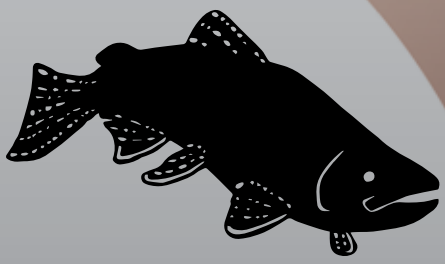
Monitoring and Research Results 2010-2015

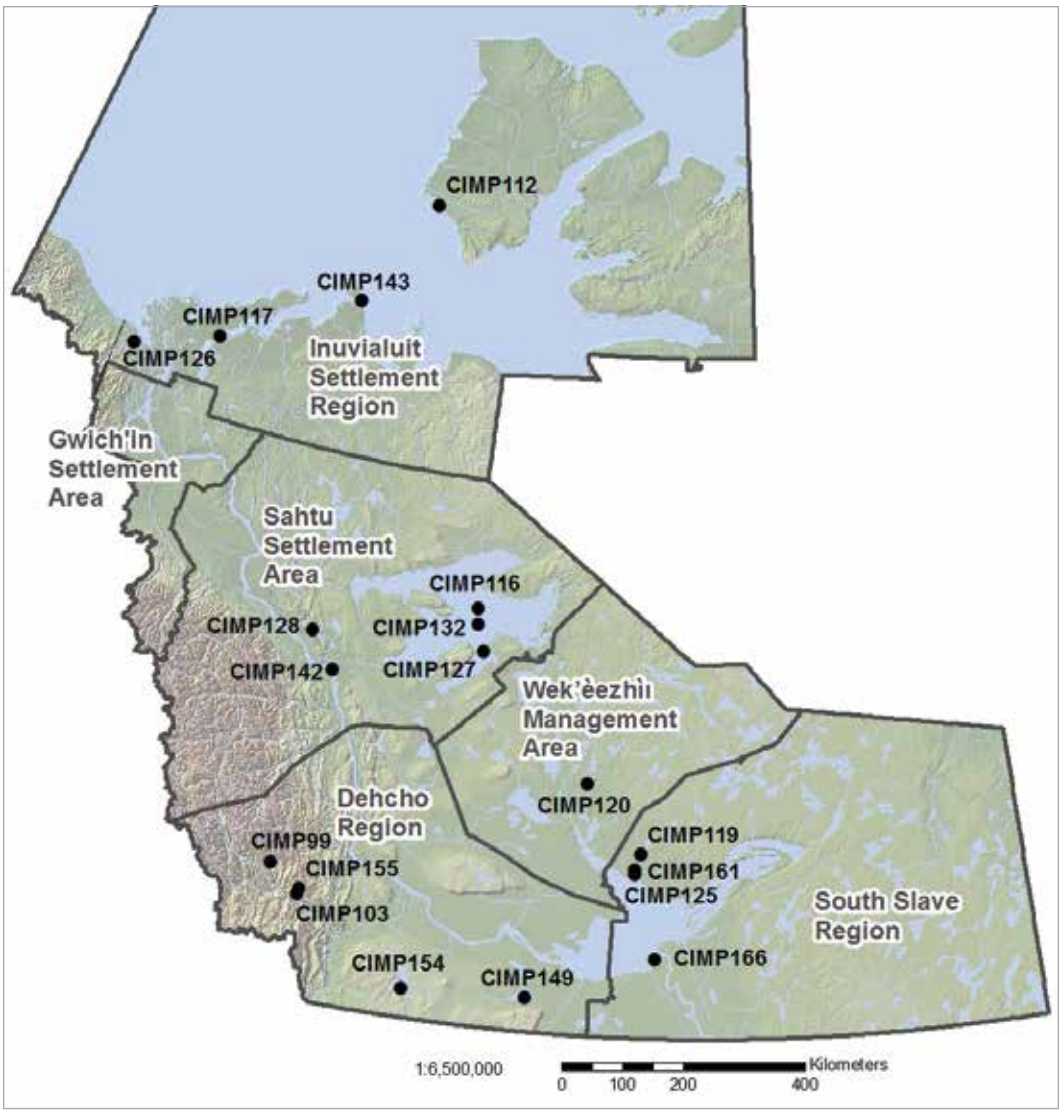
FISH

NWT Cumulative Impact Monitoring Program (NWT CIMP)



Government of
Northwest Territories

NWT CIMP-funded fish projects in the NWT



Cover illustration by Trey Madsen

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March 2016

About the Northwest Territories Cumulative Impact Monitoring Program (NWT CIMP)

The Northwest Territories Cumulative Impact Monitoring Program (NWT CIMP) coordinates, conducts and funds the collection, analysis and reporting of information related to environmental conditions in the NWT. Its main purpose is to support better resource management decision-making and sustainable development in the territory by furthering our understanding of cumulative impacts. Based on the priorities of environmental regulators, co-management boards and Aboriginal organizations, the program has focused on caribou, water and fish since 2011.

NWT CIMP strives to place research and monitoring results in the hands of those who need it to make decisions. As such, we are focused on reporting back to communities and to environmental regulators who can use the information to manage the land and water. This booklet of fish monitoring and research is one way in which the program shares results. Other means include community presentations by researchers, regional results workshops, peer-reviewed publications, and online through the NWT Discovery Portal.

NWT CIMP funds approximately 30 projects, providing $1.5 million to the research and monitoring of cumulative impacts in the Northwest Territories annually. This publication provides high level summaries of the results from the fish research and monitoring projects that were funded in 2010-2015 (see map on facing page).

For more information on the program, visit **www.nwtcimp.ca**. For NWT CIMP project results, visit **www.nwtdiscoveryportal.enr.gov.nt.ca** or email the principal investigator directly.

Contents

CIMP112

Years Funded: 3

Principal Investigator:
Chris Furgal[1]
(705) 748-1011 x7953
chrisfurgal@trentu.ca

Co-Investigators:
J. Knopp[1]
J. Reist[2]
T. Whillans[1]

[1] Trent University
[2] Fisheries and Oceans Canada

Understanding impacts of environmental change on char in the ISR: Science and Inuvialuit Knowledge for community monitoring

Purpose

To establish long-term and cumulative impacts monitoring programs in the ISR by developing a regional framework for monitoring the key Valued Ecosystem Components (VECs): Beluga, fish and their habitat.

Key Findings

- Climate change is affecting Inuvialuit fish resources. As a result, Inuvialuit are adapting their harvest practices to mitigate these changes.
- Inuvialuit Knowledge (IK) indicates air temperatures and ocean water are warming, sea ice is thinning, winds are stronger, and there are more rain and storm events.
- Local warmer air temperatures, resulting from a longer open ocean season, are affecting lake ice, resulting in earlier break up and later freeze up, resulting in potentially longer growing seasons for char.
- A robust suite of indicators was developed using science and IK for use in community-based monitoring.

How does this project help cumulative impact monitoring?

This project provides current conditions of Arctic Char, near Sachs Harbour, and provides the basis for Inuvialuit Knowledge indicators. Future community-based monitoring will enable tracking of change over time.

PhD candidate Jennie Knopp interviewing elder Geddes Wolki during a Traditional Knowledge interview in Sachs Harbour, NWT. Photo: J. Kuptana

CIMP117

Years Funded: 1

Principal Investigator:
Nikolaus Gantner[1]
(250) 5853-3577
gantnern@uvic.ca

Co-Investigators:
O. Niemann[1]
F. Wrona[1, 2]
J. Reist[3, 4]
G. Anderson[4]
H. Hintelmann[5]
C. Furgal[5]
S. McFadyen[1]
B. Kissinger[4]
J. Knopp[5]
D. Ross[6]
Hunters and Trappers Committee of Tuktoyaktuk
Tuktoyaktuk Community Corporation (TCC)
Inuvialuit Land Administration (ILA)
Tuk-Inuvik Working Group
Hunters and Trappers Committee of Inuvik

[1] University of Victoria
[2] Environment Canada
[3] Fisheries and Oceans Canada
[4] University of Manitoba
[5] Trent University
[6] Aurora Research Institute

Evaluation of hydro-climatic drivers of contaminant transfer in aquatic food webs in the Husky Lakes watershed

Purpose

To identify and quantify the physical, chemical and ecological processes that affect contaminant transfer in the Husky Lakes watershed in response to climate change, and to develop monitoring tools.

Key Findings

- Mercury concentrations in Lake Trout from Husky Lakes are generally low, and are lower than in nearby Noell Lake.
- Mercury concentrations in freshwater apex-species – for example, Lake Trout – are greater than in smaller, marine species such as Pacific Herring.
- Different fish species from the same lake have a specific mercury stable isotope 'fingerprint'. These 'fingerprints' vary among fish tissue type and from lake to lake.
- The mercury 'fingerprint' in sediments did not reveal significant variations among lakes or along chemical gradients.
- Lake Trout use saline environments to varying degrees.
- Microchemistry profiles indicate that the Lake Trout population within Husky Lakes uses multiple types of spawning habitats and otolith strontium concentrations suggest that Lake Trout spawn in brackish water.
- Preliminary results suggest invertebrate size may be related to salinity levels.

