Relicensing Study 3.3.20

ICHTHYOPLANKTON ENTRAINMENT ASSESSMENT AT THE NORTHFIELD MOUNTAIN PROJECT

Updated Study Report Summary

Northfield Mountain Pumped Storage Project (No. 2485)

and Turners Falls Hydroelectric Project (No. 1889)

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1.1 Study Summary

The purpose of this study is to quantify entrainment of American shad ichthyoplankton at the Northfield Mountain Project. The objectives of this study are to:

- Calculate the number of American shad eggs and larvae entrained at the Northfield Mountain Project;
- Estimate the loss of adult and juvenile shad equivalents based on shad egg and larvae entrainment at the Northfield Mountain Project;
- Compare entrainment rates with one through four units pumping; and
- Determine the temporal distribution of entrainment within the prevailing pumping period.

1.2 Study Progress Summary

Task 1: Entrainment Sampling

Entrainment sampling to collect American shad eggs and larvae (ichthyoplankton) was accomplished by tapping off of existing piping that supplies cooling water from the Connecticut River to the station. PVC and rubber piping, a digital flow meter, a 1,000-liter plastic tank, and a 0.333 mm mesh plankton net were utilized to construct the sampling system. Approximately 100-200 cubic meters of intake water at a rate of 3 and 3 ½ gallons per second was filtered for each sample. Intake cooling water was diverted through a four-inch diameter flexible hose to an entrainment sampling tank. An inline Signet® digital flow meter was mounted in the hose to record the volume of water sampled. The hose's discharge was directed into a conical 0.333 mm mesh plankton net suspended in a 1,000 liter plastic tank. The plastic tank was designed with an overflow system. Once sufficient volume was obtained, the net was removed from the sampling tank and its contents rinsed into the cod-end collection jar with fresh water. The sample jar was then removed from the plankton net and the contents preserved with a 10% formalin solution and subsequently sorted. Entrainment sampling was conducted between May 28, 2015 and July 17, 2015 during pump back operations (see Table 1). The Northfield Mountain Project typically pumped between 6 and 7 hours during the night allowing for up to two samples per evening.

At least once per week samples were collected every 2 hours during a pumping cycle. We designated these ***Random*** samples because the number of pumps operated during sampling was not controlled. In addition, pumpback operations were manipulated to specifically sample operations with 1 2, 3, and 4 pumps running (***Scenario*** samples). Sample collection was initiated at least 30 minutes after the pumping cycle began to ensure the water was well mixed.

Scenario 1: 1 pump operational (Unit 2)
Scenario 2: 2 pumps operational (Unit 2 and one other)
Scenario 3: 3 pumps operational (Unit 2 and two others)
Scenario 4: All 4 pumps operational

These four scenarios were intended to coincide with peak shad spawning.

Table 1. Dates of entrainment sampling at Northfield Mountain, May 28 through July 17, 2015.

Sample Number	Rep	Date	Regime	Number of Pumps
1	1	5/28/2015	Random	3
2	2	5/28/2015	Random	3
3	1	6/5/2015	Random	3
4	2	6/5/2015	Random	3
5	1	6/9/2015	Scenario	4
6	2	6/9/2015	Scenario	4
7	1	6/10/2015	Scenario	3
8	2	6/10/2015	Scenario	3
9	1	6/11/2015	Random	1-3
10	2	6/11/2015	Random	3
11	1	6/15/2015	Random	1-3
12	2	6/15/2015	Random	1-4
13	1	6/18/2015	Scenario	2
14	2	6/18/2015	Scenario	2
15	1	6/19/2015	Scenario	1
16	2	6/19/2015	Scenario	1
17	1	6/26/2015	Random	1-3
18	2	6/26/2015	Random	3
19	1	7/1/2015	Random	1-2
20	2	7/1/2015	Random	3
21	1	7/8/2015	Random	4
22	2	7/8/2015	Random	4
23	1	7/17/2015	Random	1

Task 2: Sample Processing

Samples are currently being sorted by staff biologists with the aid of a dissecting microscope. American shad larvae and eggs will be removed from the samples, identified to the lowest practical taxonomic category, and enumerated. Larvae and eggs of blueback herring and American shad in the Connecticut River are not easily distinguishable. However, blueback herring numbers are very low, therefore any herring eggs or larvae will be identified as American shad.

