Admin # 185

RESULTS OF A PROPOSED STUDY TO MONITOR THE EFFECTIVENESS OF DOWNSTREAM JUVENILE CLUPEID PASSAGE AT THE AMOSKEAG DEVELOPMENT'S (FERC NO. 1893) FISH BYPASS FACILITY

DRAFT

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1.0 INTRODUCTION

Public Service Company of New Hampshire (PSNH), a subsidiary of Northeast Utilities, has begun the process of preparing for the relicensing of the Merrimack River Hydroelectric Project (FERC NO. 1893) consisting of the Amoskeag, Hooksett and Garvins Falls Developments, all located on the Merrimack River in New Hampshire. As part of the relicensing effort, PSNH was asked by state and federal regulatory agencies to design a study that would determine the effectiveness of the Project's three downstream fish bypass systems at passing emigrating juvenile clupeids (alewife, blueback herring and American shad).

Normandeau Associates, Inc. submitted a study plan to PSNH in September 2002, which described procedures that would be followed to assess the bypass at the Amoskeag Development (Appendix A). In the study plan, Normandeau proposed to design and install a net downstream of the Amoskeag Development bypass to determine bypass usage by juvenile clupeids. The bypass net was designed to effectively filter 100% of the downstream bypass flow and would be used to recapture marked juvenile clupeids that exit via the bypass system, following their release upstream of the Amoskeag Dam. The immersion dye Acridine Orange would be used to mark the juvenile clupeids. The study plan was discussed at a fish passage meeting at Amoskeag on September 16, 2002 and a plan was forwarded via email to the U.S. Fish and Wildlife Service (USFWS) on 15 October 2002. Agency comments were received by Public Service on 17 October 2002 (Appendix A). Agency comments to the plan included the following:

- Plan should acknowledge that the Garvins and Hooksett development bypasses will also need to be assessed for juvenile clupeid usage in the future.
- Study plan should outline a design and timetable for undertaking the assessments at Garvins and Hooksett.
- For Amoskeag, agencies agreed to a test of 125 cfs for the first flow, but if this was unsuccessful, they requested we test up to 282 cfs (5% of turbine flow).
- Agencies requested that they be consulted after the first release/flow setting, and that they would advise PSNH as to the flow recommended for the second release.
- Frequency of net tending and fish enumeration needs to be identified in the plan and then the net should be removed after tests are completed so wild fish can pass unharmed.
- Agencies requested that the tests be timed to miss the peak of downstream movement to minimize impacts to wild fish.
- If passage results were good, then bypass survival will need to be evaluated.

The following report describes the results of an attempted study, conducted on 25 October 2002, to assess the effectiveness of the fish bypass facility at Amoskeag Development, as well as problems encountered during the study, which precluded the study's successful completion.

2.0 METHODS

Starting in September 2002, Normandeau personnel began monitoring Northwood Lake to determine when water temperature was suitable to initiate juvenile herring emigration. The monitoring and fish collection results from Northwood Lake are provided in Table 2-1 below.

Table 2-1. Juvenile Alewife Collections at Northwood Lake.

Date	Water Temperature (°C)	Number Of Fish Collected	Comments
9-27-02	17.0	—[1]	Outlet dam and temperature check
10-3-02	16.3	—	Outlet dam and temperature check
10-8-02	16.3	—	Outlet dam and temperature check
10-10-02	16.1	—	Checked lake for signs of fish
10-14-02			Boards removed from dam outlet for winter drawdown
10-15-02	13.1	950	Fish started migrating after dark
10-16-02	12.9	650	Heavy rain
10-17-02	12.1	700	Air temps. Dropping
10-18-02	11.3	0	Sampling difficulties, second board removed from dam, outlet flow increased greatly
10-21-02	10.5	0	8 net pulls, effort abandoned

[1] — = no fishing effort expended; lake was visually surveyed for signs of fish attempting to move downstream and water temperatures were taken.