How does this project help cumulative impact monitoring?

This study advances our understanding of how changes in climate and land use can influence lake ecology, and contaminants transfer in food webs in the Husky Lakes watershed.

Community monitor records the length of a Husky Lake Trout in May 2012. Photo: N. Gantne

CIMP126

Years Funded: 1

Principal Investigator:
Colin Gallagher[1]
(204) 983-8893
colin.gallagher
@dfo-mpo.gc.ca

Co-Investigators:
Aklavik Hunters and Trappers Committee
K. Howland[1]
T. Loewen[1,2]
R. Bajno[1]
J. Reist[1]
L. Dow[1]

[1] Fisheries and Oceans Canada
[2] University of Manitoba

Harvest-based monitoring of western Beaufort Sea coastal fisheries

Purpose

To determine the impacts of harvesting on Dolly Varden of the NWT (Rat River, Big Fish River and Vittrekwa River).

Key Findings

- The subsistence fishery at Shingle Point and other locations along the Beaufort Sea coast were characterized.
- Dolly Varden originate in the Gwich'in Settlement Area and Inuvialuit Settlement Region and migrate along the Beaufort Sea coast of the Yukon Territory; maximum subsistence harvest occurs in July.
- Total harvest information was collected, establishing a benchmark for Aklavik subsistence needs.
- Proportions of NWT Dolly Varden populations that contribute to the mixed-stock fishery (a larger fish population made up of distinguishable sub-populations) at four locations along the Beaufort Sea coast were determined for the summer of 2011 (Fig. 1).

How does this project help cumulative impact monitoring?

This project establishes baseline harvest levels of the subsistence fishery, enabling the future monitoring of temporal trends. This information is particularly important to the community of Aklavik, who rely on this fishery.

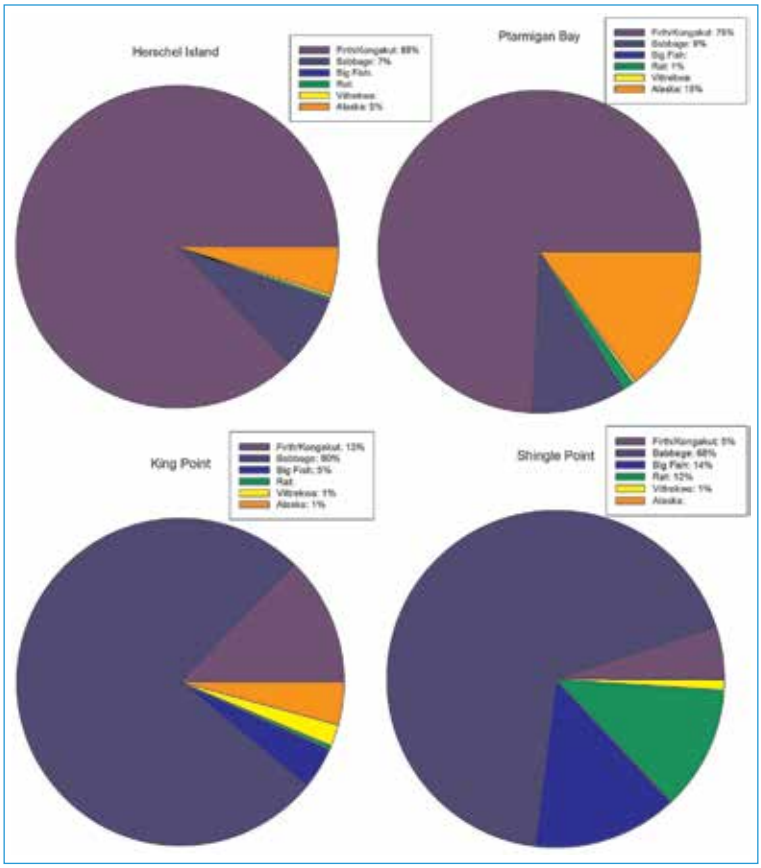


Figure 1: Percent contribution among populations of Dolly Varden from the Northwest Territories (Big Fish, Rat and Vittrekwa rivers) to the mixed-stock fishery at four locations along the Beaufort Sea coast, Yukon, in summer 2011.

Community monitor removing captured Dolly Varden from gill net. Photo: T. N. Loewen

CIMP143

Years Funded: 3

Principal Investigator:
Lisa Loseto[1]
(204) 983-5315
lisa.loseto
@dfo-mpo.gc.ca

Co-Investigators:
C. Hoover[1]
T. Loewen[1,2]
K. Snow [3,4]
J. Paulic[1]
J. Reist[1]
W. Walkusz[1]
J. Watkins[1]
V. Gillman[4]

[1] Fisheries and Oceans Canada
[2] University of Manitoba
[3] Joint Secretariat
[4] Fisheries Joint Management Committee

Community coastal-based monitoring: A regional approach for the ISR

Purpose

To establish long-term and cumulative impacts monitoring programs in the ISR by developing a regional framework for monitoring the key Valued Ecosystem Components (VECs): Beluga, fish and their habitat.

Key Findings

- An ecosystem model was created to represent local species and ecosystem linkages for the Beaufort Sea Shelf. The model is a systematic approach to incorporating data from all species and trophic levels within the Beaufort Sea Shelf food web, accounting for food web structure and function. The model is able to identify unique or redundant species within the food web to assist in identifying indicators. The model calculated ecosystem level indicators and baseline values were obtained.
- The ecosystem model allows for incorporation of multiple stressors – for example, climate change, harvest, food web dynamics – over time (1970-2012). Key stressors related to species groups are identified in the output.
- Standardized monitoring protocols are being developed for Marine Protected Areas and are being integrated into community-based monitoring frameworks.
- Gaps in existing knowledge, suitable for modeling purposes, were identified (Fig. 2). Data for many of the categories identified may exist, but are not available or are not in a useable format. There is a noticeable gap in the ecosystem knowledge for fish.

How does this project help cumulative impact monitoring?

This project is developing ecosystem-level indicators to incorporate into regional long-term monitoring, and developing standardized protocols to collect the necessary data. These tools can be used to monitor cumulative effects.

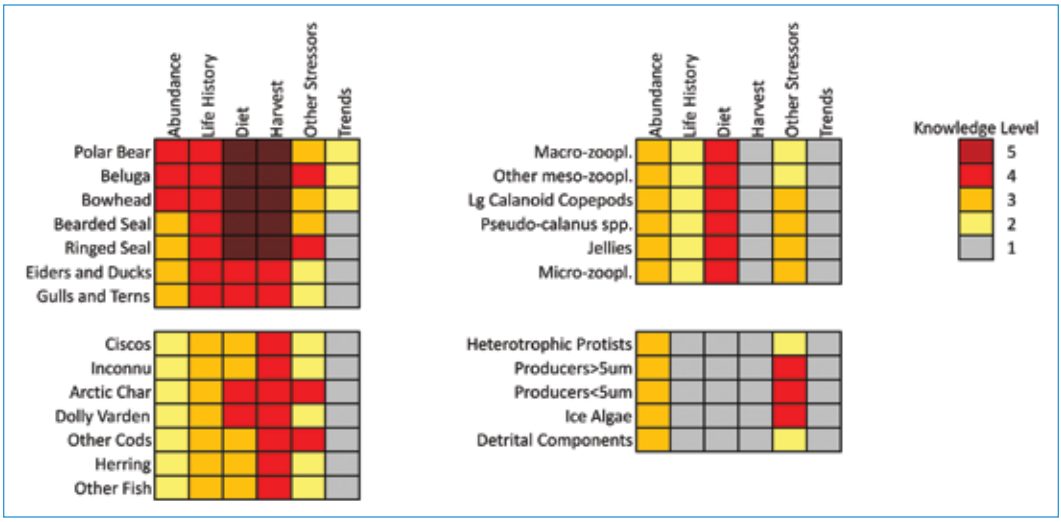


Figure 2: State of knowledge of species groups for the ECOPATH ecosystem model. Types of data are presented by the availability of information ranging from high (knowledge level 5) to low (knowledge level 1). Level 1, little to no data or studies available; 2, basic information is available, no data for the region; 3, few studies available, primarily on similar species in different regions; 4, some data available for the region, but not well known; 5, multiple studies for the region, well known. This analysis was based on the pedigree ranking in Ecopath with Ecosim (Christensen et al. 2005), and takes into account data available for modeling purposes and does not account for raw or inaccessible data. Reproduced with permission from Hoover et al. 2014.

