# OVER A DECADE OF EXPERIENCE IN
# Arctic, sub-Arctic, and boreal aquatic biodiversity research and monitoring

## CRI's Northern Rivers Research:

### A model that merges fundamental and applied science to address increasing pressures to northern regions

Northern regions are increasingly experiencing rapid, human-induced changes to aquatic ecosystems. These changes threaten the natural environment and the livelihoods and traditions of northern communities worldwide. Scientific and community efforts are expanding to understand the importance of northern waters and what changes may occur with increasing pressures.

For more than a decade, CRI Science Directors and their teams have been actively involved in research and monitoring of northern freshwater ecosystems. CRI research encompasses various aquatic environments including rivers, lakes, estuaries and deltas. CRI is committed to integrated, ecosystem-based monitoring and assessment that is coordinated and harmonized at the watershed scale. CRI partners work with local communities, government agencies, industry, and academia to provide new information to regulatory agencies, creating effective public policy for protecting aquatic environments and the quality of life in Canada and abroad.

**For more detailed information:**

LEARN MORE



1

Photo: Joseph Culp

Working with Environment and Climate Change Canada, the Government of the Northwest Territories and Parks Canada to evaluate the impacts of permafrost thaw slumping.


2

Photo: Andrea Lister

Working with the Ka'a'Gee Tu First Nation, Government of the Northwest Territories and Fisheries and Oceans Canada to determine fish health in the Tathlina and Kakisa lakes, Northwest Territories.


3

Photo: Andrea Lister

Advising the Government of the Northwest Territories' Water Resource Division as it establishes a biomonitoring program for large transboundary rivers.


4

Photo: Anna Meisner

Working with local communities and the Slave River and Delta Partnership (SRDP) to implement the Slave Watershed Environmental Effects Program (SWEEP).


5

Photo: US National Park Service

Developing an integrated approach with the US National Park Service and researchers from Simon Fraser University to change the perception of the evolutionary potential of different sockeye salmon (*Oncorhynchus nerka*) life history strategies.


6

Photo: Jelle Faber

Working with local communities, Environment and Climate Change Canada, Parks Canada and the provincial governments of Alberta and the Northwest Territories to monitor the Peace-Athabasca Delta.


7

Photo: Marilynn Kullman

Partnering with local communities and companies to generate new knowledge about contaminants in fish from High Arctic lakes.


8

Photo: Mark Gautreau

Working with the Department of Fisheries and Oceans Canada to provide guidance for the collection and sampling of fish for Environmental Effects Monitoring in northern lakes.


9

Photo: Andrea Lister

Collaborating with community members and Environment and Climate Change Canada to determine if emerald shiner (*Notropis* atherinoides) or spottail shiner (*Notropis* hudsonius) would be useful indicator species to investigate point-source disturbances on northern rivers.


10

Photo: Andrea Chute

Working with Environment and Climate Change Canada to examine northern rivers to develop models that will further the understanding of how river ecosystems change with current trends in global temperatures.


11

Photo: Noemie Jenni

Studying peatlands to provide insight into the future hydrology of fens where increases in annual runoff are anticipated.


12

Photo: Jess Kidd

Studying the impacts of oil sands operations on the Athabasca watershed in northern Alberta.


## International Collaboration for Arctic Research and Monitoring

Since 2010, the **Canadian Rivers Institute** has been assisting in coordinating the international efforts of the Arctic Council's Circumpolar Biodiversity Monitoring Program (CBMP) – Freshwater. Through its partnership with Environment and Climate Change Canada (ECCC), CRI has been the Secretariat responsible for coordinating the implementation of the Arctic Freshwater Biodiversity Monitoring Plan, which provides Arctic countries with a structure and set of guidelines for initiating and developing monitoring activities that employ common approaches and indicators.

