HydroNet 1.4 Component: Biological Drivers of Productive Capacity

Rationale: Biological differences among river systems result in differences in the trophic efficiency of energy flow, which can lead to differences in productive capacity and to differences in how systems respond to flow regulation. Understanding the relative importance of biological factors, such as fish behaviour, survival and growth, and community trophic structure, helps identifying the environmental conditions that explain a significant portion of the variations in productive capacity within and among natural and regulated ecosystems and the impacts of various flow regimes.

Description: *The four projects to examine the biological drivers of PCFH address key biotic factors impacting fish and their habitats when river discharge is regulated for hydropower, compared with natural rivers, and evaluate the components of a successful fishway mitigation strategy:*

- ***Condition and survival*** in response to river flow regulation (*Lead Richard Cunjak, UNB-CRI);* quantifying the relationship between survival and condition of eggs and juvenile stages of autumn spawning fishes and the environmental factors (e.g., temperature, dissolved oxygen) affected by flow regulation, will identify how altered winter flows lead to increased or decreased egg survival and the ability to complete smoltification;
- Regional differences in ***fish biodiversity and their effects on fish production*** and trophic structure (*Lead Joseph Rasmussen, Lethbridge University);* exploring how biodiversity differs across Canada and how this affects trophic relationships and habitat use, allows quantifying how PCFH is influenced by fish biodiversity and how flow regimes affect fish biodiversity;
- ***Thermal habitat stability*** downstream of hydroelectric structures: (*Lead Michael Power, U Waterloo);* documenting changes in the mean and variance of individual fish growth and condition linked to modification of downstream thermal regimes identifies the implications of dam operations for growth in forage (e.g., sculpin) and migratory (e.g., brook charr) species by compensating for thermal regime changes.
- ***Hydraulic and biological evaluation of upstream sturgeon passage*** at the Vianney-Legendre Fishway (*Lead: Steven Cooke, Carleton Unversity);* researching the hydraulic conditions that favour or deter fish passage of sturgeon, combined with biomechanics and kinematics in a range of flow conditions, serves to develop and evaluate fish passage facilities for a range of species across Canada.

List of Student Projects related to this component:

- *Is Atlantic salmon egg survival a function of hyporheic water quality and or flow regulation?* - Paula Thoms (M.Sc. UNB-CRI)
- *Assessment of the winter condition of Atlantic salmon parr and pre-smolts experiencing hydropeaking flows* – Sherr Vue (M.Sc. UNB-CRI)
- *The physiological, behavioural and morphological responses of fishes to streamflow alteration and the consequent effects on population dynamics* – Adrian Hards (Ph.D. UNB-CRI)
- *Effect of regional differences in fish biodiversity on fish production and trophic structure* – Preston Lennox (Ph.D. Lethbridge University)
- *Effects of hydro-electric dam ramping rate regimes on fish growth, condition and habitat use* – Brianne Kelly (Ph.D. Waterloo)
- *Behavioural and biomechanical aspects of fish passage in lake sturgeon* – Jason Thiem (Ph.D. Carleton)
- *Advancing fishway science in Canada* – Charles Hatry (M.Sc. Carleton University)
- *The hydraulics of the Vianney-Legendre Vertical Slot Fishway and its' optimization for successful upstream fish passage* – Adam Marriner (M.Sc. Alberta)
- *Accessing how variable flow regimes influence the feeding ecology of fishes and food web structure of river communities* – Jaclyn Brush (Ph.D. Alberta)

Outcomes /Deliverables:

- Baseline data: egg survival and development of fall spawning salmonids as well as ability to complete smoltification, and key factors of flow regulation, measurable responses of fish to changes in a key habitat attributes (temperature; dissolved oxygen);
- Literature review: assessment of regional differences in biodiversity and trophic relationships, fish species richness and community production;
- Quantification of role of biodiversity on PCFH in different regions
- Design criteria and model for fish passage and potential costs.

Benefits from this research

Quantifying the role of biodiversity on the productive capacity and the structure and function of whole food webs on large spatial scales, understanding how seasonal flow regulation affects biological aspects of PCFH and how dam operations impact resident fish help fish and environmental management to assess the impacts of environmental disturbances of hydropower operations and to develop flow regulation strategies to minimize impacts.