In early October 2002, Normandeau captured wild juvenile clupeids from Northwood Lake in Epsom, NH. Northwood Lake was chosen for fish collection because of the large number of juvenile alewives available, and because the lake has good access that allowed for efficient capture of fish. A total of 2,250 juvenile alewives were collected from Northwood Lake using a 300 ft by 10 ft beach seine with ⅜ inch stretch mesh. Fish were removed from the seine and transferred to a 180-gallon tank mounted in a truck for transportation to the holding tanks at Amoskeag Dam. To reduce fish stress during transportation, oxygen was bubbled into the tank and salt was added to increase salinity to 5-6 ppt. Due to the size of the transport tank, no more than 1,000 fish were moved at a time to ensure a high survival rate. Upon arrival at Amoskeag Dam, all fish were transferred from the transportation tank to two 700-gallon holding tanks. Both tanks were equipped with a flow-through water source, which delivered 3 to 4 gallons of water per minute to each tank. Tank overflow was diverted to the fish ladder and a back-up pump system was assembled and stored on site in case of equipment failure. Fish survival during capture and transport to the holding tanks was greater than 99% for the three dates fish were captured at Northwood Lake.

On 24 October 2002, numerous juvenile clupeids were observed in pools below the Amoskeag fish bypass after the bypass flow was temporarily stopped to install the bypass net. Approximately 900 fish were collected from the pools, 75% of which were American shad. These fish were added to the holding tanks at Amoskeag Dam, which resulted in a total of 3,150 juvenile clupeids available for the mark and recapture study.

Also on 24 and 25 October 2002, a PSNH construction contractor drilled eleven holes in the bedrock for the bypass net installation. Once the holes were drilled, steel pipes measuring 7 feet long were inserted into the holes to provide a framework for the net and it's wings. After the net was installed

on 25 October, it was removed to allow the bypass channel to be flushed of debris. At 1530 hours, the bypass gate was closed and the bypass net was reinstalled.

On 24 October, a total of 2,000 test fish and control fish were marked by exposing fish to a 1:40,000 solution of the immersion stain Acridine Orange for four hours. Immediately before the study was initiated on 25 October, stained fish were transferred via a 3-inch diameter hose to a floating net pen in the head pond. After the bypass was opened to pass 125 cfs, the net pen was towed upstream by boat and the fish were released.

3.0 RESULTS AND DISCUSSION

The fish bypass study was initiated at 1800 hours on 25 October 2002. During the 2.5 hours the bypass was closed to reattach the net, a significant amount of woody debris had accumulated at bypass gate. As soon as the gate was opened, the large woody debris began to build-up on the net's wing, and at 1810 hours the left wing of the net detached. The bypass gate was closed to allow the wing to be reattached and sampling resumed at 1845 hours. The sampling chronology during the 25 October mark and recapture study is provided in Table 1 below.

The net failure was attributed to a combination of large woody debris and the high volume of leaves that built up on the net's wing and caused the steel support structure to eventually fail. The increased amount of leaves and debris collected in the net was due to the time of year when the study was conducted and windy conditions along the river during the week before the study was initiated. From 18 to 21 October 2002, mean daily wind speed from Manchester to Laconia (approximately 50 miles upstream), was 5.8 to 8.8 mph, with gusts of 20.7 to 32.2 mph.

Table 3-1. Chronology of sampling times for October 25 bypass test.

Time	Occurrence	Fish Captured
1800	Test fish released	—
1810	Left wing detached, bypass closed	—
1845	Sampling resumed	—
1920	29 fish captured	20 unmarked alewives, 3 marked alewives, 4 unmarked American shad 2 bluegill
2100	Net failure, study terminated, 69 fish captured	26 unmarked alewives, 32 unmarked American shad, 7 bluegill, 1 Atlantic salmon, 1 pumpkinseed, 2 unidentified fish

Heavy rains began the evening of the release, which further exacerbated the debris loading during the test. Debris loading became severe enough along the net's wing that the force caused two of the steel support rods to bend completely over, causing the wing to fail and the test to be postponed. Because of the heavy rains, and some spillage after October 25, it was not possible to safely get the drilling

contractor in the bypass to reinstall additional steel net supports and continue the study. The remaining fish in the holding tanks were held for an additional ten days after the October 25th test and were released alive into the river when water temperatures dropped below 8°C.

Normandeau has concluded that our current study plan to assess bypass usage by juvenile clupeids at Amoskeag using a bypass net and test fish marked with a dye may not succeed for multiple reasons.