Through the implementation process, the CRI has played a lead role in organizing the collection of monitoring data from the circumpolar region and managing the CBMP-freshwater database to support the development of the first regional and circumpolar assessments of Arctic freshwater biodiversity. As the Secretariat of the CBMP-freshwater, CRI aims to continue to improve communication and coordination of Arctic freshwater scientists and further its collaboration with First Nations, Métis, Inuit, government, academia, and industry to support management decisions in Canada's Arctic that protect freshwater biodiversity.

The **Circumpolar Biodiversity Monitoring Program (CBMP)** is an international network of scientists, governments, Indigenous organizations and conservation groups working to harmonize and integrate efforts to monitor the Arctic's living resources. The CBMP has been endorsed by the Arctic Council and the UN Convention on Biological Diversity and the official Arctic Biodiversity Observation Network of the Group on Earth Observations Biodiversity Observation Network (GEOBON). CRI is working with CBMP partners across the Arctic to harmonize and enhance long-term freshwater monitoring efforts.
For more information: **www.caff.is/freshwater**.

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# CRI's Northern Rivers Research: Project Summaries


**1.** CRI Science Director Joseph Culp and CRI Associate Jennifer Lento worked with Environment and Climate Change Canada (ECCC), the Government of the Northwest Territories (GNWT) and Parks Canada to evaluate the effects of permafrost thaw slumping on the structure and function of biotic communities in streams and rivers in the Peel Plateau and Banks Island, Northwest Territories. Research questions addressed how slumping changes algal biomass, decomposition, and benthic invertebrate diversity and abundance.

**Dr. Culp** is currently based at Wilfrid Laurier University, and **Dr. Lento** is based at the University of New Brunswick.


**2.** CRI Science Director Deborah MacLatchy and CRI Associate Heidi Swanson work alongside the Ka'a' Gee Tu First Nation, the Government of the Northwest Territories (GNWT) and Fisheries and Oceans Canada (DFO) to assess the health of fish in the Tathlina and Kakisa lakes, located in southern Northwest Territories (NT). Since 2012, whitefish and walleye have been collected annually during the winter and summer months. The standardized growth and reproductive indices of these fish species are assessed to provide baseline data that help to predict how these northern fisheries may respond to potential future disturbances, including climate change and oil and gas activities. These fisheries are an important source of food and income for First Nation communities in NT. Currently, the project is focused on increasing the number of lakes sampled and analyzing mercury contamination in the food web of the lakes.

**Dr. MacLatchy** is based at Wilfrid Laurier University and **Dr. Swanson** is based at the University of Waterloo. Staff and students involved in this research include **Dr. Andrea Lister**, **Dr. Gerald Tetreault**, and Grant Harrison.


**3.** CRI Associate Jennifer Lento is assisting the Government of the Northwest Territories' (GNWT) Water Resource Division in establishing a biomonitoring program for large transboundary rivers. CRI researchers have been focused on developing protocols for benthic macroinvertebrate sampling and analyses for long-term water quality monitoring.

**Dr. Lento** is based at the University of New Brunswick.

**4.** From 2013-2015, CRI Science Director Tim Jardine worked alongside researchers from the University of Saskatchewan in partnership with local communities and the Slave River and Delta Partnership (SRDP) to implement the Slave Watershed Environmental Effects Program (SWEEP). SWEEP developed a community-based monitoring program to monitor the Slave River and Delta watershed. Traditional knowledge and western science were employed to establish indicators of health for the Slave River and Delta.

**Dr. Jardine** is based at the University of Saskatchewan.

For more information:
**sweep.insighthosting.com/**


**5.** CRI Science Director Scott Pavey worked with the US National Park Service and researchers from Simon Fraser University to discover the most recent case of ecological speciation in the wild following natural colonization of sockeye salmon (*Oncorhynchus nerka*). sockeye salmon is an important species of cultural, economic, and aesthetic importance in the Alaskan Peninsula of southwest Alaska. This research led to the most recent documentation of ecological divergence following natural colonization ever described in any fish species within 100 generations, including adaptive changes in adult body shape and egg size.

