

A Management Plan for American Shad in the Connecticut River Basin

Connecticut River Atlantic Salmon Commission
February 4, 1992

Preface

This plan is endorsed by the Connecticut River Atlantic Salmon Commission for implementation in its efforts to restore anadromous fishes to the Connecticut River basin. The plan was prepared by the Shad Studies Subcommittee under authority of the Technical Committee for Fisheries Management of the Connecticut River. The Subcommittee serves an advisory role to the Technical Committee and Commission regarding current management issues and information needs pertinent to shad and river herring restoration in the basin. The Subcommittee will also periodically revise the plan to reflect progress made toward realization of the restoration goal and objectives. Major revisions to the plan will require review and approval of the Commission.

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I. Introduction

In 1967, State (CT, MA, NH, VT) and Federal Fishery Agencies (USFWS, NMFS) signed a Statement of Intent for a cooperative fishery restoration program in the Connecticut River basin. The Statement called for the establishment of a population of two million shad to the mouth of the Connecticut River with passage of one million above Holyoke Dam, 850,000 above Turners Falls Dam, and 750,000 above Vernon Dam thus restoring shad to their historical range at Bellows Falls, Vermont. These goals were initially chosen based on an estimation of potential spawning habitat situated above each mainstem dam in relation to the total and fishway efficiencies experienced on the Columbia River. Efforts continue to try to meet these goals.

American shad population levels in the Connecticut River demonstrate natural variability (Figure 1) typical of Clupeid fishes. Annual spawning run estimates of American shad have varied from 386,000 to a high of 1,634,000 since 1966 (Table 1). The variability seen is the result of differences in recruitment of individual year-classes and has been shown to be related to environmental conditions (Crecco and Savoy 1984).

Fish passage facilities, providing upstream access for American shad to Bellows Falls, Vermont, were improved at Holyoke Dam by 1976, and completed at Turners Falls and Vernon Dams in 1980 and 1981, respectively. Poor passage within the fish ladders at Turners Falls was improved by changing ladder flow patterns - prior to the 1983 and 1984 runs (Table 2). Similar modifications to improve passage efficiency through the Vernon fish ladder were made in advance of the 1984 and 1989 spawning runs.

Comparison of mean American shad population levels between pre and post 1976 Holyoke Lift improvements demonstrate little difference (Figure 1. 1966-1975, $x=837,581$; 1976-1990, $x=828,426$), however, recruitment of virgin American shad has increased slightly (Figure 2. 1966-1975, $x=604,339$; 1976-1984, $x=718,506$) coincident with fish passage improvements. This would suggest that a small increase in American shad production has resulted from restoring the American shad to their historic range. Increased upriver fish passage at Holyoke without successful downstream passage facilities has resulted in a decline in the proportion of repeat spawners in the Connecticut River (Table 1). This places increased reliance on virgin spawning shad which may be a destabilizing influence on longterm population levels. Careful monitoring of age and spawning history as well as monitoring of proposed downstream passage facilities will be necessary.

During the period 1975-1979 no significant downriver passage of spent adult American shad was provided at Holyoke Dam. Beginning in 1980, a combination of techniques has been employed to provide passage around turbines at Holyoke (canal drawdowns, bascule gate opening, operation of the Boatlock Station Bypass)¹ and in 1983 at Turners Falls Dam where the log sluice is opened for a period each day during June and July when adult shad are present (Table 3). These requests for bypass operations were first formalized in an Annual Notification Letter to individual dam operators in 1987 as a request from the fisheries agencies and then later through the FERC process in the case of Holyoke. The signing of the Memorandums of Agreement with Northeast Utilities Service Company (NUSCO) and New England Power Company (NEP) in 1990 provide specific dates for completion of bypass facilities at all applicable mainstem dams for American shad as well as Atlantic salmon (Appendices C and D). Careful monitoring of the population dynamics of the American shad population after these facilities are completed will be necessary to evaluate their effectiveness.

