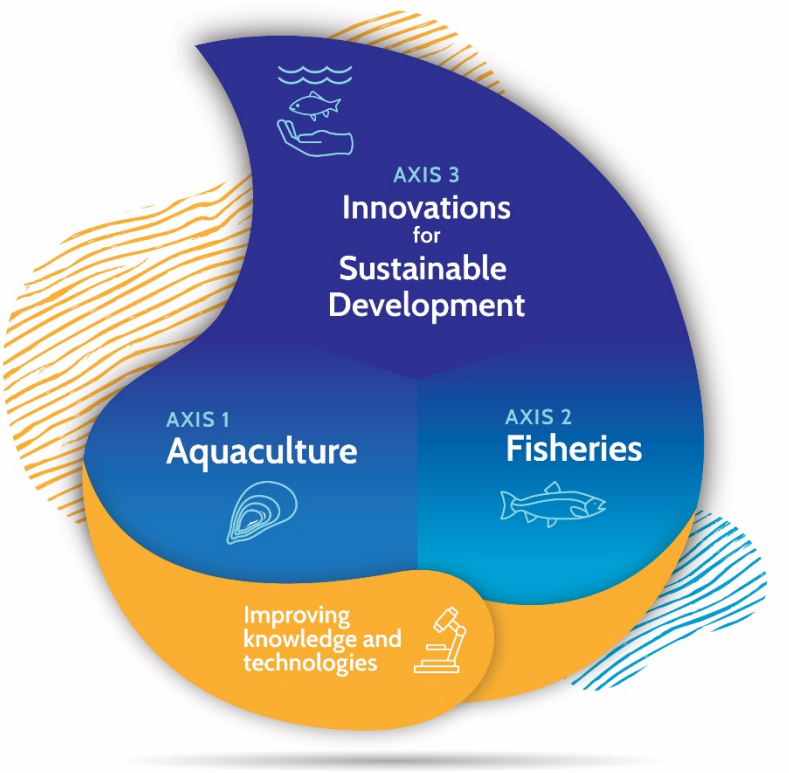
Ressources Aquatiques Québec | RAQ

Scientific Program

November 17, 2020

RAQ's new scientific program is based on FAO's Blue Growth Initiative, the goal of which is to improve the sustainable management of aquatic living resources by reconciling use and conservation to attain economically, socially, and environmentally responsible development. Our scientific program is designed with the aim of providing innovative tools and the knowledge necessary to achieve the sustainable development of Quebec's aquatic resources. Axes 1 and 2 include theoretical and practical developments related to the overall goal of implementing the sustainable development (axis 3) of our sectors of activity.



RAQ researchers work in three interconnected areas of research. The *Aquaculture* and *Fisheries* axes, which are our main themes, converge on the third axis of *Innovations*, which is specifically dedicated to advancements toward sustainable development. All applied research is based on solid knowledge, and axes 1 and 2 both include improving

fundamental and technical knowledge with the ultimate goal of maximizing the sustainable management of Quebec's aquatic resources.

We work to acquire fundamental knowledge supporting our main research goals by studying different concepts, including 1) understanding the role and functioning of host–microbiota interactions using the holobiont approach; 2) maintaining expertise in the omics (genomics, proteomics, metabolomics, lipidomics); 3) expanding knowledge on the adaptive capacity of exploited aquatic species (evolutionary biology, ecology, ecophysiology); and 4) identifying molecules of interest based on new metabolomic approaches. This innovative and dynamic program illustrates our vision of today's research.

1. AXIS 1: Aquaculture

Increasing the productivity and sustainability of aquaculture companies requires improvements in nutrition, disease control, and genetics as well as production innovations.

Based on the four fundamental concepts mentioned in the introduction, our overall objectives related to the aquaculture axis are as follows:

1) Develop sustainable methods for disease control,
2) Develop tools to help estimate the health status of organisms,
3) Increase knowledge concerning disease susceptibility,
4) Develop feeds better suited to the principles of circular economy,
5) Improve knowledge on nutritional needs and digestive physiology,
6) Support genetic improvement programs,
7) Identify gene networks associated with the expression of phenotypes of interest,
8) Improve our understanding of metamorphosis,
9) Improve production techniques.

1.1. Theme Fundamental Knowledge in Aquaculture

This theme encompasses basic research in aquaculture that focuses on the concepts mentioned in the introduction.

1.2. Theme Health

Mass production exposes aquatic organisms to stressful conditions that promote opportunistic diseases. Disease prevention and control in aquaculture currently rely mainly on antibiotics, although their usefulness is widely questioned. In this context, RAQ

researchers are developing innovative prevention and treatment alternatives to address this heavy burden on the industry.

1.3. Theme Animal Nutrition

The feeding of farmed animals is directly linked to their health. A high-performance diet will allow better production, optimal growth, and more resistant animals. Better knowledge of nutritional needs and physiological interactions is therefore necessary to improve the digestibility of food and to obtain better-quality products with reduced environmental impacts.

1.4. Theme Stock Selection

Another way to increase the productivity of aquaculture species is through genetic breeding programs focused on physiological performance, production performance, and pathogen resistance. By integrating the latest tools in genomics, RAQ researchers have recently made several significant advances in genomics and identified molecular markers related to phenotypic traits of interest in aquaculture settings. Genetic improvement is a broad sector involving many of our members, and our researchers will intensify and diversify their work in this area.