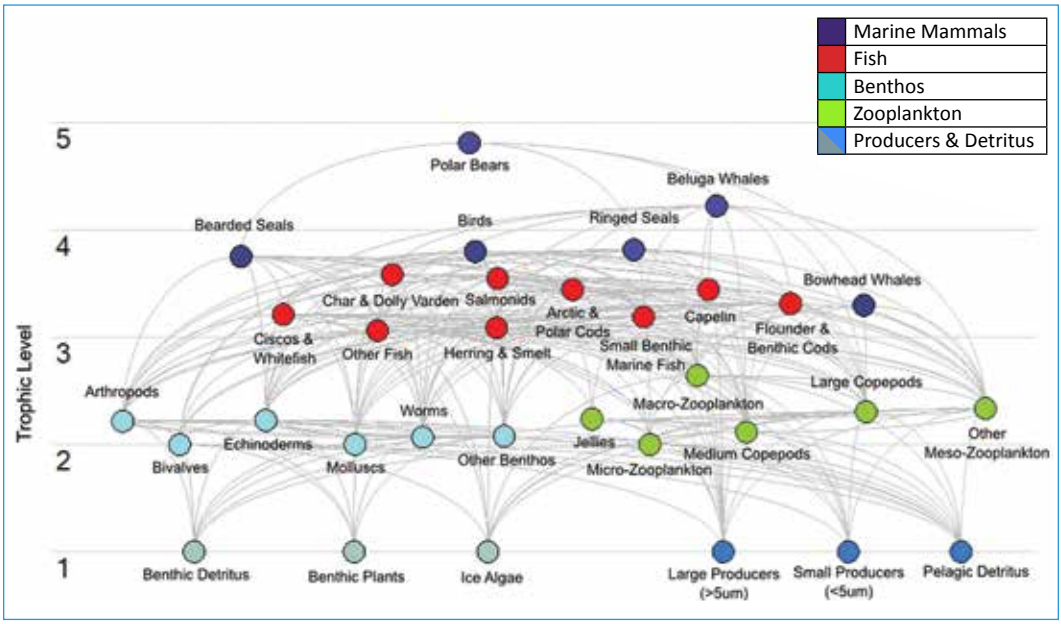


Figure 3: Food web diagram based on the ECOPATH food web model for the Beaufort Sea Shelf (Hoover et al. in prep). Each functional group (group of species) within the model is connected through predator prey interactions (grey lines). Trophic levels of species range from 1 (producers and detritus) to ~5 (polar bears), with each major trophic grouping shown in different colors.

References

Christensen, V, C Walters, and D Pauly. 2005. *Ecopath with Ecosim: A User's Guide Version 5.* Fisheries Centre: University of British Columbia.

Hoover, C., Chmelnitsky, E., Cobb, D., Michel, C., Niemi, A., Ramlal, P., Walkusz, W., Swanson, H. Reist, J., Nielsen, O., Harwood, L., Postma, L., Higdon, J., Ferguson, S., Young, R., and Loseto, L. 2014. Summary of the Beaufort Sea Shelf Ecosystem Research Initiative. Can. Tech. Rep. Fish. Aquat. Sci. 3078: ix + 87p.

CIMP127

Years Funded: 4

Principal Investigator:
Kim Howland[1]
(204) 984-4227
kimberly.howland
@dfo-mpo.gc.ca

Co-Investigators:
W. Tonn[2]
R. Tallman[1]
M.Y. Janjua[1]
L. Chavarie[2]
C. Podemksi[1]
D. Simmons[3]
C. Gallagher[1]
K. Adair[1]
M. Leclaire[3]
R. Baydack[3]

[1] Fisheries and Oceans Canada
[2] University of Alberta
[3] University of Manitoba

Long-term monitoring of Great Bear Lake fisheries and the aquatic ecosystem

Purpose

To conduct spatially extensive ecosystem level monitoring of Great Bear Lake using standardized collection techniques for harvested and forage fish, zooplankton, benthos, primary producers and water quality, and more intensive complementary community-based monitoring of water quality and invertebrates at fixed sites.

Key Findings

- Evidence that competition for resources and different diets may drive the diversity observed in Lake Trout and Cisco.
- Different Cisco morphotypes (body types) in northern great lakes have developed independently from those in southern lakes, suggesting that the different lake-specific northern morphotypes should be treated as separate designatable units for environmental protection and management purposes.
- Preliminary findings suggest that climate change is affecting limnology and biota in Great Bear Lake based on comparisons of current and historical data sets. For example, temperature profiles suggest that a thermocline (temperature change with depth) is now forming in most parts of Great Bear Lake (Fig. 4). Previously, the water temperature in Great Bear Lake was reported to be isothermal (constant throughout the depth of the lake).
- Evidence of long-term effects of harvesting and the subsequent recovery in fish populations (e.g. Keith and McTavish Arm).

How does this project help cumulative impact monitoring?

This project establishes ecological baseline conditions of the world's last pristine great lake and will enable the monitoring of temporal trends. This knowledge is important to the management and conservation of fish in Great Bear Lake and other larger northern lakes where within-species diversity is high.

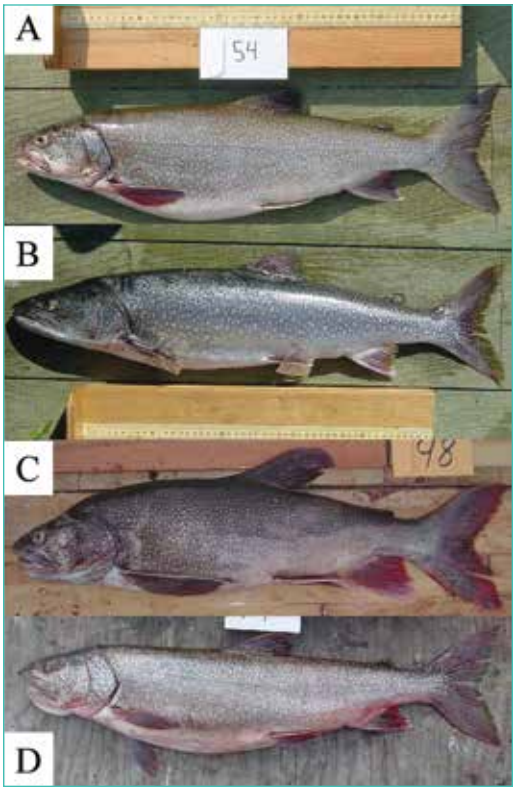
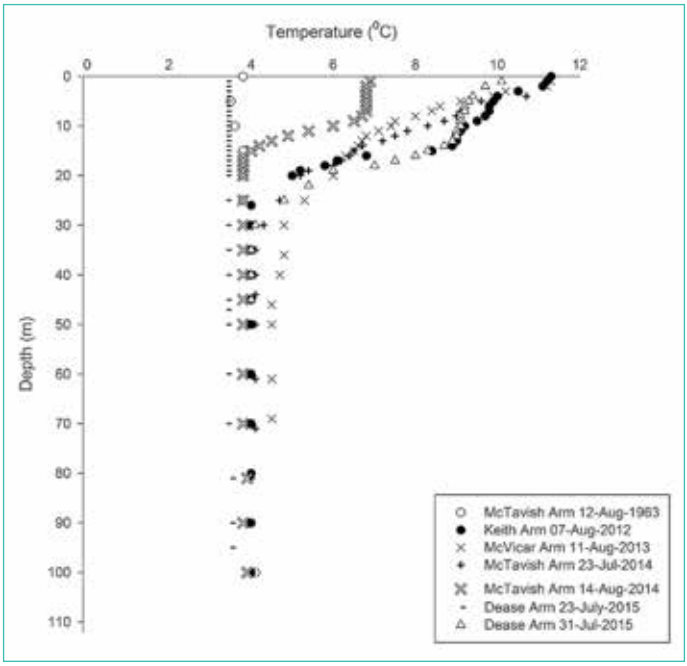


Figure 4: Different Lake Trout morphs found in Great Bear Lake. A) Morph 1, distinguished by its curved head, short jaw, moderate fins, deep body and moderate caudal peduncle; B) Morph 2, distinguished by its flat head, long jaw, short fins, elongate body and long narrow caudal peduncle; C) Morph 3, distinguished by its long fins, sub-terminal mouth, deep body with hump and short wide caudal peduncle; D) Morph 4, distinguished by its large curved sub-terminal lower jaw. Photo: K. Howland

Figure 5: Comparison of temperature profiles over time from Great Bear Lake. This figure shows examples of the typical temperature profiles seen in each area of the lake in recent years as compared to an example from past sampling in the 1960s. Note that for the Dease and McTavish Arms areas the degree stratification in recent years appears to vary with distance from shore, with more offshore areas remaining isothermal or weakly stratified (e.g. Dease Arm 23 July). It is uncertain whether these locations remain isothermal throughout the open water period or if they stratify later in the summer beyond the time when temperature data were collected.



CIMP128

Years Funded: 3

Principal Investigator:
Gary Stern[1]
(204) 984-6761
gary.stern
@dfo-mpo.gc.ca

Co-Investigators:
H. Sanei[2]
G. Low[3]
M. Low[3]

[1] Fisheries and Oceans Canada
[2] Geological Survey of Canada
[3] Dehcho First Nations

Impacts of climate change on contaminants in consumed fish

Purpose

To establish levels of mercury found in fish commonly consumed and to determine if there is a link between algal-derived mercury and levels of mercury in fish over time.

