Canadian National Implementation Plan for AMAP 2013-2015

Prepared by the Northern Contaminants Program Secretariat, Aboriginal Affairs and Northern Development Canada

8/29/2014

Photo: Crispin Halsall

Canadian National Implementation Plan for AMAP 2013-2015

Seven federally funded programs are supporting research in the Canadian Arctic relevant to AMAP between 2013 and 2015. These include the Northern Contaminants Program (NCP), ArcticNet, the Beaufort Regional Environmental Assessment (BREA), and the Cumulative Impacts Monitoring Program (CIMP), the Nunavut General Monitoring Plan (NGMP), the Environmental Studies Research Fund (ESRF), and the Program of Energy Research and Development (PERD). The Federal Government is also developing a 5-year science and technology program associated with the Canadian High Arctic Research Station that is scheduled to open in 2017.

The bulk of Canada's National Implementation Plan for contaminants under AMAP comprised 34 projects in 2013/2014, and 36 projects in 2014/2015 being conducted under the NCP. These projects are organized under three categories: Human Health, Environmental Monitoring and Research, and Community Based Monitoring and Knowledge Integration. Tables 1a, 1b, 1c, list the titles of each project and Annex 1, contains full plain language summaries for each of these projects.

ArcticNet is a broad based network of researchers with the central objective to translate our growing understanding of the changing Arctic into impact assessments, national policies and adaptation strategies. All 38 ArcticNet cycle II projects are listed in Table 2 and described in Annex 2.

In August 2010, the Government of Canada announced the Beaufort Regional Environmental Assessment (BREA) in support of increased research to inform regulatory decisions for potential offshore exploration and development activities in the Beaufort Sea. Research project conducted under BREA are listed below in Table 3, and summarized in Annex 3.

The Cumulative Impact Monitoring Program (CIMP) aims to achieve excellence in environmental management and stewardship through effective monitoring and assessment of cumulative impacts in the NWT. Cumulative impacts include changes to the biophysical, social, economic, and cultural environments caused by the combination of past, present and "reasonably foreseeable" future actions. CIMP provides high-level guidance and coordination support to monitoring and research activities; ensures that regulatory, scientific and traditional knowledge information related to cumulative impacts is effectively and efficiently collected through enhanced partnerships; and ensures that information related to cumulative impacts is effectively and efficiently managed, analyzed and reported. Projects conducted under CIMP are listed below in Table 4, and summarized in Annex 4.

The NGMP collects and analyzes information on the long-term conditions of Nunavut's environment, people, communities and economy. To do this, it gathers existing ecosystemic and socio-economic monitoring data, and identifies gaps where more monitoring needs to take place. This includes both traditional and scientific knowledge.

The NGMP also supports the development of monitoring information where gaps exist. Limited funding is made available for monitoring data development initiatives that meet the NGMP priorities. In the future it will provide public monitoring reports and ultimately make meaningful ecosystemic and socio-economic information for Nunavut accessible to the public. Effective long-term monitoring will contribute to the sustainable development of Nunavut's land, resources and social economy. A list of projects funded by the NGMP in 2013 is provided in Table 5.

The Environmental Studies Research Fund (ESRF) is a research program that sponsors studies on environmental and social implications related to oil and gas exploration and development in Canada's frontier lands. The information arising from these studies is designed to assist all involved stakeholders, including citizens, companies and government, in their decision-making related to oil and gas exploration and development. ESRF research is funded by levies on oil and gas companies that hold licenses for exploration and development in Canada's frontier lands. A brief description of Arctic related projects funded through ESRF in 2013 is provided in Table 6.

The Program of Energy Research and Development (PERD) is a federal, interdepartmental program operated by Natural Resources Canada (NRCan). PERD funds research and development designed to ensure a sustainable energy future for Canada in the best interests of both our economy and our environment. A list of projects funded by PERD 2013-2014, and 2014-2015 is provided in Tables 7a and 7b.

As a signature deliverable of its Northern Strategy, the Government of Canada committed to establish a new world-class research Station in the High Arctic. The Canadian High Arctic Research Station (CHARS) will provide a hub for science and technology (S&T) in Canada's North that complements and anchors the network of existing facilities across the North. The Station, to be located in Cambridge Bay, Nunavut, is currently in the construction phase and opening is planned for July 2017. CHARS will embody a new model for Arctic S&T: working year-round in the North for the North. The programming for the Station will be solutions-driven and will explore new ways of bringing knowledge to action. The Strategic plan for the Station, the S&T Blueprint, will identify short-term (5-year) priorities to deliver on the mandate. This will include research and monitoring activities that contribute to the four main S&T themes: resource development, exercising sovereignty, environmental stewardship and climate change, and strong and healthy communities. During the first programmatic cycle, efforts will be targeted to build the program as the facility is built and to develop the core capacity and expertise required for a successful launch. The Science and Technology 5- year program will include priority-driven themes – renewable and alternative energy, baseline information for preparedness for development, infrastructure for development, underwater situational awareness and the cryosphere. In addition, cross-cutting longer term themes will include capacity building and outreach, social and wellness, traditional knowledge, knowledge mobilization, technology development and monitoring.

Additional updates may be provided over the course of the year to reflect any new projects, particularly as they may relate to issues of interest to AMAP.

Table of Contents

Table 1a, Projects being carried out under the Northern Contaminants Program related to Human Health

2013/2014

Project Number	Project Title	Project Leader
H-01	Assessment of contaminant and dietary nutrient interactions in the Inuit Health Survey: Nunavut, Nunatsiavut and Inuvialuit	Laurie H.M. Chan (U of Ottawa)
H-02	Nunavik Child Cohort Study (NCCS): follow-up with late adolescents	Gina Muckle (CHUL)
H-03	Nunavik Child Cohort Study (NCCS): add-on study for follow-up with teenage children – observed behaviours and stress	Pierich Plusquellec(U Montreal)
H-04	Contaminant Nutrient Interaction Issues as part of a Public Health Intervention Study of Inuit Children in Nunavik: Communication of results.	Huguette Turgeon O'Brien (Laval)
H-05	Monitoring of environmental pollutants in maternal blood in Nunavik: time trend assessment and evaluation of the Arctic Char program.	Eric Dewailly (CHUQ)
H-08	Country foods and cardiovascular health in Nunavik: studying the complex balance between selenium and environmental contaminants	Pierre Ayotte (CHUQ)
H-10	Quantifying the Effect of Transient and Permanent Dietary Transitions in the North on Human Exposure to Persistent Organic Pollutants	Frank Wania (U of T)

2014/2015

Project Number	Project Title	Project Leader
H-01	Development of Blood Guidance Values for Persistent Organic Pollutants for the Canadian Arctic	Laurie Chan (U of Ottawa)
H-02	Do country food nutrients protect against mercury toxicity and cardiometabolic diseases? Integrating data from cutting-edge science and mobilizing knowledge towards Nunavimmiut health	Pierre Ayotte (CHUQ)
H-03	Environmental contaminants, stress and behaviour: statistical analysis in late adolescent Inuits from the Nunavik Child Cohort Study (NCCS), and in adult Inuit from the Inuit Health Survey	Pierrich Plusquellec (CHUQ)
H-04	Lake Melville and Labrador Inuit: Understanding and projecting human health implications of exposure to local and long-range mercury sources	Tom Sheldon (Nunatsiavut Government)
H-05	Exposure to food chain contaminants in the Canadian Arctic: spatial and time trends	Eric Dewailly (CHUQ)
H-06	Tukisinirlungniq: Understandings of the Risks and Benefits of Consuming Beluga in Arviat, NU	Shirley Tagalik (Arviat Wellness Centre)
H-07	Quantifying the Effect of Transient and Permanent Dietary Transitions in the North on Human Exposure to Persistent Organic Pollutants and Mercury	Frank Wania (U of Toronto)

Table 1b, Projects being carried out under the Northern Contaminants Program related to Environmental Trends Related to Human Health and International Controls

2013-2015 Long-Term Monitoring Projects

Project Number	Project Title	Project Leader
M-01	Northern Contaminants Air Monitoring: Organic Pollutant Measurements	Hayley Hung (EC)
M-02	Air Measurements of Mercury at Alert	Alexandra Steffen (EC)
M-03	Passive Air Sampling Network for Organic Pollutants and Mercury	Hayley Hung and Alexandra Steffen (EC)
M-04	Temporal Trends of Persistent Organic Pollutants and Metals in Ringed Seals from the Canadian Arctic	Derek Muir (EC)
M-05	Temporal and Spatial Trends of Organic and Metal Contaminants in Canadian Polar Bears: Part III	Robert Letcher (EC)
M-06	New and emerging persistent halogenated compounds in beluga whales from the Canadian Arctic	Gergg Tomy (U of Manitoba)
M-07	Temporal trends of mercury and halogenated organic compounds in Hendrickson Island, Sanikiluaq and Pangnirtung beluga	Gary Stern (U of Manitoba)
M-08	Temporal Trends of Contaminants in Arctic Seabird Eggs	Birgit Braune (EC)
M-09	Temporal trends and spatial variations in persistent organic pollutants and metals in sea-run Arctic char from Cambridge Bay, Nunavut	Marlene Evans (EC)
M-10	Temporal Trends of Persistent Organic Pollutants and Mercury in Landlocked Char in the High Arctic	Derek Muir (EC)
M-11	Spatial and Long-term Trends in Persistent Organic Contaminants and Metals in Lake Trout and Burbot from the Northwest Territories	Marlene Evans (EC)
M-12	Temporal Trend Studies of Trace Metals and Halogenated Organic Contaminants (HOCs), Including New and Emerging Persistent Compounds in Mackenzie River Burbot, Fort Good Hope, NT	Gary Stern (U of Manitoba)
M-13	Long Term Trends of Halogenated Organic Contaminants and Metals in Lake Trout from Yukon Lakes	Gary Stern (U of Manitoba)
M-14	Arctic Caribou Contaminant Monitoring Program	Mary Gamberg (Gamberg consulting)

2013/2014 Research Projects

M-16	A latitudinal investigation of ecosystem sensitivity to methylmercury bioaccumulation in Arctic fresh waters	John Chetelat and Murry Richardson (EC and U of O)
M-17	Host-parasite-mercury interactions in a marine bird	Grant Gilchrest (EC)
M-18	Evaluating the Accumulation of Persistent Organic Pollutants in Arctic Cod in the Beaufort Sea Using Samples From The BREA Program	Brendan Hickie (Trent U)
M-20	Monitoring environmental changes and contaminant exposure in the Canadian Arctic by otolith microchemistry	Norm Halden (U of Manitoba)
M-22	Polycyclic Aromatic Compounds, Flame Retardants and Other Persistent Organic Pollutants in Canadian Archipelago Air and Water	Liisa Jantunent (EC)
M-23	Investigation of Mercury Toxicity in Landlocked Char in High Arctic Lakes	Paul Drevnick (INRS)
M-25	Quantifying contaminant loadings, water quality and climate change impacts in the world´s largest lake north of 74°	Vince St. Louis (UofA) and Derek Muir (EC)

2014/2015 Research Projects

M-15	Community based seawater monitoring for organic contaminants and mercury in the Canadian Arctic	Derek Muir (EC)
M-16	A latitudinal investigation of ecosystem sensitivity to methylmercury bioaccumulation in Arctic fresh waters	John Chetelat(EC) and Murray Richardson (U of Ottawa)
M-19	Spatial variation in Canadian Arctic prey fish communities and contaminant levels and consequences for diets and contaminant levels in ringed seals	Aaron Fisk and Melissa McKinney (U of Windsor)
M-21	Metal loading and retention in Arctic tundra lakes during spring runoff	Murray Richardson (Carleton U) and Jamal Shirley (NRI)
M-22	Polycyclic Aromatic Compounds, Flame Retardants and Other Persistent Organic Pollutants in Canadian Archipelago Air and Water	Liisa Jantunen (EC)
M-23	Investigation of Mercury Toxicity in Landlocked Char in High Arctic Lakes	Paul Drevnick (INRS)
M-25	Quantifying contaminant loadings, water quality and climate change impacts in the world´s largest lake north of 74°	Vince St. Louis (UofA) and Derek Muir (EC)
M-26	Heavy Metal and Radionuclide Contaminants in Caribou and Moose	Iga Stasiak and Brett Elkin (GNWT)

Table 1c, Projects being carried out under the Northern Contaminants Program related to Community Based Monitoring and Knowledge Integration

2013/2014

Project Number	**Project Title**	**Project Leader**
CB-01	Mercury Levels in Food Fish Species in Lakes used by Dehcho Community Members with a focus on Choice and Risk Perception of eating Traditional Country Food	George Low, DehCho First Nations
CB-02	Evaluation of hydro-climatic drivers of contaminant transfer in aquatic food webs in the Husky Lakes Watershed (Inuvialuit Settlement Region, Northwest Territories)	Jolie Garies (ARI) and Klaus Gantner (Trent U)
CB-03	Paulatuk Beluga whales: Health and Knowledge	Diane Ruben, Paulatuk Hunters and Trappers
CB-04	Tlicho Aquatic Ecosystem Monitoring Project (TAEMP)	Jodi Snortland, Tlicho First Nations
CB-05	Enhancing community-based monitoring of ecosystem changes in the ISR through the inclusion of Local and Traditional Ecological Knowledge Indicators	Vic Gilman (FJMC) and Lisa Loseto (DFO)
CB-06	Harvest monitoring of metal bioaccumulation at Kuujjuaraapik (Nunavik): Have levels changed 20 years after the Great Whale environmental assessment?	Raymond Mickpegak (Sakkuk Landholding Corp.)

2014/2015

Project Number	Project Title	Project Leader
CB-01	Mercury Levels in Food Fish Species in Lakes used by Dehcho Community Members with a focus on Choice and Risk Perception of eating Traditional Country Food	George Low (DehCho First Nations)
CB-02	Community-Based Monitoring of Arctic Char in Nunatsiavut: Increasing Capacity, Building Knowledge	Rodd Laing (Nunatsiavut Government)
CB-03	Paulatuk Beluga whales: Health and Knowledge	Diane Ruben (Paulatuk Hunters and Trappers)
CB-04	Tlicho Aquatic Ecosystem Monitoring Project (TAEMP)	John McCullum (Wek'eehzii Renewable Resource Board)
CB-05	Enhancing community-based monitoring of ecosystem changes in the ISR through the inclusion of Local and Traditional Ecological Knowledge Indicators	Vic Gilman (FJMC) and Lisa Loseto (DFO)
CB-06	Harvest monitoring of metal bioaccumulation at Kuujjuaraapik (Nunavik): Have levels changed 20 years after the Great Whale environmental assessment?	Raymond Mickpegak (Sakkuk Landholding Corp.)
CB-07	Mercury in fish from Old Crow	William Jose (Vuntut Gwich'in Government)

Table 2. Projects being carried out under ArcticNet

Project Title – IRIS 1 (Western & Central Arctic)	**Project Leader**
1.1 Adaptation in a Changing Arctic: Ecosystem Services, Communities and Policy (*Community Adaptation*).	Smit, Barry (University of Guelph)
1.2 Effects of Climate Change on Contaminant Cycling in the Coastal and Marine Ecosystems	Stern, Gary; Macdonald, Robie and Wang, Feiyue (University of Manitoba/)
1.3 High Arctic hydrological, Landscape and Ecosystem Responses to Climate Change (*Hydrology*)	Lamoureux, Scott and Lafrenière, Melissa (Queen's University)
1.4 Hydro-Ecological Responses of Arctic Tundra Lakes to Climate Change and Landscape Perturbation (*Tundra Lakes*)	Wrona, Fred (University of Victoria)
1.5 The Canadian Arctic Seabed: Navigation and Resource Mapping (Seabed Mapping)	Hughes Clarke, John (University of New Brunswick)
1.6 The Law and Politics of Canadian Jurisdiction on Arctic Ocean Seabed (*International Law*)	Byers, Michael (University of British Columbia)
1.7 Community-Driven Research on *H. pylori* Infection in the Inuvialuit Settlement Region (*H. pylori infection*)	Goodman, Karen (University of Alberta)
1.8 The Arctic cod (Boreogadus saida) ecosystem under the double pressure of climate change and industrialization (Arctic Cod)	Fortier, Louis (Université Laval)
1.9 Remote Sensing of Canada's New Arctic Frontier	Babin, Marcel (Université Laval)
1.10 Climate analysis and scenario development for the Canadian Arctic and Subarctic (Climate analysis)	Brown, Ross (Environment Canada)
Project Title – IRIS 2 (Eastern Arctic)	**Project Leader**
2.1 Freshwater Resources of the Eastern Canadian Arctic *(Freshwater Resources)*	Vincent, Warwick (Université Laval)
2.2 Marine Biological Hotspots: Ecosystem Services and Susceptibility to Climate Change *(Marine Ecosystem Services)*	Tremblay, Jean-Éric (Université Laval); Gosselin, Michel (Université du Québec à Rimouski); Archambault, Philippe (Université du Québec à Rimouski)
2.3 Impacts of Vegetation Change in the Canadian Arctic: Local and Regional Assessments *(Arctic Vegetation)*.	Henry, Greg (University of British-Columbia)
2.4 Instability of Coastal Landscapes in Arctic Communities and Regions *(Coastal Landscape)*.	Bell, Trevor (Memorial University of

	Newfoundland); Forbes, Don (Memorial University of Newfoundland / Geological Survey of Canada)
2.5 The Emerging Arctic Security Environment *(Arctic Security)*	Huebert, Rob (University of Calgary)
2.6 Improving Access to University Education in the Canadian Arctic *(University Education)*	Rodon, Thierry (Université Laval)
2.7 *Inuit Qaujimajatuqangit* and the Transformation of High School Education in Nunavut *(High School Education)*	Walton, Fiona (University of Prince Edward Island)
2.8 Arctic Geomicrobiology and Climate Change	Rysgaard, Soren (University of Manitoba)
2.9 Effects of Climate Change on the Canadian Arctic Wildlife *(Arctic Wildlife)*	Berteaux, Dominique (Université du Québec à Rimouski)
2.10 Polar Data Management for Northern Science	LeDrew, Ellsworth (University of Waterloo)
Project Title – IRIS 3 (Hudson Bay)	**Project Leader**
3.1 Carbon Exchange Dynamics in Coastal and Marine Ecosystems *(Carbon Dynamics)*	Papakyriakou, Tim (University of Manitoba)
3.2 Freshwater-Marine Coupling in the Hudson Bay IRIS *(Freshwater-Marine Coupling)*	Barber, David (University of Manitoba); Sydor, Kevin (Manitoba Hydro)
3.3 Impacts of Global Warming on Arctic Marine Mammals *(Marine Mammals)*	Ferguson, Steven (University of Manitoba/Fisheries and Oceans Canada)
3.4 Integrating and Translating ArcticNet Science for Sustainable Communities and National and Global Policy and Decision-Making *(Science to Policy)*	Hik, David (University of Alberta); Furgal, Christopher (Trent University)
3.5 Long-Term Observatories in Canadian Arctic Waters *(Marine Observatories)*	Gratton, Yves (INRS-ETE)
3.6 Sea Ice, Climate Change and the Marine Ecosystem *(Sea-Ice)*	Barber, David (University of Manitoba)
3.7 Climate Change and Food Security in Regional Inuit Centers *(Food Security)*	Ford, James (McGill University)
3.8 Adaptation, Industrial Development and Arctic Communities *(Industrial Development)*	Keeling, Arn (Memorial University of Newfoundland)
3.9 Climate Change and Commercial Shipping Development in the Arctic *(Commercial Shipping)*	Lasserre, Frédéric (Université Laval)
Project Title – IRIS 4 (Eastern sub-Arctic)	**Project Leader**

4.1 Food Security, Ice, Climate and Community Health: Climate Change Impacts on Traditional Food Security in Canadian Inuit Communities *(Community Health)*	Chan, Laurie (University of Ottawa); Furgal, Chris (Trent University)
4.2 Growth Variability and Mercury Tissue Concentration in Anadromous Arctic Charr *(Arctic Charr)*	Power, Michael (University of Waterloo); Furgal, Chris (Trent University)
4.3 Country Foods *Health* Benefits in a Changing Canadian Arctic *(Health Benefits)*	Dewailly, Éric (Université Laval)
4.4 Permafrost and Climate Change in Northern Coastal Canada *(Permafrost)*	Allard, Michel (Université Laval); Pollard, Wayne (McGill University)
4.5 Population Dynamics of Migratory Caribou in Nunavik/Nunatsiavut *(Caribou)*	Côté, Steeve (Université Laval)
4.6 Understanding and Responding to the Effects of Climate Change and Modernization in Nunatsiavut *(Nunatsiavut Nuluak)*	Bell, Trevor (Memorial University of Newfoundland); Sheldon, Tom (Nunatsiavut Department of Lands and Natural Resources)
4.7 International Inuit Cohort Study: Developing the Next Phase *(Inuit Health Cohort)*	Dewailly, Éric (Université Laval)
4.8 Enabling the coproduction of Inuit and Science knowledge through integrated information management (Inuit Knowledge)	Nickels, Scot (Inuit Tapiriit Kanatami)
4.9 Inuit Knowledge and Geospatial Ontologies in Nunatsiavut *(Inuit Knowledge)*	Furgal, Chris (Trent University); Sheldon, Tom (Nunatsiavut Government)

Table 3. Projects being carried out under Beaufort Regional Environmental Assessment:

Project Title	Project Leader
Active Acoustic Mapping of Fish in the Beaufort Sea, 2011-2013	Louis Fortier (ArcticNet)
Fishes, Habitats and Ecosystem Linkages to Oil and Gas Development in the Beaufort Sea, 2011-2015	Jim Reist (Fisheries and Oceans Canada)
Baselines, accumulation, cycling and potential effects of hydrocarbons in Beaufort sediments and biota, 2012-2014	Gary Stern (Fisheries and Oceans Canada)
The Southern and Northeastern Beaufort Sea Marine Observatories, 2011-2014	Martin Fortier (ArcticNet)
Forecasting Extreme Weather and Ocean Conditions in the Beaufort Sea, 2011-2015	Fraser Davidson (Fisheries and Oceans Canada)
Seasonal Forecasting of Ocean and Ice Conditions in the Beaufort Sea, 2011-2015	Gregory Flato (Environment Canada)
Modeling of Freshwater Flows to the Beaufort Sea for Improved Offshore Prediction by the Metarea Ocean Forecast System, 2012-2015	Philip Marsh (Wilfrid Laurier University)
CanICE – A Sea Ice Information Database and Web-Based Portal, 2011-2014	Lina Assad (Environment Canada)
Quantifying Sea Ice Dynamics in the Beaufort Sea, 2012-2015	Chris Derksen (University of Waterloo)
Characterizing Deformed Multi-Year Ice in the Beaufort Sea, 2011-2015	Michelle Johnston (National Research Council)
Distribution and Thickness of Different Sea Ice Types and Extreme Ice Features in the Beaufort Sea, 2011-2015	Christian Haas (York University)
Radarsat Mapping of Extreme Ice Features in the Southern Beaufort Sea, 2011-2015	David Barber (University of Manitoba)
Regional Assessment of Deep Water Seabed Geohazards for Oil Spill Prevention, 2011-2015	Steve Blasco (Natural Resources Canada)
Regional Synthesis of Coastal Geoscience for Management of Beaufort Oil and Gas Activity, 2012-2014	Dustin Whalen (National Research Council)
Regional Coastal Monitoring in the Inuvialuit Settlement Region: Ecosystem Indicators, 2012-2015	Vic Gillman / Frank Pokiak (Fisheries Joint Management Committee / Inuvialuit Game Council)

Table 4. Projects being carried out under the Cumulative Impact Monitoring Program (CIMP) – 2013/14

Project Title	Project Leader
Establishing a watershed framework for assessing cumulative impacts of development	Krista Chin (Aboriginal Affairs and Northern Development Canada AANDC)
A multi-scale assessment of cumulative impacts in the Northern Mackenzie basin	Claire Marchildon (AANDC)
Arctic Borderlands Co-op: Community based ecological and cumulative impacts and monitoring program	Michael Svoboda (Arctic Borderlands Ecological Knowledge Coop)
Baseline monitoring of Arctic vegetation and snow changes over the Bathurst caribou habitat using satellite remote sensing and community-based field observations	Wenjun Chen (Canadian Centre for Remote Sensing)
CARMA's knowledge to action: developing and testing thresholds and monitoring for cumulative impacts on caribou	Don Russell, CARMA
Understanding and predicting fish mercury levels in the Dehcho region using models of bio-magnification and bio-accumulation	George Low (Dehcho First Nations)
A watershed-scale sampling protocol for accurate distribution and trend assessment of stream salmonids in the Northwest Territories	Neil Mochnacz (Department of Fisheries and Oceans Canada DFO)
Monitoring Pacific salmon to understand cumulative impacts of climate change in the Arctic	Karen Dunmall (DFO)
Integrated ecomonitoring and assessment of cumulative impacts on Great Slave Lake fisheries ecosystems	Xinhua Zhu (DFO)
Community coastal based monitoring: A regional approach for the ISR	Lisa Loseto (DFO)
Long term monitoring of Great Bear Lake fisheries and the aquatic ecosystem	Kim Howland (DFO)
Changing hydrology in the Taiga Shield: Geochemical and resource management implications	Chris Spence (Environment Canada)
Monitoring Boreal caribou in the Dehcho	Nic Larter (Government of the Northwest Territories – Environment and Natural Resources GNWT-ENR)
Spatial distribution of wolves on Bathurst	Dean Cluff (GNWT-ENR)

caribou summer range	
Succession and regeneration response on seismic lines with respect to ecology, disturbance factors and time	Lisa Smith (GNWT – Environment and Natural Resources)
Landscape scale flooding in the Great Slave Lake Plain: Expansion of lakes, flooding of wetlands and implications for bison habitat and local land users	Terry Armstrong (GNWT – Environment and Natural Resources)
Implementing collaborative cross-NWT water quality monitoring to address the needs of water partners, focusing on cumulative impacts and community concerns	Erin Kelly (GNWT-ENR)
Engaging Fort Resolution youth in cumulative impacts monitoring and assessment – Developing and operationalizing a framework for youth engagement	Jennifer Fresque-Baxter (GNWT-ENR)
A watershed approach to monitoring cumulative impacts of landscape change	Steve Kokelj (GNWT – Industry Tourism and Investment)
Gwich'in Harvest Study	Janet Boxwell (Gwich'in Renewable Resources Board)
Inuvialuit Settlement Region community-based monitoring program (ISR-CBMP) – Pilot program	Jennie Knopp (Inuvialuit Joint Secretariat)
Investigating the cumulative effects of environmental change and human activity in the Tathlina watershed	Melaine Simba (Ka'a'gee Tu First Nation)
Ni Hat'ni Dene Program	Gloria Enzoe (Lutsel K'e Dene First Nation)
Dene mapping project repatriation and analysis: Understanding valued places at the intersection of caribou ecology and harvesting	Deborah Simmons (Sahtu Renewable Resources Board)
Marian watershed community-based aquatic effects monitoring program	Kerri Garner (Tlicho Government)
Tlicho community based monitoring of Bathurst and Bluenose East caribou	Kerri Garner (Tlicho Government)
Community-based monitoring of wildlife health phase 2: Stress and pathogens in a changing landscape	Susan Kutz (University of Calgary)
Monitoring environmental change in the Mackenzie Delta Region: Inuvialuit observations and participatory-multimedia mapping	Trevor Lantz (University of Victoria)
Tlicho aquatic ecosystem monitoring	Jody Snortland (Wek'eezhii Renewable

project	Resources Board)
Snowpack accumulation: influence on caribou distribution, surface water chemistry and lake productivity	Michael English (Wilfrid Laurier University)
Establishing a water quality dataset for cumulative effects assessment in the North Slave	Todd Slack (Yellowknives Dene First Nation)

Table 5. Projects being carried out under the Nunavut General Monitoring Plan (NGMP) – 2013/14

Project Title	Project Leader
Continuation of the establishment of a long-term, river-based monitoring program for Arctic Char (Salvelinus alpinus) in the Cambridge Bay area, Nunavut	Brenda Sitatak, EHTO, Cambridge Bay
Development and Implementation of a community based fishery monitoring program and stock assessment framework for Arctic Char in Baffin Region, NU.	Jackie Maniapik, Pangnirtung HTA
Eastern Canadian Arctic Killer Whale Tagging, Biopsy, and Monitoring	James Roth, University of Manitoba
Monitoring of Nunavut Large Terrestrial Carnivores: Wolverine, Wolf, Grizzly Bear	Dominique Berteaux, Université du Québec à Rimouski
Petroleum hydrocarbons in invertebrates at the base of marine food webs in Baffin Bay	Gary Stern, University of Manitoba
Hudson Strait-Foxe Basin Marine Coastal Monitoring Surveys: Assessing the Impacts of Declining Summer Sea-Ice and Northern Development (ongoing)	Mark Forbes, Carleton University
Small polynyas in Nunavut: targets for biodiversity, climate change and contamination	Mark Mallory, Acadia University
Community-Based Monitoring of Ice-Breeding Seals and Polar-Bear Feeding in the Gulf of Boothia	Gregory Thiemann, York University
Phase III -- Delivering a fisheries-focused Nunavut Community Aquatic Monitoring Program (N-CAMP) to 3 pilot communities, Igloolik, Kugluktuk, and Coral Harbour	Janelle Kennedy, Government of Nunavut - Department of Environment, Fisheries and Sealing
Re-Assessment of the Baffin Bay Polar Bear Sub-Population	Markus Dyck, Government of Nunavut - Department of Environment
Impacts of Hydroelectric projects on winter sea ice and wildlife entrapments in Hudson Bay	Joel Heath, The Arctic Eider Society
Nunavut Drinking Water Quality: Source to Tap Monitoring	Rob Jamieson, Dalhousie University
Monitoring Educational and professional success amongst Inuit of Nunavut who have registered in a post-secondary program	Thierry Rodon, Laval University
Understanding Community Change in the Qikiqtaaluk: Examining communities affected by the Mary River Project through community	Sandra Kownak and Bethany Scott, Qikiqtani Inuit Association

based research	
Providing a Repository and Dissemination Service for NGMP Data	Steve Marks, Canadian Polar Data Network
Improve Access to Nunavut Monitoring Information using the Nunavut Database	Shannon Vossepoel, University of Calgary
Past, Present, and Reasonably Foreseeable Project Mapping Initiative	Ryan Barry, Nunavut Impact Review Board
Oil Spill Detection and Modelling Solutions for Hudson and Davis Strait	William Jefferies, LookNorth
Kitikmeot Inuit Traditional Land Use and Occupancy Baseline Data Integration Project	Luigi Torretti, Kitikmeot Inuit Association

Table 6. Projects carried out under the Environmental Studies Research Fund (ESRF) – 2013/2014

(from ESRF annual report 2013 available at: http://www.esrfunds.org/annrap_e.php)

Project Title	Project Description
The Seabed Stability Conditions Shelf/Slope Transition Zone, Canadian Beaufort Sea: A Synthesis of 1970–2008 data	This study will provide information on seabed stability conditions and active geological processes on the outer-shelf/upper-slope region of the central Beaufort Sea from the eastern edge of the Mackenzie Trough to the eastern edge of the Shelf at the entrance to Amundsen Gulf.
The Emergency Spatial Pre-SCAT for Arctic Coastal Ecosystems — Beaufort Sea/Mackenzie Delta	This project will identify and map shoreline characteristics, coastal habitats and resources at risk in the Canadian Beaufort Sea/Mackenzie Delta. It will also examine satellite imagery as a potential tool for monitoring and predicting biodiversity in the Beaufort Sea with a focus on marine birds and mammals. The results will be incorporated in an update to the current "Arctic Environmental Sensitivity Atlas System" (Version 3.01, 2004, E.C.), available in digital (CD) and hardcopy formats.
The Uniqueness of Fishes and Habitat Utilization in Oil and Gas Lease Blocks Relative to Non-Lease Areas in the Canadian Beaufort Sea	This research project investigates the distribution, variety and abundance of Arctic marine fish and their supporting habitats, including water- mass movements, sediment type, water quality and food availability. The study looks at marine fish and their habitats from a regional perspective, within specific areas of possible oil and gas exploration and production, and within areas that could potentially be affected by development (e.g., equipment staging areas, transport routes, burrow pit locations).
Timing of Beluga Entry Relative to Ice Break-Up in the Mackenzie Estuary During Late Spring	This study will define current patterns of the arrival of beluga whales coinciding with the ice break-up in the Mackenzie Estuary from Herschel Island eastward following the edge of the land-fast ice, to

	the eastern end of the Tuktoyaktuk Peninsula. These patterns will then be compared with historical data from the 1974–1985 period on beluga entry and break-up dates.
Quantitative Assessment of the Interaction between Beaufort Sea Crude Oils and Mackenzie River Delta Suspended Sediments	Extensive bench-scale testing will be conducted on oil-sediment interaction at low temperatures with and without chemical dispersants, using selected crude oils from the Beaufort Sea and Norman Wells and selected sediment samples from the Mackenzie River Delta and Norman Wells.
Central Mackenzie Surface Water and Groundwater Baseline Assessment and Monitoring Program	This study examines the state of traditional and scientific knowledge regarding surface and groundwater in the Central Mackenzie Valley. It investigates water quality, annual and seasonal surface water cycles, flow patterns and rates, surface and groundwater interactions, aquifer characteristics, and well and aquifer yields. The study will also assess current and projected water quantity needs for domestic, traditional and industrial uses, as well as the benefits of maintaining healthy aquatic ecosystems.
Cross-Cultural Knowledge-Sharing Pertaining to Wildlife, Habitat and Harvesting in the Central Mackenzie Valley	This study will use cross-cultural knowledge- sharing to examine wildlife, habitat and wildlife harvesting in the Central Mackenzie Valley (CMV) related to oil and gas exploration and development. The wildlife component of this study will focus on caribou in the CMV, with an emphasis on determining the population, diversity and habitat of this species. Measurements will also be made on the regeneration pattern on seismic lines.
A Road Map for Planning Controlled Oil-Spill Countermeasures Research in the Canadian Beaufort Sea	This project will guide government, industry and university researchers in the complex organizational process required prior to conducting oil-spill countermeasures field research in the Canadian Beaufort Sea. The resulting road map will outline the various components of this process: consultations with Northern

	community stakeholders; environmental assessment requirements; the regulatory permits requirements; and the safety, logistical, infrastructure and support requirements needed to be in place prior to commencing field experiments.

Table 7a. Projects being carried out under the Program of Energy Research and Development (PERD) – 2013/2014

Project Title	Project Leader
Beaufort Sea Wave Design Criteria	Val Swail (Environment Canada)
Ice and Snow properties of the coastal Canadian Beaufort Sea	Ingrid Peterson and Simon Prinsenberg (DFO)
Geological hazards in Baffin Bay	Calvin Campbell (GSC-NRCan)
Hummocked Multi-year Ice: The Most Severe, but Least Understood Type of Sea Ice	Michelle Johnston (National Research Council)
Changing sea ice constraints on hydrocarbon development in canada's arctic	Humfrey Melling (DFO)
Regional assessment of geohazards related to deep water hydrocarbon development, Beaufort Sea outer shelf/upper slope	Scott Dallimore and Steve Blasco (GSC-NRCan)
Beluga Habitat use of the Mackenzie Estuary: Surveys and Acoustics	Lisa Loseto (DFO)
Arctic Coastal Ocean Processes, Seasonal Ice and Storms	Will Perrie (DFO)
Investigation of habitat utilization of Beaufort fishes during the open-water season	Andy Majewski (DFO)
Establishing requirements for exploratory drilling in ice-covered deep waters	Ivana Kubat (National Research Council)
Quantifying the effect of pressured ice action on ships	Ivana Kubat (National Research Council)
Natural Attenuation as an Oil Spill Response Strategy in the Arctic	Charles Greer (National Research Council)
Arctic microbial communities and their potential role in the mitigation of oil spills	Christine Michel (DFO)

Table 7b. Projects being carried out under the Program of Energy Research and Development (PERD) – 2014/2015

Project Title	Project Leader
Targeted Assessment of Geological Hazards in Baffin Bay	Calvin Campbell (GSC-NRCan)
Changing sea-ice constraints on hydrocarbon development in Canada’s Arctic	Humfrey Melling (DFO)
Geohazard issues on the Beaufort Shelf and Slope	Edward (Ned) King (NRCan)
Establishing requirements for exploratory drilling in ice-covered deep waters	Ivana Kubat (National Research Council)
Arctic Coastal Ocean Processes, Seasonal Ice	Will Perrie (DFO)

and Storms	
Reducing uncertainty in pack ice driving forces: Katie's Floeberg	Denise Sudom (National Research Council)
Quantifying the effect of pressured ice action on ships	Ivana Kubat (National Research Council)
Potential for natural hydrocarbon degradation in the Beaufort Sea	Christine Michel (DFO)

Annex 1 – Summary of projects conducted under the Northern Contaminants Program

H-01 (2013-2014)
Assessment of contaminant and dietary nutrient interactions in Inuit Health Survey: Nunavut, Nunatsiavut and Inuvialuit

Project leader: Dr. Laurie H.M. Chan, Professor and Canada Research Chair in Toxicology and Environmental Health, Center for Advanced Research in Environmental Genomics, University of Ottawa

PLAIN LANGUAGE SUMMARY

The Inuit Health Survey (IHS) is a major study that provides a snapshot and baseline data on the health status of Inuit across the North for the first time. The Assessment of contaminant and dietary nutrient interactions in the Inuit Health Survey: Nunavut, Nunatsiavut, and Inuvialuit is a component of the Inuit Health Survey. In 2013-2014, the work will focus on: 1) secondary data analysis on the relationship between contaminant exposure and chronic diseases and food security, 2) follow up survey on the response to the public health messages and risk perception of the residents in 3 communities in Nunavut, 3) develop a common platform for data sharing/analysis for IHS, data collected from Nunavik and Greenland, 4) follow up consultation/communication with the IHS national steering committee. The survey, including sample collection, was conducted in Nunavut in 2007 and in Western Nunavut, Inuvialuit Settlement Region, and Nunatsiavut in 2008, on board the Coast Guard research ship (CGGS) Amundsen. Results describing the body burden and estimated dietary intake of contaminants were reported to each of the 3 regional steering communities in 2011 and key results/messages were presented in community reports and released in each of the 3 regions 2012. This will be the final year of the project. Results of the study will provide useful information to assist health professionals and policy makers at the regional, provincial, territorial, national, and international levels in developing environmental health policies and aid Inuit in making informed dietary choices.

H-02 (2013-2014)
Nunavik Child Cohort Study (NCCS): follow-up with late adolescents

Project leader: Gina Muckle, Centre de recherche du CHUQ, Université Laval

PLAIN LANGUAGE SUMMARY

Prenatal Exposure to PCBs and mercury were associated with growth and effects on cognitive development in children. The Inuit from Nunavik are among the populations most highly exposed to these environmental pollutants due to their bioaccumulation in fish and marine mammals, which are consumed by the Inuit. However, consumption of fish and marine mammals also provides nutrients such as omega-3 fatty acids, which are known to enhance early brain development. We have conducted four studies in Nunavik over the last 20 years: monitoring of prenatal exposure from cord blood sampling, an effect study with infants up to 12 months of age, and an effect study at preschool age. In

2010, we completed the follow-up of 294 11 year-old children and, during the years 2010 and 2011, we analyzed most of the 11-year data.
In fall 2011, study results were presented to the Nunavik population and public health recommendations provided by the Public Health Director of Nunavik. Summary of study results and public health recommendations can be found at http://www.rrsss17.gouv.qc.ca. Last year, we launched the follow-up of the cohort at adolescence and during current year, we are proposing to continue this work and recruit 66 additional adolescents.

H-03 (2013-2014)
Nunavik Child Cohort Study (NCCS): add-on study for follow-up with teenage children – observed behaviours and stress

Project leader: Pierich Plusquellec, Université de Montreal

PLAIN LANGUAGE SUMMARY

Prenatal exposure to lead, PCBs and mercury were associated to behavioural impairments in children. In the last three cohort studies conducted in Nunavik (1 year-old, 5 years-old, 11-years-old), we have assessed behavioural development and found subtle effects of lead on attention, activity, impulsivity, but also of PCBs on emotional outcomes. For year 2013/2014, we are proposing an add-on study to the main follow-up of children at age 17 proposed by G Muckle. Adolescence is thus a period at which mechanisms of hormone disruption by environmental contaminants become obvious, and at which emotional development is particularly at risk. Our proposal focus on the assessment of observational data on attention, activity and emotional reactivity obtained from coding of videotapes since those data have been shown to be highly sensitive to environmental contaminants exposure. Furthermore, this proposal focus on the assessment of the endocrine stress system through a self-report questionnaire, saliva samples and hair sample to assess basal glucocorticoids levels, reactive glucocorticoids levels following the testing situation, and chronic stress. This focus on the stress system is based on recent scientific results showing that exposure to environmental contaminants may impair this endocrine system, and thus impact behavioural outcomes. Finally, we included in this proposal secondary analysis on data from the Inuit Health Survey, in order to document associations between environmental contaminants and a physiological index of chronic stress, called the allostatic load index.

H-04 (2013-2014)
Contaminant Nutrient Interaction Issues as part of a Public Health Intervention Study of Inuit Children in Nunavik: Communication of results.

Project leader: Huguette Turgeon O'Brien, Université Laval, and Doris Gagné, Université Laval

PLAIN LANGUAGE SUMMARY

As part a broader project called the Nutrition Program in Nunavik Childcare Centres, the present study primarily aims to document the contaminant nutrient interactions in preschool Inuit children from Nunavik. From 2006 to 2010, a total of 245 children were

recruited and 110 of them were seen for a follow-up visit one year later. Heavy metals and persistent organic pollutants, dietary intakes, and nutritional status were measured at both visits. Children who consumed traditional food had significantly higher intakes of proteins, omega-3 fatty acids, and many vitamins and minerals than nonconsumers. Lead, PCB 153, PBDE 47, PFOS and PFOA were detected in all samples at recruitment. PBDE 47, 99 and 100 were more prevalent and detected at higher levels than in Nunavimmiut adults. Thirteen percent of participants had values equal to, or exceeding the blood guidance value for methylmercury (8 µg/L), or were above the PCB level of concern (5 µg/L). Moreover, 64.5% of children had a low serum vitamin D level (<75 nmol/L 25(OH)D) whereas 50% of them suffered from iron deficiency. An inverse association was found between children's iron status and blood lead levels. In regression models, tomato products and dietary calcium intake had a protective effect against mercury and lead exposure, respectively. The 2013-2014 research funding support is requested in order to complete the development of a communication plan with the Nunavik Nutrition and Health Committee (NNHC). Key findings will be delivered to target audiences including parents and frontline workers.

H-05 (2013-2014)
Monitoring of Environmental Pollutants in Maternal Blood in Nunavik: Time Trend Assessment and Evaluation of the Arctic Char Program

Project leader: Eric Dewailly, Centre de recherche du CHUQ, Université Laval

PLAIN LANGUAGE SUMMARY

Inuit are exposed to a wide range of environmental contaminants through their traditional diet, which includes significant amounts of fish and sea mammals. During the past twenty years, several studies have monitored the exposure of Nunavimmiut to persistent organic pollutants (POPs) and heavy metals. A decrease trend in human exposure has been observed for most POPs in the Nunavik over the last two decades. Most of our biomonitoring data since 1997 originate from Hudson Bay and time-trend data are lacking for the Ungava Bay population. In addition, new emerging contaminants have now reached the Arctic food chain and very little is known about the body burden of these compounds in Inuit people. In contrast, mercury exposure appears more stable but remains a public health threat, as new epidemiologic data from Nunavik confirmed that mercury exposure during the prenatal period is deleterious for the unborn baby brain development. The Nunavik Regional Board of Health and Social Services (NRBHSS) has therefore suggested new food advisories for child-bearing age women (beluga meat). Moreover, in villages along the Hudson Bay, the Inuulitsivik Health Centre, in collaboration with the NRBHSS, began in September 2011 a program that freely distributes Arctic char (Salvelinus alpinus, anadromus spp) to pregnant women, in order to reduce Hg exposure and improve nutritional status among pregnant women. The efficacy of this program needs to be assessed. This research project proposes to continue the biomonitoring activities in Nunavik in order 1) to expand the biomonitoring of pregnant women to the Ungava Bay region for a limited list of POPs and metals as well as key nutrients; 2) to assess exposure to new emerging environmental contaminants for which increasing concentrations in wildlife and human samples have been reported worldwide; 3) to initiate the evaluation of the efficacy of the Arctic Char program in reducing Hg exposure

among pregnant women from the Hudson Bay (1st trimester of pregnancy, T0 of the intervention program).

