Study Plan for Determination of Downstream Passage Routes and the Post Passage Condition of Atlantic Salmon Smolts Using the Hydro Kennebec Project's Fishway

Prepared for
Hydro Kennebec, LLC
A Member of the Brookfield Group
1024 Central Street
Millinocket, ME 04462

Prepared by
NORMANDEAU ASSOCIATES, INC.
25 Nashua Road
Bedford, NH 03110

R-21335.099

March 2011

1.0 INTRODUCTION

1.1 Background

As required by a 1998 settlement agreement with the Hydro Kennebec Developers Group, and as approved by the Commission on April 21, 2006, Hydro Kennebec L.P. installed interim downstream fish passage facilities at the Hydro Kennebec Project in 2006. These facilities, which were designed through consultation with the Maine Department of Marine Resources (DMR), Maine Atlantic Salmon Commission (ASC), United States Fish and Wildlife Service (USFWS), Maine Department of Inland Fisheries and Wildlife (MDIFW), and the National Marine Fisheries Service (NMFS), include a 10' deep angled fish boom in the forebay leading to a 4' wide by 8' deep slot (the fish bypass) capable of passing 4% of turbine flow. The slot is cut into the wall between the turbine intakes and the bascule gate structures, and discharges to a plunge pool next to the powerhouse. The plunge pool in turn leads to the turbine tailrace. Additional improvements were made to the fish passage facilities prior to 2007 operations, including (1) the installation of a weir in the fishway to deepen the plunge pool (to minimize the potential for fish injury), and (2) completion of the operating mechanism for the gate structure. In addition, the fish boom was re-positioned (raised) to prevent overtopping in June 2007 following an inspection by the USFWS.

1.2 Objectives

Field studies conducted at the Hydro Kennebec Project on the Kennebec River during 2011 are intended to address two objectives 1) assessment of the downstream fishway passage effectiveness for Atlantic salmon smolts passing the Hydro Kennebec Project, and 2) a mark-recapture assessment of the survival of Atlantic salmon smolts passed through the downstream fishway at the Hydro Kennebec Project. Specific objectives related to the mark-recapture study are to a) determine if Atlantic salmon smolts are injured or killed upon passage through the downstream fishway at the Hydro Kennebec Project; b) determine the mortality and injury rate with a precision of ± 10.0%, 90% of the time and c) if fish incur injuries attributed to passage at the fishway we will draw upon our extensive research at other projects to recommend operations or structural changes to minimize injury.

2.0 FISHWAY PASSAGE EFFICIENCY

2.1 Overview

Radio-telemetry techniques will be used to determine the efficiency of the projects downstream fish bypass system at guiding and passing radio tagged salmon smolts. The downstream bypass system includes a 10 ft deep angled fish boom in the forebay leading to a 4' wide by 8' deep slot capable of passing 4% of turbine flow. The slot is cut into the wall between the turbine intakes and the bascule gate structures, and discharges to a plunge pool next to the powerhouse. The plunge pool in turn leads to the turbine tailrace.

Downstream fishway effectiveness will be evaluated by releasing and monitoring radio tagged smolts with the bypass gate set to pass 4% of turbine flow. It is anticipated that the first release will occur in mid-May during a non spill condition.

To evaluate the effectiveness of the downstream fishway, 5 groups of 20 radio-tagged fish will be released approximately 0.25 miles upstream of the Project during periods of no spill. The intent of releasing smolts during a non-spill period is to maximize the number of smolts exposed to the guidance boom and downstream fishway. Passage efficiency will be calculated as the percentage of all smolts passing the Project via the downstream fishway. Individual radio tagged smolts which remain upstream of the Project will not be included in the evaluation of downstream fishway efficiency.

2.1.1 Radio Telemetry Equipment

Salmon smolt utilization of the downstream fishway will be assessed using Lotek SRX 400 radio telemetry receivers programmed with Code-Log software version W30 (receivers). The receiver will identify the pulse trains (codes) of VHF radio transmitters (radio tags) within a specified set of frequencies (channels) by sequentially scanning and recording valid signals in a 512k byte non-volatile data storage memory. At the downstream fishway and unit intakes, where it is anticipated that fish will pass quickly, a DSP 500 Digital Spectrum Processor (DSP) will be utilized. The wideband digital receiver/coprocessor provides frequency discrimination using real or near real time spectrum analysis allowing for optimal temporal/spatial resolution. The DSP accomplishes this task by mapping input signals onto a 1 MHz baseband, which is then digitized by a 1-bit sampling analog-to-digital (A/D) converter.