Key Findings

- Sediment core data from both Trout Lake and Kelly Lake show increasing concentrations of mercury over time, which are likely due in part to a longer ice-free season related to climate warming.
- Mercury concentrations found in the sediment and in fish tissue were compared. Algal-related mercury (from the sediment data) was determined to be accumulated in fish.
- A significant increase in mercury concentrations in fish tissue were found when concentrations were compared between 1977 and 1982 and 2011 and 2012.
- These data helped the GNWT to create a GIS-based model that presents visual predictors of increased mercury in lakes (see CIMP140).

How does this project help cumulative impact monitoring?

This information is useful in understanding the contaminant levels in fish that people eat and establishes values that can be compared to over time and among different populations.

CIMP99

Years Funded: 2

Principal Investigator:
Garry Scrimgeour[1]
(403) 221-7913
garry.scrimgeour
@pc.gc.ca

Co-Investigators:
M. Suitor[1]
J. Tsetso[2]
J. Wilcockson[3]

[1] Parks Canada Agency
[2] Nahanni National Park Reserve
[3] Hatfield Consulting

Quantifying the cumulative effects of industrial activities on the health of fish in rivers in the Northwest Territories

Purpose

To develop a non-lethal sampling method for assessing contaminant levels in fish tissue. Contaminant burdens are typically determined by killing the fish and removing a fillet for analysis. The ability to complete cumulative effect assessments in low productivity northern rivers is compromised because low fish population densities cannot withstand lethal sampling methods. Developing a non-lethal sampling method will remove this barrier to the completion of cumulative effects assessments.

Key Findings

- Preliminary analyses suggest that burdens of metals in fish fins can serve as a minimally invasive and non-lethal method of quantifying burdens of metals in Bull Trout and Arctic Grayling.
- Statistically significant relationships were found between low (tissue plugs) and high (fillet) volume muscle samples for 13 common parameters (As, Cd, Cs, Co, Cu, Fe, Mg, Hg, K, Rb, Se, Na and Tl).
- Caudal fin samples provided the highest number of statistically significant relationships with the tissue plug samples (9/12 and 10/12 parameters for Arctic Grayling and Bull Trout, respectively).

How does this project help cumulative impact monitoring?

This project is developing a method that can be used as a standard approach to monitoring contaminants in fish while minimizing sampling-related mortalities that can stress sensitive fish populations. Standard approaches allow data from different projects, years or locations to be compared for cumulative impact analysis.

CIMP103

Years Funded: 1

Principal Investigator:
Neil Mochnacz[1]
(204) 984-3147
neil.mochnacz
@dfo-mpo.gc.ca

Co-Investigators:
M. Suitor[2]
D. Tate[2]
L. Brekke[1]

[1] Fisheries and Oceans Canada
[2] Parks Canada Agency

Assessment of critical Bull Trout habitat in the South Nahanni watershed

Purpose

To track movements and delineate habitat use of Bull Trout in the Prairie Creek watershed using acoustic telemetry, prior to proposed development within the watershed.

Key Findings

- Spawning Bull Trout were captured in Prairie Creek and several tributaries across the watershed.
- Two Bull Trout in spawning condition were tagged in the headwaters of Funeral Creek. They later moved downstream into Prairie Creek, well below the proposed Canadian Zinc mine site surrounded by the Nahanni National Park Reserve.
- Local movements were observed in Funeral Creek between late August and mid-October.
- No tagged fish were detected in the South Nahanni River, downstream of Prairie Creek.

How does this project help cumulative impact monitoring?

This project is establishing distributions and habitat use within Funeral and Prairie Creek system for a sensitive cold-water fish species that is susceptible to changes in its environment. This will enable managers to monitor spatial and temporal trends over time, which is particularly important in advance of mining development proposed for this watershed.

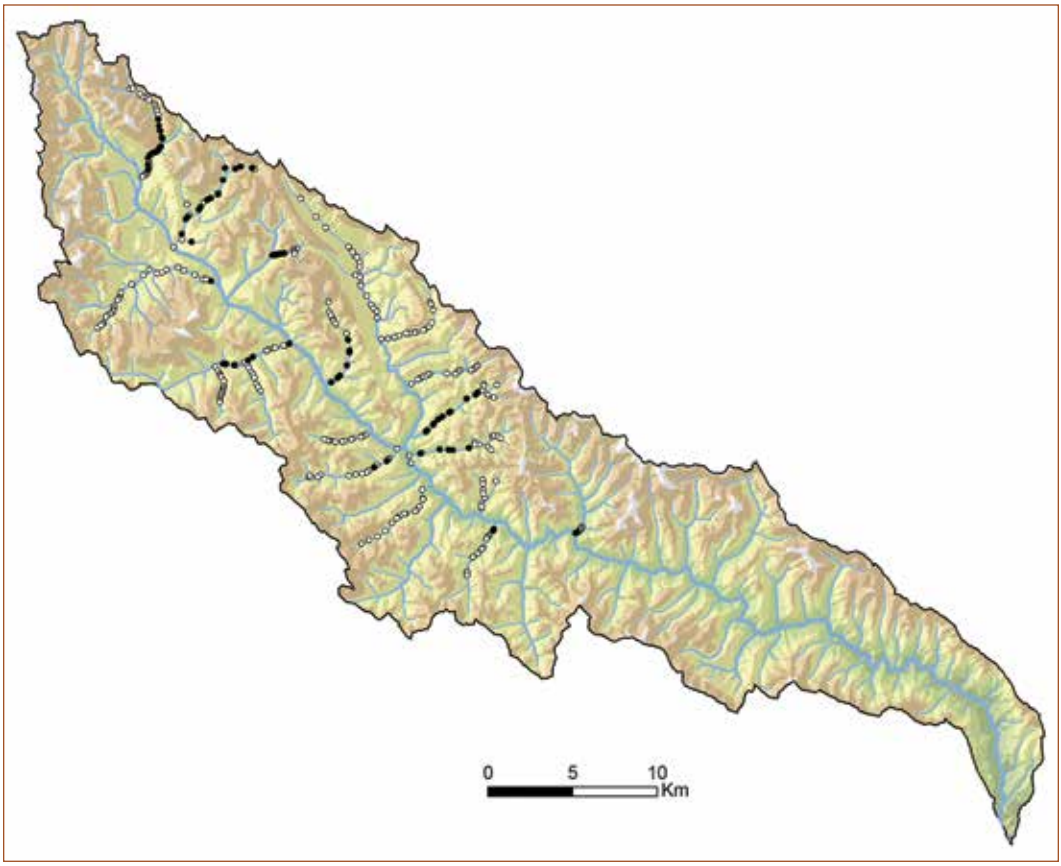


Figure 6: Juvenile Bull Trout distribution in the Prairie Creek watershed based on 2012-2014 data. Black dots represent presence.

CIMP155

Years Funded: 2

Principal Investigator:
Neil Mochnacz[1]
204-984-3147
neil.mochnacz
@dfo-mpo.gc.ca

Co-Investigators:
J. Reist[1]
D. Isaak[2]
M. McPherson[1]
K. Maier[3]
G. Low[4]
D. Simmons[5]
S. Kokelj[6]
D. Tate[7]
C. Barth[8]

[1] Fisheries and Oceans Canada
[2] Unites States Forest Service
[3] Gwich'in Renewable Resources Board
[4] Dehcho First Nations
[5] Sahtu Renewable Resources Board
[6] NWT Geoscience Office
[7] Parks Canada Agency
[8] North/South Consulting

A watershed-scale sampling protocol for accurate distribution and trend assessment of stream salmonids in the Northwest Territories

Purpose

To develop a standardized protocol to accurately monitor the distribution and temporal patterns of occurrence of stream salmonids in the NWT.

Preliminary Findings

- Juvenile Bull Trout habitat use in northern mountain watersheds is better understood.
- Juvenile Bull Trout occupy one of the coldest thermal niches of all stream salmonids from this region.
- Arctic Grayling distribution and habitat use in the Little Nahanni River watershed is better understood.
- The standard monitoring protocol will be calibrated in NWT streams so it can be widely used.

How does this project help cumulative impact monitoring?

A standardized salmonid sampling protocol will enable scientifically defensible, repeatable monitoring of change so data can be compared over time and in different watersheds. Data collected using this protocol can be used to compare occupancy and abundance data over time and across watersheds, and will be useful in conducting cumulative effects analyses.