Additionally, juvenile body shapes were found to be adaptive to different swimming and feeding strategies. Kokanee, the non-anadromous form of sockeye, were also examined to determine the timing of three independent origins of populations in Katmai National Park and Preserve, Alaska. The integrated approach of this research has changed the perception of the evolutionary potential of the different life history strategies of sockeye salmon, and prompted managers to re-prioritize conservation efforts.

**Dr. Pavey** is based at the University of New Brunswick.

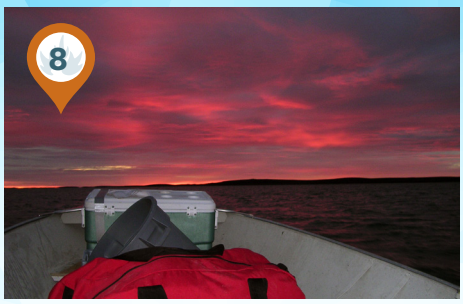
For more information:
**www.scottpavey.com**

**6.** Environment and Climate Change Scientists Dr. Donald Baird (CRI Science Director) and Dr. Daniel Peters and Dr. Wendy Monk (both CRI Associates) are working with Parks Canada, Alberta Environment and Parks, Aurora Research Centre (Dr. Sarah Rosolen) and CRI Associate Dr. Mehrdad Hajibabaei (University of Guelph) and local communities to carry out research and monitoring on the Peace-Athabasca Delta.

**Dr. Baird** and **Dr. Monk** are based at the University of New Brunswick. **Dr. Peters** is based at the University of Victoria, and **Dr. Hajibabaei** is based at the University of Guelph.


7. CRI Science Director Karen Kidd and CRI Associate Heidi Swanson partnered with local communities and companies to generate new knowledge about contaminants in fish from High Arctic lakes. Mercury and other persistent contaminants accumulate in food chains to levels that may pose a threat to fish and wildlife and people who eat fish. CRI researchers have conducted studies in lakes near Hope Bay and Resolute, Nunavut to understand how the diet and migration of Arctic char (*Salvelinus alpinus*) and lake trout (*Salvelinus namaycush*) from lakes to coastal waters affect their levels of contaminants.

**Dr. Kidd** is based at McMaster University and **Dr. Swanson** is based at the University of Waterloo.




8. CRI Science Director Michelle Gray and CRI Associate Kelly Munkittrick worked with Fisheries and Oceans Canada (DFO) to develop a protocol for the collection and sampling of slimy sculpin (*Cottus cognatus*) in Lac de Gras, NT, and other northern lakes. The objective of the protocol is to provide guidance for environmental effects monitoring (EEM) in northern regions. Industrial developments in northern Canada are required to monitor the aquatic environments that they influence. Monitoring these aquatic environments presents unique challenges that are not encountered in southern regions. An objective of EEM programs is to assess the effect of industrial effluents on fish and fish habitat.

**Dr. Gray** is based at the University of New Brunswick and **Dr. Munkittrick** is based at Wilfrid Laurier University. CRI student Dr. Tim Arciszewski also contributed to this project.


9. From 2013-2015, CRI Science Directors Deborah MacLatchy and Mark Servos collaborated with community members and Environment and Climate Change Canada (ECCC) to complete a pilot project at Fort Smith, NT. The purpose of the project was to determine whether local small-bodied fish with limited home ranges would be useful to investigate point-source disturbances on northern rivers. Emerald shiner (*Notropis atherinoides*) and spottail shiner (*Notropis hudsonius*) were captured from the Slave River downstream and upstream of an outflow pipe of the Fort Smith sewage lagoon. Body, liver, and gonad weights along with key reproductive hormones were compared. No differences in gonad or body weights in fish among different sites were detected. The liver size of emerald shiner at the outflow pipe was larger than fish at other sites, however, which indicates a possible response to contaminants or nutrients. Reproductive hormone levels of female emerald shiner were different downstream of the outflow pipe. The results indicate emerald shiner are present in sufficient numbers at these sites and may be useful for future biomonitoring studies in northern rivers.