Digital radio tags (model NTC-3-1, Lotek Engineering), which measure 6.3 mm x 14.5 mm and weigh 0.8 g in air, will be used for this study. These tags transmit signals on one channel corresponding to a set frequency of 149-152 MHz. When set at a 2.5 second burst, these tags will operate for 11 days.

Two types of antennas will be used for the study: Cushcraft P150-4 four-element Yagi antennas (4-element antenna) and custom-made underwater antennas (dropper antenna). Four-element antennas are aerial antennas that provide the greatest directional reception range of any antenna used in the study. The 4-element antenna will be used to confirm the upstream presence or downstream passage of fish.

Dropper antennas will be vertically deployed. The dropper antennas ability to be placed at various depths in or below structures will be used to form reception ranges at points of passage (downstream fishway and turbine units). These antennas will be constructed by stripping the shielded end of a 50-OHM RG58A/U coaxial cable, the length of the stripped portion of cable is a multiple of half the wavelength (λ) of 150 MHz.

2.1.2 Radio Telemetry Monitoring Locations and Antenna Arrangements

Figure 1 includes the three radio telemetry monitoring station locations and coverage area. Monitoring station 3 in Figure 1 is a general portrayal of the river coverage area (i.e. bank to bank) but its exact location will be determined following consultation with Brookfield.

Monitoring Station 1: Monitoring Station 1 will be used to monitor the headpond area and will be responsible for documenting radio-tagged smolts approaching the Project. This station will consist of one receiver connected to one 4-element Yagi antenna located along the wing-wall adjacent to the upstream side of the powerhouse.

Monitoring Station 2: Monitoring Station 2 will be installed to monitor the downstream fishway as well as Units 1 and 2 of the Projects powerhouse. This station will utilize one DSP receiver and 6 dropper antennas (two located in the downstream fishway and two located in each of the two unit intakes). A DSP will be used due to the expected high velocity flows through these passage routes.

Monitoring Station 3: Monitoring Station 3 will be installed downstream of the Project tailrace. This station will consist of one receiver connected to one 4-element Yagi antenna and will be set up using deep cycle batteries and a solar panel if no power exists downstream of the project. This receiver will monitor all radio-tagged smolts that pass the Project and document that they continued their downstream movement. This receiver will also be used to document fish passing the Project via the bascule gates. Should spill through the bascule gates occur during the test period, smolts passing via that spill will be identified by subtracting out the fish detected by Monitoring Station 3 that were determined to have passed via the downstream fishway or Project turbines by Monitoring Station 2.

Manual monitoring from the shoreline and/or boat to assist in smolt passage assessment will occur near daily both upstream and downstream of the Project following release of each group.

2.1.3 Fish Procurement, Tagging, and Release

Hatchery-reared Atlantic salmon smolts will be used for the study and will be supplied by the Green Lake National Fish Hatchery in Maine. A group of approximately 200 fish (to be used for this study as well as the mark-recapture study detailed below) will be transported from the hatchery to the Hydro Kennebec Project in an aerated fish transport tank equipped with a water recirculation system and placed in tanks with flow through water systems.

Smolts for each release will be tagged in five groups of 20 fish per release (for a total of 100 radio tagged smolts). For each tagging event, smolts were anesthetized with clove oil and a radio transmitter will be inserted through the esophagus and placed in the stomach of each fish. After tagging, smolts will be measured to the nearest 1 mm fork length and transferred into a holding tank supplied with flowing river water. The smolts will be held for approximately four hours to observe smolt condition and account for any tag regurgitation prior to release. Releases will take place approximately 0.25 miles upstream of the Project and will occur after dark. Radio-tagged smolts will be let go in small groups so that all 20 are released within an hour or so after dark. We will release the first group of 20 test fish during May when spill conditions are under control and continue the releases over a two week period. Since the agencies are concerned about the effectiveness of the downstream bypass and guidance boom, we will attempt to conduct releases during a period when the bascule gates are not spilling. The remaining smolts not tagged at the end of the study will be released into the Kennebec River downstream of the Project.

2.1.4 Data Collection and Analysis

Data will be off-loaded from receivers daily throughout the study period with a laptop computer and stored on removable memory sticks. Backup copies of all telemetry data will be made prior to receiver initialization. Data will be consolidated into a PC database for review and verification.