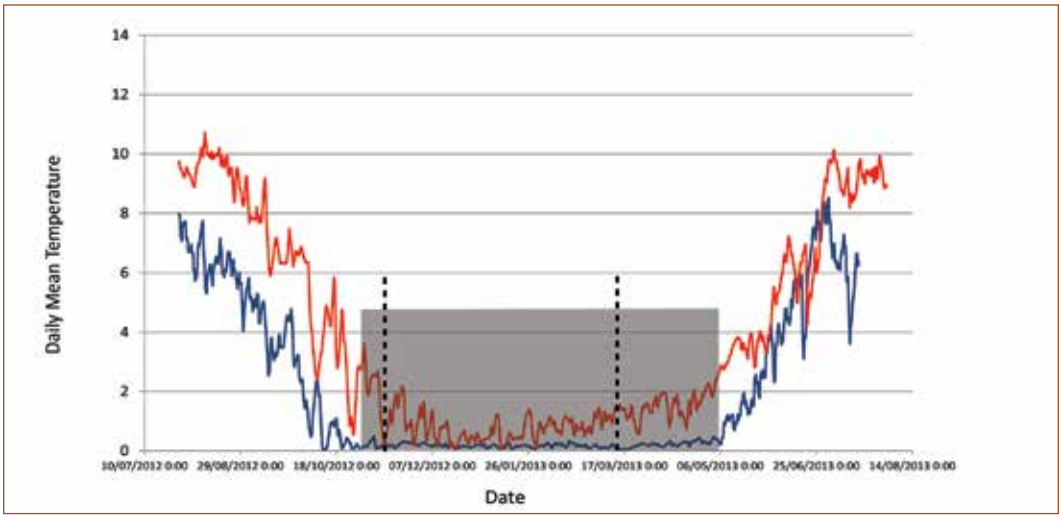


Figure 7: Comparison of annual thermal regimes (temperature in degrees Celsius) for streams occupied by juvenile Bull Trout in the Prairie Creek watershed, NWT, (blue line) and a watershed at the southern extent of the species' range in Idaho (red line). Note that the dashed horizontal lines represent the best approximation of where daily mean stream temperatures decline to approximately 0°C and then deviate significantly from 0°C. The gray shading highlights the period of time at the northern edge of the Bull Trout's range, where the water temperature is at or near 0°C, showing the temperature differential across the range of the Bull Trout.

CIMP149

Years Funded: 3

Principal Investigator:
Mike Palmer[1]
(867) 767-9233 x53084
mike_palmer@gov.nt.ca

Co-Investigators:
M. Simba[2]
J. Blais[3]
A. Lister[4]

[1] ENR, Government of the Northwest Territories
[2] Ka'a'gee Tu First Nation
[3] University of Ottawa
[4] Wilfred Laurier University

Investigating the cumulative impacts of environmental change and human activity in the Tathlina watershed

Purpose

To better understand how the cumulative effects of upstream industrial development and regional environmental change may be influencing the Tathlina watershed. Indicators of ecosystem health were monitored, historical environmental change and contaminant loading were assessed, and a regional community-based water quality monitoring program was developed to monitor disturbance and future change in the watershed.

Key Findings

- Limnological changes related to climate warming are occurring in the Cameron Hills and Tathlina Lake region.
- Drainage patterns, terrestrial carbon and mercury transport to aquatic ecosystems are being altered by peat subsidence in the lowlands region around Tathlina Lake, resulting in increased dissolved organic carbon and sedimentary mercury concentrations in lakes.
- Primary production has increased in Tathlina Lake and may exacerbate problems with low levels of dissolved oxygen in the lake during the winter, which can negatively impact fish populations.
- Hydrocarbon pollution (PAHs) in stream invertebrates are not elevated in sites downstream of oil and gas development in the Cameron Hills.

How does this project help cumulative impact monitoring?

This project monitored the cumulative impacts of development and landscape change in the Tathlina watershed, developing new methodology to monitor indicators of ecosystem health when assessing the impacts of oil and gas development on receiving aquatic systems. These methods are now being applied in the central Mackenzie Valley to help establish baseline PAH levels in benthic invertebrates of streams in the region prior to increased oil exploration. This baseline information can be looked at in relation to the cumulative impact assessment of existing and future impacts, and the monitoring techniques that can be used for future cumulative impacts monitoring initiatives.

Environmental monitors. Photo: M. Palmer

CIMP154

Years Funded: 2

Principal Investigator:
George Low[1]
(867) 875-7522
geobarbgeo
@hotmail.com

Co-Investigators:
H. Swanson[2]

[1] Dehcho First Nations
[2] University of Waterloo

Understanding and predicting fish mercury levels in the Dehcho region using models of bio-magnification and bio-accumulation

Purpose

The purpose of this project is to investigate and explain the variable patterns of fish mercury accumulation in the Dehcho Region, and determine viable management options.

Key Findings

- Preliminary analyses of data show that declines in fishing pressure and increased beaver dams may explain some of the lake-to-lake variation in mercury concentrations in fish. Beaver activity has significantly increased in some lakes due to a decline in trapping. An increase in beaver dams and declines in fishing pressure have both been correlated to increased mercury levels in fish.
- Preliminary results show that fish mercury concentrations in Ekali Lake were generally safe and were low in Trout Lake.
- These data were provided for inclusion in the web map NWT Mercury Predictors in Lakes (CIMP148).

How does this project help cumulative impact monitoring?

This project establishes baseline conditions of mercury concentrations for fish species in lakes of different sizes and levels of harvest. This will enable future monitoring of spatial and temporal trends in subsistence fish species.

Lake Trout drying near Trout Lake, NT. Photo: H. Swanson

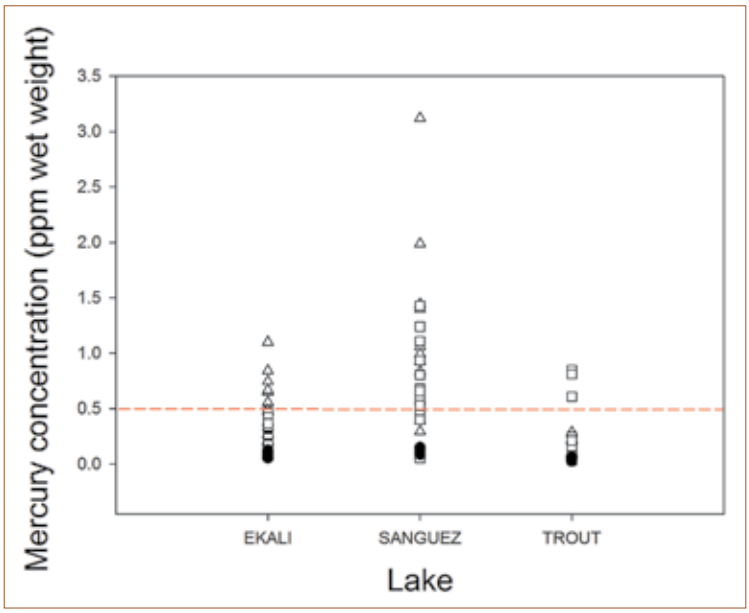


Figure 8: Mercury concentrations in Northern Pike (triangles), Walleye (squares) and Lake Whitefish (circles) from three important fishing lakes in the Dehcho Region, NT. The Health Canada Guideline for the consumption of fish is marked by the red dashed line.

CIMP120

Years Funded: 3

Principal Investigator:
Jody Pellissey[1]
(867) 873-5740
jpellissey@wrrb.ca

Co-Investigators:
B. Tracz[1]
S. Beaumont[1]
S. Richardson[2]
S. Beaverho[2]
S. van der Wielen[2]
R. Judas[3]
S. Elasser[3]
B. Wheler[3]
F. Larouche[4]
E. Lea[4]
P. Vecsei[5]
E. DeRoose[6]
D. Flemming[6]
M. Evans[7]

[1] Wek'èezhìı Renewable Resources Board
[2] Tłı̨chǫ Government
[3] Wek'èezhìı Land and Water Board
[4] Fisheries and Oceans Canada
[5] Golder Associates
[6] Health and Social Services, GNWT
[7] Environment Canada

Tłı̨chǫ Aquatic Ecosystem Monitoring Program

Purpose

To determine whether fish health, water and sediment quality near Tłı̨chǫ communities are changing over time, using Tłı̨chǫ and scientific knowledge. Tłı̨chǫ community members, including elders and youth, are directly involved in the monitoring and the exchange of information with research scientists in communities and on-the-land settings.

Key Findings

- Samples are collected from lakes near each of the four Tłı̨chǫ communities (Behchokǫ̀, Wekweètì, Gamètì and Whatì) once every four years.
- Fish tissue, water quality and sediment samples have been collected from Russell Lake (2011), Snare Lake (2012), Rae Lakes (2013) and Lac la Martre (2014).
- Some of the larger predatory fish tissue samples, water quality samples and sediment quality samples were elevated or exceeded national guidelines.
- Overall, results suggest that fish, water and sediment quality are considered to be good (i.e. not abnormal) when compared against national guidelines. Presentation of results occurred in all Tłı̨chǫ communities.

How does this project help cumulative impact monitoring?

This project helps to establish ecological baseline conditions for fish health, water and sediment quality. Establishing baseline datasets will enable the monitoring of temporal and spatial trends over time.

Removal of the otolith (ear stone) for aging the cisco. Photo: P. Vesci

CIMP125

Years Funded: 1

Principal Investigator:
Pete Cott[1]
pcott@ualberta.ca

Co-Investigators:
M. McPherson[1]

[1] Fisheries and Oceans Canada

Arsenic and mercury in lake whitefish and burbot near the abandoned Giant Mine on Great Slave Lake

Purpose

To establish environmental baseline conditions of metals, arsenic and stable isotopes in fish tissues adjacent to a heavily impacted mine site prior to any further development in Yellowknife Bay, NT.

