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Eel Passage Research Center – 2014 Year-End Update

Background and Introduction

Downstream passage of eels at hydroelectric projects is a concern in several regions of the world, including the Atlantic Coasts of North America, Europe, Scandinavia, and the British Isles; as well as Australia, New Zealand, and New Guinea. The concern is perhaps greatest for the closely-related species of the North Atlantic – the American eel (*Anguilla rostrata*) and the European eel (*Anguilla anguilla*). The European eel is listed as critically endangered by the European Union and Norway, and the American eel faces possible listing under the U.S. Endangered Species Act and the Canadian Species at Risk Act. Currently the American eel is listed as a Species of Concern by the Canadian federal government and as endangered by the Ontario Provincial Government. In late 2014, the International Union for the Conservation of Nature (IUCN, "Red List") classified the American eel as endangered. Hydropower projects distributed over the portions of North America, Europe, Scandinavia, and the British Isles draining to the Atlantic Ocean face mandates to provide safe downstream passage for eels.

Upstream passage for juvenile eel at hydroelectric projects is relatively straightforward, with established design and operational parameters for eel ladders. Downstream passage of adults at hydroelectric projects, however, has proven to be problematic, especially at larger facilities with deep and wide intake structures. Behavioral characteristics of eels during downstream migration make turbine passage protection and guidance to alternative passage routes challenging. As part of the relicensing of the St. Lawrence FDR Project (FERC Project No. 2000) New York Power Authority (NYPA) conducted a number of extensive field studies investigating means of guiding and collecting migrating adult eels for transport around the Robert Moses Power Dam. Following relicensing, NYPA commissioned a review of technologies for guiding, capturing, holding, transporting, and monitoring outmigrating eels (Versar 2009) that constitutes a comprehensive assessment of the state of science and technology related to downstream passage of anguillid eels.

Currently, no effective method exists to safely pass eels around large, operating hydroelectric facilities. Measures mandated at some smaller facilities are also problematic for plant operators due to the protracted, episodic nature of outmigration and the lack of effective protection and passage technologies. As regulators and fisheries managers effectively press for upstream eel passage, there is the expectation that downstream passage measures will be implemented in the future when the eels passed upstream mature and migrate downstream to the sea.

Action Plans for Canadian generators on the St. Lawrence River contain mandates to address the challenge of downstream eel passage through targeted research to reduce turbine mortality at Ontario Power Generation's R.H. Saunders Generating Station and Hydro Quebec's Beauharnois Generating Station The settlement agreement reached as part of the relicensing of New York Power Authority's St. Lawrence-FDR project established the $24 million Fish Enhancement, Research, and Mitigation Fund (FEMRF). The purpose of the FEMRF is to benefit fisheries resources in the Lake Ontario/St. Lawrence River Basin and to continue research on the American eel and other species that may be affected by the Project. The research required by the Canadian Action Plans for the St. Lawrence River and the FEMRF purpose to fund eel passage research provided the impetus to organize a collaborative research center to coordinate these discrete but aligned interests.

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Purpose and Scope

The EPRI-led Eel Passage Research Center (EPRC) was established to meet the need for coordinated, collaboratively-funded research to address the challenge of safe downstream passage of American eel at hydropower projects on the St. Lawrence River. This multi-national effort builds upon previous research conducted on the St. Lawrence River by current funders of the EPRC.

Problem Definition

The EPRC's R&D activities address the following goal:

> *Maximize the survival rate of eels that would otherwise pass through turbines at Moses-Saunders and Beauharnois without significantly reducing power production*

Research and development to attain this goal will support three management objectives:

- Concentrate adult eels for downstream transfer around turbines at Moses-Saunders and Beauharnois Generating Stations
- Transfer adult eels downstream around turbines at Moses-Saunders and Beauharnois Generating Stations
- Demonstrate effectiveness of selected methods

Physical screening of intakes has been deemed infeasible; thus, research to address the first objective will investigate and develop one or more technologies to guide eels to a collection or bypass location using the eels' behavioral response to sensory stimulation. Stimuli may include (individually or in combination):

- light
- sound
- pressure
- electricity
- electro-magnetic field
- water velocity, turbulence, or shear
- chemicals
- others yet to be identified

Research will be needed to identify means of transferring eels from an area of concentration around the Moses-Saunders and Beauharnois generating stations. Depending upon the distance involved, this could include capture and transport (e.g., trucking, barging) or bypass via a conduit.

