Miller Hydro Group: Atlantic Salmon Downstream and Upstream Passage Study Plans

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I. Introduction

Miller Hydro Group (MHG) owns and operates the Worumbo Hydroelectric Project (FERC No. 3428). The Worumbo Project is located on the Androscoggin River in Lisbon Falls and Durham, Maine. The project operations are within the Gulf of Maine (GOM) Distinct Population Segment (DPS) of Atlantic salmon. On May 14, 2012, Miller Hydro Group submitted to the Federal Energy Regulatory Commission (FERC) a draft Biological Assessment (BA) which was prepared under the Emergency Consultation procedures of the Endangered Species Act (ESA), and in consultation with National Marine Fisheries Service (NMFS). As an attachment to the BA, MHG submitted a separate BA addressing the measures to protect Atlantic Salmon during the ongoing operation of the Worumbo Project.

On June 7, 2012, FERC adopted MHG's BA without modification, and requested the initiation of formal consultation under Section 7 of the ESA. Included in the BA of Worumbo's continued project operations was an Interim Species Protection Plan (SPP). The Interim SPP identified upstream and downstream passage monitoring studies necessary to develop a final SPP. The monitoring studies will be conducted for up to three years (2013, 2014, and 2015). Please reference Table 1 for the planned schedule of studies.

Table 1: OVERVIEW OF SPECIES PROTECTION PLAN TIMING

2012	2013 – 2015 (depending on years of studies)	Late 2015 – 2016 (after 2015 field season is completed)
• Miller develops Interim SPP and Draft BA • FERC issues BA • NMFS issues Biological Opinion (BO) and Incidental Take Statement (ITS) covering 2012 – 2016	• Miller conducts Atlantic salmon upstream passage and downstream passage monitoring studies • Miller conducts predation monitoring	• Miller reinitiates consultation • Miller develops Final SPP, including Atlantic salmon enhancement measures, if determined to be necessary from 2013 – 2015 monitoring results • NMFS issues Incidental Take Statement to cover period of 2017 to issuance of new license (current license expires in 2024)

Downstream and upstream studies, described in detail below, will evaluate the passage effectiveness and survival of Atlantic salmon at Worumbo. The proposed study plan assumes that National Marine Fisheries Service's (NMFS) Biological Opinion (BO) will include an Incidental Take Statement. The Incidental Take Statement will authorize Miller Hydro Group for potential "takes" of Atlantic salmon that could occur due to project operations or conducting the upstream and downstream passage studies, detailed below.

It is expected that implementation of this study plan will be coordinated with downstream hydroelectric projects.

II. Downstream Smolt Passage

A. Study Objectives

Downstream Atlantic salmon smolt passage will be conducted in order to evaluate the survival of downstream passage at Worumbo. Survival will be defined as successfully passing the Worumbo Project. For this study, the Worumbo Project will start approximately 200 meters upstream of the trash racks and end at a point downstream where latent effects of the passage can be quantified. Please reference the Section II. B. Study Methods for more information on the definition of survival. The study results will be used to identify any necessary downstream passage improvements. Performance standards will be established and tested once downstream passage at Worumbo is better understood. Survival rates, route of passage, delay, and travel time will all be evaluated during the downstream study.

B. Study Methods

Radio telemetry will be used to monitor downstream salmon smolt passage. Radio telemetry allows you to measure both the passage survival rate and passage efficiency without being constrained by detection range, underwater noise, and shallow water limitations associated with alternative Passive Integrated Transponder (PIT) tag and acoustic telemetry study methods.

The downstream study would include a paired release model, where 100 radio-tagged smolts, plus control groups, would be jointly released and evaluated. Studies would occur in three independent trials at the beginning, middle, and late periods of downstream smolt migration season. The majority of smolts migrate in a short period of time, as demonstrated by NMFS' Penobscot River smolt trapping studies conducted between 2000 and 2005. The studies show that 74% of the downstream run occurs in 15 days of May and that the majority of the smolt migration appears to take place after water temperatures rise to 10°C (USFWS unpublished cited in Black Bear Hydro Partners 2012). Trial groups will be evaluated only when river flows are within the 10-90th percentile for average May flows. River flow historical data will be based

on the USGS Auburn gage. River temperature must be approximately 10 degrees Celsius, but not above 18 degrees Celsius in order to conduct the studies. Please reference Table 2 for proposed trial release dates. Trial releases will occur within the stated range for the three migration periods identified below. The proposed schedule contains approximate dates. Actual release dates will be dictated by river flow, temperature, and hatchery releases.