1. The Normandeau plan depends on conducting the net study during the peak of the downstream run, which puts a significant number of wild fish in peril (net kills all fish captured) and agencies requested that we not fish the net during peak passage time and to plan the release before or after the majority of run has passed.

2. Amoskeag bypass is not conducive to a net study because of the bypass configuration: large debris spills into the bypass at high velocities, making fishing below the bypass dangerous and tough on nets.

3. Flows tested may approach 282 cfs, which would require a very large net set-up and even if one was installed, the bypass would have to be turned off hourly to remove debris/fish, biasing the study results (fish only have turbine passage available when the bypass is turned off).

4. A wedge wire sampler would also fail because of the bypass configuration (large debris would eventually destroy the sampler as it spilled into the bypass).

5. The future bypass flow and habitat flow that will be requested for the eastern bypass reach would require that PSNH fish two different bypass flows simultaneously for marked fish.

Because of these concerns, Normandeau recommends the use of underwater (and in-air) cameras. This method could be used to assess multiple bypass flows simultaneously, no wild fish would be harmed and the bypass flow can continue uninterrupted during the peak fall passage period.

APPENDIX A

Study Plan and Agency Comments

Proposed Study Plan to Monitor the Effectiveness of the Amoskeag Development's (FERC NO. 1893) Downstream Fish Bypass at Passing Juvenile Clupeids

Draft

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1.0 INTRODUCTION

Public Service Company of New Hampshire (PSNH), a subsidiary of Northeast Utilities, has begun the process of preparing for the relicensing of the Merrimack River Hydroelectric Project (FERC NO. 1893) consisting of the Amoskeag, Hooksett and Garvins Falls developments, all located on the Merrimack River in New Hampshire. As part of the relicensing effort, PSNH has been asked by the fisheries agencies to design a study to determine the effectiveness of the Project's three downstream fish bypass systems at passing emigrating juvenile clupeids (alewife, blueback herring and American shad).

Normandeau proposes to design and install a bypass net at the Amoskeag development to determine bypass usage by juvenile clupeids. The bypass net will effectively filter 100% of the downstream bypass flow and will be used to recapture marked juvenile clupeids that exit via the bypass system following their release upstream of each development. Normandeau proposes to use the immersion dye Acridine Orange to mark the juvenile clupeids.

2.0 STUDY OBJECTIVE AND APPROACH

The study objective will be to determine the effectiveness of the Amoskeag downstream fish bypass system at passing juvenile clupeids (American shad, alewife and blueback herring). To accomplish the objective, Normandeau proposes to capture wild juvenile clupeids from the Merrimack River system and hold them in flow-through 700 gallon tanks located at Amoskeag. Normandeau personnel will coordinate with agency biologists during the fall of 2002 to be present when juvenile clupeids are released from Northwood Lake as the flashboards are being lowered. Collecting the juvenile clupeids in this manner will significantly reduce field time, will help ensure that enough test fish can be collected to successfully complete the tests and it will also reduce capture and transport stress.

Normandeau plans on beginning the study after the test fish are captured at Northwood Lake in early October. Waiting until October ensures the fish will have a desire to migrate downstream because of lower water temperatures and fall rain events – two factors that are known to trigger the downstream migrations of these species. Normandeau plans on releasing the marked fish close to the Amoskeag Dam near the middle of the headpond (within 0.25 mile of the dam). Releasing the fish too far upstream exposes them to significant predation, and any marked fish not captured in the bypass net during a test will be assumed to have exited via the turbines, the only other exit available to them (the fish ladder will be turned off at the time of these tests).

Normandeau proposes to use the immersion stain Acridine Orange to mark the juvenile clupeids for all tests. Normandeau biologists developed the use of Acridine Orange to mark juvenile clupeids in the early 1990's in studies conducted at hydro facilities in the lower Merrimack River. Acridine Orange proved superior to Bismark Brown Y and other immersion stains because the mark lasted longer (up to 2 weeks compared to 4 days for other stains) and survival during the staining procedure was greater (more than 99% survival, compared to 85% with Bismark Brown Y). Additionally, Normandeau is the only firm that currently has permission from the FDA to use Acridine Orange to mark fish in scientific studies.

The number of fish marked and released will depend on how many individuals are collected from Northwood Lake or from other lake outlets where these fish were stocked during spring 2002.