Effectiveness of various stimuli, technologies, and devices must be demonstrated during research, development, demonstration, and full scale deployment. Research is needed to develop tools and techniques to assess effectiveness of guidance and collection technologies.

The scope of Eel Passage Research Center R&D encompasses and is limited to that which is necessary to achieve the three management objectives described above. While other R&D may support recovery and sound management of eels in the Upper St. Lawrence River, it is outside of the current scope of activities for the EPRI-led Eel Passage Research Center.

Location

The primary venue for field-based research and development is the St. Lawrence River, above Montreal (Figure 1). Field-based research may be conducted at other locations, if doing so advances the purpose of providing safe downstream passage on the St. Lawrence River. Such research may be conducted on a smaller system to facilitate deployment and investigation of a sub-scale, prototype device; or in another location because of greater availability of migrating eels for study. Laboratory studies also may be appropriate if they support the goal and objectives of the EPRC.

Figure 1. Geographic focus of the Eel Passage Research Center. Map courtesy of New York Power Authority

Center Structure, Funding, and Administration

The Eel Passage Research Center is organized and managed by the Electric Power Research Institute (EPRI). The Eel Passage Research Center is a virtual center. It has no facilities, equipment, or staff of its own; rather, it is an administrative structure for collaboratively funding and conducting eel passage research. It encompasses multiple funding types and multiple research projects extending over a period of at least five years. Currently, all funding is directed toward a single program of research and all funders have access to the entire portfolio of research. In the future, however, the EPRC may encompass multiple programs of research with differing suites of funders.

Funding Structure

Current funders of the Eel Passage Research Center (EPRC) are hydroelectric generators in Canada and the United States concerned with mitigating turbine passage mortality at their facilities and the Fish Enhancement, Mitigation and Research Fund which is administered by the U.S. Fish and Wildlife Service. The Eel Passage Research Center (EPRC) currently comprises three classes of funding. Tier 2 funders participate in all activities of the EPRC and have immediate access to all EPRC products. Tier 1 funders have these privileges and also provide direct input to the overall theme and specific content of the research that takes place. Current Tier 1 funders have specific interest in eel passage on the St. Lawrence River. Tier 1 and Tier 2 funding is for a term of five years.

Ad hoc funding provides a mechanism for a funder (other than a Tier 1 or Tier 2 funder) to collaboratively fund and participate in a defined subset of the EPRC research portfolio. Participation and access to research products will be limited to that subset of the research portfolio. The amount and term of ad hoc funding is case-specific. If the level of interest and funding warrants it, a parallel structure will be developed specifically to address eel passage challenges for facilities other than those on the St. Lawrence River.

Administrative Structure

The EPRI-led Eel Passage Research Center draws upon contributions from a Management Committee, a Technical Committee, a technical support contractor, and R&D contractors. The respective roles of these entities is described below.

EPRI Scope of Services

EPRI provides overall technical leadership and management of the Eel Passage Research Center. This includes recruitment of funders; Center planning; reporting, selection and management of R&D contractors; meeting facilitation and management; and implementation of the terms of reference as defined in the funding agreement between EPRI and Center funders. EPRI has acquired the services of a support contractor for assistance with these tasks.

Management Committee

Final recommendations to EPRI regarding research scope and funding decisions are developed by consensus of a Management Committee comprising the EPRI Project Manager and a single representative of each Tier 1 funding organization.

Technical Committee

The technical deliberations of the Eel Passage Research Center take place among a Technical Committee (Figure 2) comprising:

- Technical representatives from each of the Tier 1 funding organizations
- Technical representatives of the members organizations of the Eel Working Group of the USFWS-administered Fish Enhancement, Mitigation, and Research Fund
- Regulatory and resource management agency personnel individually selected by Tier 1 funders because of their engagement with Tier 1 funders' eel protection and mitigation activities.

Tier 1 funders are not limited in the number of representatives they may assign to the Technical Committee. Representatives of Tier 2 funding organizations may participate as observers of all Technical Committee activities.

Technical Committee activities include:

- Deliberation on the development of the Adaptive R&D Plan
- Preliminary specification of R&D priorities
- Deliberation on the development of R&D scopes of services
- Review of contractor proposals and advice on contractor selection
- Review of contractor deliverables and EPRI reports

From time to time the Technical Committee are polled to gain a sense of interests, concerns, and priorities; however, final decisions are informed by consensus among the members of the Management Committee.