Table 2: PROPOSED TRIAL RELEASE PERIODS

	Early Migration	Mid Migration	Late Migration
	May 1, 2013 - May 10, 2013	**May 11, 2013 - May 20, 2013**	**May 20, 2013 - May 31, 2013**
Trial Group	34 smolts released upstream	34 smolts released upstream	34 smolts released upstream
Control Group	15- 20 smolts released downstream	15- 20 smolts released downstream	15- 20 smolts released downstream

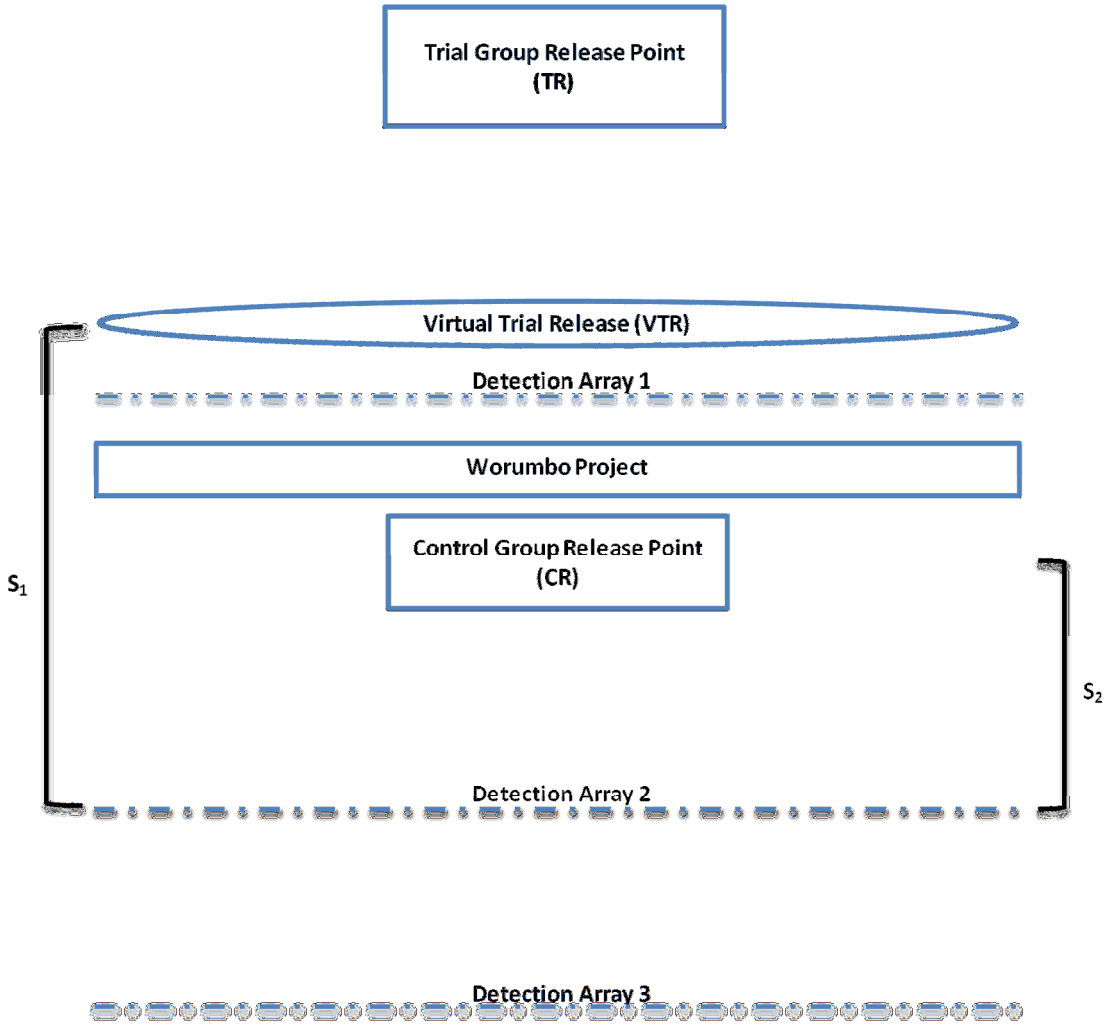
The trial groups of smolts will be released upstream of the Worumbo Project and the control groups will be placed downstream of the project. Smolts in the two test groups will undergo identical tagging and handling procedures prior to release. The paired release model will reduce the risk of including smolt mortality that is independent of the Worumbo Project. Both the control and trial group will have unique release and monitoring sites. The monitoring sites will be several kilometers downstream of the respective release points to avoid a positive detection of dead, tagged fish.