Key Findings

Arsenic

- Arsenic concentrations are higher in fish tissues collected nearest to Giant Mine compared to far-field sites (Fig. 9).
- Inorganic arsenic (the more toxic form) was found in the liver tissue collected from Lake Whitefish from Baker Pond on the Giant Mine site.
- Juvenile Lake Whitefish were found to have higher concentrations of total arsenic in the liver tissue than adults.
- Elevated arsenic concentrations in the fish tissues collected near the mine site suggest that the area continues to be a source of arsenic to the aquatic food web.

Mercury

- Mercury levels were higher in a small inland lake (Chitty Lake) outside of the influence of the mine site.
- No tissues sampled for mercury exceeded Health Canada Guideline for the consumption of fish.

How does this project help cumulative impact monitoring?

This project determined metal concentrations in fish adjacent to a heavily impacted mine site and compared them to less impacted areas. This information is useful in understanding the contaminant levels in fish that people eat and establishes values that can be compared with over time.

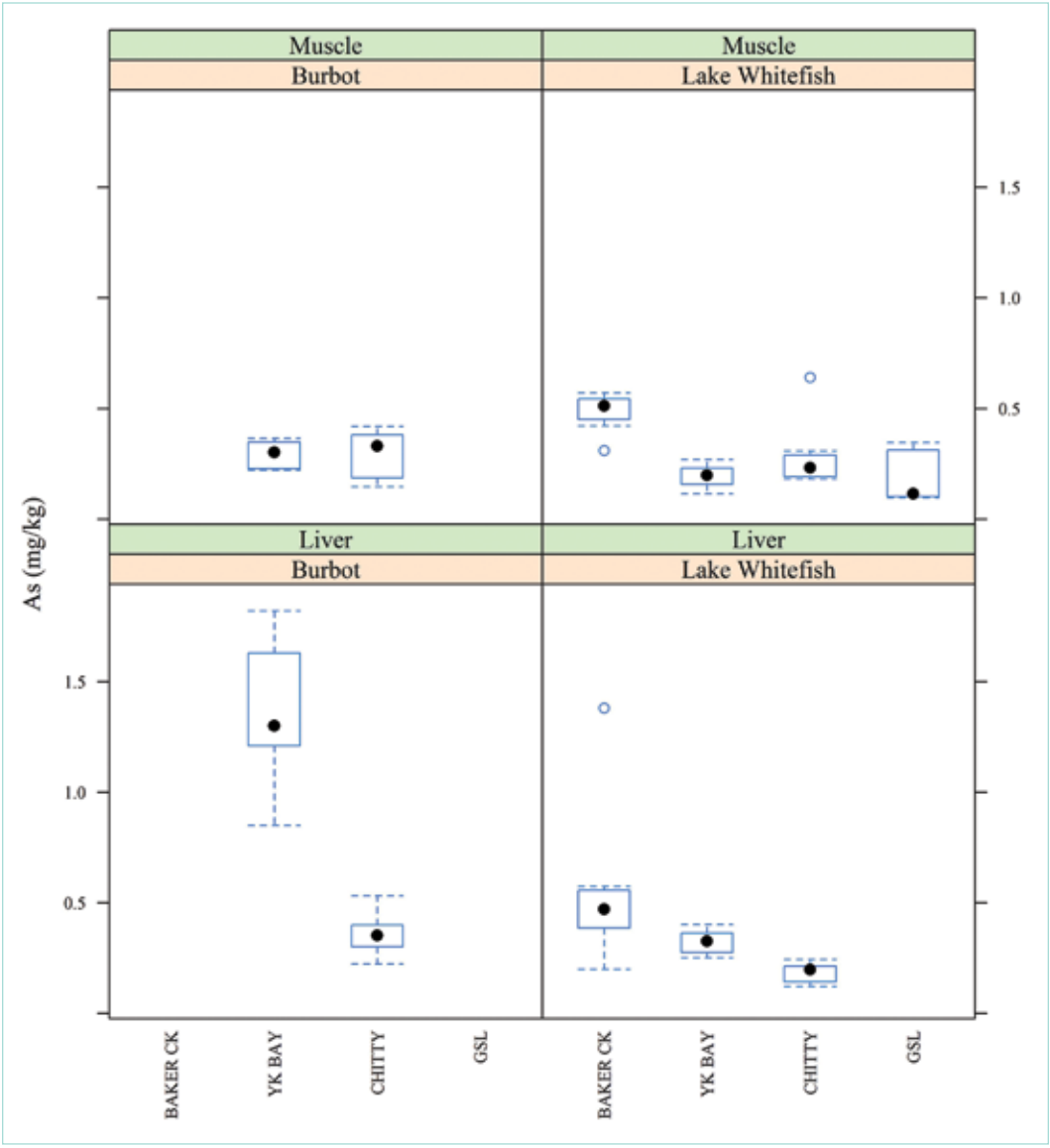


Figure 9: Levels of total arsenic in muscle and liver tissues of Burbot and Lake Whitefish in Baker Creek, Yellowknife Bay, Chitty Lake and Great Slave Lake, NWT.

CIMP166

Years Funded: 1

Principal Investigator:
Karl-Erich Lindenschmidt[1]
(306) 966-6174
karl-erich.lindenschmidt@usask.ca

Co-Investigators:
P. Jones[1]
L. Doig[1]
T. Jardine[1]
L. Bharadwaj[1]

[1] University of Saskatchewan

Geospatial models and isotope tracers to identify key fish habitats along the Slave River

Purpose

To combine geospatial modeling and isotope tracers with Traditional and local Knowledge to predict and evaluate important areas for spawning, rearing and staging for fish, linking cumulative effects to fish with local conditions of the Slave River.

Preliminary Findings

Arsenic

- A geospatial model for the Slave River and Delta is being developed. The Slave River Delta was sectioned into units (geomorphic response units) with similar geomorphological and hydrological features (e.g. curviness, width and water depth) to determine sections of habitat preferred by different fish species assemblages.
- In the Slave River Delta, metals, including mercury and arsenic, were found to accumulate most in the smaller channels with higher clay content. The Steamboat Channel had the most mercury in its sediment, followed by the Nagel Channel (Fig. 10).
- All of the mercury and arsenic levels found in the Slave River Delta sediment were below CCME levels.

How does this project help cumulative impact monitoring?

This project is refining a predictive model to assess the health of the Slave River ecosystem. Models that have been calibrated with site-specific field data are useful in understanding the current state of the environment and forecasting environmental changes under various stressor scenarios.

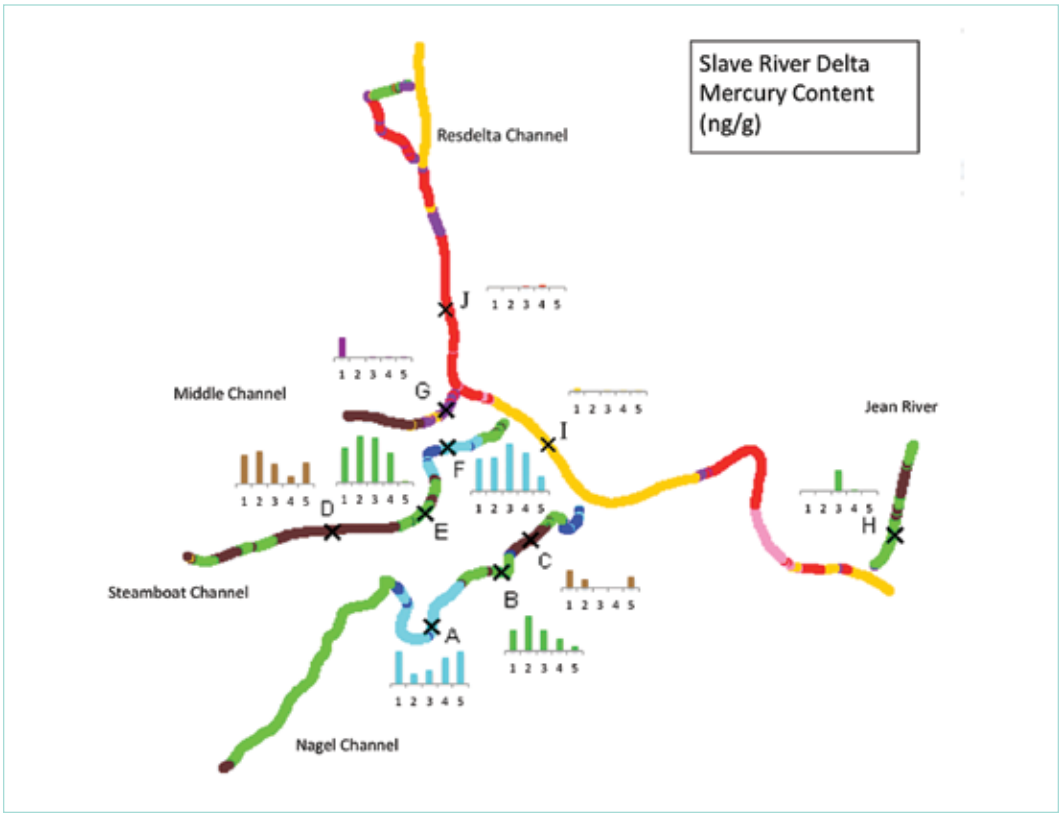


Figure 10: Specific Geomorphic Response Units (GRUs) of the waterways in the Slave River Delta. The different coloured sections indicate reaches of different sets of geomorphological features. The mercury concentrations in the top 1 cm of river sediment at the sampling sites are included.