1.5. Theme Development of Production Systems

Improving production tools and techniques is another aspect that improves aquaculture yields and profitability. Several researchers from different fields are involved in this research, and engineering expertise plays a key role. For many species, aquaculture is carried out directly in the natural environment, so organisms experience significant environmental variations. A good understanding of their ability to adjust to these variations is essential to improve operations. For species reared in controlled environments and for the rearing of different developmental stages, optimization of the artificial rearing environments requires much study. A growing area of interest is the production of microalgae, where engineering has enabled the development of in silico platforms (photobioreactors) that can adequately determine metabolic responses.

2. AXIS 2: Fisheries

To address the growing problems of overexploitation, the challenges associated with the return of certain species, and habitat degradation, it is crucial to gain new knowledge about fisheries ecosystems. Based on the four fundamental concepts mentioned above, our overall objectives related to the fisheries research axis are as follows:

1) Characterize the diversity of exploited natural populations,

2) Determine the spatial structure of populations and connectivity between habitats,
3) Document the ecological and physiological characteristics of each population,
4) Gain knowledge to better plan for the impact of global change on exploited species,
5) Determine the performance of young stages and recruitment success,
6) Measure the biological and socio-economic impacts of seeding,
7) Assess the effectiveness of new approaches to population monitoring.

2.1. Theme Fundamental Knowledge of Fisheries

This theme brings together basic fisheries research focused on the concepts cited in the introduction.

2.2. Theme Determining Stock Structure

Our researchers gain knowledge to better define the management and conservation units of several exploited species. Determining population structure, connectivity, local adaptation, and underlying physiological mechanisms are essential for proper resource management. The approaches developed by our researchers are original and innovative—for example, the connectivity between populations is measured with several tools that combine population genomics and the chemistry of calcified parts.

2.3. Theme Productivity and Habitats

Environmental changes strongly influence the response of exploited species, so the knowledge to better predict the impact of these changes is crucial. The ultimate goal is to move toward the predictive management of exploited stocks to optimize exploitation for the benefit of users while ensuring sustainability of the resource for future generations.

2.4. Theme Mechanisms Controlling Recruitment

The biology of several economically important marine species is still little known, particularly concerning recruitment processes. Knowledge on factors that influence recruitment is important both for natural populations and exploited species, as is the understanding of interrelationships between production and the preservation of natural stocks. A better grasp of the factors controlling recruitment is particularly crucial in a context of global change: it has been shown that early life stages are the most vulnerable to environmental variations. The impact of recruitment on population structure needs to be better understood for the sustainable management of exploited resources.

2.5. Theme Needs and Consequences of Seeding to Support Fishing Activities

A well-known management measure used to maintain stocks is the practice of massive seeding, particularly for salmonids, but also for other species such as lobster and striped bass. Vital work is being done to quantify the costs and benefits of seeding to support fishing. For efficient management, it is important to identify the impacts of seedings, such as the risk of genetic erosion. Mitigation methods must also be developed with the industry to reduce possible negative impacts and to increase yield and performance related to seeding.

3. AXIS 3: Innovative Applications from a Sustainable Development Perspective

In the current context of optimized inventory management, food security, by-product enhancement, and environmental quality are all important concepts to consider. Our researchers are working to develop innovative applications to promote food sovereignty, transformative governance, and the responsible exploitation of aquatic resources from a sustainable development perspective.

The following objectives are grouped in this axis:

1) Propose solutions tailored to remote areas to ensure food security,
2) Provide innovative tools to improve the management of aquatic resources,
3) Propose innovative processes to develop by-products from Quebec's fisheries and aquaculture industries,
4) Study interactions and estimate the impacts of operating practices on the environment and human communities,
5) Provide innovative ways to mitigate environmental impacts related to exploitation by human communities.

3.1. Theme Resource Management and Food Security

Food insecurity is a major problem in northern Quebec and Canada, where its occurrence is twice that of the average Canadian household. Fishing has always been an indispensable cultural component of the livelihood of northern First Nations. However, many management issues arising from complex social–ecological factors, such as regulation, access to resources, impacts of climate change, environmental damage, and pollution caused by large dams and mining projects, limit the sustainable use of fisheries products. Predicting the impacts of rapid changes affecting northern environments is therefore crucial for optimizing resource management in a food security environment. RAQ researchers want to understand how these processes will influence the ability of northern communities to adapt to a changing Arctic and to determine sustainable solutions with community members.

3.2. Theme Value-Added By-Products

RAQ researchers are interested in the development of exploited aquatic species, from microalgae to fish. Different molecules are targeted—from lipids, proteins, and pigments to mussel byssus by-products. Examples of projects in this area are numerous, such as the development of biomaterials, promoting the consumption of fish as a way to fight cardiovascular disease, and optimization of aquaculture feeds. To develop this last example, our researchers are interested in identifying value-added by-products that require specific transformations to make the nutrients more accessible or to remove non-nutritional elements from aquaculture feed. This market is competitive, and it is challenging to achieve both profitability and nutritional quality. Thus, innovative processes are required for the enhancement of these by-products from Quebec's fisheries and aquaculture industry. All these by-products are available because of Quebec's natural riches. Advancing these products promotes economic development in the region in the context of an ever-changing economy.

3.3. Theme Environmental Quality

The desire to open up northern Quebec to the sustainable exploitation of resources in a context of environmental upheaval requires a thorough understanding and control of inputs and outputs in the environment. The nature and quality of the environment are inseparable variables affecting the potential of aquaculture production and the exploitation of resources. Our researchers are not only active in understanding interactions and estimating the impacts of exploitation on the environment and human communities, but also in developing ingenious mitigation measures.

3.4. Theme Innovations and Society

In the context of changes in Estuary and Gulf of St. Lawrence fish stocks as well as transformations in governance patterns for the exploitation of these resources, RAQ researchers are participating in social science research on the development of innovative transformative governance models focused on the sustainable socio-economic development of riparian communities.