Contracting

All contracting in support of the Eel Passage Research Center is by EPRI. This includes (Figure 2):

- Contracted technical and administrative support to the EPRI project manager
- Contracted R&D to advance the goal and management objectives of the EPRC

Contracts may be either sole sourced or competitively bid depending on which selection method is deemed by EPRI to best meet technical requirements in a cost-effective and timely manner. The Technical Committee provides input to EPRI's decisions regarding sole source versus competitively bid contracting.

With regard to R&D contracts, the Technical Committee:

- provides input to the development of draft scopes of work
- reviews draft scopes of work
- reviews proposals submitted in response to RFPs and sole source solicitations
- reviews preliminary final reports on contracted R&D projects

Summary of 2013 Activities

The Eel Passage Research Center (EPRC) commenced activities in 2013. During 2013, the following activities took place:

- organizational meetings were held,
- terms of reference were specified,
- funding agreements were established,
- a Management Committee was identified,
- a Technical Committee was established,
- technical workshops were held,
- bi-weekly update calls were held,
- research priorities were identified for 2014
- draft scopes of work for 2014 R&D were developed by EPRI, and reviewed by the Technical Committee,
- outreach activities were undertaken

Center Products

The principal products of EPRC activities in 2013 included:

- Supplemental Project Notice
- Terms of Reference and Preliminary Scope of Work
- Meeting and workshop reports and meeting materials
- Draft scopes of work for 2014 research priorities
- Adaptive R&D Plan (partial)
- Annual Report to Funders

Requests for Proposals were completed and released for two of the research priorities identified in 2013, and additional RFPs are near completion. The two released RFPs are:

- Assessment of Downstream Migrating American Eel Behavior: Reduced-scale Field and Laboratory Studies of Eel Behavior in Response to Various Behavioral Cues
- White Paper Investigation of Recent Research on the Effect of Light on Outmigrating Eels and Recent Advancements in Lighting Technology

Adaptive R&D Plan

The R&D planning over the five year funding term employs a structured approach to program design that is adapted from a framework for formulating complex ecological assessments. In the current application of the framework, the *Assessment Question(s)* indicated Figure 2, below, are actually R&D questions. Similarly, *Study Plan* becomes R&D Plan in the current application.

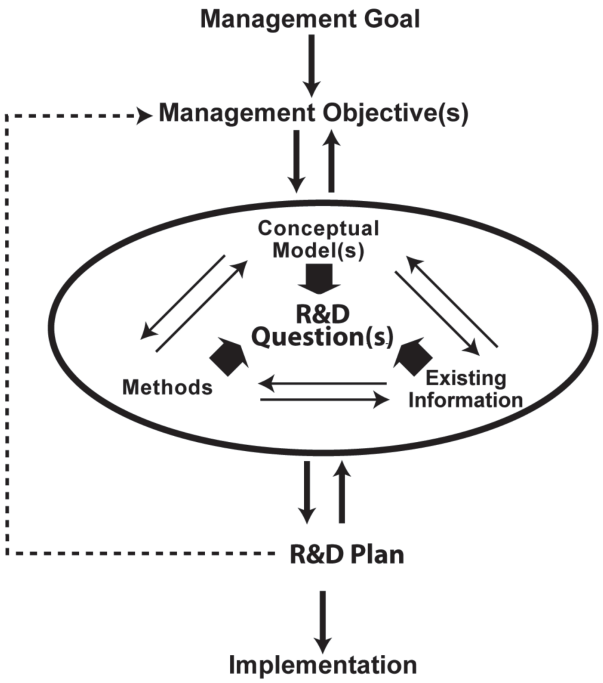

Figure 2. Framework for formulating the Adaptive R&D Plan. The dotted line indicates Management Committee review of the R&D Plan to ensure conformity to management goals and objectives.