A quality control program designed to ensure that the Average Outgoing Quality Limit for sorting and identification is greater than 90% will be followed. To accomplish this, one sample from each series of ten samples processed from a single individual will be randomly selected to be re-sorted. No one will be allowed to perform a QA/QC on his or her own samples. The person checking the sample (the QA/QC-er) will re-process the sample to determine what percentage of both larvae and eggs was missed, if any. If the percentage missed in either category is equal to or greater than 10 percent, the following QA/QC procedure will be followed until a "passing" QA/QC is obtained: Starting with samples sorted prior to the failed QA/QC, samples will be re-sorted in sequential order, working back, until a 'passing' QA/QC is obtained (i.e., Number found by QA/QC-er is less than 10% of total eggs or larvae in the sample). The process will be repeated with subsequently sorted samples, sequentially until a passing QA/QC is obtained. Any larvae or egg found during the QA/QC process will be added to the totals on the corresponding data sheet and included in the entrainment estimates.

All sorting, as well as field data, will be entered into a Microsoft Access database developed specifically for this project. All data entered will be verified for accuracy against the original data sheets prior to commencement of analyses, which are described below.

Task 3: Entrainment Data Analysis Methods

Entrainment Estimates
Entrainment estimates for American shad eggs and larvae will be derived based on the extrapolation of raw counts using a volumetric ratio and summing of weekly estimates derived from samples. The daily water volume pumped will be calculated based on daily average flow rates obtained from Northfield Mountain Project personnel. An estimate for each day not sampled will be calculated by multiplying the average entrainment density (number of larvae/eggs per m^3 of cooling water) for a weekly time period by the total number of days sampled in that week, i.e. Sunday to Sunday, by the volume of cooling water used on each day not sampled. All daily estimates will then be summed to generate a total for the larvae and eggs of each species entrained.

Equivalent Adult Estimates
The numbers of entrained fish larvae and eggs will be converted into adult equivalents to determine population impact. Adult equivalent losses (AELs) are estimates of the number of entrained organisms removed from the population that otherwise would have survived to some future age, or age of equivalence. To estimate AELs, the estimates of American shad larvae and eggs are multiplied by the survival fraction at a given lifestage:

$$AEL = \sum_{j=1}^{n} S_{i,A} N_i$$

where:
N_i = number of fishes lost at stage *i*; and
$S_{i,A}$ = fraction of fishes expected to survive from age *i* to the age of equivalence.

Survival rates of early lifestages are often expressed on a lifestage-specific basis so that the fraction surviving from any particular lifestage to adulthood is expressed as the product of survival fractions for all lifestages through which a fish must pass before reaching adulthood (j_{max} = the stage immediately prior to the age of equivalence):

$$S_{i,A} = \prod_{j=i}^{j_{max}} S_j$$

Survival fraction data for all lifestages of American shad entrained will be compiled from EPA (2004).

Ichthyoplankton Densities
Larval sample densities will be determined by dividing the number of American shad eggs and larvae by life stage (egg, yolk-sac larvae, post yolk-sac larvae) in each sample by the sample volume. The densities will then be standardized to the number of larvae per 500 m^3. Densities by life stage will be analyzed by date and time.

Task 4. Report

A final report will be completed March 1, 2016.

1.3 Variances from Study Plan and Schedule

To date, there are no variances from the study plan or schedule.

1.4 Remaining Activities

- Finish sample sorting
- Data entry and analysis
- Final Report