However, attempts will be made to capture up to 6,000 fish. If enough test fish are captured, Normandeau will conduct two releases of 3,000 marked fish per test. The first release will test a bypass flow of 125 cfs; if the first release is not successful at passing of 80% or more of the marked clupeids, Normandeau will do the second release of 3,000 marked fish with a bypass flow of 175 cfs. Fish used for each test will be counted and placed in a tank with the immersion dye Acridine Orange for several hours (dye turns the fish a golden color). Once marked, fish will be released upstream of the development and the bypass net will be fished continuously for at least 4 days. In studies conducted in the lower river with juvenile clupeids, most marked fish passed the hydro sites within a few days. It is possible that downstream migrating clupeids may take more time to pass Amoskeag, and if this is the case, PSNH and NAI biologists will decide whether to fish the net longer than 4 days. NAI will verify that the marked fish have passed the project by the absence of marked fish in the bypass net as the study progresses and if there is an absence of marked fish in cast net samples that will be collected above in the Amoskeag forebay area throughout the 4 day sampling period. These cast net samples will help verify the assumption that marked fish are mixing with the wild unmarked fish. NAI has determined in numerous similar studies that fish marked with Acridine Orange do mix naturally with the wild fish and that the mark does not negatively affect the fishes behavior.

Any marked fish not captured in the bypass net by the end of each test will be assumed to have passed through the turbines, provided certain assumptions have been met. The first assumption is that downstream passage at each development is either through the bypass or turbines – the study must occur when there is no spill over the dams. This will mean that the temporary bypass sluice/flow provided for the upcoming flow study in the eastern side of the Amoskeag bypass reach will have to be shut off during the Amoskeag mark and recapture test. The second assumption is that the marked fish have passed the site during the test, and as stated above, this will be verified by cast net sampling above the dam and the absence of marked fish in the bypass net as the study progresses.

NAI will conduct net efficiency tests of the bypass net before and after the mark and recapture study. Known numbers of marked fish will be introduced into the bypass flow to determine if there is escapement from the net. Also, a control group of marked fish from each test will be handled in the same manner as the marked fish being released except they will be placed back into the holding tanks for the studies duration to determine the survival rate of each group of marked fish. These control fish also become important if the net study continues beyond 4 days, because the extent of the mark can be readily viewed as the test progresses (the dye Acridine Orange fades gradually over a 2 week period).

3.0 QUALITY CONTROL/QUALITY ASSURANCE PROCEDURES

In the field, at least 5% of the bypass net samples will be randomly selected for quality control. These samples will be re-analyzed for proper ID of the mark, species identification and enumeration of fish captured.

4.0 DELIVERABLES

A draft report that includes the bypass efficiency results for the Amoskeag Development will be completed by December 31, 2002.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Field Office
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Concord, New Hampshire 03301-5087

REF: FERC No. 1893
Public Service Company of New Hampshire

October 17, 2002

Mr. Curtis Mooney
Public Service Company of NH P.O. Box 330
Manchester, NH 03105-0330

Dear Mr. Mooney:

We have completed our review of the draft *Proposed Study Plan to Monitor the Effectiveness of the Amoskeag Development's (FERC No. 1893) Downstream Fish Bypass of Passing Juvenile Clupeids* transmitted via e-mail on Octoberl5, 2002. We have the following comments and recommendations.

1.0 INTRODUCTION

The introduction notes that the Service and other fisheries agencies recommended studies be conducted to assess the downstream passage of juvenile clupeids at the Garvins, Hookset and Amoskeag developments. However, the second paragraph and the remainder of the draft plan only discuss a proposed assessment at Amoskeag.[1] At a meeting held on September 16, 2002, it was discussed that starting evaluations at Amoskeag made sense due to the current herring transfer program focusing on the Suncook River drainage and the lack of a permanent plunge pool for good marked fish recovery at Garvins Falls. However, Hookset and Garvins will also need to be assessed. The study plan should acknowledge this fact and identify general study design and procedures that would be followed and a timetable for undertaking these assessments.

2.0 STUDY OBJECTIVE AND APPROACH\

In general, the objective and approach stated in the plan are acceptable. However, we do not agree with the proposed test flows. The basis for the two potential test flows is not provided.