While efforts to restore American shad to the Connecticut River Basin have primarily addressed upstream passage issues in the mainstem river, similar issues have received attention in certain major tributaries. Of these tributaries, the Farmington River in Connecticut has received most of the attention to date. Shad passage discussions, however, are underway on the Westfield River in Massachusetts. Efforts have also been initiated to quantify and describe the contribution of tributaries to the shad sport fishery.

On the Connecticut River mainstem, one unanticipated benefit of the fishway at Bellows Falls dam is the expansion of the upstream range of American shad beyond their historic limit. It is not known whether shad will pass the Bellows Falls fishway in significant numbers, and how this range expansion could affect the Connecticut River shad population. Downstream passage for both adult shad and juvenile shad (should reproduction occur upriver from Bellows Falls) will be provided through the Atlantic salmon passage facilities scheduled for operation in 1994.

1. Reports documenting the evaluation of the bypass techniques are cited under the references section.

Detailed information on the biology and status of American shad stocks of the eastern United States, including the Connecticut River, is available in the fishery management plan developed by the Atlantic States Marine Fisheries Commission (1985). The purpose of the Connecticut River Basin plan is to identify management objectives and activities that are specific to the basin and essential to attaining full restoration of the species to the basin.

II. Management Goal

To restore and maintain a spawning shad population to its historic range in the Connecticut River basin and to provide and maintain sport and the traditional in-river commercial fisheries for the species.

III. Management Objectives

The seven management objectives listed below support the management goal. Each objective is followed by reference to tables and appendices which document progress on activities toward full achievement of the stated objective.

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually. (Table 1)
2. A maximum rate of exploitation shall not exceed 40% of the spawning population, based on a 5-year running average (Crecco and Savoy 1987). (Table 1)
3. Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem. (Table 2)
4. Maximize outmigrant survival for juvenile and spent adult shad. (Table 3)
5. Enhance and promote the recreational opportunities associated with shad fishery management throughout the species' historical range. (Tables 4, 5, 6, & 7)
6. Establish and maintain a permanent population monitoring program on the Connecticut River. (Appendix A)
7. Establish an annual research program to address management programs associated with shad restoration goals and objectives. (Appendix B)

IV. Program Evaluation

The plan will be reviewed and, if necessary, revised annually to reflect current management problems and issues and progress made toward shad restoration in the Connecticut River basin.

V. References

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Savoy. T.. and D. Shake. 1991.

Population dynamics studies of American shad. *Alosa sapidissima*. in the Connecticut River. Final completion Report for AFC-17. Connecticut Department of Environmental Protection. 50 p.

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APPENDIX A. ANNUAL POPULATION MONITORING REQUIREMENTS

Requirements listed under this section are presented in order of priority, but all are required to monitor shad population status and trends from year to year.

1. Population estimates for numbers of shad entering the Connecticut River.
2. Estimates of shad sport harvest throughout the Connecticut River basin and commercial harvest at tidewater.
3. Upstream and downstream passage counts for adult and juvenile shad with pertinent age structure and sex ratio data at each Connecticut River mainstem fish passage facility.
4. An estimate of the relative abundance of juvenile shad produced in the Connecticut River basin.

APPENDIX B. RESEARCH AND DEVELOPMENT ACTIVITIES

The following studies and development projects were undertaken in 1991:

1. Aquatec, Inc. monitored the relationship and effect Vermont Yankee Nuclear Power Plant operation on American shad distribution, growth and population dynamics in the upper Turners Falls and lower Vernon impoundments. The sex ratio, fecundity and age distribution of adult American shad at the Turners Falls and Vernon Darn fishways was studied. Sampling of juvenile American shad occurred in the upper Turners Falls pool and in the lower Vernon pool.
2. NUSCO and NEP conducted downstream fish passage studies for adult and juvenile American shad at each company's hydroelectric facilities in accordance with the MOA schedules.
3. The USFWS Sunderland Office of Fishery Assistance sampled the American shad population below Cabot Station for length-weight data and sex ratios. Radio telemetry were tested.
4. The Conte Anadromous Fish Research Center (CAFRC) conducted two studies on shad in 1991 that were aimed at understanding the behavior of adults in fishways: (1) experimental investigations of the choice of water flow habitat during the diel cycle of prespawed adults, and (2) development of a video system to monitor shad behavior in the Turners Falls fishway. CAFRC also developed the methods to conduct a detailed evaluation of the Turners Falls fishway in 1992. Juvenile shad studies to be undertaken by the CAFRC in 1991 included field studies using hydroacoustic techniques to determine the effect of physical environmental factors on migration ecology and migratory route.

APPENDIX C. CRASC-NUSCO DOWNSTREAM FISH PASSAGE MOA, JULY 26, 1990

ARTICLE I: PASSAGE AND STUDY DATES

1. Holyoke Canal System

NUSCO agrees to provide downstream passage facilities for Atlantic salmon and fish from the family Clupeidae at the Holyoke Canal System by April 1992. and to evaluate its effectiveness by November 1994.

2. Hadley Falls Station

NUSCO agrees to provide downstream passage facilities for Atlantic Salmon and fish from the family Clupeidae at the Hadley Falls Station by April 1993, and to evaluate its effectiveness by November 1995.

3. Turners Falls Project

If the Holyoke Canal System downstream passage facilities are initially successful, NUSCO agrees to provide downstream passage facilities for Atlantic salmon and fish from the family Clupeidae at the Turners Falls Project by April 1994. If significant continued modifications are needed at the Holyoke Canal System downstream passage facilities, the date for providing the Turners Falls Project downstream passage facilities may be delayed to April 1995. The decision as to the initial success of the Holyoke Canal System downstream passage facilities shall be made no later than October 1992.

4. Northfield Project

NUSCO agrees to complete studies and provide implementation schedules as required at the Northfield Project by March 1993.

APPENDIX D. CRASC-NEP DOWNSTREAM FISH PASSAGE MOA, JULY 26, 1990

ARTICLE II: SCHEDULE NECESSARY TO MEET PASSAGE DATES

1. Overall Schedule

The Company will follow the schedule of activities which is outlined below:

VERNON

- Through Spring 1990 - Physical model testing
- Spring 1990 - Study and identify alternative systems. Conduct radio-tagged fish studies.
- Summer 1990 - Install and operate. Vernon "fish pipe"
- 1991 - Evaluate alternative systems with radio-tagged fish studies
- 1992 to 1993 - Engineer and designed preferred system
- Spring 1993 - Issue a notice to proceed with construction of preferred system**
- April 1994 - Operate preferred system and monitor passage
- 1994 to 1996 - Evaluate effectiveness and modify facility as necessary

** The issuance of a notice to proceed in this agreement means. notification of the selected contractor to proceed with construction as described and defined in the agreed on contract.

TABLE 1. Population estimates, year-class strength, exploitation rates, numbers and percentage of repeat spawners of American shad in the Connecticut River. 1966-1990.

Year	Year-Class Strength ¹	Population Estimate ²	Exploit Rate (%)	Repeat Spawners ³			
				Females	%	Males	%
1966	1026000	535000	28.7				
1967	559000	742000	19.8				
1968	266000	940000	13.0				
1969	575000	1185000	9.4				
1970	655000	1264000	10.0	133055	27	208112	27
1971	1000000	1188000	10.4	115812	25	326056	45
1972	344000	477000	19.3	51320	25	114288	42
1973	299000	421000	25.2	65612	40	51312	20
1974	594000	914000	12.0	89922	24	188709	35
1975	725000	847000	22.1	50170	16	138815	26
1976	653000	1040000	19.1	61158	12	185659	35
1977	1177000	386000	30.2	25507	10	32850	25
1978	861000	623000	16.2	55307	24	54934	14
1979	1062000	618000	14.2	69660	24	81825	25
1980	851000	745000	13.5	39337	11	120098	31
1981	402000	957000	17.4	74862	23	164275	26
1982	225000	1042000	12.0	23142	6	98511	15
1983	753000	1634000	12.2	116673	21	312761	29
1984	482000	1329000	12.0	78174	12	264435	39
1985		795000	16.4	71766	21	176673	39
1986		795000	27.7	37209	9	156467	41
1987		481000	32.7	70679	35	150590	54
1988		529000	24.6	33199	19	35475	10
1989		796000	16.7	200615	45	70056	20
1990		655000	14.6	51016	19	57957	15