H-08 (2013-2014)

Country foods and cardiovascular health in Nunavik: studying the complex balance between selenium and environmental contaminants

Project leader: Pierre Ayotte, Centre Hospitalier Universitaire de Québec (CHUQ) and Québec National Institute of Public Health

PLAIN LANGUAGE SUMMARY

Selenium (Se) is an essential element highly present in the traditional marine diet of Inuit and their exposure to this element is among the highest in the world. In fish and marine mammal eating populations, there is increasing evidence suggesting that high Se intake may play a role in offsetting some deleterious effects of methylmercury (MeHg) exposure. However, in other populations, elevated plasma Se concentrations have been recently associated to type 2 diabetes, hypercholesterolemia and/or hypertension. In addition to plasma Se levels, the most common biomarker of Se status, several other biomarkers (e.g. selenoproteins) have been identified and these may help to better characterise Se status. We will investigate relations between these new biomarkers of Se status and emerging health issues such as diabetes and cardiovascular diseases in Inuit adults, taking into account possible interactions with mercury and other environmental contaminants. We will also identify the forms of selenium and mercury present in various traditional foods and their bioaccessibility. These much needed data will improve our capacity to assess the risks and benefits of Se intake and the traditional marine diet in this population.

H-10 (2013-2014)

Quantifying the Effect of Transient and Permanent Dietary Transitions in the North on Human Exposure to Persistent Organic Pollutants

Project leader: Frank Wania, University of Toronto

PLAIN LANGUAGE SUMMARY

Human exposure to persistent organic pollutants (POPs) in both industrialized and remote regions is strongly influenced by diet. What we eat and where these food items originate are key determinants of body burden and risks associated with chronic exposure to such compounds. It is well known that all foods are not equal with respect to contamination with POPs. This implies that contaminant exposure can be affected by changes in diet. Such dietary changes may be transient, e.g. if a woman who plans to become pregnant or already is pregnant temporarily avoids food items known to be more contaminated, such as the fatty tissues of marine mammals. Or such dietary changes may be more gradual and permanent, e.g. if someone gradually shifts from a traditional diet of locally hunted animals to a diet that includes more store-bought food imported to the community. Here we propose to develop and use a series of computer-based simulation models that quantify how much such dietary changes can affect exposure to contaminants. At the

same time we will seek to quantify how much these changes affect the intake of beneficial nutrients. It is hoped that the model can eventually be used to make informed decisions on dietary choices that minimize risk from contaminants while maximizing nutritional food value.

H-01 (2014-2015)
Development of Blood Guidance Values for Persistent Organic Pollutants for the Canadian Arctic

Project leader: Dr. Laurie H.M. Chan, Professor and Canada Research Chair in Toxicology and Environmental Health, Center for Advanced Research in Environmental Genomics, University of Ottawa

PLAIN LANGUAGE SUMMARY

The interpretation of exposure data requires guidance values against which risk level can be assessed. The International Polar Year Inuit Health Survey for Adults (2007-2008) provided a rich dataset of exposure data to several environmental contaminants. However, guidance values from Health Canada or United States occupational sources were available for only four of the measured contaminants – PCB Arochlor 1260, lead, mercury and cadmium. The relevance of the biomonitoring data for all other contaminants, therefore, is unclear and communication of risk imposed by such contaminant exposures becomes difficult. The proposed work will attempt to identify and propose possible guidance values for these contaminants and to use the guidance values as benchmarks to compare the observed biomonitoring data. The results will be incorporated into knowledge translation messages of risk level to Inuit populations. The work will involve searching the literature and modeling using pharmacokinetic approaches. We will discuss with Health Canada and the regional health authorities on the use of possible guidance values and try to develop suggested action plan or communication message for the portion of studied population that had blood levels exceeding the proposed guidance values.

H-02 (2014-2015)
Do country food nutrients protect against mercury toxicity and cardiometabolic diseases? Integrating data from cutting-edge science and mobilizing knowledge towards Nunavimmiut health

Project leader: Pierre Ayotte, Centre Hospitalier Universitaire de Québec (CHUQ) and Québec National Institute of Public Health

PLAIN LANGUAGE SUMMARY

Despite a decreasing temporal trend over the last decades, methylmercury (MeHg) exposure in the Inuit population of Nunavik is still among the highest in the world. Traditional marine foods are the major source of this exposure, but are also rich in nutrients such as selenium (Se) and omega-3 polyunsaturated fatty acids (n-3 PUFA). Through an interdisciplinary program incorporating nutrition, epidemiology, toxicology and implementation research, we are addressing the complex issue of benefits and risks of country foods in the Inuit population of Nunavik, especially with regard to cardiometabolic diseases. In addition to continuing the integration of data obtained during

the last two years of our program, we will conduct key additional work centred mainly on diabetes risk. Type 2 diabetes mellitus (T2D) prevalence among Inuit has been low compared to that of general populations, and much lower than in most aboriginal populations which are now struggling with T2D epidemics. However the dietary and lifestyle transition occurring in the Inuit population of Nunavik may change the situation in the near future. An emerging risk factor is MeHg exposure: MeHg administration was shown to impair pancreatic function in laboratory animals, and recently, MeHg exposure was associated with T2D risk in a prospective study of young American adults. There is an urgent need to determine if validated predictive biomarkers of T2D are modulated by MeHg exposure and by putative protective factors in the traditional diet such as Se, n-3 PUFA and polyphenols, from wild berries intake. These biomarkers of T2D, more specifically 2-minoadipic acid, branched chain amino acids and acylcarnitine serum levels, will be determined in participants of the 2004 Inuit Health survey and their associations with new biomarkers of MeHg exposure, Se status (selenoproteins, small selenocompounds – serum levels determined in last year's project) and n-3 PUFA status will be examined. In addition, in vitro experiments will be conducted to examine the protective role played by Se and n-3 PUFA on: (i) the impact of MeHg on the metabolism of fat tissues; and (ii) the bioavailability of Hg in country foods. The integration of these much needed data will increase our understanding of the determinants of T2D and cardiovascular diseases (CVD) risk in this population. In addition, it will improve our capacity to develop and implement interventions that aim to promote the benefits of traditional marine diet, while minimizing MeHg exposure in this population.

H-03 (2014-2015)
Environmental contaminants, stress and behaviour: statistical analysis in late adolescent Inuit from the Nunavik Child Cohort Study (NCCS), and in adult Inuit from the Inuit Health Survey

Project leader:
Pierich Plusquellec, Université de Montreal

PLAIN LANGUAGE SUMMARY

Prenatal exposure to lead, PCBs and mercury were associated to behavioural impairments in children. In the last three cohort studies conducted in Nunavik (1 year-old, 5 years-old, 11 years-old), we have assessed behavioural development and found subtle effects of lead on attention, activity, impulsivity, but also of PCBs on emotional outcomes. Although we continue to look at the association between environmental contaminants and attention, activity and impulsivity, we have also focused on emotional outcomes, mainly stress. This focus on the stress system is based on recent scientific results showing that exposure to environmental contaminants may impair this endocrine system, and thus impact behavioural outcomes. Furthermore, adolescence is a period at which mechanisms of hormone disruption by environmental contaminants become obvious, and at which emotional development is particularly at risk. Finally, stress is a significant risk factor of attention, activity, impulsivity levels but also of various physical and mental disorders in adolescents. For the last 2 years (2012 to 2014), we have collected data on stress (cortisol levels in saliva and in hair samples) and on behavioural dimensions (analysis of video recordings) from the follow-up study of children at age 17 leaded by G Muckle. For 2014/2015, we propose to analyze comprehensively those data in teenagers but also to

relate them to ongoing analyses on the effects of environmental contaminants on a physiological index of chronic stress from data collected through the Inuit Health Survey. If the expected association between exposure to environmental contaminants and the stress system is found in the Inuit, then we could focus on way to better understand and deal with stress in Inuit.

H-04 (2014-2015)
Lake Melville and Labrador Inuit: Understanding and projecting human health implications of exposure to local and long-range mercury sources

Project leader: Tom Sheldon, Nunatsiavut Governmnet

PLAIN LANGUAGE SUMMARY

The goal of this Human Health Risk Assessment is to better understand how Inuit living on Lake Melville might potentially be exposed to methylmercury (MeHg) through the consumption of country foods. The study will consist of two parts: 1. a dietary survey to find out how much fish, seal and other country foods are being consumed from the Lake Melville environment over three different seasons (Winter, Spring hunt and Fall freeze-up), and 2. the taking of hair samples to measure for mercury exposure. A total of about 2000 surveys and hair samples will be taken in the communities of Rigolet, North West River, Happy Valley-Goose Bay and Mud Lake during the month of June, and the dietary survey will be redone with a smaller sample (about 250 people) during the Fall.

Inuit living on Lake Melville are concerned about the possibility of increased methylmercury (MeHg) in the foods that they harvest from Lake Melville as a result of past and future hydro development on the Churchill River. This research will use the information it collects to develop a model to estimate how exposure to methylmercury might change due to industrial (short-range) and climate (long-range) changes.

H-05 (2014-2015)
Exposure to food chain contaminants in the Canadian Arctic: spatial and time trends.

Project leader: Eric Dewailly, Centre de recherche du CHUQ, Université Laval

PLAIN LANGUAGE SUMMARY

Inuit are exposed to a wide range of environmental contaminants through their traditional diet, which includes significant amounts of fish and sea mammal. During the past twenty years, several studies have monitored the exposure of Nunavik's Inuit to persistent organic pollutants and heavy metals as well as in other Inuit Nunangat regions. A decrease trend in human exposure has been observed for most POPs and metals in Nunavik over the last two decades. A part of it is probably due to a decrease in environmental and food concentrations, however another part might be associated with a lower traditional food consumption over time. Since the late 90's, increased emphasis was placed on health effects studies in relation to exposure to polychlorinated biphenyls, chlorinated pesticides, mercury and lead in Nunavik. These new results reemphasis the

needs of 1) mitigation interventions and 2) biomonitoring activities to follow these public health interventions conducted at the local or international levels. As an example, the Arctic Char program, a Nunavik program aiming at distributing Arctic Char to pregnant women from Hudson Bay, particularly by measuring the impact of the program on blood mercury as well as insuring that indices of food security such as iron deficiency anemia are improving. On the biomonitoring side, new emerging organic contaminants have now reach the Arctic food chain and very little is known about their concentrations in Inuit people. Very little also is known about regional differences. We also wish to analyse concomitantly the data from adults from all Inuit Nunangat regions (n=3500) in order to show gender, regional and age trends and differences. We also propose to prepare the contaminant protocol of the new Qanuippitaa survey which is planned for 2015. Moreover, with the new contaminants (SCCPs, CNs, HCBD, HBCD as well as new PBDEs) being measured in 2013-2014 in pregnant women, we would like to extend these measurements in archived samples in order to better explore the time trends of these new chemicals. Finally, with the Minamata convention on Hg, we also want to take the momentum of initiating a new international Arctic monitoring activity centred on Hg analyses of maternal blood in circumpolar countries.

H-06 (2014-2015)
Tukisinirlungniq: Understandings of the Risks and Benefits of Consuming Beluga in Arviat, NU

Project leader: Shirley Tagalik, Arviat Wellness Center, Chris Furgal, Trent University, and Amanda Boyd, Washington State University

PLAIN LANGUAGE SUMMARY

This project proposes to enhance our understanding of the factors influencing food choices in Inuit communities and the potential role that concern over contaminants, and the legacy of past health advice or advisories may play in the consumption of country food items. It is an action-oriented project co-led by the Community of Arviat, NU Wellness Centre and Trent and Washington State Universities. It will be conducted over a two year period. Since the early 1970s, residents of Arviat have been hunting beluga whales and consuming only the maaqtaq. Meat, which used to be consumed dry and fresh is now routinely given to the dogs or discarded. Arviat, like other Inuit communities, faces various food security challenges and needs current information relating to the viability and feasibility of different culturally acceptable food options for its' population. This project proposes to use a mental models approach to explore the current perceptions and misperceptions regarding the safety of beluga whales as a country food item in this community. In conjunction with the generation of up to date beluga contaminants (mercury-Hg) and nutrients (selenium-Se) data from the area, this project proposes to generate updated health messages on the consumption of beluga for this population. This messaging will be developed in consideration of current perceptions and misperceptions of the safety (health benefits and risks) of consuming beluga as a country food item, current levels of Hg and Se in these food items and current diet behavior and levels of exposure to contaminants in the region. In Year 2, messages will be delivered and evaluated to assess their impacts in terms of perception and diet behavior in the

community. This project has value to other similar cases across the North where the legacy of past contaminant advisories is currently unknown or where uncertainty exists regarding the impacts of contaminant perception on current diet behaviour.

H-10 (2014-2015)
Quantifying the Effect of Transient and Permanent Dietary Transitions in the North on Human Exposure to Persistent Organic Pollutants

Project leader: Frank Wania, University of Toronto

PLAIN LANGUAGE SUMMARY

Globally, human exposure to persistent organic pollutants (POPs) and mercury is strongly influenced by diet. Moreover, it is well known that dietary POP and mercury exposure risks vary greatly based on where foods originate from and how they are prepared. This implies that contaminant exposure can be affected by changes in diet. Such dietary changes may involve transitions from one food type or source region to another, i.e. populations gradually shifting from a local traditional food (TF) diet to one including more imported food, or they may involve transient changes during major life stages, i.e. mothers adjusting their diet during pregnancy and nursing. Additionally, such dietary changes may relate instead to changing food preparation, for example individuals continuing to eat the same types of food but altering their cooking methods. Here we propose an approach to quantify the effect of such dietary changes on human POP and mercury exposure by combining the use of computer-based simulation models and experimental TF study. At the same time we will attempt to estimate how much these changes affect the intake of beneficial nutrients. We hope that our model and analytical results may eventually be used to inform Northern food consumption choices that minimize risk from POPs and mercury while maximizing diet nutritional values.

M-01 (2013-2015)
NORTHERN CONTAMINANTS AIR MONITORING: ORGANIC POLLUTANT MEASUREMENTS

Project leader: Hayley Hung, Environment Canada

PLAIN LANGUAGE SUMMARY

The atmosphere is the main pathway for organic contaminants to enter Arctic ecosystems. This project involves the measurement of these contaminants in Arctic air. It is part of a continuing monitoring program started in 1992. Measuring how much organic pollutants are present in Arctic air over time will provide us information on whether their air concentrations are decreasing, increasing or not changing over time; where these chemicals have come from; how much from which region and what climate conditions influence their movement to the Arctic. The government can then create policies to limit their emissions and hopefully reduce what comes into the Arctic. Results from this continuing project are used to negotiate and evaluate the effectiveness of international control agreements and to test atmospheric models that explain contaminant movement from sources in the South to the Arctic. In FY2014-15, weekly sampling will continue at the baseline site of Alert, Nunavut, but only one out of four weekly samples will be analyzed for routine trend analysis. The remaining samples will be extracted and archived for future exploration of notable transport episodes and determination of emerging priority chemicals. Starting in Dec 2005, we have extended the program to screen for emerging chemicals, such as current-use pesticides, brominated flame retardants and stain-repellent-related perfluorinated compounds, in Arctic air at Alert. Last year, Alert air samples from 2011 were screened for short-chain chlorinated paraffins (SCCPs). We would like to continue this work in the coming fiscal year with additional efforts in screening for organophosphate flame retardants (OPs). A funding request to Environment Canada's Chemicals Management Plan (CMP) will be submitted to complement this work under NCP. A passive flowthrough air sampler specifically designed for use in cold environments has been deployed at Little Fox Lake, Yukon, since August 2011. We propose to continue measurements at this location in the western Canadian Arctic to assess the influence of trans-Pacific and Asian contaminant sources on the western Canadian Arctic.

M-02 (2013-2015)
AIR MEASUREMENTS OF MERCURY AT ALERT AND LITTLE FOX LAKE

Project leader: A. Steffen, Environment Canada

PLAIN LANGUAGE SUMMARY

This project looks at the levels of mercury in the Arctic air from Alert, Nunavut and Little Fox Lake, Yukon. The primary goals of this project are to look at changes of mercury levels over time and determine how it behaves in the air. Mercury is in the air as a gas or attached to dust (particles). As a gas, it stays in the air a long time but on particles it can fall onto the surface and end up in the ecosystem. This study provides data on how much mercury is in the air, how it is brought into the Arctic by air and how much falls onto snow. The data collected is used in mathematical models to predict future scenarios of Hg levels in the Arctic air. This information supports national and

international policies to control the release of Hg worldwide. This research also contributes to understanding how climate change may influence Hg contamination in the Arctic. Finally, this research provides a part of the overall puzzle to try to understand how Hg affects those living in the north.
Objectives for the year include:

- Measure mercury in air at both sites.
- Study how mercury moves between gas, particles and snow to understand its fate in the ecosystem.
- Provide data to support computer models of the chemistry and movement of mercury in the air.

M-03 (2013-2015)
NORTHERN CONTAMINANTS AIR MONITORING: ORGANIC POLLUTANT MEASUREMENTS

Project leader: Hayley Hung and Alexandra Steffen, Environment Canada

PLAIN LANGUAGE SUMMARY

This project will measure pollutants, namely persistent organic pollutants (POPs) and mercury, in the air at multiple locations across Canada's North. When POPs and mercury enter the ecosystem, they may affect the health of northerners. Currently, there are few locations in Canada's Arctic where these pollutants are being measured. Pollutants are carried through the air from more southerly regions to the Arctic, and expanding the number of locations where they are measured will provide more information about where they come from and how they are changing over time. In order to increase the geographical coverage so we can get a more comprehensive picture of the levels of pollutants, the development of passive sampling is being proposed. Passive samplers are a low-cost, low-maintenance way to monitor air pollutants and therefore ideally suited to the Arctic environment. The simplicity of the method is also suitable for involving students or other interested persons in sample collection, enhancing communication between the project team and local communities as well as creating training opportunities for Northern students. The project will ramp up over 3-4 years, eventually producing air concentrations of multiple pollutants at a network of sites across the north. These data will help researchers determine the paths that pollutants take to get to the Arctic and, after a longer time, how changes in sources and the landscape affect how mercury and POPs travel through the air and enter the Arctic environment. In FY2014/15, the team proposes to initiate passive air sampling for POPs at 7 sites across the North.

M-04 (2013-2015)
Temporal trends of persistent organic pollutants and metals in ringed seals from the Canadian Arctic

Project leaders: Derek Muir (Environment Canada), Michael Kwan (Nunavik Research Centre), and Marlene Evans (Environment Canada)

PLAIN LANGUAGE SUMMARY

The major question that this project is addressing is how are concentrations of legacy contaminants, such as PCBs and other persistent organic pollutants (POPs), as well as mercury, changing over time in ringed seals and are trends similar across the Canadian Arctic. Trends of new contaminants are also investigated. The project currently involves annual sampling at Sachs Harbour, Resolute, Arviat, and Nain as required in the NCP "Blueprint". All sampling is done by local harvesters and coordinated by HTAs in each community who are supplied with sampling kits and instructions. Hunters record biological information on each animal and are paid for each completed kit. HTAs receive funding to cover coordination and administrative costs. The work at Arviat is coordinated with DFO marine mammal scientists. Samples of blubber samples of female and juvenile seals are analysed to determine trends in POPs concentrations. Liver of male and female seals is analysed for mercury other heavy metals as well as new contaminants such as brominated and fluorinated chemicals. Muscle samples are analysed for mercury and also for carbon and nitrogen stable isotopes to assess seal diets. Samples are archived for possible future contaminant studies.

As concentrations of legacy chemicals, such as PCBs and organochlorine (OC) pesticides like DDT, continue to decline slowly. Mercury concentrations in liver and muscle vary from year to year but overall are not increasing. The results for new contaminants are more complicated. Some brominated and fluorinated chemicals have increased until about 2005 but are now declining in concentrations in seals. The annual measurements have demonstrated that seals are very good indicators of changing uses and production of chemicals widely used in consumer and industrial products.2

The objectives for 2014-15 are to

1. Continue to determine temporal trends of POPs and new organic chemicals of potential concern as well as mercury and other metals in ringed seals using annual collections
2. Provide the information on levels and temporal trends of these contaminants to each participating community and to the Nunavut Environmental Contaminants Committee, the NWT Environmental Contaminants Committee and the Nunatsiavut Health and Environment Research Committee.