Data will be stored in the SRX_400 receivers as either a single event or a period of multiple events. If a fish was detected and remained in the reception area for a given period of time, it will be recorded as a continuous event. Single events or events occurring greater than ten minutes apart will be recorded individually. Data stored for each event will include start date, start time, channel, code, average pulse rate, average signal strength, end date, and end time.

2.1.5 Reporting

A draft report on the results of all releases will be developed by August 31, 2011 with a final report prepared by September 30, 2011.

3.0 BYPASS MARK-RECAPTURE STUDY

3.1 Overview

Spillway and bypass passage routes at power stations are not always completely safe for emigrating fish using these routes. Normandeau Associates Inc. has used its HI-Z tag fish recapture technique (Heisey et al. 1992) to assess condition of both juvenile and adult fish passing these routes at close to 100 different projects. These evaluations have found that structures in the path of the discharge from spillway and bypasses can cause injury to passed fish, particularly if fish intercept structures at high velocities and/or there is little water depth in the vicinity of these structures (Heisey et al. 2008, Johnson et al. 2003, Mathur et al. 1996, 1999).

The HI-Z fish recapture technique will be used to address the USFWS concern that turbulent conditions within the downstream fishway at the Hydro Kennebec Project may cause injury to passing fish. To conduct this evaluation, a total of 50 test fish will be released through the downstream fishway. A total of 25 individuals will be released downstream of the tested passage route to serve as controls. Mortalities and/or injuries associated with passage through the downstream bypass will be recorded as well as the type and severity and likely cause of injury.

3.1.1 Fish Procurement, Tagging, and Release

Hatchery-reared Atlantic salmon smolts will be used for this study and will be supplied by the Green Lake National Fish Hatchery in Maine. A group of approximately 200 fish (to be used for this study as well as the fish bypass efficiency study detailed above) will be transported from the hatchery to the Hydro Kennebec Project in an aerated fish transport tank equipped with a water recirculation system. Fish will be held in circular tanks (approximately 500 gal) located near the test site and will be continuously supplied with ambient river water and covered to prevent fish

from escaping. The salmon smolts will be held for 24 hrs after transport to allow for recovery from the stress associated with capture and transport.

During the tagging process, two HI-Z tags will be attached to each smolt as well as a small radio tag. All test and control smolts will be measured to the nearest 1 mm fork length. Prior to release into the river, the HI-Z tags will be activated. Test smolts will be released directly into the downstream fishway. Control smolts will be subjected to the same handling and tagging procedures as test fish but will be released into the Project tailrace, downstream of the downstream fishway. Following release, the HI-Z tags for both test and control fish will inflate after approximately 2 – 4 minutes and buoy the fish to the surface where they will be retrieved by boat crews using dip nets. Upon recapture, inflated HI-Z tags and the radio tag will be removed, and each fish examined for injuries. Each fish will be assigned a condition code that categorizes initial physical injuries. Fish will then be held on site in pools for 48 h to assess delayed effects of passage. Following the 48 hr holding period, all live fish will be anesthetized for an additional injury evaluation. Photographs of the injured fish will be taken. Injury classification categories are provided in Section 3.1.2 of this study plan.

3.1.2 Data Collection and Analysis

Each tagged fish will be classified as alive, dead, or unknown, and severity of any injuries will be determined. Recapture rates will be calculated based on the number of alive and dead fish physically retrieved compared to the total number of fish released. All fish that die following passage will be necropsied to assess the probable cause of death. Severity of injuries will be further categorized based on the following criteria.

- A fish with only loss of equilibrium (LOE) is classified as major if the fish dies within 1 hour. If it survives or dies beyond 1 hour it is classified as minor.
- A fish with no visible external or internal maladies is classified as a passage related major injury if the fish dies within 1 hour. If it dies beyond 1 hour it is classified as a non passage related minor injury.
- Any minor injury that leads to death within 1 hour is classified as a major injury. If it lives or dies after 1 hour it remains a minor injury.
- Hemorrhaged eye: minor if less than 50%. Major if 50% or more
- Deformed pupil(s) are a: major injury.
- Bulged eye: major unless one eye is only slightly bulged. Minor if slight.
- Bruises are size-dependent. Major if 10% or more of fish body per side. Otherwise minor.
- Operculum tear at dorsal insertion is: major if it is 5 % of the fish or greater. Otherwise minor.
- Operculum folded under or torn off is a major injury
- Scale loss: major if 20% or more of fish per side. Otherwise minor
- Scraping (damage to epidermis): major if 10% or more per side of fish. Otherwise minor
- Cuts and lacerations are generally classified as major injuries. Small flaps of skin or skinned up snouts are: minor.
- Internal hemorrhage or rupture of kidney, heart or other internal organs that results in death at 1 to 48 hours is a major injury.
- Multiple injuries: use the worst injury

3.1.3 Reporting

A draft report on the results of the HI-Z tag study will be developed by August 31, 2011 with a final report prepared by September 30, 2011.