[1] We note that the discussion throughout the document needs to be edited to be clear whether one or more developments are being discussed.

We can accept the use of the 125 cfs test condition, which equates to a spill of 2.3 feet over the 10-foot wide gate as a starting point. But, this flow equates to only 2% of the maximum turbine flow. Given the lack of narrow intake racks and the length of the powerhouse intake and associated distance to the bypass gate, we are concerned that the bypass will not be effective at such a low flow. As stated in our comments dated March 5, 2002 regarding the salmon smolt bypass study report, flows of 5 % of turbine capacity (282 cfs) should be considered for testing.

The proposed approach is to have a release of marked fish with the bypass gate set at 125 cfs. If the passage success is under 80%, a second release at a bypass *flow* of 175 cfs is proposed. We question the cutoff of 80% efficiency. If, in fact passage at 125 cfs is 80% efficient, we do not consider the issue resolved. The highest efficiency reasonably possible should be the goal.

With that in mind, unless initial results are very close to 100% effective, additional testing at a higher bypass discharge should be undertaken. We believe that the exact setting of the gate for the second test should be based on the results of the initial test. If at 125 cfs, bypass effectiveness is high but not near 100%, a setting of 175 cfs (3% turbine capacity) may be reasonable. If, however, efficiency is quite low, testing a much higher discharge (i.e. 282 cfs) is appropriate.

The exact settings for a second release should be coordinated with this office and the New Hampshire Fish and Game Department. Consultation and close coordination throughout the study are recommended. After the results from the first release are in, we will consult with and advise PSNH as to the flows we recommend for testing with the second release.

The frequency that the net will be tended and fish enumerated needs to be identified. Also, prior to release and after each test release, the net recovery system needs to be removed as wild fish will be vulnerable to capture and mortality as long as the net is deployed. At our September 16, 2002 consultation meeting on this study, we indicated that it would be desirable to try to time the releases when wild clupeids are not concentrated at the Amoskeag forebay so that loss of wild fish would be minimized. It would be preferable for test fish capture at Northwood Lake and natural fish migrations be timed so that releases are made just before and then just after the bulk of the wild fish pass the site if this is possible.

4.0 Deliverables

The report of the study results should provide hourly data on turbine settings *(flow* amounts for each unit) over time and the report should assess any correlations between total and individual unit discharges and bypass efficiencies.

BYPASS SURVIVAL

If the results from the bypass effectiveness test indicate that bypass efficiency is good, bypass survival will need to be evaluated and likely improved. In our March 5, 2002 letter on salmon smolts passage, we discussed the need for a plunge pool and its sizing. An excerpt from that letter follows:

> Bypass mortality is most likely associated with an insufficient plunge pool. Based on our standard design criteria, the depth of a plunge pool should be equal to 25 % of the height of the fall of fish into the pool. For Amoskeag, with a height of fall from the top of flashboards of approximately 30 feet, the plunge pool should be a minimum of 7.5 feet deep. The plunge pool must also be of sufficient size to effectively dissipate energy from the bypass discharge and permit fish to orient and safely continue downstream. Ideally, the plunge pool would be elongated and gradually transition to the downstream channel.
>
> At this time, we recommend that the bypass plunge pool area be surveyed to assess the size and depth of the plunge pool under the range of tested bypass flows, and assess the current status of egress options under various discharges. Thought should be given now as to plunge pool modifications that can increase the plunge pool size, depth, and energy dissipation and assure a safe egress route. Designs of an adequate plunge pool structure will be needed for project relicensing.

The same issues and criteria pertain to clupeid passage at Amoskeag.

We appreciate this opportunity to comment, and look forward to further progress on fish passage at these projects. If you have any questions, please contact John Warner of this office at (603) 223-2541.

Sincerely,

William J. Neidermyer
Assistant Supervisor Federal
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cc: FERC-OHL

Eng. Field Office - Dick Quinn Merrimack River Coord. - Joe McKeon USFWS-Ken Sprankle/Doug Smithwood NHFGD - Jon Greenwood NHFGD - Bill Ingham NHDES - Paul Piszczek USFS/GMNF - Steve Roy MDFW - Caleb Slater MDMF - Rusty Iwanowicz Normandeau Assoc. - Rick Simmons

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