on the Connecticut River have documented potential impacts from significant delays of American shad at multiple dams during the spring migration period (Castro-Santos and Letcher 2010).

Mortality from predation (striped bass) (Threat Rank: Medium)

Mortality from abundant predator populations has been documented as a factor that is potentially limiting the recovery of some diadromous fish populations.

A tenfold increase in the striped bass population coincided with a decline in many diadromous fish populations in the late 1990's (Grout 2006). Very large striped bass will consume adult shad, but large fish account for a small proportion of the striped bass population (Davis et al. 2009). Most predation of American shad likely occurs at the juvenile life stage, with some predation of adult shad by larger marine predators.

List of Lower Ranking Threats:

Mortality from commercial over-harvest due to fishing bycatch

Species impacts from changes in timing of migration and flooding that decrease spawning success

Actions to benefit this Species or Habitat in NH

Monitor fish passage

Objective:
Monitor upstream and downstream passage at dams.

General Strategy:
Monitor diadromous fish passage at dams with trained staff, video equipment or periodic sampling. Assess the efficiency of upstream and downstream passage facilities. Make recommendations for improving existing or proposed fish passage structures.

Political Location: **Watershed Location:**

Monitor shad stocking

Objective:
Monitor the contribution of restoration strategies including hatchery supplementation and adult shad transfers.

General Strategy:
Hatchery raised shad fry stocked in the Merrimack River have otoliths marked with tetracycline. Lethal sampling of adult returns or juvenile shad is used to determine the percentage of hatchery origin shad in the population. The offspring of adult shad stocked into habitat up river can be sampled using electrofishing boats or seines. The level of sampling effort required to achieve statistically significant results is currently beyond the capacity of the NHFG and the USFWS.

Political Location: **Watershed Location:**

Map spawning habitat

Objective:
Identify and map the spawning habitat used by anadromous fish in the Connecticut, Merrimack, and Coastal watersheds.

General Strategy:
While spawning adults are counted each spring in many New Hampshire Rivers, the locations of important spawning areas have yet to be quantitatively identified and mapped. The extent of suitable spawning habitat for alewives, blueback herring, sea lamprey, and American shad is not well known. This research would likely involve the use of radio telemetry and visual surveys during the spawning season.

Political Location: **Watershed Location:**

Fish passage efficiency studies

Objective:
Evaluate the effectiveness of both upstream and downstream fishways.

General Strategy:
Studies should be conducted to evaluate the upstream and downstream passage efficiency at dams using pit tags and radio telemetry equipment. Information on size selection, mortality, migration delays, and passage success should be collected at each site.

Political Location: **Watershed Location:**

Fish transfers

Primary Threat Addressed: Disturbance from dams that block species from spawning areas or other important habitat

Specific Threat (IUCN Threat Levels): Natural system modifications / Dams & water management/use / Dams (size unknown)

Objective:
Transfer diadromous fish species into suitable freshwater habitat that is currently inaccessible due to dams or other manmade barriers.

General Strategy:
In some cases it may be appropriate to move diadromous fish into habitat that is currently inaccessible. Improving access to quality spawning habitat may increase the spawning population within a river system. In many cases, a certain number of returning fish will trigger fish passage at a dam where a fish passage prescription has been negotiated through the FERC licensing process. In other cases, congregations of diadromous species downstream from a dam demonstrate a clear need for fish passage at the site. Sources of fish passage should come from within basin whenever possible, but in river reaches where diadromous fish species have been extirpated, fish may need to be transferred from neighboring watersheds. The risk of introducing diseases or invasive organisms should be considered when transferring fish from out of basin. Some level of testing may be required.

Political Location: **Watershed Location:**

Dam removal

Primary Threat Addressed: Disturbance from dams that block species from spawning areas or other important habitat

Specific Threat (IUCN Threat Levels): Natural system modifications / Dams & water management/use / Dams (size unknown)

Objective:
Remove barriers to migration.

General Strategy:
When the opportunity presents itself, dam removals provide the best long term solution to reconnecting diadromous fish with their historical freshwater spawning habitat. Dam removal projects are challenging and they often stall without a dedicated project manager. Hiring and training staff to identify and facilitate dam removal projects will increase the number of projects that can be completed each year. Creating priority lists of dam removal projects for each species would also help focus resources on the projects with the most benefit as well as help generate funding.

Political Location: **Watershed Location:**

Population assessment

Objective:
Assess the current and potential productivity of diadromous fish species in New Hampshire waters.

General Strategy:
Setting restoration goals for diadromous fish species is difficult without realistic targets for population recovery. Developing population models based on fecundity, extent and quality of habitat, and sources of mortality would help estimate the potential abundance of diadromous fish species under different management scenarios. This information would be useful to fisheries managers as they set stocking targets or prioritize restoration work. Understanding the potential abundance of diadromous fish populations would more clearly define successful restoration and put current population levels in perspective.

Political Location: **Watershed Location:**

Improve fish passage at dams

Primary Threat Addressed: Disturbance from dams that block species from spawning areas or other important habitat

Specific Threat (IUCN Threat Levels): Natural system modifications / Dams & water management/use / Dams (size unknown)

Objective:
Construct, maintain, and monitor fishways at dams that currently limit access to suitable freshwater habitat for diadromous fish.

General Strategy:
At sites where dam removal is not an option, fish passage construction can improve connectivity between freshwater and marine habitats. Fish passage construction may be negotiated during the FERC licensing process. Fish passage engineers with the USFWS are available to assist with designing the appropriate fishway for a particular site, depending on the needs of the species and the size of the dam (among other factors). At some sites outside of FERC jurisdiction, funding may have to come from other sources. Once installed, there should be a plan for fish passage operation, maintenance, and monitoring. Identifying the party responsible for each aspect of fishway operation is critical for maintaining effective passage over the long term. Periodic performance evaluations should also be completed at each fishway to ensure that fish are moving efficiently through the project without excessive delays.

Political Location: **Watershed Location:**

References, Data Sources and Authors

Data Sources

American shad returns have been recorded at the fishways in the Merrimack and Connecticut Rivers since the early 1980's. Fishway count data is maintained by state and federal fish and wildlife agencies.

Data Quality

American shad return numbers are relatively accurate at staffed or video recorded counting facilities. Counts at the fish lift in Lowell are estimated. The annual abundance of juvenile shad in the New Hampshire sections of the Connecticut and Merrimack River is unknown.
Counts of American shad vary in quality by site, but in most cases they provide relatively accurate estimates of the spawning population in a river. These estimates are useful for evaluating long term trends. There is very little understanding of factors that influence juvenile shad productivity or survival at sea. Subsamples of American shad in the Connecticut and Merrimack Rivers provide population data including length, weight, age, sex, and percentage of repeat spawners. These samples are taken and analyzed by staff with the Massachusetts Division of Marine Fisheries (MDMF).

2015 Authors:

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2005 Authors:

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