1. Year-class strength is the sum of virgin recruitment of 4, 5 and 6 year old shad (Savoy and Shake, 1991).
2. Population estimates derived from Holyoke Lift rate numbers as described in Crecco and Savoy (1985).
3. Connecticut Department of Environmental Protection Bureau of Marine Fisheries unpublished data taken from fish collected at the river mouth.

TABLE 2. Adult shad passage at the three lowest Connecticut River mainstem fishways. 1966-1990. Percent efficiency (% Eff.) relative to the immediate downstream facility is also expressed.

Year	Pop. Est ^a	Holyoke Lift		Turners Falls Gatehouse		Vernon Ladder	
		No. ^b	% Eff	No. ^c	% Eff.	No.	% Eff.
1966	535000	16000	3.0				
1967	742000	19000	2.6				
1968	940000	25000	2.7				
1969	1185000	45000	3.8				
1970	1264000	66000	5.2				
1971	1188000	53000	4.5				
1972	477000	26000	5.5				
1973	421000	25000	5.9				
1974	914000	53000	5.8				
1975	847000	114000	13.5				
1976	1040000	347000	33.4				
1977	386000	203000	52.6				
1978	623000	145000	23.3				
1979	557000	256000	41.4				
1980	745000	376000	50.5	300	< 0.1		
1981	957000	380000	39.7	200	< 0.1	97	48.5
1982	1042000	290000	27.8	10	< 0.1	9	81.8
1983	1634000	530000	32.4	12710 ^d	2.4	2597 ^e	20.4
1984	1329000	490000	36.9	4330 ^f	0.9	335 ^g	7.7
1985	795000	480000	60.4	3860	0.8	833	21.6
1986	795000	350000	44.0	17860	5.1	982	5.5
1987	481000	280000	58.2	18960	6.8	3459	18.2
1988	647000	290000	54.8	15790	5.4	1370	8.7
1989	796000	350000	44.0	9510	2.7	2953 ^h	31.1
1990	655000	360000	55.0	27910	7.8	10894	39.0

a. Population estimates derived from Holyoke Lift rate numbers as described in Crecco and Savoy (1985).

b. Passage counts rounded to nearest 10,000th fish.

c. Passage counts rounded to nearest 10th fish.

d. The Ice Harbor style ladder at Cabot Station (Turners Falls) is structurally modified to improve flow patterns for increased shad passage during the 1983 run.

e. Flow through the Ice Harbor style ladder at Vernon Station is increased in an attempt to increase shad passage.

f. Structural modifications similar to those made at Cabot Station are undertaken at the spillway ladder (Turners Falls) in advance of the 1984 shad run.

g. The first structural changes are made to the Ice Harbor style ladder at Vernon.

h. Structural modifications similar to those made at Cabot Station are undertaken at the Vernon ladder.

TABLE 3. Downstream passage of American shad at the Holyoke and Turners Falls Dams on the Connecticut River. 1980-1990.

Year	Holyoke Dame		Turners Falls ³
	Boatlock Station ¹	Bascule Gate ²	
1980	142,190		
1981	31,313		
1982	3,093		
1983	120,096		15,066
1984	58,370		3,394
1985	123,040		15,167
1986	50,589		18,279
1987	38,686	open-no counts	18,880
1988	22,263	119,540	11,488
1989	3,300	56,000	no counts made bypass operated
1990	52,534	76,116	no counts made bypass operated

¹ Boatlock Station bypass estimates.