The EPRC has adopted the following goal for its R&D activities:

> *Maximize the survival rate of eels that would otherwise pass through turbines at Moses-Saunders and Beauharnois without significantly reducing power production*

Research and development to attain this goal will support three management objectives:

- Concentrate adult eels for downstream transfer around turbines at Moses-Saunders and Beauharnois Generating Stations
- Collect and transfer adult eels downstream around turbines at Moses-Saunders and Beauharnois Generating Stations
- Demonstrate effectiveness of selected methods

Physical screening of intakes has been deemed infeasible; thus, research to address the first objective will investigate and develop one or more technologies to guide eels to a collection or bypass location using the eels' behavioral response to sensory stimulation. Stimuli may include (individually or in combination):

- light
- sound
- pressure
- electricity
- electro-magnetic field
- water velocity, turbulence, or shear
- chemicals
- others yet to be identified

Figure 3 depicts the conceptual model for eel migration on the Upper St. Lawrence River. The light blue ellipses indicate waterbodies separated from one another by water control structures indicated by gray ovals. The differing sizes of the blue ellipses are intended to highlight the differing quantities of habitat encompassed by each, including tributaries; however, the ellipses are not drawn to scale. The gray ovals depict all possible pathways for upstream and downstream movement by eels, whether they are actually used by eels or not. Text on the left hand side indicates sources of data on eel abundance and movement. The dotted lines with arrowheads on the right hand side of the picture (labeled B1 through B4) indicate possible bypass routes for eels.

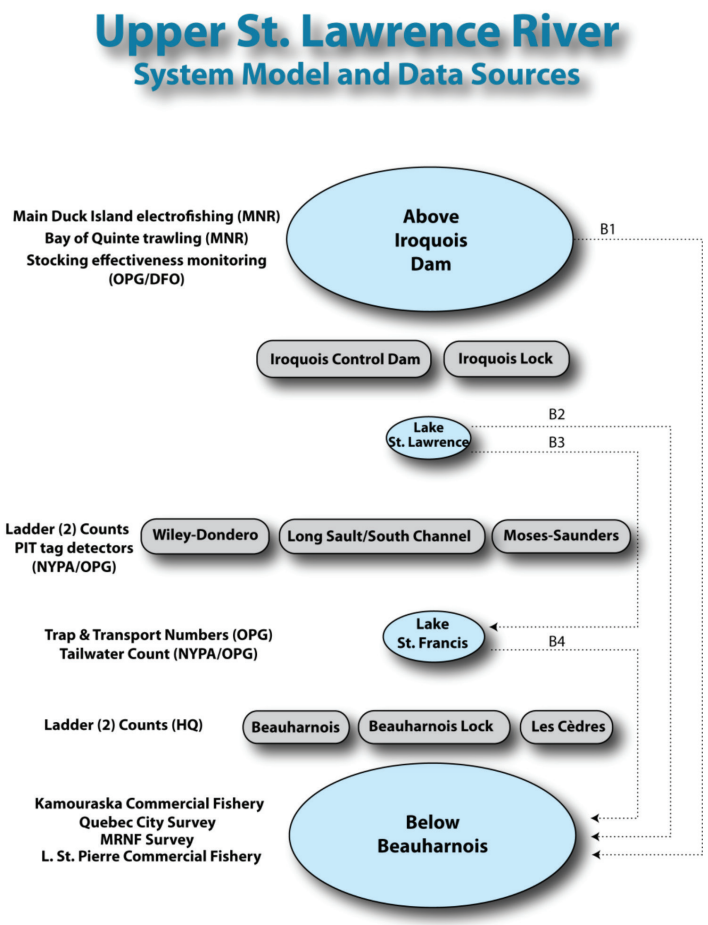

Figure 3. Conceptual model of the Upper St. Lawrence River system and data sources.

Figure 4 depicts a simplified conceptual model of American eel downstream migration on the upper St. Lawrence River, showing only those water control structures deemed significant for downstream passage. N_1 through N_4 (in red) indicate the number of outmigrants originating in the respective waterbody. B1 and B4 indicate the anticipated bypass pathways the EPRC research is intended to support. Aggregate turbine mortality for eels passing downstream via the Moses-Saunders Power Dam and Beauharnois Generating Station is indicated by m_1 and m_2 respectively. Studies of turbine mortality at Moses-Saunders and Beauharnois reported aggregate mortality rates of 25% and 18%, respectively. Information is lacking on the abundance and spatial distribution of eels above Beauharnois.