M-05 (2013-2015)
Temporal and spatial trends of legacy and emerging organic and metal contaminants in Canadian polar bears

Project leader: Robert Letcher, Environment Canada and Carleton University

PLAIN LANGUAGE SUMMARY

The polar bear (Ursus maritimus) is the apex predator of the arctic marine ecosystem and food web, and an integral component of northern (Canadian) Aboriginal culture. Starting in 2007 and ongoing in 2014-2015, on an annual, and in future on a biennial basis (even years only), this project is assessing longer-term temporal trends and changes of NCP priority persistent organic and elemental pollutants (POPs) in polar bears from the southern and western Hudson Bay (Nunavut) subpopulations. Hudson Bay is a hot spot with respect to Arctic warming, where reductions in sea-ice condition is related to shifts in the aquatic food web and the prey (seal) species, and subsequently influences polar bear exposure to POPs. For POPs that are currently banned or regulated, such as PCBs, chlordanes, DDTs, tetra- to octa-brominated diphenyl ethers (PBDEs), and mercury (Hg) and other bioaccumulative elements, polar bear trend monitoring is necessary to determine if in response, concentration reductions are occurring and why. In the case of new/emerging POPs, such as hexabromocyclododecane (HBCDD), BDE-209 and other PBDE replacement flame retardants (FRs), per-/ poly-fluoroalkyl substances (PFASs), α- and β-endosulfan isomers and endosulfan sulfonate, short-chain chlorinated paraffins (SCCPs), hexachlorobutadiene (HCBD) and polychlorinated naphthalenes (PCNs), baseline exposure assessment in polar bears is underway to support retrospective and/or future temporal trend monitoring, and thus provide evidence to support nomination for regulatory enforcement. To more clearly reveal temporal trends, POP concentration variance due to confounding factors is being determined from the collection of data such as age, sex, body condition, time of collection and lipid content. Also, carbon and nitrogen stable isotopes (SIs) and fatty acid (FA) profiles are used as ecological tracers of diet and/or food web change. Northern peoples are integral partners as they carry out the annual harvest of polar bears and provide the collected tissue samples for this POP monitoring.

Objectives:
Long term:
In relation to the Blueprint section 7.4.8 Environmental Monitoring and Research - Marine Ecosystems, in polar bears from Canadian subpopulations, to determine spatial differences and/or temporal trends and changes, and conduct research to determine the influence of environmental processes and change, of POPs of interest (Table A.1). These POPs and metals are priorities for the NCP (and LRTAP and Stockholm Convention), and will support Canadian and international chemical management initiatives. Also, to screen for new and emerging, targeted POPs that are predicted or likely to bioaccumulate in polar bears, which may also include congeners, isomers and/or precursors and degradation products.

Short term:

1. For polar bears within the two management zones in Hudson Bay, in 2014-2015 to continue to monitor with increased resolution, the temporal trends and changes of NCP priority POPs and elements that are classified as bioaccumulative legacy and new and emerging contaminants.
2. Using carbon and nitrogen SIs and FAs as ecological tracers, examine the influence of diet/food web structure, trophic level, sex, age, time of collection and

lipid content as confounding factors on POP temporal trends in Hudson Bay polar bears.
3. To provide information to Hudson Bay aboriginal communities participating in the study, as well as other communities, on the levels, changes and fate of POPs in polar bears.
4. To archive the remaining polar bear tissue samples that were collected in Environment Canada's National Wildlife Specimen Bank (EC-NWSB), NWRC, Carleton University.

M-06 (2014-2015)
New and emerging persistent halogenated compounds in beluga whales from Sanikiluaq

Project leader: Gregg Tomy, University of Manitoba, and Lisa Loseto, Department of Fisheries and Oceans

PLAIN LANGUAGE SUMMARY

This project attempts to answer the question: are 'new' contaminants some of which have only recently been detected in Arctic animals, increasing or decreasing in beluga whales from Sanikiluaq? These animals were selected for this study because (i) they represent an important part of the traditional diet of northern people and are ecologically relevant (i.e., high trophic status) for temporal trend studies and, (ii) our archive data bank at the Freshwater Institute has tissues from these animals collected over a large time window. Findings from this study are important and provide information to international regulatory bodies, e.g., Stockholm Convention and UNECE-LRTAP-POPs.

M-07 (2013-2015)
Temporal trends of mercury and halogenated organic compounds in Hendrickson Island, Sanikiluaq and Pangnirtung beluga

Project leader: Gary A. Stern, University of Manitoba, and Lisa Loseto, Department of Fisheries and Oceans

PLAIN LANGUAGE SUMMARY

The objectives of this project are to maintain current data on contaminant levels in Arctic beluga and to continue to assess the temporal trends of bioaccumulating substances such as heavy metals and halogenated organic compounds (HOCs).This will allow us to determine whether contaminant levels in the beluga, and hence exposure to Arctic people who traditionally consume them, are changing with time. These results will also help to test the effectiveness of international controls and, in conjunction with projects such as ArcticNet and BREA to understand the effects that climate variation may have on these contaminant levels. Climate variation has been attributed to observed changes to atmospheric sea-level pressure, wind fields, sea-ice drift, ice cover length of melt season, precipitation patterns, hydrology and ocean currents and water mass distribution. It is almost certain that these primary changes have altered the carbon cycle, trophic relationships between species, and biological systems but the difficulty of observing these

changes together with existing irregular, incomplete time series measurements makes it exceedingly difficult to discern what these changes have been. Because contaminants enter global systems and transport through the air and water, the changes listed above will clearly alter contaminants pathways and ultimately the levels observed in the Arctic marine ecosystem. Current data sets for Hg and OCs are noted below.

Hendrickson Island
Mercury (liver and muscle): 19 time points over a 32 year time period (1981, 1989, 1993, 1994, 1995, 1996, 2001-2013).
OCs (blubber): 17 time points over a 24 year time period (1989, 1994, 1996, 2001-2013)

Sanikiluaq
Mercury (liver and muscle): 15 time points collected over a 19 year period (1994, 1995, 1998, 2002-2013)
OCs (blubber): 3 time points (1994, 1998, 2013)

Pangnirtung (note: n = 1 to 3 samples collected in year 2006-2010)
Mercury (liver and muscle): 17 time points collected over a 28 year period (1982, 1984, 1986, 1991-1997, 2002, 2005-2010)

M-08 (2013-2015)
Temporal Trends of Contaminants in Arctic Seabird Eggs

Project leader: Birgit Braune, Environment Canada

PLAIN LANGUAGE SUMMARY

Contaminants have been monitored in seabird eggs collected from Prince Leopold Island in the Canadian High Arctic since 1975. Sampling of thick-billed murre eggs from Coats Island in northern Hudson Bay was initiated in 1993 for comparison. Declines have occurred in most of the legacy organochlorines (e.g. PCBs, DDT) as well as dioxins and furans. However, contaminants such as perfluorinated carboxylates and mercury have been increasing. Shifts in diet are affecting contaminant trends in eggs of thick-billed murres in northern Hudson Bay. Annual monitoring of the thick-billed murre and northern fulmar eggs at Prince Leopold Island since 2005 has improved the power of the time series. Therefore, sampling will continue on an annual basis for these two species, as specified in the Blueprint. However, the Blueprint specifies that analyses of the persistent organic pollutants will be biennial starting in 2014.

M-09 (2013-2015)
Temporal trends and spatial variations in persistent organic pollutants and metals in sea-run Arctic char from Cambridge Bay, Nunavut

Project leader: Marlene S. Evans, Environment Canada

PLAIN LANGUAGE SUMMARY

This study will investigate mercury and metals concentrations in sea-run Arctic char from Ekaluktutiak (Cambridge Bay). Analyses of persistent organic pollutants (POPs) will not continue at this site in 2014 because concentrations are low and declining. We will continue to monitor mercury in char because there is some evidence of a small trend of increase in mercury concentrations and in anticipation that such a study will be complimentary to activities at the Canadian High Arctic Research Station. While our fish will be obtained from the domestic fishery which has been providing us with 20 whole fish each year, we also will analyze char collected by Les Harris who is conducting stock assessments on the major river systems supporting the commercial fishery. We propose to visit Ekaluktutiak in the summer to provide an update on study results and explore opportunities for additional study of these char through other funding sources.

M-10 (2013-2015)
Temporal trends of Persistent Organic Pollutants and Mercury in Landlocked char in the High Arctic

Project leaders: Derek Muir (Environment Canada)**,** Günter Köck (Austrian Academy of Sciences)

PLAIN LANGUAGE SUMMARY

The major question that this project is investigating is how are changes in concentrations of contaminants in landlocked Arctic char from lakes in Nunavut changing over time. Our approach is to measure concentrations of pollutants such as persistent organic pollutants (POPs) and mercury in the fish each year to see if levels are decreasing or increasing. The project began in 1999 by studying Char and Resolute Lakes because char had been previously collected from both lakes. Since then we have continued to sample Resolute and Char Lakes each year and have added Amituk Lake, and Hazen Lake in Quttinirpaaq National Park on Ellesmere Island, which were originally sampled in the early 1990s. Other lakes in the region, especially North and Small Lakes, west of Resolute Bay, have also been sampled to provide information on lake to lake variation of mercury in char. The project now has information on long term (15-20 year) trends of POPs and mercury and we are now able to investigate factors influencing contaminant levels in landlocked char such as time of ice out in the lakes, diet of the char and climate warming.

All of the fish collected so far have been analysed for mercury and other metals. A smaller number have been analysed for PCBs and other POPs including new contaminants. Mercury concentrations in Arctic char have declined in Amituk, Resolute, North, and Char lakes. Mercury concentrations in most char from Char Lake and Amituk Lake are above guidelines for human consumption. Concentrations of PCBs and chlorinated pesticides are low and have declined overall in all four study lakes over the period 1992/93 to 2012.

In 2014-15 we plan to continue annual sampling of Amituk, North, Small, Hazen, and Resolute lakes. We will analyse samples for mercury and multielements and will archive samples for POPs. The project depends on the help of local people in the Hamlet of Resolute. Since 2005 Debbie Iqaluk has worked on the project and enabled us to collect

fish from all our targeted lakes on Cornwallis Island in a wide range of weather and ice conditions. Sampling will be carried out by hand methods or gill netting. Results of the project will continue to be reported annually to the HTA and the Hamlet of Resolute Bay (Qausuittuq) and to the Nunavut Environmental Contaminants Committee on a timely basis.

M-11 (2013-2015)
Spatial and long-term trends in persistent organic contaminants and metals in lake trout and burbot from the Northwest Territories

Project leaders: Marlene S. Evans (Environment Canada) and Derek Muir (Environment Canada)

PLAIN LANGUAGE SUMMARY

We are investigating trends in contaminant concentrations in West Basin burbot (domestic fishing zone Resolution Bay area) and lake trout (commercial fishery zone) and East Arm lake trout (domestic fishery Lutsel K'e area). The monitoring program has changed so that analyses for persistent organic pollutants (POPs) of these fish are to occur only in odd (e.g., 2015) years and the only metal being monitored is mercury. Accordingly, in 2014, we will analyze the two species of fish from the three locations for mercury; biological variables such as length, weight, age, percent water, obvious parasites, and carbon and nitrogen isotopes also will be measured. However, we propose to continue our metals determinations as there is some evidence that some metals may be increasing in concentration. Sufficient fish tissue will be archived for potential later analyses, e.g., POPs or other compounds. We recently published a scientific paper reporting trends of mercury increase in Great Slave Lake fish and are working with the Arctic Monitoring and Assessment Program (AMAP) to characterize trends in POPs. In 2014, we will work on a paper reporting POPs trends in Great Slave fish in addition to contributing to the AMAP report. We also will synthesize the results of our collaborative periodic assessment of mercury concentrations and trends in smaller lakes in a scientific manuscript. We will visit Fort Resolution, Lutsel K'e and Hay River to present and discuss our study results and explore expanded partnerships; we also will work on other communications, e.g., posters.

M-12 (2013-2015)
Temporal trend studies of trace metals and halogenated organic contaminants (HOCs), including new and emerging persistent compounds, in Mackenzie River burbot, Fort Good Hope, NWT

Project leaders: Gary Stern (University of Manitoba)

PLAIN LANGUAGE SUMMARY

The objective of this project is to maintain current data on contaminants levels in Mackenzie River burbot (Rampart Rapids, Fort Good Hope) and to continue to assess the temporal trends of bioaccumulating substances such as trace metals (e.g. mercury, selenium, arsenic, lead and cadmium), organochlorine contaminants (e.g. PCBs, DDT, toxaphene and selected current use chemicals such as brominated flame retardants (e.g.

PBDEs) and fluorinated organic compounds (e.g. PFOS and it's precursors) so as to determine whether the levels of these contaminants in fish (health of the fish stock) and thus exposure to people living in Arctic communities who consume them as part of their traditional diet, are increasing or decreasing with time.

Tissues from burbot collected at Fort Good Hope (Rampart Rapids) in December 2013 were analysed for organohalogen contaminants (OCs/PCBs/PBDEs/FOCs) and heavy metals (Hg/Se/As). Data from this time point was combined with the existing metal data (1985, 1988, 1993, 1995, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012) and OC (1988, 1994, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2011, 2012) together covering time spans of 28 and 25 years, respectively.

Key findings to date include:

- Mean Hg concentrations in muscle and liver over the entire data sets were 0.353 ± 0.142 (n = 479) and 0.089 ± 0.074 (n = 488) □g g-1, respectively.
- While Hg levels in both liver and muscle continue to rise they are still below the recommended consumption guideline level of 0.50 □g g-1 for commercial sale.
- Significant declines, 10- and 4-fold, occurred for both □- and □-HCH over 24 year time period between 1988 and 2013.
- PBDE concentration seemed to have peaked in the mid-2000s and are now on the decline.
- Current □PBDE levels are approximately one order of magnitude less than those of PCBs.
- Since 1986, a consistent decline was observed in both PFOA and PFOS concentrations. Conversely, PFDA concentrations show a consistent increase over time. PFNA and PFUA levels peaked in 2003.

The objectives for the 2014-2015 fiscal year will be to increase the mercury time series by yet another year. Tissue samples will archive for potential analysis in future years. This data will not only provide communities with important consumption data but will also help us to understand the driving forces behind these increases. Policy makers will then use these results to develop mitigation and adaptation polices if required.

M-13 (2013-2015)
Long term trends of halogenated organic contaminants and metals in lake trout from two Yukon Lakes; Kasawa and Laberge

Project leaders: Gary Stern (University of Manitoba)

PLAIN LANGUAGE SUMMARY

Plain language summary

The objective of this project is to maintain current data on contaminants levels in lake trout from two Yukon lakes (Laberge and Kusawa) to continue to assess the temporal trends of bioaccumulating substances such as trace metals (e.g. mercury, selenium,

arsenic), organochlorine contaminants (e.g. PCBs, DDT, toxaphene), selected current use chemicals such as brominated flame retardants (e.g. PBDEs), and fluorinated organic compounds (e.g. PFOS and it's precursors) so as to determine whether the levels of these contaminants in fish (health of the fish stock) and thus exposure to people who consume them are increasing or decreasing with time. These results will also help to test the effectiveness of international controls.
In 2014-2015, as in previous years, 10 trout from each lake will be collected and analyzed for Hg, legacy and current use organic contaminants. Table 1 below lists the time points and collection periods for each contaminant group including the 2014 collection year.

Table 1. Contaminant collection periods and time points for Kusawa and Laberge lake trout

	Kusawa				Laberge			
	Hg, Se, As	OCs	BPDEs	FOCs	Hg, Se, As	OCs	BPDEs	FOCs
Time points	18	16	12	9	16	17	13	9
Years	21	21	15	9	21	21	21	9
Start date	1993	1993	1999	2006	1993	1993	1993	2006
End date	2014	2014	2014	2014	2014	2014	2014	2014

M-14 (2013-2015)
Arctic Caribou Contaminant Monitoring Program

Project leaders: Mary Gamberg (Gamberg Consulting)

PLAIN LANGUAGE SUMMARY

This project will determine contaminant levels in Canadian Arctic caribou to determine if these populations remain healthy in terms of contaminant loads, whether these important resources remain safe and healthy food choices for northerners and to see if contaminant levels are changing over time.

Previous studies have found that cadmium and mercury levels in caribou kidneys and livers from across the circumpolar north, are higher than in domestic animals grown for food consumption. This has prompted a health advisory from Yukon Health and Social Services, based on a health assessment from Health Canada. Although a study by the Centre for Indigenous Peoples' Nutrition and Environment confirmed that traditional foods are safe to eat at the estimated consumption rates they did recommend that a trend-monitoring program be established to verify that the levels are not rising from local or long-range inputs and that new contaminants be addressed as they arise (Receveur et al. 1998).

This project monitors two caribou herds, the Porcupine (YT) and the Qamanirjuaq (NU). Monitoring populations from the eastern and western Arctic will also give scientists a better understanding of the distribution of contaminants in the Arctic and the variability of contaminant burdens between herds. Twenty animals from each herd will be sampled, and their kidneys analyzed for a suite of 34 elements, including arsenic, cadmium, lead and mercury.

M-15 (2014-2015)
Community based seawater monitoring for organic contaminants and mercury in the Canadian Arctic

Project leader: Derek Muir, Environment Canada, Aaron Fisk, University of Windsor, Jane Kirk, Environment Canada, and Rainer Lohmann, University of Rhode Island

PLAIN LANGUAGE SUMMARY

Seawater would be collected in Barrow Strait near Resolute and analysed for priority contaminants identified under the NCP "Blueprint". The proposal addresses a knowledge gap that has been identified by the NCP i.e. the lack of data on levels and time trends of contaminants in the ocean waters. This study follows up previous NCP-funded work at Resolute in 2011 and 2012 where samplers were deployed in Barrow Strait by community members. We propose to do the sampling by hiring and training community members, who would then be responsible for the location and timing of field work and eventually for helping to train people in other communities to carry out the sampling. Three sampling approaches would be used to target a range of contaminants. Passive samplers (thin plastic films) would be deployed under the ice and on moorings in open water for contaminants such as PCBs and brominated flame retardants. Results from passive samplers would be compared with large volumes collected by pumping seawater through resin columns. Mercury and fluorinated chemicals determined in smaller (1L) samples using Niskin or Van Dorn samplers which close underwater allowing for a depth profile to be collected. A video of the sampling techniques would be developed for training persons in other communities. After refining the techniques at Resolute we propose to extend the sampling program to Anaktalak Fiord (Nain), Dease Strait (Cambridge Bay, NU) and Baffin Bay (Clyde River) in 2015-16. Ultimately our goal is to extend the existing information on contaminants in seawater at Resolute so that a time series would be developed. Results for other sites would allow comparison to test the representativeness of Barrow Strait as a sampling site.

M-16 (2013-2015)
A latitudinal investigation of ecosystem sensitivity to methylmercury bioaccumulation in Arctic fresh waters

Project leader: John Chételat, Environment Canada, and Murray Richardson, Carelton University

PLAIN LANGUAGE SUMMARY

Mercury is a priority contaminant of the Northern Contaminants Program (NCP) due to its prevalence in the Arctic and high levels found in some traditional food species. The

main objective of this project is to investigate how climate affects methylmercury (MeHg) bioaccumulation in Arctic lakes. We will compare MeHg bioaccumulation in three study areas along a latitudinal gradient in climate-controlled ecosystem types in the Canadian Arctic, specifically sub-Arctic taiga (Kuujjuarapik), Arctic tundra (Iqaluit) and polar desert (Resolute Bay). Building on work conducted at Kuujjuarapik in 2012 and Iqaluit in 2013, we propose to conduct a field program in 2014 at polar desert sites at Resolute. In each water body, we will investigate key aspects of MeHg bioaccumulation—MeHg bioavailability to benthic food webs and organism growth rates—as well as how watershed characteristics affect the transport of Hg and organic carbon to lakes. We will consult with and report to the Resolute Bay HTA and hire a local to participate in the field program. Using the three years of data, we will develop a conceptual model of climate-driven environmental processes that affect the exposure of Arctic freshwater fish to MeHg. This information is critical for understanding how climate change is affecting temporal and geographic trends of Hg bioaccumulation in NCP-monitored fish.

M-17 (2013-2014)
Host-parasite-mercury interactions in a marine bird

Project leader: Grant Gilchrist, Environment Canada

PLAIN LANGUAGE SUMMARY

Northern common eider ducks (Somateria mollissima borealis) are an important indicator and harvested species hunted across the north. Our research team is currently working with northern communities to better understand how pollution (contaminants), disease (avian cholera) and predation pressure (bear impacts on colonies) influence eider population dynamics. This work includes understanding bird health in terms of parasite and mercury loads. For example, it has been found that parasitic worms in the gut can influence how heavy metals are absorbed and affect wildlife, specifically in marine bird species (Wayland et al. 2001, Bergey et al. 2002). Our first objective will be to use eider ducks that have already been collected for parasite assessment to explore how heavy metals and endoparasites interact within an avian host to influence host health, reproduction and population dynamics. Eider ducks are a useful model for exploring these questions because large sample sizes are readily available through collaborations with northern communities during their annual eider duck harvest. The results from this study will contribute to other northern marine bird species that are more highly exposed. Our second objective will be to assess mercury in eider ducks. Mercury is increasing in a number of Arctic wildlife populations (Riget et al. 2011), and although mercury has historically been assessed in eider ducks, little recent work has been done since the 1980s and 90s. We will assess current levels and overall trends. This will contribute information to human exposure assessments for the consumption of this country food (mitiq). To date 260 eiders have already been collected in collaboration with the Hunter and Trapper Associations (HTAs) of Cape Dorset, Coral Harbour and Sanikiluaq, Nunavut. These birds will form the basis of the proposed work. Analysis and results are expected to be completed by the spring of 2014. Despite the logistical and analytical complexity of this

project, this proposal seeks funds to complete the mercury analysis of these eider collections.

M-18 (2013-2014)
Evaluating the Accumulation of Persistent Organic Pollutants in Arctic Cod in the Beaufort Sea Using Samples From The BREA Program

Project leader: Brenden Hickie, Trent University, and Gary Stern, University of Manitoba

PLAIN LANGUAGE SUMMARY

Persistent organic pollutants (POPs) such as PCBs, DDT and other organochlorine pesticides are delivered to Arctic ecosystems by ocean currents, rivers and long range atmospheric transport and deposition. Once in the Arctic, many of these chemicals accumulate readily through food webs, resulting in concentrations in species such as ringed seals and beluga whales that can lead to health concerns for northern people and wildlife. Characterizing the extent to which concentrations of POPs accumulate in marine food chains and important prey of ringed seals and beluga, such as Arctic cod, is a vital component linking contaminant loadings into the Arctic environment with human exposure to potentially harmful concentrations of pollutants.