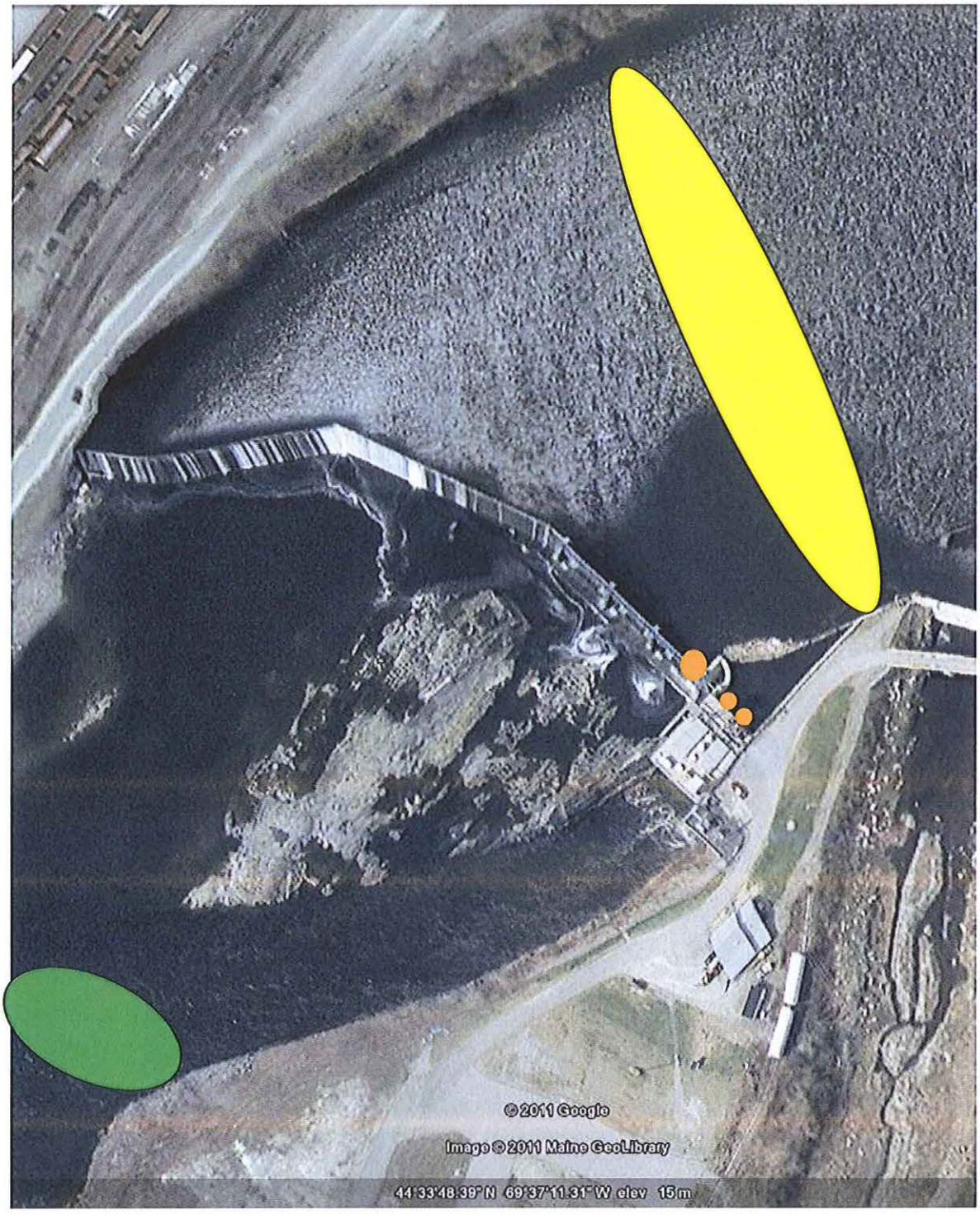

Figure 1. Locations and approximate coverage area for telemetry monitoring stations 1 (yellow), 2 (orange) and 3 (green) at the Hydro Kennebec Project.