A total of 162 hatchery smolts will be required per year to conduct the downstream passage studies, with an additional amount of smolts required for the tag/life retention studies.

Antennas and receivers will be placed around the Worumbo Project to record smolt movement and location. Trial Group releases (abbreviated as TG in Figure 1) will occur at least 2.5 km upstream of the Worumbo Project, giving the hatchery smolts sufficient time to orient themselves before approaching the dam and selecting a passage route. The Worumbo Project boundaries start 200 meters upstream of the trash racks. To eliminate non-project related mortality, only the smolts detected within 200 meters of the dam will be used in the survival analysis. Non-project related mortality include any effect that occur upstream of the defined Worumbo Project boundary that prevent the smolts from reaching the Worumbo Project. Smolts that fail to reach the Worumbo Project will not be included in the Project's survival calculation. Smolts that reach Detection Array 1 will be defined as the Virtual Trial Release Group (VTR), as shown below in Figure 1. The Control Group release (CR) will estimate the survival rates between the two downstream detection arrays. Worumbo's downstream passage survival rate will be calculated by dividing the Survival Estimate (S_1) of the Virtual Trial Release (VTR) by the Survival Estimate (S_2) of the paired, Control Release Group (CR). Data from Detection Array 1 and 2 will be used to estimate detection probabilities that may adjust survival estimates. Detection Array 2 will be placed at a between the Worumbo and Pejepscot projects

and at least 3 km downstream of the Worumbo Project point that will prevent the detection of dead tagged fish. The Detection Array 3 will be located co-incident with Pejepscot's upstream array. [Note the distance between Worumbo and Pejepscot is approximately 5.4 kilometers] downstream of Detection Array 2. Site conditions will determine the exact location of each downstream array, as site access, power line interference, and landowner permission must be considered during array placement. Smolts detected at the downstream arrays are assumed to be alive depending upon the time of travel. Data from the three individual trials will be aggregated to estimate Worumbo's downstream passage survival rate. Please reference Figure 2 below for a diagram of the study.

FIGURE 1: Downstream Radio Telemetry Study Diagram



Survival Rate of Worumbo Dam = $S_{dam} = S_1 / S_2$

C. Study Timing and Source of Fish

Downstream smolt migration studies will occur during the normal 2013 migration season. Downstream migration typically occurs when temperatures reach approximately 10 degrees Celsius. This temperature threshold usually occurs in early to mid-May. Temperatures of approximately 18 degrees Celsius are considered critical levels, where the health and survival of smolts is compromised. No trials will occur at temperatures above 18 degrees Celsius.

Miller Hydro Group is proposing to use hatchery Atlantic salmon smolts from the Green Lake National Fish Hatchery. MHG will work with the necessary resource agencies to secure required approval to conduct the downstream passage study. MHG has been in communication with NMFS and USFWS regarding the process of securing hatchery fish and developing an approved study plan.

D. Tagging, Holding, and Release Procedures

Best practice techniques will be used to minimize stress resulting from handling and tagging. Radio tags will be surgically implanted. Surgical implementation of radio transmitter tags will follow methods outlined in previous studies such as described by Adams et. Al (1998a and 1998b). Fish will be handled as little as possible. Holding water will be appropriately oxygenated by aerated pumps and air stones. The water will be changed after each batch of smolts is processed. Tag weight must not exceed 5% of the weight of the fish. Studies have shown that swimming performance of juvenile salmon is compromised when tag weight ratio exceeds 5% (Adams, et al. 1998a).