This new project will measure POPs concentrations in Arctic cod collected from a number of locations in the Beaufort Sea in 2012 to help us answer a number of research questions, including: Do POPs levels vary with sampling location (including near-shore versus off-shore) and with size or age of fish? Have concentrations of POPs changed in Arctic cod since they were last measured in the region in 1997/98? If so, how do these changes relate to the contaminant trends in beluga and ringed seals from the region that are routinely monitored as part of NCP? Overall, this project will help provide greater understanding of factors that affect the accumulation of POPs in species consumed by northern people and how levels are responding to international efforts to restrict the use of chemicals that show up in Arctic biota.

M-19 (2014-2015)
Spatial variation in Canadian Arctic prey fish communities and contaminant levels and consequences for diets and contaminant levels in ringed seals

Project leader: Aaron Fisk and Melissa McKinney, University of Windsor

PLAIN LANGUAGE SUMMARY

In conjunction with warming temperatures and sea ice reductions, there has been a shift from arctic to subarctic forage fish over the past two decades within the eastern Canadian Arctic. Subarctic capelin, sandlance and/or herring are now common in the low Arctic, and may be replacing arctic cod. This shift has, so far, occurred to a lesser extent in the mid-Arctic, and only very recently have Inuit observations of capelin been made in the high Arctic. As forage fish form the prey base for many animals including predator fish,

seabirds and marine mammals, the objective of this project is to carry out a region-specific assessment of legacy and emerging persistent organic pollutant (POP) and mercury (Hg) levels in the forage fish prey base. The project will compare three NCP "focal" ecosystems exhibiting differential extents of forage fish changes, specifically, Hudson Bay (low Arctic, Arviat), Cumberland Sound/Davis Strait (mid-Arctic, Pangnirtung) and Barrow Strait/Lancaster Sound (high Arctic, Resolute). The project will also determine the extent to which the diets and contaminant levels of an important NCP monitoring species, ringed seals, are influenced by regional variation in forage species. Results will provide community-specific information on how forage fish changes impact contaminant levels in marine mammal tissues.

M-20 (2013-2014)
Monitoring environmental changes and contaminant exposure in the Canadian Arctic by otolith microchemistry

Project leader: Norman Halden and Feiyue Wang, University of Manitoba

PLAIN LANGUAGE SUMMARY

We propose to retrieve the metal contamination records, as well as the records of migratory and feeding behaviours, stored in annually grown layers in otoliths (ear bones) from a variety of fish species in the Canadian Arctic. Metals to be studied include mercury, lead, copper, zinc among others. Our main research question is how the concentrations of these metal contaminants in fish have changed in response to changes in contaminant sources under a changing climate. Different from soft-tissue based monitoring, otolith microchemistry provides time series data simultaneously for both contaminant levels and life history of an individual fish at a scale of years to decades. Such analysis provides Aboriginal peoples, other Northerners and policy makers with robust data to inform land use and watershed decisions, and health information and food security in the Canadian Arctic in the context of economic development, climate change and subsistence fisheries. All the otolith samples were and will be collected by the local community, and extensive consultation will be sought from the community on their knowledge of environmental changes in the studied watersheds. Such collaboration has already allowed us to build several archived otolith collections, which will be further expanded to other Arctic regions.

M-21 (2014-2015)
Metal loading and retention in Arctic tundra lakes during spring runoff

Project leader: Murray Richardson, Carleton University, and Jamal Shirley, Nunavut Research Institute

PLAIN LANGUAGE SUMMARY

Spring snowmelt is the most important hydrologic event of the year in Arctic landscapes. During this relatively short period in spring, fluxes of water and waterborne contaminants such as mercury (Hg) and other trace metals to surface waters can exceed those occurring

during the remainder of the year. Nevertheless, there is a paucity of research on the transport of metal to lakes during snowmelt periods in Arctic Canada. The main objective of this project will be to quantify, using hydrological and hydrochemical measurements, the relative contributions of mercury (Hg) and other trace metals in snowmelt runoff to the water column and sediments of lakes in the vicinity of Iqaluit, NU. A systematic field program will be initiated to quantify landscape snow water equivalent (SWE) and metal concentrations in snowpack and snowmelt runoff over two spring melt periods (2014 and 2015) and the corresponding runoff contributions to 6 lakes near Iqaluit, NU. One nearby lake will be monitored and sampled continuously to undertake a full water and metal mass balance to further elucidate lake hydrology and mixing processes affecting trace metal cycling throughout the snowmelt period.

Fieldwork will be conducted in partnership with Nunavut Research Institute (NRI) and Nunavut Arctic College (NAC), and several current or recently graduated NAC Environmental Technology program students will receive extensive field training in snow and river hydrology, limnology and aquatic geochemistry. An important objective of the project is to build the NRI's capacity to plan, coordinate, and manage, field studies of aquatic contaminants cycling and snowmelt hydrology. All project protocols will be carefully documented and compiled in a research manual which will be retained by NRI along with the specialized research equipment upon completion of the project. These resources will be utilized by NRI to support future research and training initiatives beyond the life of this short study. The study will make important contributions to our scientific understanding of trace metal dynamics in Arctic watersheds during snowmelt periods, in particular the mechanisms by which snowpack accumulation and melt serves to couple atmospheric sources of contaminants to aquatic environments and food webs. Our study findings will also help to understand potentially broader changes to contaminant cycles in Arctic freshwaters caused by global warming, since snow hydrology is highly sensitive to weather and climate.

M-22 (2013-2015)
Polycyclic Aromatic Compounds, Flame Retardants and Other Persistent Organic Pollutants in Canadian Archipelago Air, Water and Sediment

Project leader: Liisa Jantunen, Environment Canada

PLAIN LANGUAGE SUMMARY

The arctic is increasingly being impacted by legacy and emerging persistent organic pollutants (POPs) through local, regional and long range transport. These compounds include flame retardants (FRs), polycyclic aromatic compounds (PACs), per-fluorinated alkylated substances (PFASs) and legacy organochlorine and current use pesticides (OCPs and CUPs).

The likely sources of PACs in the Arctic are a combination of local burning for electricity (Iqaluit's sole source of electricity is from diesel fuel), emissions from diesel burning ships, local oil exploration, forest fires and long range transport from southern sources. FRs are receiving increased attention due to their presence in all environmental

compartments including the arctic atmosphere and biota. The widespread global distribution of FRs and other POPs is believed to occur through oceanic transport and air transport in the gas-phase and sorbed to particles. As some FRs are banned by national and international regulators, the use of alternative FR will increase.
The intent of this proposal is to determine how POPs and other emerging compounds are transported to the arctic, what happens to them once they are there, and how they enter the food web. We propose to achieve this through coordinated air-water-water particulate sampling in the Canadian Archipelago in collaboration with the ArcticNet program.
We will also continue the time trends of OCPs and CUPs in Canadian Archipelago air and water to assess changes in concentrations and set baseline concentrations for emerging compounds. This is particularly important in understanding the effect of controls on emissions and how a rapidly changing climate influences transport processes.

M-23 (2013-2014)
Influence of climate warming on mercury dynamics in High Arctic lakes

Project leader: Paul Drevnick, INRS-ETE, Université du Québec, and University of Michigan

PLAIN LANGUAGE SUMMARY

Mercury (Hg) is released to the atmosphere by human activities, mostly in temperate regions, and is transported by prevailing winds to the Arctic. In lakes (and other aquatic ecosystems), microbes transform Hg into methylmercury (MeHg), which bioaccumulates in food webs, resulting in high concentrations in fish. Consumption of contaminated fish is the major source of Hg in humans and wildlife and is detrimental to health. For the NCP-sponsored char “core” monitoring project, we have collected landlocked arctic char (Salvelinus alpinus) from lakes near Resolute Bay, NU, annually for more than 15 years. As the only fish species in lakes that receive contaminants from the atmosphere, these char are good indicators for changing atmospheric inputs of Hg. Concentrations of Hg in char among lakes reflect atmospheric inputs and often exceed the Health Canada value considered safe for subsistence consumption. Over the period sampled, there has been no consistent increase or decrease with time, perhaps reflecting that atmospheric inputs are leveling off with time. Interestingly, Hg concentrations in char tend to track year-to-year changes in summer air temperature, similar to a pattern observed in SW Greenland. For this study, we are focused on understanding the relationship between Hg and temperature. We have preliminary evidence from our monitoring lakes that temperature increases the production of MeHg in sediment, and we thus hypothesize that this effect increases MeHg concentrations in sediments, sediment-dwelling insects (chironomids), and char that feed on the insects. From 2013 to 2015, we are intensively studying water temperature and MeHg dynamics in four lakes near Resolute Bay. Fieldwork will depend on the help of local people in Resolute Bay. We will couple results from this study with monitoring data from char in a bioaccumulation model to better understand and predict how the changing sources of Hg and climate change will influence the accumulation of Hg and associated ecosystem health risks over time (as requested in the NCP blueprint).

M-25 (2013-2015)
Winter atmospheric loadings and springtime runoff of mercury and perfluorinated chemicals to a pristine high Arctic watershed in Quttinirpaaq National Park, Northern Ellesmere Island, Nunavut

Project leader: Vince St. Louis (University of Alberta), and Derek Muir (Environment Canada),

PLAIN LANGUAGE SUMMARY

The high Arctic continues to receive a wide range of contaminants released by human activities in more southerly latitudes and industrialized nations around the world. Thankfully, due to emission regulations and bans in their usage, concentrations of certain legacy contaminants have been declining in the high Arctic. However, a number of contaminants such as mercury (Hg), as well as new, emerging and yet unregulated persistent organic pollutants (POPs), such as certain poly--- and perfluorinated alkyl substances (PFASs), continue to be of priority concerns. Furthermore, it now appears that climate change is also influencing the long---range transport, fate and bioaccumulation of contaminants like Hg and POPs in the Arctic. We are quantifying contaminant loadings in snowpacks and meltwater, water quality and climate change impacts in the pristine Lake Hazen watershed, Quttinirpaaq National Park, Northern Ellesmere Island, Nunavut. From a socio---economic perspective, understanding present---day contaminant loadings, water quality and climate change impacts is important for predicting how the abundances and quality of certain organisms used as Inuit traditional foods may be altered by future human activities.

M-26 (2014-2015)
Heavy Metal Contaminants in Caribou and Moose

Project leaders: Trevor Stocki (Health Canada)

PLAIN LANGUAGE SUMMARY

Community-based monitoring programs funded by non-NCP sources looking at various aspects of health and condition are ongoing for a number of barren-ground caribou herds in the Northwest Territories, driven by their importance as a key country food species as well as the recent declines documented in a number of herds (ie. Bathurst and Bluenose East herds). These initiatives have involved a number of communities throughout the NWT with ongoing programs in some communities dating back to the early 1990s. Likewise, more recent community and regionally-based monitoring projects on the health of moose in the Sahtu, Dehcho, and South Slave and Northern Mountain caribou populations in the Sahtu and Dehcho regions have provided an initial assessment of the health of these populations. Over the years, there has been increasing concern from communities regarding potential sources of anthropogenic contaminants including mercury both inside (mining and development) and outside (long range atmospheric transport) of their range, in addition to naturally occurring local metals, with implications for both wildlife and human health. Caribou and moose are an important source of country food for Northerners throughout the NWT, raising concerns about the safety of animal tissues for consumption.

We are requesting one year of funding from the NCP to enable contaminant testing be incorporated into existing caribou and moose health and condition monitoring programs, with a focus of monitoring temporal trends in contaminants in reference to historical data.

CB-01 (2013-2015)
Mercury Levels in Food Fish Species in Lakes used by Dehcho Community Members with a focus on Choice and Risk Perception of eating Traditional Country Food.

Project leader: George Low, Dehcho First Nations

PLAIN LANGUAGE SUMMARY

The Dehcho First Nations (DFN), in collaboration with Environment Canada, has been updating the data on mercury levels in fish from lakes in the Dehcho region. Mercury levels in predatory fish in some lakes may be increasing due to climate change and other factors. Our research emphasis has changed from the collection and analysis of fish for mercury, towards studying the apparent shift in diet from fish and other country food towards a market-based diet. People in some communities are consuming less fish and other country food than previously. Part of the reason seems to be a perception that water and fish are no longer safe because of the presence of mercury and other contaminants. These perceptions need to be examined at the regional and community level in order to encourage people to return to a healthy traditional diet.

An important part of this project relates to communications, capacity building and outreach. The annual Return to Country Foods Workshop has evolved from a “mercury” workshop involving six of our first nations to an expanded multi-disciplinarian Contaminant and Environmental Quality Results Workshop for our nine member First Nations and Métis organizations. The workshop expenses will be shared by NCP, Health Canada, Climate Adaptation Program, DFO and the Dehcho AAROM program.

CB-02 (2013-2014)
Husky Lakes: Evaluation of hydro-climatic drivers of contaminant transfer in aquatic food webs in the Husky Lakes Watershed (Inuvialuit Settlement Region, Northwest Territories)

Project leader: Niklaus Gantner, Trent University, Jolie Garies, Aurora Research Institute

PLAIN LANGUAGE SUMMARY

We propose to continue our investigation of hydro-climatic effects on food webs and related contaminants transfer to top predators of lakes near the community Inuvik and Tuktoyaktuk using a mixed method approach. Past sample collections for this project have been conducted following TK interviews and in conjunction with fall/spring fishing by residents of Tuk/Inuvik. We will now work with local people and provide training in relevant methods for future monitoring based on the initial two years. This will be an extension of the project that investigates the effects of marine water entering Husky Lakes, controlled by changes in synoptic climatic conditions, while capturing TK on the system. The initial research

established a baseline for future changes of climate and land use in the ISR, in particular the proposed Inuvik-Tuk all-weather road. We expect to see differences in productivity related to ice cover, differences in food web structure, and subsequently contaminants transfer along those hydro-climatic/salinity gradients. We would also expect to see different contaminant concentrations in Lake Trout related to growth rates as a result of differences in diet in the freshwater and marine influenced basins. We will use the chemical makeup of the Lake Trout ear bone (otolith) to determine how much trout move within the Husky Lakes. We will also use a method that could allow us to track the 'fingerprint' of mercury through the food web. We will compare how the mercury 'fingerprint' differs in Yaya, Big, Noell lakes, and the Husky Lakes. We will inform the community about the concentrations in the Lake Trout in all sites. This study will build on and utilize knowledge from previous fisheries work at the Husky Lakes, Yaya, and Big Lake. The extension of this project could aid in the future design of a community based monitoring of the fisheries in the area and can be linked to other environmental pre-assessment plans currently being developed in the light of the Inuvik-Tuk all- weather road. We intend on building closer collaboration with the Joint Secretariat's Fisheries Joint Management Committee (FJMC) and the local DFO office, in addition to continue work withHTCs in Inuvik and Tuk.

CB-02 (2014-2015)
Community-Based Monitoring of Arctic Char in Nunatsiavut: Increasing Capacity, Building Knowledge

Project leader: Rodd Laing, Nunatsiavut Government

PLAIN LANGUAGE SUMMARY

This study is expanding on previous NCP work on contaminant trends in sea-run char conducted by Environment Canada, expanding to include a community-based monitoring component that builds capacity within the region of Nunatsiavut. Over the past 5 years, Labrador Inuit have experienced a drastic shift in their consumption of traditional foods from a diet consisting of mostly caribou to one that includes an increased amount of ringed seals and sea-run char. This shift in diet is due to the drastic reduction of the George River Caribou herd and subsequent ban on hunting of the herd imposed by the Newfoundland and Labrador Government in winter 2013.

This research program is partnered with Environment Canada, with analysis of the char samples taking place in Burlington, Ontario. Through this proposal, and in-kind contribution from Environment Canada, a capacity building opportunity exists to send one of the staff members from the Nain Research Centre to learn how to analyze the char samples at the facilities in Burlington. This training opportunity will not only be educational, but will allow for the future acquisition and operation of analysis equipment at the Nain Research Centre, with a staff member fully capable of operating the equipment.

Twenty fish will be captured at two locations, Nain and Saglek Fjord, just before they return inland from feeding in the sea. The char will be caught and processed by local community members, with support from staff at the Nain Research Centre, including the

Northern Contaminants Researcher. Community members will receive payment for their contribution to this research program.

Information will be used for a variety of purposes including providing needed information for dietary advice, understanding contaminant loads and how they are changing as a result climate change and increased industrial development.

CB-03 (2013-2015)
Paulatuk Beluga whales: Health and Local Observational Indicators

Project leader: Diane Ruben, Paulatuk Hunters and Trappers Committee

PLAIN LANGUAGE SUMMARY

The community of Paulatuk hunts beluga whales in the summer. The hunts are limited by sea ice conditions that have been changing over the years. More open water earlier in the summer has changed the beluga occurrence and the hunts. Hunters have had concerns and questions about the health and well-being of the beluga whales and their supporting ecosystems. While these are whales part of the same population as those harvested at Hendrickson Island, previous research from 2005 showed differences in mercury concentrations, diet markers and other biological measurements (Loseto et al., 2008). This suggests that while the whales are from the same population there are differences among the whale groups that are not fully understood.

The differences in whales collected at Hendrickson Island and those collected in Paulatuk raises new questions about variability among beluga and how one monitoring site is reflective of a large population with a home range. The Hendrickson Island beluga program provides health information in context with the ecosystem, and the new information collected from beluga whales harvested at Paulatuk would strengthen the holistic knowledge about this beluga population.

In 2013 Paulatuk HTC partnered with the “Enhancing community-based monitoring of ecosystem changes in the ISR through the inclusion of Local and Traditional Ecological Knowledge Indicators” (Local Ecological Indicators Project-abrev). While the partnership was a success having the programs run separately was not ideal, thus here propose a linked program between the two projects to strengthen and enhance the overall beluga monitoring program. Outcomes from the Local Ecological Indicators Project are meant to feed into monitoring programs and enhance them to be more holistic and inclusive of Inuvialuit knowledge and observations (in 2015/2016) however the operations and the progress with beluga monitoring in Paulatuk provided circumstances that are ideal to merge them.

Previous work has shown whales collected at Hendrickson have similar mercury concentrations as those collected at other nearby monitoring sites (Kendall Island, East Whitefish) that are located in the Mackenzie Estuary. The habitat near Paulatuk is very different than the Mackenzie Estuary. How habitat is used differs and may reflect different diets and processes among the whales. Including this site as a satellite

monitoring site to Hendrickson will not only addresses community questions on health but will also enhance our understanding of the beluga on a larger scale. Two beluga monitors at two stations were set up (Tippi area and a Mobile Monitor) Due to poor weather (high winds) fewer whales were taken and sampled. Whales harvested in 2013 were larger than those in 2005, averaging 4.3m in length (larger than whales at Hendrickson for 2013 that averaged 4m). Beluga harvested in 2011 averaged 4m in length. These whales were also taken later on in the season which is fitting with local observations of habitat use different sized whales in the area.

Mercury data for 2011 and 2012 raised questions about beluga diet and accumulation rates as they were higher than those in 2005. Results for 2013 are not complete due to a transition in the lab to the University of Manitoba, muscle data is reported for below. Age analyses, stable isotope and fatty acid analyses for 2013 are underway.

Given the success of the 2012 and 2013 community lead beluga program and the leadership taken with the new LEK/TEK project we are proposing these projects run together to support evolution of design for this beluga monitoring program. We hope this will help in addressing new questions arising from our results. As in the past the program will continue to operate in partnership with other projects (e.g. Hendrickson Island Beluga program, ISR regional coastal monitoring of beluga and fish, BREA offshore fisheries project, local indicators project).

CB-04 (2013-2015)
Tlicho Aquatic Ecosystem Monitoring Project

Project leader: Jodi Snortland and John McCullum, Tlicho First Nations

PLAIN LANGUAGE SUMMARY

The Tłı̨chǫ Aquatic Ecosystem Monitoring Program (TAEMP) continues to provide a means of addressing community concerns related to observed changes in the environment, and builds on work carried out from 2010-2013. As a successful community-driven program, it meaningfully involves community members in conducting contaminants-related research, including the collection of samples and observations using both Tłı̨chǫ and scientific knowledge to address the question: “Are the fish and water safe to consume?” Community elders and youth in Whatì will be informed through community workshops, discussing concepts such as: monitoring, indicators of change, as well as traditional and scientific knowledge relevant to water, sediments, fish, and potential contaminants. A key outcome of the workshops will be advance planning of an on-the-land monitoring camp to take place at a location selected by community members from Whatì which supports an aboriginal subsistence fishery.

Guided by the “Tłı̨chǫ Fisheries Health Datasheet” (developed through the project in 2011), Elders and community members will have opportunities to describe the indicators they use to identify fish health and provide assessments of current fish health near their community. Biologists will sample fish tissues from lake Trout and burbot for analysis of a variety of metals, including mercury. Elders and community members will provide direction on where fish and water samples are to be collected, and youth will be provided basic training on how

samples are collected in a standardized manner. Water and sediments will be sampled and analyzed for metals, as well as chemical and physical properties.

Results of the program will be communicated via a public meeting in Whatì, and in a publically available report. Further, the GNWT Health and Social Services, Chief Medical Officer, the NWT Regional Contaminants Committee along with the Tłı̨chǫ Government Department of Culture and Lands Protection will take the lead in developing appropriate messaging and communication strategies once laboratory results have been reviewed and analyzed.

CB-05 (2013-2015)
Enhancing community-based monitoring of ecosystem changes in the ISR through the inclusion of Local and Traditional Ecological Knowledge Indicators

Project leader: Vic Gilman, Fisheries Joint Management Commission, Lisa Loseto, Department of Fisheries and Oceans, Sonja Ostertag, University of Northern British Columbia

PLAIN LANGUAGE SUMMARY

Beluga monitoring has taken place in the Inuvialuit Settlement Region (ISR) since the 1970s and the sampling program on Hendrickson Island has been a flagship program in the circumpolar north. The beluga monitoring program at Hendrickson Island provided the impetus for increased beluga monitoring throughout the ISR along with partnered fish and habitat monitoring. Together, these programs feed into an ecosystem-based approach to monitoring (DFO-FJMC led). In 2012, communities requested more monitoring of beluga whales (Paulatuk) and the inclusion of LEK and TEK in beluga research in the ISR (Tuktoyaktuk, Inuvik). These requests led to the development of a community based beluga-monitoring program based in Paulatuk (NCP) and two pilot projects to document LEK/TEK based in Inuvik (e.g. Beluga/Fish TEK, HC) and Paulatuk (TEK, HC). This project proposal is responding to the need to more effectively include local and traditional ecological knowledge (LEK and TEK) in beluga monitoring programs (e.g. Section 8.3 from the NCP Blueprint for 2014).