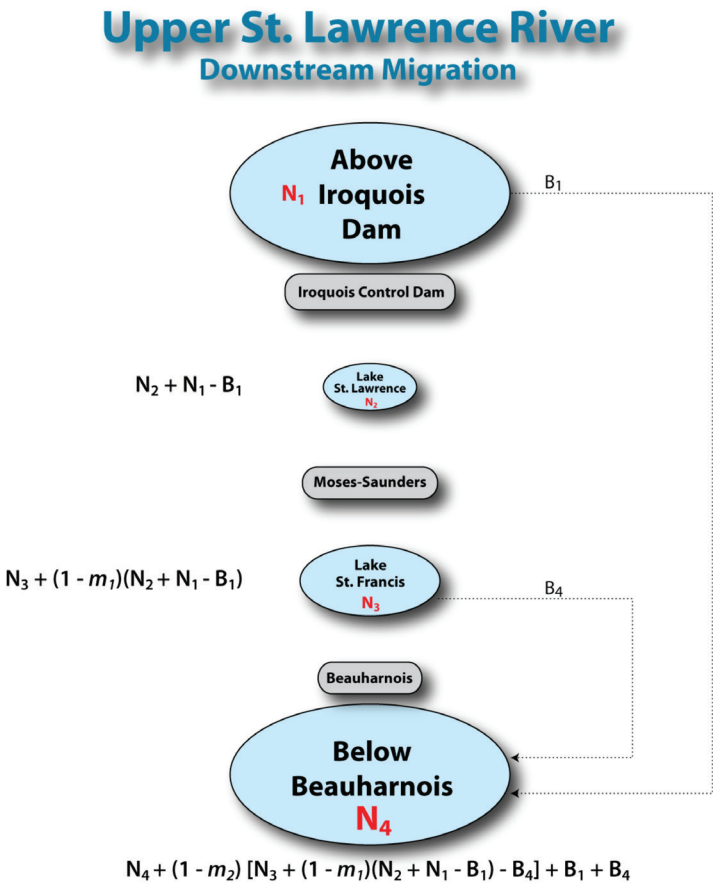

Figure 4. Simplified conceptual model of the Upper St. Lawrence River system for downstream migration.

Further work is required to complete the Adaptive R&D Plan and specify a comprehensive set of R&D questions and a decision framework addressing those questions in the most efficient manner possible.

Summary of 2014 Activities

In 2014, the Eel Passage Research Center released two additional RFPs:

- Assessment of Technologies to Study Downstream Migrating American Eel Approach and Behavior at Iroquois Dam, the Beauharnois Power Canal and the Beauharnois Generating Station
- CFD Model Development for Iroquois Control Dam and Beauharnois Approach Channel

The Technical Committee reviewed proposals received in response to the four RFPs and selected contractors for completion of respective projects.

Work commenced on two of the four projects:

- Assessment of Downstream Migrating American Eel Behavior: Reduced-scale Field and Laboratory Studies of Eel Behavior in Response to Various Behavioral Cues
- White Paper Investigation of Recent Research on the Effect of Light on Outmigrating Eels and Recent Advancements in Lighting Technology

On December 9 in Cornwall, Ontario, the project managers for these two projects reported to the Technical Committee on their preliminary results. Final draft reports for the respective projects are expected in February 2015.

CFD model development for Iroquois Control Dam and Beauharnois Approach Channel will commence in 2015. Ontario Power Generation conducted acoustic Doppler current profiler (ADCP) surveys in the vicinity of Iroquois Dam and in Beauharnois Power Canal to provide calibration data for the model development.

Assessment of technologies to study downstream migrating American eel at Iroquois Dam and Beauharnois Power Canal will commence in 2015 as well. In November, 2014, the contractor team met with selected Technical Committee members and visited Iroquois Control Dam to facilitate final project planning.

The Technical Committee held bi-weekly and ad hoc conferences calls throughout the year, and technical workshops were held on February 26-27, July 9-10, October 22-23, and December 9-10 to plan and review R&D activities. The technical workshops in July and October were held at Alden Research Laboratory in Alden, MA, to observe the experimental flumes and apparatus. A kick-off meeting among the Technical Committee and the team developing the white paper on the science and technology related to light for eel guidance took place during the American Fisheries Society annual meeting in Quebec City in August.

References Cited

Versar. 2009. *Review of Technologies for Guiding, Capturing, Holding, Transporting, and Monitoring Outmigrating Eels*. Prepared for New York Power Authority by Versar, Inc. July 2009.

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