**Dr. MacLatchy** is based at Wilfrid Laurier University and **Dr. Servos** is based at the University of Waterloo. Staff and students involved in this research include **Dr. Andrea Lister**, Brett Pomeroy, Lauren Jones, and **Dr. Gerald Tetreault**.


**10.** CRI Science Directors Allen Curry, Joseph Culp and Karen Kidd, and CRI Associates Wendy Monk and Jennifer Lento worked with Environment and Climate Change Canada (ECCC) to examine the river continuum concept across spatial scales of small to large river ecosystems, and along a climatic gradient from temperate (Atlantic Canada) to northern rivers. The Koroc River flows from the Torngat Mountains for more than 150 kilometres until it reaches the sea. The Koroc River provides a longitudinal profile of habitats and biotic community composition for contrasts with the smaller Arctic/Alpine streams of the Torngat Mountains and the large, temperate streams to the south. Using stable isotopes, and continuous water temperature and level data, these northern rivers provide the end point in developing models to understand how river ecosystems change with the current trends in global temperatures.

**Dr. Curry, Dr. Monk** and **Dr. Lento** are based at the University of New Brunswick. **Dr. Culp** is based at Wilfrid Laurier University, and **Dr. Kidd** is based at McMaster University.


**11.** CRI Science Director André St-Hilaire from the Université du Québec has been involved with Water Budget Analysis in aqualyzed peatlands in the James Bay region. Bogs and fens are the two main types of peatlands in the James Bay region. Minerotrophic fens cover a large proportion of land in mid-latitude Quebec. Over the last century, these fens have been slowly transformed into shallow lakes due to a rise in water levels, which is a process known as aqualysis. These aqualysed fens have altered reactions to rain events. For two years, four sites in the La Grande River Basin were monitored for rainfall, water table levels, and surface runoff. Summer and fall hydrographs for rain events were generated, and in situ water table and outlet surface runoff were compared. The results indicate that the location and shape of individual ponds may influence rates of runoff. This research provides insight into the future hydrology of fens in this region where annual runoff is anticipated to increase.

**Dr. St-Hilaire** is based at the Institut national de la recherché scientifique (INRS) at the Université du Québec.


**12.** For 20 years, CRI Science Directors Michael van den Heuvel and Natacha Hogan, along with CRI Associate Collin Arens, have been studying the impacts of oil sands operations on the Athabasca watershed in northern Alberta. The research has been focused on evaluating the health of fish in the Athabasca River and the response of fish health to aquatic reclamation. Yellow perch has been a focal species for these studies. Research highlights include the discovery of immune impairment leading to disease in fish exposed to high concentrations of oil sands-related compounds. The atmospheric deposition of contaminants appears to be more important than seepage of process affected waters from lease sites. Additionally, a novel method to estimate fish exposure through the examination of naphthenic acids in bile was developed.

**Dr. van den Heuvel** is based at the University of Prince Edward Island, **Dr. Hogan** is based at the University of Saskatchewan, and **Dr. Arens** is at Golder Associates in Edmonton.

CRI scientists and their networks of research associates, graduate students and staff support communities, governments, and industry in making informed, evidence-based decisions through high-impact research. Their research focuses on protecting and improving the health of rivers through innovative science that is translated into knowledge needed to create a paradigm shift in river management, by:

- Understanding how changes in water flow affect biological processes;
- Developing indicators that best measure biological and water quality changes in rivers;
- Advancing monitoring practices to improve how aquatic ecosystems affected by human activities are managed.

Founded by four researchers based at UNB in 2001, CRI has grown into a collaborative of hundreds of scientists based at dozens of institutions across Canada and around the world.

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