Smolts will be anesthetized using the best practice tagging procedures. Smolts will be weighed to the nearest 0.1 gram, measured to the nearest millimeter, and have the radio transmitter code confirmed and recorded. All data will be recorded. Short term tagging effects, tag retention, and post tag mortality will be evaluated.

The smolts will then be taken to the respective release points. The exact release point will be specified prior and subject to change depending on river conditions and access. If possible, smolts will be released on both sides of the Androscoggin. Smolts should be placed in the river after sunset.

E. Tag Life – Tag Retention Study

During the first tagging session, an additional randomly selected group of 10 tags and 10 smolts will be tagged and placed in holding tanks with circulating river water (or water of similar temperature as holding facilities are available) and held for seven days in order to assess the battery life and retention of the radio tags. Battery life can vary from the manufacturer's estimated life due to temperature effects and other factors including tag failure. These 10

tagged fish will be monitored continuously in order to determine the time span when each of the tags remains operational.

Any tags that are expelled from the incision on the fish will also be recorded. Careful tagging procedure will minimize the potential for tag expulsion but on occasion a tag can be expelled out of the incision as the fish moves through the river. The fish can continue downstream, but the tag will no longer be detected and that fish will be falsely assigned as a mortality. These numbers will be factored into the survival estimates for the study fish in the river to correct for any bias that might result from prematurely failing tags or tags that may get expelled out of the fish.

F. Radio Telemetry Equipment

The smolts used in the downstream study are estimated to travel up to 15 kilometers, depending on the exact location of the release and downstream detection arrays. A previous study on Atlantic salmon smolts in the Penobscot River reported that mean migration rates were 1.46 km/hr (USGS unpublished data). MHG anticipates that the smolts will pass both the Worumbo Project and Pejepscot Project boundaries within 1 to 3 days. Radio tags must have a minimum stated life of 10 days. The radio tag signals will use the same frequency but each smolt will have a unique identifying code. The radio transmission interval will be 2 seconds, which can support fast moving migration and fulfill the study's battery life requirements.

Coded tags will be deployed, allowing all antennas and receivers to continuously scan on a single frequency. A radio transmitter with a 2-second interval between transmissions will be required. A radio transmitter with a 2-second interval between transmissions will be required. For this study, Lotek Nano NTC-3-1 or similar coded radio transmitters will be used with a 2-second interval between transmissions. Lotek calculates the standard
battery life for these tags at a 2-second ping rate to be 20 days (Lotek Wireless Inc).

G. Monitoring Stations

Data stations will be set up at and around the Worumbo Dam. Each station will have a radio telemetry antenna, data logger, receiver, and battery. Tests will be run prior to studies to optimize detection ranges, and stations will receive data continuously throughout the study. Beacon tags will be placed during the installation of the data stations and used to test the detection ranges throughout the project.

The figure below illustrates a preliminary plan to place the monitoring stations. The proposed locations of the stations may need to be modified as required as a result of any issues during the installation process. Issues could include detection problems, interference, or site constraints. The focal areas, represented by the red ovals, for each antenna (placed at the red

cross) will be configured in a way that will capture radio tag signals within 200 meters of the Worumbo Project. The red ovals do not represent the actual detection ranges to scale. Coverage and range will be determined and adjusted as necessary during installation, with the objective of providing detection ranges out to 200 meters upstream of the trash racks. Each antenna will have discrete reception fields that measure downstream passage routes. The downstream antenna range will provide data on the amount of smolts passing through the powerhouse. The orange square represents the location of drop antennas, which will be placed in front of the downstream passage system. An antenna station will be set up downstream to measure the fish passing through the powerhouse.

There will be three unique types of antennas deployed during the study. The antenna types are: 4 element Yagi antennas, 6 element Yagi antennas, and an underwater (drop) antenna. The 4 element Yagi antennas will provide the largest directional ranges upstream of the dam. The 6 element Yagi antennas will be placed at downstream bypass channels and have a narrower detection field.