² Counts are estimates based on extrapolated subsamples.

³ Counts made at Cabot Station log sluice.

TABLE 4. Expanded effort and harvest data for shore and boat anglers on the Connecticut River between the Enfield Dam and the Wilson State Boat Launch, 1986-1990.

Shore Anglers					
Year	Total Hours	Total Anglers	Average Angling Day	Catch per Hour	Total Shad Caught
1986	9054	6707	1.35	0.49	2806
1987	7039	4662	1.51	0.41	2876
1988	8544	4910	1.74	0.28	2371
1989	6518	4404	1.48	0.54	3513
1990	7054	5187	1.36	0.60	4209
Boat Anglers					
Year	Total Hours	Total Anglers	Average Angling Day	Catch per Hour	Total Shad Caught
1986	24392	1477	4.13	0.38	8962
1987	11294	1412	4.00	0.44	4968
1988	9251	1041	4.19	0.44	4053
1989	3990	660	3.15	0.43	1730
1990	6623	902	3.43	0.83	5478

Total Anglers			
Year	Total Hours	Total Anglers	Total Shad Caught
1986	33446	8184	11768
1987	18333	6074	7844
1988	17795	5951	6424
1989	10508	5064	5243
1990	13677	6089	9687

TABLE 5. Expanded effort and harvest data for shore and boat anglers below Holyoke Dam, between Route 116 and Route 391 bridges, 1986-1990.

Shore Anglers					
Year	Total Hours	Total Anglers	Average Angling Day	Catch per Hour	Total Shad Caught
1986	56960	16184	3.74	0.97	57512
1987	48227	17151	2.81	1.00	48917
1988	22948	8946	2.56	0.71	16213
1989	27995	8307	3.37	0.99	27715
1990	21393	8557	2.50	0.69	14761
Boat Anglers					
Year	Total Hours	Total Anglers	Average Angling Day	Catch per Hour	Total Shad Caught
1986	29637	6634	4.50	1.27	35875
1987	36045	7639	4.70	1.06	36579
1988	24023	5005	4.80	1.26	30269
1989	22967	4176	5.50	1.18	27101
1990	21243	4125	5.15	0.63	13383

Total Anglers			
Year	Total Hours	Total Anglers	Total Shad Caught
1986	86597	22818	93387
1987	84272	24790	85496
1988	46971	13951	46482
1989	50962	12483	54816
1990	42636	12682	28144

TABLE 6. Public visitation counts at fishways on the Connecticut River, 1981 to 1990

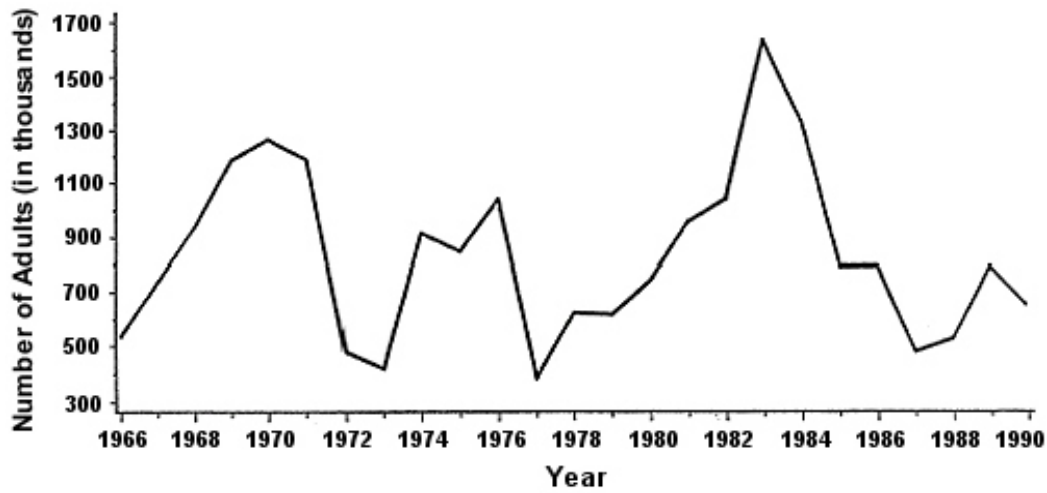
Year	Holyoke	Turners Falls	Vernon
1981		12,568	
1982		5,162	
1983		6,997	
1984		4,984	
1985		5,012	7,878
1986		6,686	15,787
1987	12,980	6,224	6,789
1988	11,440	6,848	6,893
1989	9,781	5,699	7,543
1990	11,643	10,087	12,586
Means	11,461	7,027	10,079