CIMP116

Years Funded: 2

Principal Investigator:
Ross Tallman[1]
(204) 983-3362
ross.tallman
@dfo-mpo.gc.ca

Co-Investigators:
M.Y. Janjua[1]

[1] Fisheries and Oceans Canada

The road to ecosystem redemption: Comparative study of degraded and pristine giant lakes of North America using Ecopath

Purpose

To model energy changes within food webs of the Great Bear and Great Slave Lakes and to compare indicators derived from the model between these two lakes and two Laurentian Great Lakes to identify key indicators that may be used to warn of ecosystem change towards a less pristine state.

Key Findings

- Analysis of the Great Slave Lake ecosystem shows that Northern Pike, Burbot and benthic fish species have a key role in the ecosystem.
- Some fish groups, such as Arctic Grayling and Round Whitefish, have almost no impact on the rest of the food web in Great Slave Lake because of their relatively low abundance.
- There is consensus between the modeled output (1985-2015) and Traditional Knowledge regarding the increased relative biomass of Lake Trout and Inconnu, and the decreased relative biomass of Lake Cisco.
- Lake Trout is identified as the main keystone species in Great Bear Lake.
- Traditional Knowledge highlights that climate change is the only major stressor on Great Bear Lake, whereas there are many major and minor stressors identified on Great Slave Lake, including mining, water level control (i.e. Bennet Dam), oil developments (mostly south of the NWT) and climate change.
- Great Bear and Great Slave Lakes were determined to be relatively stable ecosystems compared to the Laurentian Great Lakes.

How does this project help cumulative impact monitoring?

This project refines a model to predict ecosystem level changes under a variety of impact scenarios, such as changes in commercial harvest. Such models enable the predictions of trends over time that can be used and validated for management purposes.

CIMP132

Years Funded: 1

Principal Investigator:
Xinhua Zhu[1]
(204) 983-7795
xinhua.zhu
@dfo-mpo.gc.ca

Co-Investigators:
D. Leonard[1]
G. Low[2]
R. Tallman[1]
N. Halden[3]
T. Carmichael[1]
M. Toyne[1]
K. Howland[1]
C. Podemski[1]
M. Evans[4]
L. Li[1]
L. Harris[1]
C. Gallagher[1]
C. Day[1]

[1] Fisheries and Oceans Canada
[2] Dehcho First Nations
[3] University of Manitoba
[4] Environment Canada

Integrated eco-monitoring and assessment of cumulative impacts on Great Slave Lake fisheries ecosystems

Purpose

To establish a baseline for harvestable fish populations and biological characteristics to better understand fish communities and their association with environmental gradients over space and time, and to enhance community-based monitoring capacity.

Key Findings

- This study provides a baseline of aquatic ecology and fisheries in Great Slave Lake, which lacks a long-term, well-developed monitoring system.
- It was determined that Lake Whitefish ages in Great Slave Lake were being under estimated using scales versus otoliths, biasing the fish population parameters.
- Total annual flow in the Slave River had not changed significantly between the 1950s and 1960s (Fig. 12a). In the 1970s, winter flows increased and summer flows decreased. Summer runoffs in 1960 and 2014 were identified to be similarly decreased (Fig. 12b), which may significantly impact the nutrient recycling and low trophic producers.
- Number of fish Per Unit Effort (NPUE: individuals/1000 m^2/net set) and Biomass Per Unit Effort (BPUE: Kg/1000 m^2/net set) have reduced by more than 70% over time in several areas of Great Slave Lake (Fig. 13a, 13b).
- NPUE was higher towards the bottom of the lake, compared to the lake surface, except in Resolution Bay (Fig. 13c). A significant difference was not found in BPUE for the vertical distribution of fish (Fig. 13d).
- Fish populations may be experiencing pronounced variations in the main basin of Great Slave Lake, as possible outcomes of cumulative impacts.

How does this project help cumulative impact monitoring?

This project establishes baseline conditions of fish species, including subsistence species, and will enable the monitoring of temporal trends in species composition over time. This research project can lead to development of a standardized monitoring tool to detect changes to northern lake ecosystems and assist the Department of Fisheries and Oceans to make critical stock management decisions.

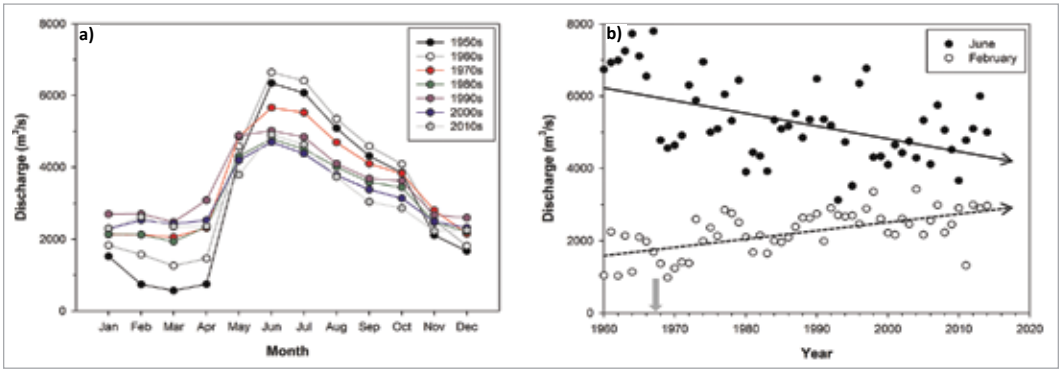


Figure 11: (a) Decadal comparison of monthly discharge of Slave River at Fitzgerald, Alberta. (b) Inter-annual variation of water inflow in June through Slave River, indicating possible impacts on lower trophic production. Linear regression is used (solid line) and grey arrow indicates the time for the start of the Bennett Dam operation on the Peace River.

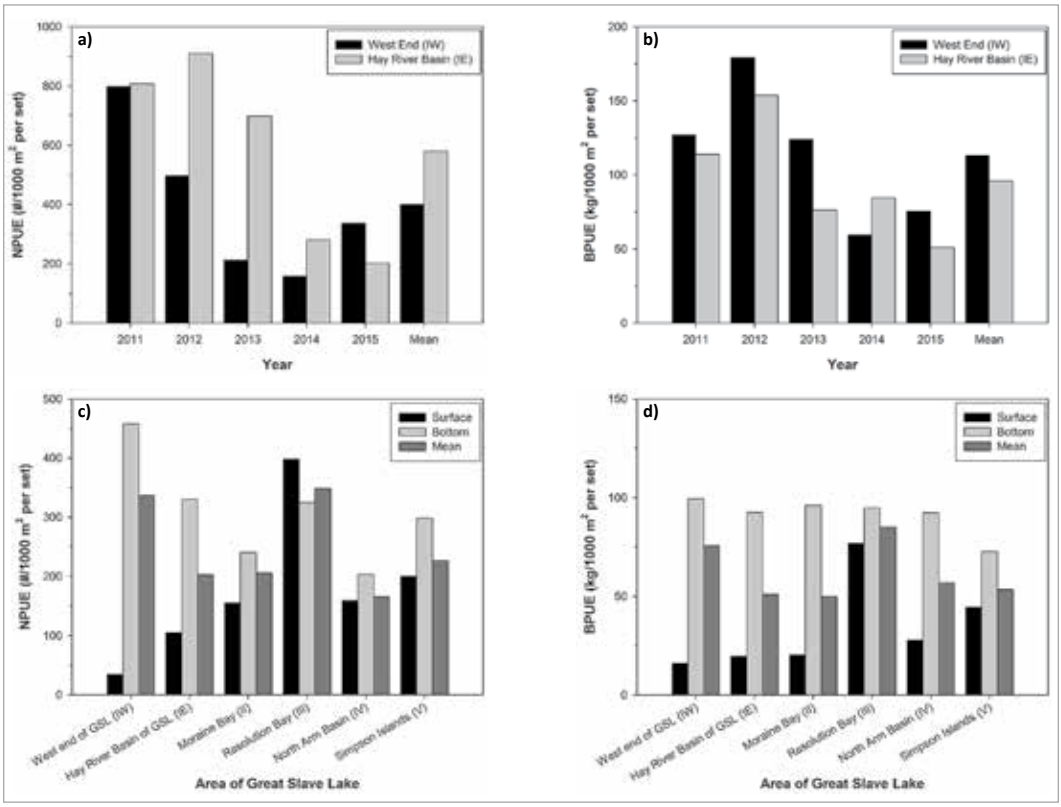


Figure 12: Variation of fish abundance (a and c) and biomass (b and d) in the main basin of Great Slave Lake, suggesting considerable reduction of fish production in the western basin.