This proposal is a continuation of the research piloted in 2013 to identify indicators for beluga whales based on observations made by community members during harvesting activities. These ‘local ecological indicators’ of beluga whale health complement the current standardized monitoring programs. Prior to the whaling season in 2013, community meetings were held in Paulatuk, Inuvik and Tuktoyaktuk to characterize the observations of beluga whales made by community members, and to develop strategies for documenting these observations. In July and August, observations were recorded for harvested and migrating beluga whales, based on the advice and design developed during the June community meetings. Preliminary results from the program were presented back to the communities and HTCs in November and based on the positive response towards the pilot project, we propose to continue this research program with an emphasis on refining the tools for recording observations, developing appropriate data management and analysis techniques, and, establishing a platform for disseminating results within the

ISR. Furthermore, this project aims to increase capacity and provide opportunities for northerners to be involved in beluga research and monitoring both directly (i.e. in monitoring programs) as well as indirectly (i.e. knowledge dissemination, leading on communicating outcomes).

A comprehensive beluga-monitoring program in the ISR will provide key data on changes in the ecosystem through the use of biological, LEK and TEK indicators. The beluga programs in Darnley Bay and Kugmallit Bay provide ideal platforms for developing this enhanced monitoring program. The Hendrickson program has a successful past to build from, and Paulatuk is a new program with a need for more observational data given complex findings and low sample sizes for interpreting results. Understanding how the arctic ecosystem has changed and is changing will contribute to the interpretation of temporal trends in contaminant concentrations. This project began in June 2013 and will continue until August 2015. The project aims to evaluate and include LEK/TEK indicators alongside traditional science indicators for beluga monitoring in an effort to enhance monitoring programs. This project will not operate independently of previously collected LEK/TEK for beluga in the region as significant work has taken place in support of the development of beluga management zones the Tarium Niryutait Marine Protected Area.
Given outcomes of 2013 and the differences in research and monitoring programs among the communities and HTCs in the ISR, it became apparent that the Paulatuk portion of this project would operate more effectively if partnered with their CBM beluga proposal, whereas the Inuvik and Tuktoyaktuk components remained partnered in this proposal that link with the ongoing beluga monitoring programs at their beluga monitoring sites and the Paulatuk CBM. This also helps the PHTC to advance the evolution of their beluga monitoring program that is unique from the Inuvik and Tuktoyaktuk programs.

The proposed study aims to answer the following questions:

1. How can local ecological indicators of beluga be documented and analyzed to monitor changes in the Beaufort Sea?
2. What are the linkages between traditional scientific observations and local observations?
3. How can we use long-term, existing programs (e.g. Hendrickson) to enhance our data collection and knowledge in challenging areas (e.g. Paulatuk/Darnley Bay)?

CB-06 (2013-2015)
Harvest monitoring of metal bioaccumulation at Kuujjuaraapik (Nunavik): Have levels changed 20 years after the Great Whale environmental assessment?

Project leader: Raymond Mickpegak, Sakkuk Landholdings Corp., John Chetelat, Environment Canada

PLAIN LANGUAGE SUMMARY

Twenty years ago, many measurements were taken of trace metal levels in aquatic and terrestrial wildlife near Kuujjuaraapik as part of a major environmental assessment for the Great Whale hydro-electric project. More recent information is not available for contaminant levels in locally-harvested foods, while locals have observed ecosystem changes associated with climate as well as altered marine currents from freshwater discharges of hydro-electric reservoirs into James Bay. The main objective of this community-based study is to measure current levels of metals (including mercury, cadmium and lead) in local country foods and compare them with previous measurements to monitor potential change. During this two-year project, the Sakkuq Landholding Corporation of Kuujjuaraapik will organize the collection of country foods by local hunters in both winter and summer seasons of 2014. To encourage youth participation in the project, youth will be hired to assist experienced hunters. At the end of the second year, meetings will be held to discuss findings with the community and explore potential options for future study. This project will build local capacity for contaminants monitoring in Kuujjuaraapik as well as provide relevant temporal trends information for sub-Arctic Nunavik, a region undergoing significant ecosystem change.

CB-07 (2014-2015)
Mercury in fish from Old Crow

Project leader: William Jose, Vuntut Gwitchin Government

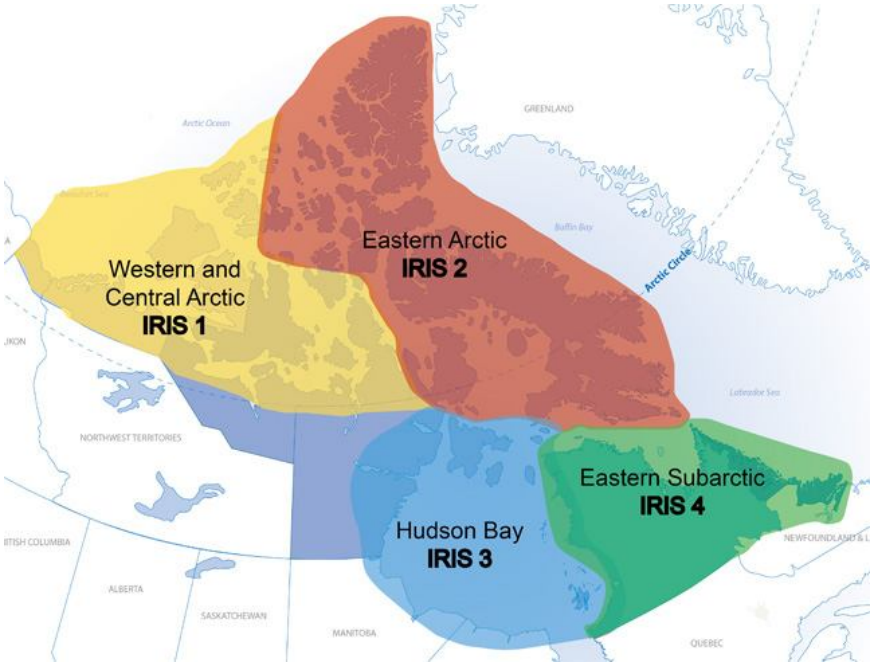
PLAIN LANGUAGE SUMMARY

This project will measure mercury levels in six commonly harvested fish species from the Old Crow area, to determine whether they continue to be healthy food choices for northerners. The fish will be collected by traditional harvesters and will be processed by community members with the assistance of an experienced contaminant researcher. Results of the project will be presented to the community at a public meeting and in a written report including a plain language summary.

Annex 2. Summary of ArcticNet projects related to AMAP

Broad Objective: The central objective of the Network is to translate our growing understanding of the changing Arctic into impact assessments, national policies and adaptation strategies.

In the context of a changing Arctic World, the research program of ArcticNet focuses on four main themes: coastal marine ecosystems, coastal terrestrial ecosystems, Inuit health and adaptation, and industrial development in the North. To address the identified knowledge gaps and research challenges, the core research program comprises 38 research projects grouped into four Integrated Regional Impact Studies (IRIS) that each underpins an Integrated Regional Impact Assessment (IRIA) to be re-edited at intervals of a few years. Each of the four IRIS corresponds to one of the main politico-physiographico-oceanographic region of the coastal Canadian Arctic. Although allocated to one IRIS for convenience, most projects operate in several of the regions and contribute to several of the four IRIA. Along with results of other arctic studies and assessments, and the expertise of our Inuit partners, the scientific conclusions and recommendations produced by the core research program of ArcticNet are compiled in the Integrated Regional Impact Assessment (IRIA) developed for each region.



Associations with AMAP: All of the projects described below are associated with AMAP and its climate change science related mandate. Some projects are directly related to AMAP contaminants monitoring with links to the Northern Contaminants Program.

IRIS 1, Western and Central Arctic

The Western and Central Arctic IRIS focuses on the Inuvialuit Settlement Region and, for reasons of ecosystem continuity, extends into the SW sector of the Canadian Archipelago for the study of marine and terrestrial ecosystems. Demographically, the ISR Land-Claim Region is home to about 3000 Inuvialuit distributed in six communities. Among all regions of the Canadian Arctic, climate warming has been most intense in the Western High Arctic with temperature increases of 2 to 3°C in the last 50 years. The relatively productive ecosystem of the Mackenzie River Delta contrasts with the low-diversity coastal plain and islands which belong to the Southern Arctic ecozone (rolling uplands and lowland plains; long cold winters and short cool summers; dwarf shrub decreasing in size northward; musk ox, wolf, arctic fox, grizzly and polar bear, and caribou (Furgal et al. 2003). Throughout the region, the silty clays and organic terrain are rich in massive ice and the unlithified coast is subject to intense erosion as ground ice melts and the protection afforded against waves by landfast sea ice declines. The coastal ISR borders the south-west Beaufort Sea, including the shallow Mackenzie Shelf which is strongly influenced by the Mackenzie River plume, and the deeper Amundsen Gulf that connects to the Canadian Archipelago. The Beaufort sea is home to the largest stock of beluga whales in the world, a large population of bowhead whales in summer, polar bears and ringed and bearded seals. Marine diversity is generally low and productivity is weak to moderate except in a few biological hotspots such as the Cape Bathurst polynya on the eastern margin of the Mackenzie Shelf. Marine ecosystems north of the Amundsen Gulf remain largely unexplored.
Navigation on the Mackenzie River system, hard minerals mining (e.g. around Kugluktuk) and exploration for oil in the Delta region dominate the industrial sector. Exploration for oil was extended offshore in 2007 and 2008 with the sale of concessions at the continental margin of the Beaufort Sea.
Leader: Gary Stern
Coordinator: Ashley Gaden

Projects and Project Leader(s):

Smit, Barry (University of Guelph)
Project 1.1 Adaptation in a Changing Arctic: Ecosystem Services, Communities and Policy (Community Adaptation). Contributes to all 4 IRISes.

This project documents the changing physical, biological and socio-economic conditions that are affecting people in the Arctic and identifies policies and strategies to assist communities in dealing with these changes. The project builds on previous work on the vulnerabilities of Arctic communities, and it is feasible because of established collaborations with northern people and organizations. The project includes case studies in all four of the ArcticNet IRIS regions. One main focus of the project involves integrating scientific and traditional knowledge of ice, permafrost, coastal dynamics and wildlife with information about community use of these ecosystem services. The other

main thrust is to identify the opportunities in existing policies and co-management arrangements for adaptation strategies to help communities deal with changing conditions.

Stern, Gary; Macdonald, Robie and Wang, Feiyue (University of Manitoba/Fisheries and Ocean Canada)
Project 1.2 Effects of Climate Change on Contaminant Cycling in the Coastal and Marine Ecosystems (Contaminants). Contributes to all 4 IRISes.

Contaminants pose a potential hazard to Arctic fish and marine mammal health, and ultimately to northerners that consume the tissues of these animals as part of their traditional diets. It is therefore imperative that we strive to understand how climate variability in physical forcing and the biogeochemical response to this primary forcing will affect among others 1) contaminant transport processes and cycling; 2) biomagnification through Arctic marine food webs; 3) foraging behaviour of marine mammals (e.g. in response to changing sea ice regimes); 4) changes to hunting patterns and diets of northerners to reflect availability of traditional foods (e.g. less ice may lead to reduced reproductive success of ringed seals forcing northerners to consume more beluga tissues which typically have 10-fold higher contaminant concentrations). Overall, results from our research will help assess the vulnerability of coastal Inuit communities to climate change, document and project impacts of climate change on traditional food security and community health and provide the information required by communities, scientists and policy makers to help develop adaptation strategies. Our findings will help to test and shape the policy for the future management of contaminants emissions and long range transport to the Arctic and will support integrated ocean management programs such as Marine Protected and Large Ocean Management Areas (MPA & LOMA, respectively) such as zone 1(a)s in the Beaufort Sea.

Lamoureux, Scott and Lafrenière, Melissa (Queen's University)
Project 1.3 High Arctic hydrological, Landscape and Ecosystem Responses to Climate Change (Hydrology). Contributes to IRIS 2.

Water is crucial for northern communities and ecosystems and plays a vital role, in conjunction with climate and permafrost, in the morphology and stability of arctic landscapes. To determine the impacts of climate change on freshwater quality and availability in the High Arctic, we created a watershed and landscape ecosystem observatory. The research is conducted primarily at the Cape Bounty Arctic Watershed Observatory (CBAWO) on Melville Island, near the Nunavut/NWT border, with additional work at Polar Bear Pass on Bathurst Island. Research will investigate how climate change will affect rivers, permafrost, soils, vegetation, greenhouse gas emissions and the release of contaminants into High Arctic rivers, lakes and ponds.
Our integrated watershed network will provide an unprecedented understanding of the sensitivity and anticipated future effects of climate change to the High Arctic water, permafrost and ecosystem. By closely integrating related water and ecosystem process

studies, this project will identify key environmental and societal vulnerabilities. Our goal is to develop impact models to assess linkages between anticipated environmental change and possible adaptations by communities and government agencies (clean water supply and ecological integrity) and industry (resource extraction, infrastructure protection).

Wrona, Fred (University of Victoria)
Project 1.4 Hydro-Ecological Responses of Arctic Tundra Lakes to Climate Change and Landscape Perturbation (*Tundra Lakes*).

Average annual air temperatures in the Northern Hemisphere have been the warmest 30-year period of the last 800 years (IPCC 2013) and there is growing evidence that the Arctic terrestrial cryosphere is also being significantly altered and is highly susceptible to the effects of a rapidly changing and increasingly variable climate (ACIA 2005; IPCC 2007a,b, 2013; AMAP-SWIPA 2011). Permafrost temperatures have increased in the past few decades, and these increases have been attributed to increased air temperature and changes in the timing and thickness of snowcover (IPCC 2013). While freshwater systems and related hydro-ecological processes are particularly sensitive to changes in climate and related impacts on cryospheric components, the specific nature and the magnitudes of the effects on ecosystem structure and function are not well understood. The occurrence of lake shoreline retrogressive thaw slumping (SRTS) has been increasing in the western Canadian Arctic over the past several decades, as has the incidence of the slumping of steep hillside terrains of fluvial valleys (Kokelj *et al.* 2013). The goals of this research are to: 1) conduct three integrated landscape-lake process and modeling studies that will improve our regional understanding of the sensitivities/responses of upland tundra lakes to CVC; 2) to develop and validate an integrated landscape-geochemical, lake-ice, hydro-ecological model applicable to cold regions/Arctic systems; 3) to evaluate how changes in atmospheric circulation and related hydro-climatic trends are affecting the spatial distribution of water resources (lentic and lotic) and the occurrence of extreme hydrologic events in high-latitude western and northern Canada; and, 4) to develop and test new and innovative automated water quality/hydrometric monitoring systems for application in the Arctic. The project is producing legacy data and products of direct benefit to the development of adaptation options for the conservation, protection and management of arctic freshwater ecosystems to present and future climate variability and change.

Hughes Clarke, John (University of New Brunswick)
Project 1.5 The Canadian Arctic Seabed: Navigation and Resource Mapping (Seabed Mapping). Contributes to all 4 IRISes.

This project undertakes the core seabed mapping component of the ArcticNet research program. Underway acoustic mapping of the seabed relief, sediment distribution and shallow subsurface sediments are the prime datasets used by researchers to understand the geological processes shaping the seafloor, to assess natural hazards and coastal

habitats and to reconstruct the history of past climatic changes. These mapping results are applied to specific projects in this proposal including :
- **Marine geohazards to hydrocarbon development**: Canada has potentially huge economic benefits to gain by having access to the natural resources of the Arctic Archipelago region. Exploitation in this manner however, can only proceed in a safe and responsible manner, by managing the potential detrimental impacts to the environment. A key requirement is to be able to assess potential natural hazards that might result in harmful affects both to persons and the environment. Natural hazards such as underwater landslides, collapse of offshore structures built on gassy seabeds and the impacts of glacial and sea ice must be known and their risk managed.
- **Opening new shipping lanes and improving navigational charting**: Despite previous focused mapping programs in the bottleneck regions, the Archipelago region remains sparsely mapped with shipping normally restricted to narrow singular corridors that may be ice covered. Because the Amundsen is operating a multipurpose mission throughout the region, there is a golden opportunity to simultaneously map uncharted regions to provide alternate pathways.
- **Past to present evolution of sea-ice regime**: Understanding past climatic history is the key to predicting potential future ramifications of a changing sea ice regime. To responsibly plan adaptation strategies, we need to be able to predict future climatic responses and their consequences. It is also the key to understanding the nature of these changes-i.e. are they part of a natural cycle or induced by present excess of greenhouse gases. The mapping is an essential precursor to designing seabed sampling strategies to recover undisturbed sediments.

Byers, Michael (University of British Columbia)
Project 1.6 The Law and Politics of Canadian Jurisdiction on Arctic Ocean Seabed (*International Law*). Contributes to IRIS 2.

The possibility that the Arctic Ocean seabed contains vast deposits of hydrocarbons is attracting considerable attention. Under the 1982 UN Convention on the Law of the Sea (UNCLOS), any state party may, within 10 years of ratifying, seek to extend certain sovereign rights over the seabed beyond its 200 nautical mile Exclusive Economic Zone. To do so, it must establish—through the collection and submission of information concerning topography and geology—that the area of seabed in question is a “natural prolongation” of the continental shelf within 200 miles. Canada, which ratified UNCLOS in 2003, is currently mapping the seabed along its northern coastline so that it can submit the necessary information to the UN Commission on the Limits of the Continental Shelf by 2013. The United States, Denmark and Russia are undertaking similar exercises, albeit with different timelines. This international, interdisciplinary research project focuses on several outstanding maritime boundary disputes—involving the United States, Denmark and potentially Russia—that must be resolved before Canada can submit a comprehensive package of information to the UN Commission. The resolution of these disputes is highly desirable because the Commission lacks authority to deal with information submitted by a state where it is possible that another state will have a claim to that same area. The project will analyze the legal and political differences involved in the different disputes, explore the various options for resolving them, and provide

detailed recommendations. These recommendations will specify a series of considered options occupying progressive positions on the scale of political and technical acceptability. Then, the government of the day will be able freely to select the option that best suits its priorities and objectives, or use the input from this project to craft a better option of its own.

Goodman, Karen (University of Alberta)
Project 1.7 Community-Driven Research on *H. pylori* Infection in the Inuvialuit Settlement Region (*H. pylori infection*).

Despite limited systematic data on its presence in northern Canada, Helicobacter pylori infection has been an emerging health concern in northern Aboriginal communities, where people are becoming aware of its health risks. In many such communities, people worry about the link between H. pylori and stomach cancer, a cancer that occurs more frequently in this region than on average across Canada. Physicians in the north view this infection as a major challenge because it is found in many patients with common stomach complaints and standard treatment is often ineffective in this setting. Health authorities have identified the need for research aimed at developing H. pylori control strategies appropriate for the north. This research program seeks to generate knowledge about how health care decision makers can effectively manage H. pylori infection in a manner that addresses community concerns. To achieve these goals, the applicants formed the Canadian North Helicobacter pylori (CANHelp) Working Group, a collaborative team that links the University of Alberta with northern health officials and community organizations. While the research goals require data from multiple northern settings, the team conducted a pilot project as a starting point in Aklavik, NWT, where they found that 62% of participants had H. pylori infection, and among those infected, there was a high prevalence of precancerous stomach conditions. This research program, developed at the request of the Inuvialuit Regional Corporation, aims to: 1) Expand the research to additional communities in the Inuvialuit Settlement Region to obtain representative data required for developing regional public health strategies pertaining to H. pylori infection; 2) Identify cost-effective and culturally appropriate H. pylori management strategies for northern communities; 3) Create knowledge exchange strategies to help community members understand H. pylori health risks and currently available solutions.

Fortier, Louis (Université Laval)
Project 1.8 The Arctic cod (*Boreogadus saida*) ecosystem under the double pressure of climate change and industrialization (*Arctic cod*).

The Arctic cod (*Boreogadus saida*), also known as the polar cod in Europe, is a key component of the Arctic Ocean pelagic ecosystem that effects up to 75% of the energy transfer between the plankton and the vertebrate fauna (fish, seals, whales and marine birds). Being an hyper-specialist adapted to life in ice-covered seas, Arctic cod is likely to be displaced by southern generalists such as the capelin and the sandlance as the ice regime becomes less severe. This project collaborates closely with "Hotspots", "Moorings" and "Sea-ice" to map the distribution of Arctic cod in the Canadian Arctic, and to measure variations in its hatching season and early growth in relation to annual

changes in ice regime, surface temperature, and zooplankton prey abundance. In partnership with the Department of Fisheries and Oceans, and the Department of Aboriginal Affairs and Northern Development (Beaufort Regional Environmental Assessment program), we assess the general distribution and reproduction of Arctic cod in the Beaufort Sea and the potential environmental risks of drilling on its ecology.

Babin, Marcel (Université Laval)
Project 1.9 Remote Sensing of Canada's New Arctic Frontier (Remote Sensing).