FIGURE 2: Approximate Antenna Range and Placement

H. Data Collection

Before monitoring studies begin, all antennas will undergo testing to confirm adequate detection range and performance. Data will be downloaded from the receiver arrays every 1 to 3 days. Data will be backed up when downloaded from the receiver. Data will include the following: start date, code, average pulse rate, average signal strength, and end date. River condition data will also be monitored throughout the study. River data will include temperature, flow, and fishway flow.

Tag detections will be validated by sorting and filtering the radio-signal data using multiple criteria including: (1) the power threshold level of the signal, (2) the frequency of the radio-tag signals per unit of time, and (3) the geographic and timing distribution of the radio signals within the antenna arrays at a site. To determine the power threshold for a valid tag signal a distribution of power levels can be constructed for each antenna based on background noise signals known not to have come from tagged fish since these signals are collected prior to releasing any tagged fish. These false signals are typically at relatively low power levels. The frequency of the signal detections will be determined over a set period of time such as at least 3 detections within 3 minutes. Finally, the spatial distribution of detections on multiple antennas will be examined to determine if subsequent detections occur at locations where it is highly unreasonable for a fish to transit between those locations within the time between the detections.

III. Adult Upstream Passage Study

A. Study Objective

Upstream adult Atlantic salmon passage will be conducted in order to evaluate the success rate of upstream passage at Worumbo. The study results will be used to identify any necessary upstream passage improvements. Performance standards will be established and tested once upstream passage at Worumbo is better understood.

B. Study Methods

The Maine Department of Marine Resources (MDMR) collects biological information on Atlantic salmon passing through the Brunswick fishway. Miller Hydro Group has and will continue to cooperate with MDMR personnel and research efforts. The current use of Passive Integrated Transponder (PIT) tags currently deployed at Brunswick will provide valuable information on the number and timing of upstream Atlantic salmon migration at Worumbo.

Miller Hydro Group will conduct upstream passage monitoring studies using the PIT tagging and tracking methodology in the MDMR's study. MHG will install PIT tag tracking equipment at the Worumbo fish lift entrances and exit. A PIT tag receiver will also be installed at the mouth of the Little River. The trackers will indicate the number of salmon that successfully use the upstream fish lift at Worumbo. To minimize the handling stress of collection activities, PIT tagging and testing will be done concurrently with studies at the Brunswick fishway. It is assumed that a similar PIT tag study will occur in 2013 at the Pejepscot Project. For purposes of this study, it will be assumed that all tagged salmon that pass the Pejepscot Project will be motivated to either pass the Worumbo Project or spawn in the Little River.

C. Data Collection

Radio tag signal receivers will be placed along the dam to monitor the presence of tagged salmon. A log will indicate the radio tag and approximate location of the salmon.

Radio tag signals will also be placed, if possible, around the Little River, to capture information on the frequency and number of salmon.

IV. Downstream and Upstream Passage Study Schedule

The downstream studies are proposed to occur based on the following schedule:

- April 2013 (or as soon as flows permit): Install and test telemetry stations. This is impossible for the mid river location.
- May 2013: Conduct Downstream passage monitoring study.
- June and July 2013: Conduct Upstream monitoring study.
- August 2013 – December 2013: Analysis of data captured during passage studies. Report preparation reviewing outcome of studies.
- Subsequent years (2014 and 2015) are generally expected to follow a similar schedule.

V. Downstream and Upstream Study Funding

Miller Hydro Group will provide all the required funding for to complete the downstream passage study.

Miller Hydro Group will provide the funding for the PIT tag monitoring stations and contribute its reasonable share of the cost for its PIT tags.

VI. Works Cited

Adams, N.S., D.W. Rondorf, S.D. Evans, and J.E. Kelly. 1998a. Effects of surgically and gastrically implanted radio transmitters on swimming performance and predator avoidance of juvenile Chinook salmon (*Oncorhychus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences 55:781-787.

_____. 1998b. Effects of surgically and gastrically implanted radio transmitters on growth and feeding behavior of juvenile Chinook salmon. Transactions of American Fisheries Society 127:128-136.

In consultation with NMFS, Miller Hydro Group developed the upstream and downstream study plan methodologies based on plans previously submitted by Black Bear Hydro Partners for the Orono, Stillwater, Milford, West Enfield, and Medway hydroelectric projects.