CIMP142

Years Funded: 3

Principal Investigator:
Karen Dunmall[1]
(204) 984-2522
karen.dunmall
@dfo-mpo.gc.ca

Co-Investigators:
J. Reist[1]
M. Docker[2]
K. Maier[3]

[1] Fisheries and Oceans Canada
[2] University of Manitoba
[3] Gwich'in Renewable Resources Board

Monitoring Pacific Salmon to understand cumulative impacts of climate change in the Arctic

Purpose

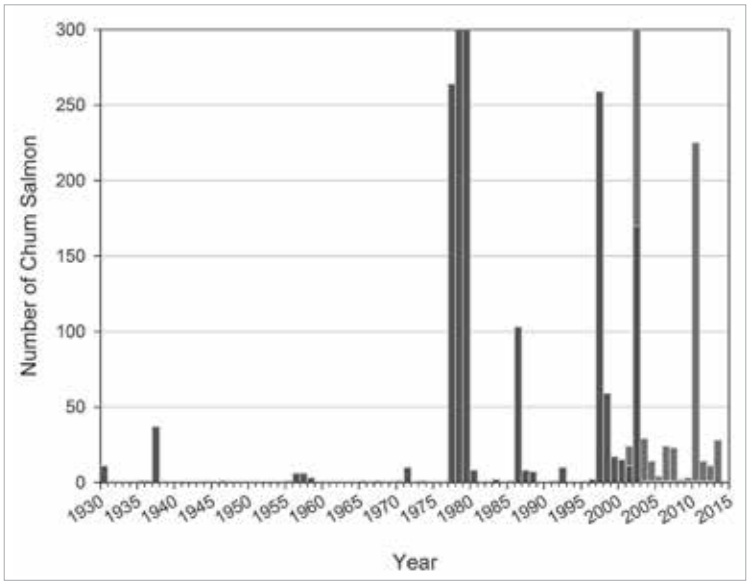
To monitor the distribution of colonizing Pacific Salmon, and study the potential competition between Pacific Salmon and native salmonids for spawning habitat, in the Mackenzie River.

Key Findings

- High harvests of Chum Salmon are occurring more frequently (Fig. 13).
- The harvests of Pink Salmon in even numbered years (e.g. 2004, 2008, 2012, 2014) are increasing (Fig. 14), and their distribution is expanding.
- Water temperature can be used to predict watersheds vulnerable to colonization by Chum and Pink Salmon. As Chars prefer slightly cooler water temperature for spawning, in most rivers, Chars and Salmon should not compete directly. However, there is a risk of competition for Chars that spawn in groundwater springs near 4°C, should Salmon colonize the same river.
- A community-based approach to monitoring Arctic Salmon colonizations has now been established across the NWT.

How does this project help cumulative impact monitoring?

This project is tracking the range expansion of Pacific Salmon into the western Arctic as a means of bio-monitoring climate change. This will enable the monitoring of spatial and temporal trends in their distributions. For more information, please see **www.facebook.com/arcticsalmon**.



Credit: K. Dunmall

Figure 13: Historical accounts and harvest records of Chum Salmon in the NWT 1930-2014. Data Source: Fisheries and Oceans Canada; Modified from Dunmall et al. 2013.

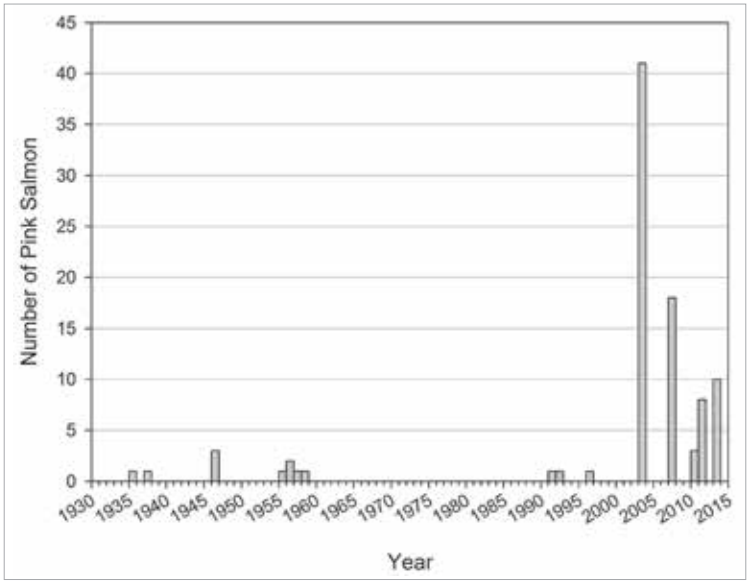


Figure 14: Historical accounts and harvest records of Pink Salmon in the NWT 1930-2014. Data Source: Fisheries and Oceans Canada; Modified from Dunmall et al. 2013.

CIMP148

Years Funded: 1

Principal Investigator:
Kami Kandola[1]
867-920-8646
445-8776
kami_kandola
@gov.nt.ca

Co-Investigators:
M. Wasiuta[1]

[1] HSS, Government of the Northwest Territories

Visual analysis of predictors for increased mercury levels in predatory fish in NWT lakes

Purpose

To provide an interactive mapping tool that presents conditions that can cause increased mercury levels in water and where mercury levels found in fish sampled can be viewed.

Key Findings

- An extensive literature review was conducted to look at predictors for elevated mercury in NWT lakes.
- A web map (**http://www.geomatics.gov.nt.ca/public_webapps.aspx**) was developed showing mercury levels found in sampled fish in NWT lakes. This tool is primarily a predictor research tool that can be used to select potential sampling locations for future studies pertaining to mercury levels in fish. The tool can also be used by community members to explore environmental conditions in lakes of interest.
- The web map can be used by researchers and potentially updated as more data becomes available. To update the web map, consultation with GNWT Health and Social Services and project administering with the NWT Centre for Geomatics (GNWT) will be required.

How does this project help cumulative impact monitoring?

The web map developed for this project allows for a visual assessment of mercury levels in fish at various locations. This baseline information can be used for cumulative impact assessment of existing and future impacts.

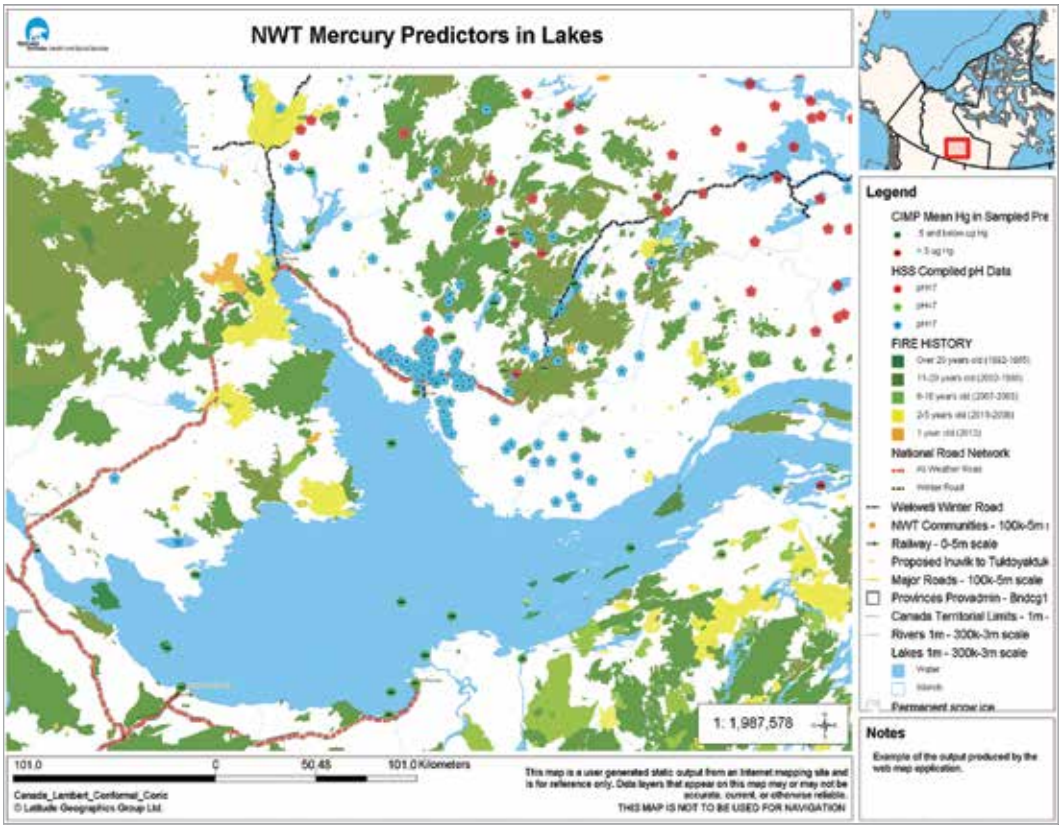


Figure 15: Screenshot of the web map displaying the Fish Parameters Layer.

For more information:
nwtcimp@gov.nt.ca

For monitoring results:
nwtdiscoveryportal.enr.gov.nt.ca