Rapid climate change and industrialization are unlocking the natural resources of the vast Canadian Arctic and increasingly impacting its ecosystems. The stewardship of these ecosystems, the environmentally sustainable development of arctic resources, and the adaptation of northern communities to their rapidly changing world require a massive intensification of scientific observations. Furthermore, these observations must be organized into geo-referenced data banks and models that will provide stakeholders in government, industry and communities with the knowledge needed to inform their decisions. The objectives of this project are aligned with the targeted achievements of the Canada Excellence Research Chair on "Remote Sensing of Canada's New Arctic Frontier" to: (1) Augment in time and space the observation of arctic marine ecosystems by implementing new algorithms for the remote-sensing of phytoplankton, particulate matter, dissolved organic carbon and seawater optical properties in the surface layer of the Canadian Arctic Ocean, from which primary production, bacterial growth, and organic matter photo-oxidation will be derived; (2) Develop, validate, and implement the urgently-needed ecosystem models that will help anticipate the impacts of climate change and industrialization on the resources and services (fisheries, navigation, minerals, energy, tourism) provided now and in the near future by the ecosystems of the Canadian Arctic Ocean; (3) Adapt existing and future new observing technologies to the extreme conditions of the Arctic Ocean, with emphasis on the field deployment of Profiling Floats, Autonomous Underwater Vehicles, and Ocean Gliders, and on the use of optical sensors; (4) In collaboration with the Canadian Cryospheric Information Network (CCIN), Centre d'études nordiques (CEN) and other national and international partners, mesh the respective expertise of ArcticNet and GEOIDE, two pan-Canadian NCE, into the development of state-of-the-art geo-referenced data archiving systems that can be accessed online by scientific, industrial and government stakeholders to produce maps and analyses of the transforming Canadian Arctic. The scientific broad objectives of this ambitious program are: (1) To understand the functioning of the arctic marine ecosystems. What is the composition of the microbial communities (biocenoses)? Who are the main players among phytoplankters and bacteria in terms of energy and biomass transfer to higher trophic levels? What are the main ecologically distinct environments (biotopes)? Where do critical biological processes really happen in this environment? What are the interactions between the biocenoses and biotopes? How does the ecosystem work? (2) To determine the carbon fluxes (rivers ? coastal environment ? ocean), with special emphasis on those affected by light. What is the impact of bacterial activity and photo-oxidation on mineralizing organic carbon? What is the extent of new organic carbon production by primary production? What are the chemical and physical factors

controlling those three carbon fluxes affected by light: primary production, bacterial activity and photo-oxidation? What is the spatial and temporal variability of those three processes? What large-scale physical phenomena control that variability? (3) To determine the impact of current and near-future changes in the Arctic environment on marine ecosystems and biogeochemical fluxes. How will CO2 production from the mineralization of old organic carbon be compensated by the new sequestration of carbon? Will the Arctic Ocean experience a major shift biotopes and biocenoses? What will be the impact on higher trophic levels? Briefly, the milestones are, for 2011-2014: (i) Develop the CERC technical team and implement the necessary land-base research facilities; (ii) adapt autonomous platforms and in situ sensors for operation in the Arctic Ocean; (iii) identify and isolate the key Arctic phytoplankton species during oceanographic cruises; (iv) characterize in the laboratory their optical and physiological properties, and derive relevant model parameters, (v) archive and process all available ocean color data and other relevant remote sensing data for the Arctic Ocean; (vi) conduct intensive sampling in key region of the Arctic Ocean with regard to biological production, using various platforms (ship, AUV, gliders and profiling floats) ; and (vii) analyze time series derived from remote sensing data and diagnostic models to identify the main drivers of biological production.

Brown, Ross (Environment Canada)
Project 1.10 Climate analysi and scenario development for the Canadian Arctic and Subarctic (Climate analysis)

Analyzing climate variability and trends and building climate projection scenarios for the Canadian Arctic and Subarctic regions is more challenging than more southern Canadian regions. This is mostly due to the inconsistent and sparse observational datasets, to the complex regional settings and the interlocked physical processes involved in this environment. The main objectives of the project are: 1) to supply information on observed and projected changes in key climate variables and indicators in support of the ongoing IRIS reports (IRIS 1-2-3), 2) to build a climate database and analyze its information to support impact and adaptation studies and the production of climate projection scenarios, 3) to analyze recent climate trends and the natural climate variability over the IRIS regions, and assess the potential of the climate model to capture the observed variability and physical processes, 4) to track state-of-the-art developments in coupled cryosphere/atmosphere/ocean models to improve the reliability of climate scenarios. This project will provide researchers, stakeholders, decision-makers and communities with more accurate knowledge of current and anticipated climate changes and contribute to support sustainable development in this complex and rapidly changing environment.

IRIS 2 Research (Eastern Arctic)

Nunavut ("our land" in Inuktitut) is the ancestral home of the Inuit of the Central and Eastern Arctic. It is the largest, least populous, and newest federal territory of Canada, having been separated officially from the Northwest Territories on April 1, 1999 (Nunavut Act and the Nunavut Land Claims Agreement Act). Nunavut comprises the greater part of the Canadian Arctic Archipelago and the islands of Ungava, Hudson and James Bay. The territory covers 1,932,255 km2 of land and 160,935 km2 of water. Several islands in the Archipelago are divided between Nunavut and the Inuvialuit Land Claim Settlement, notably Victoria, and Melville Islands. The landscape has been shaped by ice sheets and glaciers, which carved out deep valleys and fjords. Today, it is being altered by climate-related changes such as rising temperatures, retreating sea ice, and thawing permafrost. Ecosystems vary widely, from the flat tundra west of Hudson Bay to the rich North Water polynya in northern Baffin Bay. Of great scientific interest is the south-north gradient in terrestrial coastal arctic ecosystems from the northern limit of the taiga to the arctic desert of Ellesmere Island.
Nunavut is currently home to approximately 30 000 residents, 85 percent of whom are Inuit (Nunavummiut), distributed in 26 coastal communities. The population is young (35% under 18 years of age) and is projected to increase from 32 183 in 2009 to 44 581 by 2036. The economy is a mix of wage-based economy (mining, exploration, tourism, fisheries, art) and land-based economy, an integral part of the Inuit cultural and social way of life. Activities such as harvesting caribou, seals and Arctic char provide a healthy diet, education, community cohesion, and cultural identity. Nunavut's economy is still highly dependent on employment in the public sector (Government of Nunavut, municipal, education, health and security). Vast distances, a small but growing population, the high cost of materials, energy, transport and labour, and extreme and changing climate challenge the Nunavut's government and people.
Government in Nunavut co-exists with a number of public bodies directly and indirectly related to the Nunavut Land Claims Agreement. Nunavut Tunngavik Incorporated (NTI) represents Inuit beneficiaries, manages federal funding resulting from the claim, offers services and programs, and oversees co-management bodies such as the Nunavut Planning Commission, the Nunavut Wildlife Management Board and the Nunavut Water Board.

Leader: Trevor Bell
Coordinator: Kathleen Parewick

Projects and Project Leaders:

Vincent, Warwick (Université Laval)
Project 2.1 Freshwater Resources of the Eastern Canadian Arctic *(Freshwater Resources)*. Contributes to IRIS 4.

Lakes and wetlands are major ecological features of the circumpolar Arctic, and they provide many essential services including habitats for aquatic wildlife, drinking water supplies for northern residents, and water for industrial activities. Inuit communities and

northern scientists have increasingly observed that these resources are highly vulnerable to ongoing climate change. The project proposed here will extend our observations on lakes and wetlands at key sites in the eastern Canadian Arctic, to identify and measure aquatic indicators of environmental change in the past and present. These studies will allow us to make assessments of future changes in northern freshwater ecosystems to help guide the formulation of environmental management policies. We will continue our research on lakes, ice shelves and contaminants along the northern Ellesmere Island coastline based out of Ward Hunt Island Observatory, where we will work with Parks Canada to develop facilities, indicators and protocols for long term monitoring. This coastline lies at latitude 83oN, at the northern limit of Nunavut and thus North America, and it is characterized by many climate-sensitive aquatic ecosystems that are highly dependent on ice. We will extend our research to wetlands by assessing the snow storage and melt patterns in Polar Bear Pass on Bathurst Island (75oN). This Wildlife Sanctuary is composed of a mosaic of lakes and ponds, and seasonal snowmelt is considered the most important source of water to this wetland. The resultant models and understanding should be of broad application to arctic wetland wildlife habitats that have begun to respond strongly to climate change. Permafrost thaw lakes are a prominent component of northern wetland ecosystems, and we will work at several sites including Bylot Island (73oN) and Kuujjuarapik (55oN), to determine the environmental factors that control their ecosystem metabolism and net production of greenhouse gases in the present and future. We will analyze sediment cores from northern waters in the Foxe Basin region (65-70°N) to assess the natural climate variability in arctic and subarctic Canada, and to identify regional variations in climate sensitivity. Finally we will develop and apply new DNA-based techniques to assess the diversity and function of microscopic life in lakes and wetlands and to develop state-of-the-art molecular indicators of climate responses by northern aquatic ecosystems. We are contributing our findings and expertise on Canadian arctic water resources to the ArcticNet IRISs, Canadian and panArctic climate impact assessments, and circumpolar initiatives such as the 'Arctic Freshwater Synthesis' under the auspices of the International Arctic Science Committee (IASC). .

Tremblay, Jean-Éric (Université Laval); Gosselin, Michel (Université du Québec à Rimouski); Archambault, Philippe (Université du Québec à Rimouski)
Project 2.2 Marine Biological Hotspots: Ecosystem Services and Susceptibility to Climate Change *(Marine Ecosystem Services)*. Contributes to all 4 IRISes.

Living, harvestable resources in the upper Arctic Ocean ultimately depend on the production of marine microalgae. Microalgal production also mitigates global warming by fixing the greenhouse gas CO2 into biomass, of which a portion sinks to the seafloor. This process, called the “biological CO2 pump”, supplies food to the benthic organisms living at the bottom. Ongoing alterations of the physical environment will have profound impacts on the growth conditions of primary producers, affecting the timing, productivity and spatial extent of biological hotspots (i.e. areas of elevated food web productivity against the low background typical of the Canadian Arctic). This project investigates how changes in the dynamics of sea-ice and glacial ice (icebergs and ice islands), water temperature, ocean circulation and wind forcing affect primary production in the upper

water column and the benthic ecosystem underneath. Specific objectives are to 1) locate biological hotspots (and coldspots) of pelagic and benthic activity, 2) assess how they function and interact, and 3) assess how their productivity and biodiversity is likely to respond to further perturbations of the environment. To do so, we are and have been developing and implementing cutting-edge observational and experimental approaches that exploit remote sensing from space, autonomous underwater vehicles as well as the sampling and laboratory facilities of the CCGS Amundsen. Our work is done in very close collaboration with several ArcticNet projects, collaborators and partners from government and the industry.

Henry, Greg (University of British-Columbia)
Project 2.3 Impacts of Vegetation Change in the Canadian Arctic: Local and Regional Assessments *(Arctic Vegetation)*. Contributes to IRISes 1 & 4.

The tundra across the Canadian Arctic is already reacting to climate change. Northerners and scientists are observing changes, such as shrubs getting taller and more numerous. The taller shrubs catch more snow, and change the depth and pattern of snow drifting, which could affect travel and caribou migration. Increases in the cover of shrubs will also result in more sunlight being absorbed by the leaves and this will increase the temperature even further. We study these changes near Arctic communities across the North. Community members are involved in designing the studies and in conducting measurements on tundra vegetation. An important focus of the project is the measurement of changes in amounts of berries produced each year in traditional berry picking areas near the communities. Experimental studies including warming with small open-top greenhouses and altering snow deposition with snow fences have been established to determine effects on vegetation, especially berry shrubs. These studies have been incorporated into science studies in the local schools and used to show students how traditional ecological knowledge and scientific studies can be used together. The results will be used in the communities and will contribute to national and international efforts to understand the responses of tundra ecosystems to climate variability and change.

Bell, Trevor (Memorial University of Newfoundland); Forbes, Don (Memorial University of Newfoundland / Geological Survey of Canada)
Project 2.4 Instability of Coastal Landscapes in Arctic Communities and Regions *(Coastal Landscape)*. Contributes to IRISes 1 & 4.

Future climate scenarios and impacts modeling predict changes in climate variables that may increase coastal landscape instability and hazard risk. Projecting the future response of the coastal land system to these changes in climate forcing is a prerequisite for an effective adaptation strategy and forms the core of this ArcticNet project. Through improved understanding of changes in climate, sea-level, sea ice, storms and wave climate, seasonal thaw depths, and other aspects of environmental forcing we will assess integrated impacts on coastal landscape stability, including flooding, erosion, habitat

integrity, and community vulnerability. Together with northern communities and partners we plan to integrate local and external research and knowledge on climate-change trends and impacts in order to provide a common basis for decision-making at all levels, thereby enhancing community adaptive capacity. Ultimately the goal is to promote informed choices of adaptation measures and enhanced resilience in northern coastal communities.

Huebert, Rob (University of Calgary)
Project 2.5 The Emerging Arctic Security Environment *(Arctic Security)*. Contributes to all 4 IRISes.

Climate change, undefined or disputed boundaries, access to resources and newly viable transportation routes and governance issues are generating significant questions about Arctic security and circumpolar geopolitics in the twenty-first century. Anticipating future prospects for competition, conflict and cooperation in the region requires a systematic examination of the new forces at play, both internationally and domestically. Our project examines fundamental questions including: What is Arctic security? What will the circumpolar world look like in the future, given the various forces transforming the region? Our project poses these questions at the international and national levels to discern what senior government officials, indigenous groups, corporate interests, scientists, academics, and Northern residents perceive to be the most significant security and safety challenges in the Arctic -- and to determine what unilateral, bilateral and multilateral mechanisms should be in place to address them. This project makes two primary contributions: one policy focused and the other academic. First, it adds to the public policy debate about the evolving Arctic security environment. Our research team critically assesses the interplay between traditional, state-based military security and environmental, health, and societal security concerns. In linking international and domestic security practices to human impacts, we are producing more integrated frameworks and tools to anticipate the consequences of security action/inaction on Northern ecosystems and peoples. This should help to enhance Canada's capacity to deal with opportunities and challenges in a way that is sensitive to, and better integrates, Northerners' concerns and priorities. Second, this project advances academic debates about the relationship between environmental, diplomatic, political, and socio-economic processes and ideas about Arctic security. Community consultations, participation in the Arctic Security Working Group, as well as partnerships with federal departments and agencies ground our analyses of how the changing geopolitics of the Arctic are influencing government policy and affecting Northerners' culture, well-being, and economy. As a team, and in collaboration with our partners, we are refining existing frameworks and models to incorporate the complexity of these new forces, to better explain the actions that are now being taken, and to generate appropriate lessons for future relationship-building.

Rodon, Thierry (Université Laval)
Project 2.6 Improving Access to University Education in the Canadian Arctic *(University Education)*. Contributes to all 4 IRISes.

Increased participation in postsecondary education is of primary concern for Inuit. The goal of this project is to provide evidence-based research on Inuit participation in University education throughout Inuit Nunangat and to promote a national discussion amongst provider of university program in Inuit Nunangat, Northern institutions and Inuit organizations in order to develop a more coordinated effort in program delivery, curriculum development. More specifically this research has three objectives: 1) Make an inventory and evaluation of past and present university initiatives in Inuit Nunangat or for Inuit in term of curriculum, delivery methods and success, 2) Evaluate the Inuit Peoples needs and experiences with postsecondary programs or courses in order to better understand educational paths and university successes from the point of view of the Inuit 3) Develop different scenarios to improve access to university education for Inuit and Northerners in Inuit Nunangat. The data is being collected through surveys, in-depth interviews and workshops. This research provides evidence-based data on the Inuit students' university experience: Inuit participation in university programs; definition of university and educative success from a point of view of Inuit that will help university program providers deliver programs better adapted to the needs of Inuit students; monitoring of Inuit student success according to this definition; inventory and evaluation of the university program delivered in Inuit Nunangat and for Inuit students; and development of scenarios to improve access to University program for Inuit students.

Walton, Fiona (University of Prince Edward Island)
Project 2.7 *Inuit Qaujimajatuqangit* and the Transformation of High School Education in Nunavut *(High School Education)*.

Rapid economic, ecological, and sociocultural changes have serious implications for Inuit communities in the Arctic. Education can provide Inuit with a range of coping skills to adapt to these challenges, such as making more informed decisions, and managing environmental and socio-economic change. Understanding the factors that create educational success for young Inuit will enable school and community leaders to transform schools into meaningful learning environments that provide leadership development so that skilled graduates can become the next generation of Arctic stewards. Our overall goal is to uncover and share successful practices and strategies that contribute to the improvement of high school education in Nunavut. The vision of Inuit education led by Inuit and based on *Inuit Qaujimajatuqangit*, Inuit ways of knowing and being, is moving forward through recent legislative and policy changes in Nunavut and the implementation of the *National Strategy on Inuit Education*. Our research explores the changes occurring both in Nunavut high schools, and in the lived experiences of research participants. Over the funding cycle, our project has collected stories of Inuit and non-Inuit school leaders who supported young people as they navigate issues of identity in the modern world, and captured the current perspectives of Inuit youth who have experienced high school education. The findings reveal how Nunavut youth are successfully negotiating extraordinary changes in their culture and society and inform us about the

future of the Arctic which will be in the hands of these young people. To ensure that the results reach as many people as possible, our team has created bilingual documentary videos (Inuktitut/English and Inuinnaqtun/English). The documentaries, *Going Places: Preparing Inuit High School Students for a Changing, Wider World; Alluriarniq-Stepping Forward: Youth Perspectives on High School Education; and Millie's Dream: Revitalizing Inuinnaqtun* have been heavily promoted via social and print media and distributed extensively across Nunavut and to Inuit organizations in the South. Results are reaching target audiences, the education stakeholders such as political leaders and policy-makers, and parents, principals, community members, and students. To provide contextual information and statistical profiles that support the interview data, our team has also completed ten-year historical and statistical reports of four high schools in our research communities of Pangnirtung, Clyde River, Rankin Inlet, and Kugluktuk. These reports focus on grades 10, 11, and 12. They reveal information specific to each school and highlight educational indicators such as school attendance, teacher retention, and graduation rates. This project involves a partnership between the Department of Education within the Government of Nunavut, and the Coalition of Nunavut District Education Authorities, which is a territorial organization that represents 26 community groups that represent parental voices in education. The research program emphasizes the involvement of Inuit researchers and community members, responding to community priorities, and returning all the data to communities in ways that communicate the findings and inform all stakeholders.

Rysgaard, Soren (University of Manitoba)
Project 2.8 Arctic Geomicrobiology and Climate Change.

Anthropocene is a time of extraordinary change in the Arctic. It has experienced unprecedented variability in both the rates and magnitudes of change in the cryosphere, atmosphere and lithosphere, dependent ecosystem function variability, increased industrial development, and concomitant globalization of local economies. These changes are challenging our ability to respond and to develop a coordinated and scientifically informed policy for the Arctic. The objectives of this project are aligned with the targeted achievements of the Canada Excellence Research Chair on "Arctic Geomicrobiology and Climate Change" to increase understanding on geomicrobial transformations as they occur in Arctic sea ice and sediments, including the regeneration of nutrients required by primary producers and thus the health of all other inhabitants of the Arctic marine system. The project will address 4 key research questions and 2 objectives: (1) What are the relative contributions of dynamic and thermodynamic forcing to the observed change in sea ice areal extent and thickness and how is this related to intra- and extra-Arctic climate processes, variability, and change? (2) What are the consequences of change in Question 1 on biogeochemical cycling, including carbon, nitrogen, sulphur, phosphorous, oxygen, and their stable isotopes? (3) What are the consequences of changes in Questions 1 and 2 on ecosystem function, examined throughout the complete trophic structure: beginning with microbial processes, primary and secondary production, through to apex predators; and on habitat structure: benthic, pelagic, epontic, and within the ocean–sea-ice–atmosphere (OSA) interface? (4) What are the consequences of change on release, transport, and biological impact of chemical contaminants, including both organic and

inorganic contaminants, across Arctic biotic and abiotic environmental interfaces? Objective 1: To produce models of coupled physical-biological processes examined in Questions 1 through 4 as a means of making the project science predictive and able to inform future environmental conditions. Objective 2: To provide and communicate a knowledge base upon which public policy development can build to address the key issues facing the Canadian Arctic (e.g., sustainable development, globalization, socioeconomic stability, and environmental stewardship). Recent evidence suggests that microbial activity and chemical transformations within sea ice greatly influence inorganic carbonate chemistry, playing a far more important role in regulating carbon dioxide (CO2) uptake by Arctic seas than previously anticipated. The objective of the program is to investigate and quantify the importance of these fundamental microbial activities using state-of-the-art assessment techniques in a comprehensive three-pronged approach of ice tank, in situ, and modelling studies. Combining experimental ice tank and in situ studies will provide important new insight into the regulation of these processes, their seasonal and geographical distribution, and how they are coupled between surface ocean and seafloor. Modelling activities will range from small-scale studies within the sea ice and sediment compartments to local coastal regions of strategic importance and the large-scale systems of the Arctic Ocean and neighbouring seas.

Berteaux, Dominique (Université du Québec à Rimouski)
Project 2.9 Effects of Climate Change on the Canadian Arctic Wildlife *(Arctic Wildlife).*
Contributes to IRIS 3.

Many northern ecosystems are undergoing major shifts related to climate change. This adds to increasing pressures due to resource development. An understanding of these transformations and of the significance of their consequences is critical to anticipating ways in which potential negative and positive effects to wildlife populations (and ultimately humans) may be mitigated or used through sound management. Our overall goal is to provide the wildlife-related knowledge necessary to conduct the integrated regional impact studies of the “Eastern Arctic” and “Hudson Bay”, two of the four regions identified by ArcticNet to conduct regional impact studies. In addition, we contribute to all international efforts synthesizing knowledge on biodiversity for the benefit of northern populations and policy makers. We work through 4 specific objectives. First, we identify the main vulnerabilities of Arctic wildlife with regards to climate change and resource development. Second, we monitor more than 30 wildlife populations (mostly tundra wildlife and marine birds) at 6-10 study sites located in the Eastern Canadian Arctic (e.g., Belcher Islands, Rankin Inlet, Coats Island, East Bay-Southampton Island, Digges Island, Deception Bay, Bylot Island, St.Helena Island). Third, we use data from our field work and from the literature to analyze past and present responses of wildlife to climatic variability in order to develop Impact Models. Finally, we project some wildlife patterns into the future by forcing these Impact Models with regional climate change scenarios. This project is a collaboration between ArcticNet researchers and a number of partners including the Canadian Wildlife Service (Environment Canada), Parks Canada Agency, Wildlife Conservation Society Canada, Nunavut Tunngavik Inc., Nunavut Wildlife Management Board, Baffinland Iron Mine,

Department of Environment of Government of Nunavut, Nunavut General Monitoring Program, and many Northern communities, especially members of their Hunting and Trapping Organizations. Our project helps ArcticNet impact studies to provide decision makers in the wildlife sector with a sound basis for working at adaptation strategies in a changing climate.

