NSERC CREATE training program in Lake and Fluvial Ecology

Research program 2014-2020

The EcoLac research program includes three main axes:

Axis 1 – Improving knowledge on freshwater ecology:

Themes developed through this axis will contribute to developing new fundamental knowledge and also provide the scientific basis needed for the sustainable development of aquatic resources in Canada and elsewhere in the world.

Research objectives: contribute to the development of empirical models and to the understanding of how aquatic ecosystems function.

- Theme 1.1 – Aquatic biodiversity: linking structure and function. This theme will expand our knowledge on the relationships between biodiversity and ecosystem functioning at a local scale, allowing a better understanding of biodiversity loss in environments affected by human activities.
- Theme 1.2 – Phenology of aquatic environments. This theme will examine seasonal changes in community structure at different spatial scales. The objective of this theme is to better understand the phenology of ecosystems, populations, and communities, especially in the context of future scenarios of environmental changes.
- Theme 1.3 – Thresholds and alternative states of aquatic environments. This theme aims to improve our understanding of alternative states of aquatic ecosystems in terms of their biogeochemical status as well as the population and community structure. Work here will improve our knowledge on the resilience of some types of communities and aquatic ecosystems, and on the potential thresholds that can prompt a change between two alternative states.

Axis 2 – Health and integrity of aquatic ecosystems facing multiple anthropogenic stresses:

Understanding the impact, magnitude, reversibility, and synergetic effects of different anthropogenic stressors is essential for managing and preserving the integrity of aquatic communities.

Research objectives: develop empirical models and understand mechanisms by which anthropogenic activities influence ecosystem functioning.

- Theme 2.1 – Response to biogeochemical changes: eutrophication and contaminants.

(i) Biogeochemical cycles: the cycles of major nutrients (P and N), heavy metals (Hg and As), and organic carbon have been profoundly altered by human activities. The magnitude and prevalence of changes in biogeochemical cycles will be described using numerical models and historical and paleolimnological analyses.

(ii) Harmful algae: the recent proliferation of cyanobacteria in Canadian lakes and worldwide is one symptom of biogeochemical changes and land use. This theme will examine the links between cyanobacteria and lake morphometry, nitrogen and phosphorus dynamics, the structure of food webs, and gas exchange.

- Theme 2.2 – Responses to biological stress: from genes to the community. The cascading effects of biological changes on the ecology of freshwater environments are the main focus of this theme. Exotic invasive species (animals and plants), overexploitation of some fish species, and hypoxia that is occurring in many lakes worldwide are among the stressors acting on freshwater ecosystems
- Theme 2.3 – Physical alteration of habitats. This theme will examine how alterations in the physical habitat can influence aquatic communities. A subtheme will study how climate changes will influence the structure of physical habitats and what the impacts will be on biogeochemical cycles, population dynamics, and food-web structure.

Axis 3 – Aquatic networks in relation to landscape and society:

The regional and global importance of inland waters is increasingly acknowledged. Inland waters act as catalysts for biogeochemical processes, as atmospheric carbon sinks or sources, as biodiversity hotspots, and as a key provider of services to society. Coordinated research efforts are needed to address these issues at a larger scale because of the need to integrate many disciplines.

Research objectives: understanding communities and the functioning of aquatic ecosystems at the landscape level, in terms of species' distribution, biogeochemical processes, links between aquatic and terrestrial habitats, and ecosystem services.

- Theme 3.1 – Genetic and metacommunity connectivity. Freshwater habitats are highly vulnerable to climate changes, with extinction rates equal to or higher than marine and terrestrial taxa. Populations and communities in lakes and rivers are part of interconnected regional networks. Thus, the evaluation of their response to climate changes must include metapopulation and metacommunity approaches. This theme will evaluate population distributions and connectivity at regional and landscape levels with the aim of improving our understanding of their mechanisms and developing distribution–climate models for key aquatic species.
- Theme 3.2 – The role of aquatic networks in the regional biogeochemical budget. Evaluating the role of freshwater ecosystems in the regional budget of carbon, nutrients, greenhouse gases, and pollutants requires an evaluation of the biogeochemical processes across the aquatic network and their integration into processes acting at the landscape level. This theme will develop regional models of key biogeochemical processes and will integrate them into regional budgets and climate models.
- Theme 3.3 – Aquatic networks as sentinels of climate change. The detection and quantification of climate change effects on ecosystems are among the greatest contemporary scientific challenges. Freshwater ecosystems channel, integrate, and amplify signals from the landscape, atmosphere, and climate. This theme aims to establish a coordinated network of sentinel systems and to develop climate change indices based on the functional properties of lakes and rivers.

- Theme 3.4 – Services provided by aquatic ecosystems. Ecosystems provide direct benefits to society (for example, water supply, fisheries, energy production, recreational activities, and navigation). Managing and protecting aquatic resources require the quantification of ecosystem services as well as an understanding of how these services are related to aquatic ecosystems. This theme will evaluate current services provided by the aquatic ecosystem in Canada and will develop scenarios for future changes.