TABLE 7. Public visitation counts for the Rainbow Fishway on the Farmington River, Connecticut, 1985-1990¹

Year	Number of Group Tours	Number of visitors
1985	12	
1986	19	
1987	11 (Plus 2 open house days)	
1988	11 (Plus 2 open house days)	316
1989	9 (Plus 1 open house day)	297
1990	10 (Plus 1 open house day)	266

¹ Estimates of numbers of visitors are minimum numbers as the displays and viewing gallery are open to the public from the second week in April through the second week in July and in the fall from the first week in October until the second week in November.

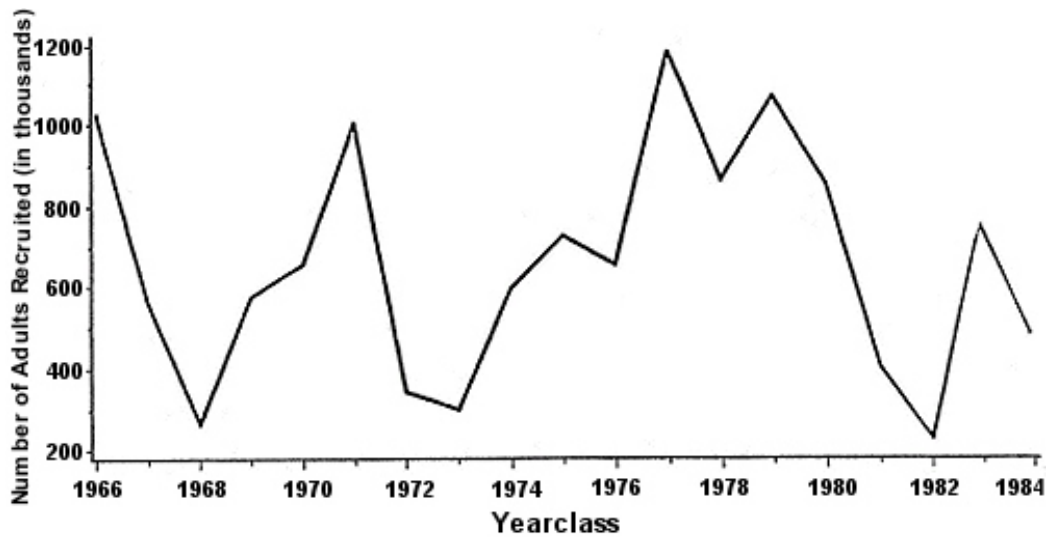
Figure 1. Population Estimate of American shad in the Connecticut River (1966 - 1990)¹



(1966 -1975 mean = 837,581) (1976 -1990 mean = 828,426)

¹Information derived from Table 1 (T. Savov. CT DEP. personal communication).

Figure 2. Virgin adult recruitment of American shad in the Connecticut River (1966 - 1984)¹



(1966 -1975 mean = 604,339) (1976 -1984 mean = 718,506)

¹Information derived from Table 1 (T. Savov. CT DEP. personal communication).