LeDrew, Ellsworth (University of Waterloo)
Project 2.10 Polar Data Management for Northern Science (Polar Data Catalogue)

The progress of science towards interdisciplinary exchange and integration of information, such as in the ArcticNet Integrated Regional Impact Studies (IRISes), demonstrates the need for more efficient use of data resources using well-structured systems of data deposition and access. The central objective of ArcticNet's *Polar Data Management for Northern Science* is thus to facilitate exchange of information and data about the polar regions among researchers and other user groups, including northern communities and international programs. During Phase 1 of ArcticNet, members of Theme 2 initiated this data management project. ArcticNet then partnered with the Canadian Cryospheric Information Network (CCIN) at the University of Waterloo and the Department of Fisheries and Oceans Canada (DFO) to develop a database of metadata, the "meta-database," describing ArcticNet datasets.

After several modifications and the joining of new partners such as the Canadian federal government program for International Polar Year (IPY), the Northern Contaminants Program (NCP), and Environment Canada, the ArcticNet meta-database, renamed the Polar Data Catalogue (PDC, http://www.polardata.ca), was launched in July 2007. In 2010 the RADARSAT Polar Science Dataset was added to the collection, and in 2011 data archiving and access became functional. The Polar Data Catalogue is now Canada's primary on-line source for data and information on research in the polar regions. The scope of research covers a range of disciplines, from natural sciences to policy to health and social sciences. Research projects presented in the PDC are conducted under the auspices of a wide variety of programs, including ArcticNet, NCP, the Canadian IPY (2007-2008), the Circumpolar Biodiversity Monitoring Program (CBMP), and the Beaufort Regional Environmental Assessment (BREA).

The Polar Data Management team is also working with other relevant projects (both national and international) toward integrated data management systems to ensure (1) preservation of polar metadata and datasets for the long term, (2) public accessibility of the metadata and datasets on the PDC in a timely and user-friendly format, and (3) responsive development of PDC data tools for use by various stakeholders, especially northern communities.

IRIS 3 Research (Hudson Bay)

The Hudson Bay marine ecosystem encompasses Hudson Bay, Foxe Basin and Hudson Strait and, at 1 240 000 km2, is the largest inland sea in the world. It connects to the Arctic Ocean through Fury and Hecla Strait and to the Atlantic Ocean through Hudson Strait. The surrounding Hudson Bay Lowlands are low, permafrost-laden plain characterized by marshes, peat and ponds. The land surrounding the Bay is slowly rising due to isostatic rebound, slowly exposing more and more coast. Its relatively southern location supports the most southern Arctic marine ecosystem in the world. This leaves the Hudson Bay system highly susceptible to climate change. The Bay experiences complete annual sea ice cover in the winter, and becomes ice-free each summer. Ice cover starts in late October in the northern parts of the Bay, while the maximum ice coverage occurs in April. Several polynyas recur in the Bay predominantly along the north-west and east coasts. The Bay is fed by numerous large rivers on its western, southern and eastern shores. This freshwater influx strongly affects the general counter-clockwise coastal circulation. The Hudson Bay watershed covers over a third of the Canadian landmass, from southern Alberta to central Ontario to Baffin Island, as well as parts of North Dakota and Minnesota.

The Bay is home to several species of fish, seals, whales, migratory birds, sea birds, as well as mammals such as the polar bear and caribou. The bioregion has been traditionally inhabited by Cree in the south, occupying parts of Manitoba, Ontario and Quebec, while Inuit have long inhabited the north, including the eastern shores of Hudson Bay, north Nunavik, and the Nunavut, including the island communities of Coral Harbour and Sanikiluaq. As part of their traditional subsistence hunting, Cree harvest waterfowl and terrestrial mammals like moose. Inuit traditional subsistence includes the harvesting of fish, seals, whales, while caribou are also important in some communities. The shores of Hudson Bay are shared by the provinces of Quebec, Ontario and Manitoba, and the territory of Nunavut. The islands within Hudson Bay are part of Nunavut, including the Belcher Islands in the south, while the waters of the Bay are under exclusive federal jurisdiction. Hydroelectric development is extent in the Hudson Bay watershed, and plays a significant role in the water flow and timing of several of the large rivers draining into the Bay. Other commercial activities in Hudson Bay include mining and shipping in summer via the Port of Churchill, the only deep water port of the Canadian Arctic.
Leader: David Barber
Coordinator: Brian Horton

Projects and Project Leader(s):

Papakyriakou, Tim (University of Manitoba)
Project 3.1 Carbon Exchange Dynamics in Coastal and Marine Ecosystems *(Carbon Dynamics)*. Contributes to all 4 IRISes.

Our overarching objective is to understand the effects of climate change on the air-sea exchange and associated exchange budgets of climate active gases (carbon dioxide-CO_2,

dimethylsulfide-DMS, and nitrous oxide-N_2O) in the Canadian coastal Arctic environment.

Oceans exert considerable influence on climate through their role on the global cycling of climatic active gases. For example, the world's oceans are nature's largest sink for CO_2 and they globally account for a significant proportion of the natural emissions of the greenhouse gas nitrous oxide (N_2O), and the vast majority of dimethyl sulfide (DMS) production. DMS is the largest source of sulfate in the marine environment, and once in the atmosphere the compound can trigger the formation of aerosols that serve as cloud condensation nuclei. While greenhouse gases (CO_2 and N_2O) act to warm the atmosphere, the increased production of DMS may have a cooling effect on climate by increasing back-scattered solar radiation. Our understanding of the effect that a changing Arctic climate and sea ice regime will have on the air-sea (and sea ice) exchange of these trace gases is currently somewhere between partially understood and mostly unknown, and hence important feedbacks that involve sea ice and the cycles of climate-active gases are currently not represented in general circulation models.

A requirement of this project is to parameterize both those processes affecting the distribution of dissolved CO_2, N_2O, and DMS in surface waters of the Arctic, and their exchange with the atmosphere. Newly developed parameterizations are being implemented into a coupled atmosphere-sea ice-ocean biogeochemistry models to learn how the ocean's response (physical, biogeochemical and biological) to climate change and variability will affect the atmosphere-ocean cycling of these climate active gases within the Arctic, and in turn how these regional processes may affect the global budgets of these gases.

Barber, David (University of Manitoba); Sydor, Kevin (Manitoba Hydro)
Project 3.2 Freshwater-Marine Coupling in the Hudson Bay IRIS *(Freshwater-Marine Coupling)*. Contributes to IRISes 2 & 4.

Climate models predict warming in the Hudson Bay watershed that may alter the amount and timing of runoff and hence, of the load of suspended solids, dissolved organic matter and other major nutrients, and heat delivered to the Bay. In the Churchill and Nelson estuaries, such changes will be superimposed on earlier changes in the hydrological regime – diversion of Churchill River flows into the Nelson River and a shift of a third of total discharge from summer to winter. Our study of transfer pathways through river estuaries into Hudson Bay will improve our understanding of the effects of these changes. The overarching objective of this project is to describe the impact of freshwater quality and quantity on marine processes within Hudson Bay. In particular we are interested in understanding the principal processes which couple the freshwater and marine systems in Hudson Bay and to examine the cumulative impacts of climate change and hydroelectric development on Hudson Bay. Our key industry partner (Manitoba Hydro) will use this information to examine aspects of environmental impacts due to development of dams along the Nelson River, including the planned development of Conawapa Generating Station. More specifically our team will determine the fluxes, pathways and fate of

suspended solids and dissolved organic matter transferred through the Churchill and Nelson estuaries during the open water season when mixing in the estuary is determined by wind-driven waves, tides and fluvial and marine currents, and under ice, when mixing is determined by tides and fluvial and marine currents alone. We will also investigate the relative significance of fluvial loading and littoral resuspension to concentrations of suspended solids in the estuaries and Hudson Bay and to study the effect of suspended solids and dissolved organic matter on radiative transfer in the estuary and nearby Hudson Bay. This team will also investigate historical effects of climate on Hudson Bay by interpretation of data stored in bottom sediments within our three supersites – the estuaries of the Nelson and Churchill Rivers, and of the Grande Rivière de la Baleine – and also in sediments deposited at the Bay-wide scale.

Ferguson, Steven (University of Manitoba/Fisheries and Oceans Canada)
Project 3.3 Impacts of Global Warming on Arctic Marine Mammals *(Marine Mammals)*. Contributes to all 4 IRISes

This project examines various aspects of Arctic marine mammal (seals, whales, and polar bears) ecology to try to determine the impacts of global warming on their abundance and distribution. Research will answer: •How will marine mammals adapt to global warming – and what are the possibilities for future survival? •What is the relationship between warming temperatures and the habitats of seals, whales, and polar bears? •What are the potential effects of global warming on reproduction and survival? •What will be the effects of changes on northern communities and Inuit lifestyle? •How can we reduce the impacts of these changes on Arctic peoples and marine mammals? Satellite tracking, analysis of tissue samples collected by local hunters, and genetics and population modeling are methods that will be used to understand how these animal populations may respond to environmental change. Several areas of Arctic marine mammal health are also being studied, including diet, diseases, contaminants, and stress. Knowing how polar ecosystems may change with global warming will help to develop strategies for conservation and species management. Northerners depend on these species as a food source and as an integral part of their unique culture, and results will help Inuit communities adapt to changes in marine mammal distribution and abundance.

Hik, David (University of Alberta); Furgal, Christopher (Trent University)
Project 3.4 Integrating and Translating ArcticNet Science for Sustainable Communities and National and Global Policy and Decision-Making *(Science to Policy)*. Contributes to all 4 IRISes.

Ecological changes, economic strains, cultural transformations and other factors are causing multiple stresses for the indigenous peoples of the Arctic. The best available information, based on contemporary science and community and traditional knowledge (TK), must be used to ensure that Canadian Inuit, circumpolar Inuit and all Canadians make policy decisions that will contribute to sustainable development in the Arctic and

the well-being of Arctic peoples. This research project is comprised of a series of sub-projects or activities that examine aspects of the science-policy interface. The central focus is to enhance our understanding of the Arctic policy landscape and factors influencing the translation and transformation of research results into decision support at various levels. It aims to understand how ArcticNet science and IK/IQ (Inuit Knowledge) can, has and might better contribute to informing policies on critical issues such as climate and other forms of change in the future. It is expected that conclusions from the sub-projects will help ArcticNet address the most effective ways to use and translate its research results into 'action' or decision-making at the local, region, national or international levels. More generally, these results will contribute to the present knowledge on how to improve the use, translation and transformation of research results into sound policy or accessible and compelling information for informed decision making in the Arctic or elsewhere in Canada and beyond.

Dmitrenko, Igor (University of Manitoba)
Project 3.5 Long-Term Observatories in Canadian Arctic Waters *(Marine Observatories)*. Contributes to all 4 IRISes.

The past decades witnessed a spectacular reduction of Arctic sea ice (Maslanik et al. 2011), culminating in September 2012 when both extent (-50%) and volume (-82%) reached all-time record lows relative to the recent climatology (last 1500 years). The ice cover insulates the ocean from the atmosphere. A shrinking ice cover means that more light and heat enter the surface Arctic Ocean, drastically changing the temperature, storm, and ice regimes, as well as conditions for life. The objective of this project is to track such changes in the physical, biological and geochemical properties of Canadian Arctic waters. In the past, we have deployed ocean observatories in Hudson Bay, Hudson Strait, Baffin Bay, Beaufort Sea and the Eastern Arctic Ocean. These observatories are the oceanic equivalent of atmospheric meteorological stations. They are deployed every fall and recovered one year later. While moored, they record temperature, salinity, water velocity, dissolved oxygen, nutrients, light intensity, fluorescence (an indicator of micro-algae biomass), the vertical flux of particles, and ice motion. In addition, hydrophones record the vocalization of whales and other marine mammals. The data is used to describe seasonal, annual and interannual variations in the Arctic environment and its local ecosystems. This, in turn, enables us to understand how global warming is affecting the Arctic and how fast.

Barber, David (University of Manitoba)
Project 3.6 The Role of Sea-Ice in ArcticNet IRISes *(Sea-Ice)*. Contributes to all 4 IRISes.

The observed decline in the summer sea ice, in terms of both magnitude and trend, is alarming. We are changing the arctic from one that has been dominated by multiyear sea ice to one that will now be dominated by first-year sea-icerelated processes. We can expect a seasonally ice free arctic early in this century. It is important to note that our planet has not had a seasonally ice-free Arctic for at least the past 1.1 million years. This

reduction in sea ice is of critical importance to all peoples of the world because of the role that the Arctic plays in the ventilation of the Atlantic and Pacific (Carmack et al. 2006) and because of the large effect that the sea ice albedo-feedback mechanism has on acceleration of warming and increased fluxes of green house gases to the atmosphere (due to permafrost melt). Both flora and fauna have evolved over millions of years to take advantage of the presence and timing of the seasonal sea ice life cycle. Now, northern peoples increasingly are finding their traditional way of life under pressure from these changes as they struggle to adapt. Global warming changes both dynamic and thermodynamic processes of snowcovered sea ice and these changes have an impact throughout both the physical and biogeochemical cycling in the Arctic marine system. The next few decades will proceed with significant challenges for the Arctic. Marine ecosystems will come under increasing pressure; industrial activity will increase as more exploration and development occurs; and the Inuit people will increasingly find it a challenge to use sea ice for cultural and subsistence purposes. This project will provide sea ice expertise to the coordinated ArcticNet IRISs of the coastal Canadian Arctic, supplying the required information for sound management of these challenges.

Ford, James (McGill University)
Project 3.7 Climate Change and Food Security in Regional Inuit Centers *(Food Security)*. Contributes to all 4 IRISes.

Food insecurity is a chronic problem affecting many Inuit communities and is likely to predispose Inuit food systems to the negative effects of climate change. Using in-depth case studies, this project will identify and characterize the vulnerability of food systems in four regional Inuit centers (RIC) (Iqaluit, Arviat, Inuvik and Kuujuuak) to climate change as a basis for identifying adaptation entry points. Thus far, the majority of work on this issue has focused on more traditional or isolated northern communities thought to have a larger dependence on country/traditional food items. Largely unexamined, but critically important in the public health context, is the vulnerability of RICs, which is a major research gap given their rapid economic and population growth and increasing size of their food insecure population. The work will specifically focus on the food security of at-risk populations within RICs in a changing climate, defined to include individuals who use community food programs on a regular basis and who by definition experience chronic food insecurity, and also other groups identified as being potentially vulnerable in the scholarship (e.g. females, public housing residents, youth). Limited research to-date has explicitly examined the vulnerability of high-risk populations to climate change in a northern Canadian context. To this end, the objectives of this project are structured around 2 phases. Phase 1 aims to: i). document and describe the nature of food insecurity among at-risk populations in RICs, ii). characterize the environmental, biological and socio-economic determinants of food insecurity at various scales; iii). document coping strategies to manage food insecurity, and iv). examine the pathways through which climate change might affect food insecurity for at-risk peoples in RICs. Phase 2 is focused on policy linkages and aims to identify opportunities and priorities for adaptation intervention to enhance food security among high risk populations in the context of rapid

current and future change, working closely with decision makers at multiple levels. The project is working closely with community members, has established partnerships with a number of regional and community organizations, is linking research to policy making at multiple levels, and contributing towards an enhanced understanding of climate vulnerability in all Inuit regions of Canada.

Keeling, Arn (Memorial University of Newfoundland)
Project 3.8 Adaptation, Industrial Development and Arctic Communities *(Industrial Development)*. Contributes to IRIS 1.

This project is engaging in community-based, historical and comparative research into industrial development as a driver of social, cultural and environmental change in the Arctic. In particular, researchers are exploring the cultural, economic and environmental impacts of mineral exploration and development on three Arctic communities, Kugluktuk (Coppermine) in the Kitikmeot region, Qamani' tuaq (Baker Lake) and Kangiqiniq (Rankin Inlet) in the Kivalliq region. A fourth community, Arctic Bay, site of the Nanisiviq mine, has recently been added to the project. Working with community researchers, this project intends to identify issues of importance in relation to mining development and community change, and to explore community adaptations to the changes brought by industry. Researchers have collected extensive archival records relating to the history of industrial development in the Arctic, and will relate this history to changing government social and economic policies in the region, such as Inuit resettlement.

This research seeks to understand how current debates and controversies over mining development reflect Inuit experiences and traditional knowledge of previous developments. This project will also contribute to the building of both northern and southern research capacity, by providing research experiences for graduate students, postdoctoral researchers and community members. In addition, through conferences, workshops and joint publications with European researchers and other Canadian research networks, this project is developing an international network of scholars interested in environmental, economic and cultural change in the circumpolar Arctic. The result provide a locally relevant, community record of this knowledge and history, as well as information useful for communities and policy makers in assessing the potential benefits and impacts of current development proposals.

Lasserre, Frédéric (Université Laval)
Project 3.9 Climate Change and Commercial Shipping Development in the Arctic *(Commercial Shipping)*. Contributes to all 4 IRISes.

The Arctic ice is receding, as ice extent in the summer is decreasing fast, faster than models predicted. The perspective of an ice-free Arctic in the summer is looming, with talks of riches to be exploited (oil, gas, minerals) and seaways developing across it between Europe and Asia. The perspective of a dramatic development in Arctic shipping triggered the debate in Canada as to how to assert Canada's sovereignty so as to protect

the environment. But is shipping really going to develop this fast ? What segments of the shipping industry could be interested in plying a seasonal, poorly mapped, unserviced northern route ? Will containerized cargo liners between Europe and Asia rush to the route ? The weak development of shipping in the region, despite several years of talks about the perspective of the opening of the Northwest and Northeast Passages, attest to the complexity of the question. Although some segments of the shipping industry might be interested in developing new routes across the Arctic, not all will be: what will then be the speed and shape of shipping development in the region ?

IRIS 4 Research (Eastern sub-Arctic)

The Eastern Subarctic IRIS encompasses the Inuit territories of Nunavik (northern Quebec) and Nunatsiavut (northern Labrador). Both territories have a form of self-government that is evolving towards greater autonomy. Population size is about 10800 residents in Nunavik and 10550 in Nunatsiavut. Demographic growth from 2001 to 2006 was very high in Nunavik at 10.4 % while the population of Nunatsiavut was decreasing at a rate of -6.0 %.
The region is bounded by seas on three sides (Hudson Bay to the west, Hudson Strait and Ungava Bay to the north, and the Labrador Sea to the east). This geography results in a continental-type climate with higher precipitation, particularly snow, than at similar latitudes west of Hudson Bay. The region lies totally within the Canadian Shield. Highest elevations are in the Torngat mountains along the boundary between Nunavik and Nunatsiavut, where the only glaciers east of the Rockies are found in continental Canada. Both transitions from forest to tundra and from discontinuous to continuous permafrost occur across the region.
The climate of the region has been warming rapidly since the early 1990s and models project an increase of temperatures by 3-4°C and precipitations by 10 to 25% for the middle of the century relative to the 1960-1990 period. Current climate change already impacts the thermal regime of permafrost and the dynamics of the active layer. A 2°C temperature increase 4 m deep over the whole territory, affects transportation infrastructures and communities. Stakeholders support ongoing research targeted at improved land planning and technical solutions for adaptation. Thaw lakes are forming in great numbers in areas of ice-rich, fine-grained soils and wetlands, with a feedback on the generation of greenhouses gases. Changes in vegetation cover are reported both by Inuit and researchers. Shrubs, particularly, are expanding in the forest-tundra. Trees, mostly larch in the eastern Ungava bay region, are extending the tree-line upwards on hillsides. Expected impacts on key animal resources such as the large caribou herds and the Arctic charr populations will likely be through a series of complex interactions between climate factors, food availability, vegetation dynamics, water temperature, ice cover duration and thickness on lakes, population dynamics, herbivory and predator-prey relationships. Therefore, adaptation processes for humans living on these resources will require multiple approaches over the geographical domain.

Leader: Michel Allard
Coordinator: Mickaël Lemay

Projects and Project Leader(s):

Chan, Laurie (University of Northern British Columbia); Furgal, Chris (Trent University)
Project 4.1 Food Security, Ice, Climate and Community Health: Climate Change Impacts on Traditional Food Security in Canadian Inuit Communities *(Community Health)*.
Contributes to IRISes 1 & 2.

Traditional/country foods are critical resources for physical, as well as mental, social and economic health of individuals and communities across the Arctic. Despite this, shifts in

traditional/country food consumption have been taking place over the past 15 – 20 years related to a variety of changes in northern ecological, social, political and economic systems. Those related to ecological shifts have been in part previously associated with reduced confidence in food safety due to identified threats from environmental contaminants such as mercury and PCBs, and more recently the changes in species availability and accessibility due to shifting climatic conditions. Specifically, climate related changes and variability in the North have been associated with changes in animal, fish and plant population health and distribution, while changes in ice, snow, precipitation regimes, and other environmental factors have the potential to influence human travel and transportation in the North, and thus Inuit access to these wildlife resources. As such, climate change and variability has the potential to influence nutrition and health status among Inuit via impacts on aspects (availability, accessibility and quality) of traditional/country food security. Earlier phases of this project both positive and negative changes in the traditional/country food harvest of five Inuit communities were reported in relation to changes and variability in climatic conditions. It was documented that environmental changes are already having impacts on both the availability of wildlife species and hunters' access to them in all regions studied. In some regions, Inuit have reported some influence of climate and environmental change on wildlife access and availability in comparison with the same hunting season in previous years. However, the impacts are not homogenous among all hunters and communities and both individuals and households show differential ability to adapt successfully. Factors such as access to economic resources and equipment, experience, and the nature of the adaptive strategy used appear to influence the success of hunter adaptations. Yet, our current commonly used assessment toos looking at household food insecurity in Inuit regions do not represent this complexity well. As a result, we have decreasing confidence in the accuracy of results from these tools in capturing the full nature of the reality of Inuit food issues. This project studies these issues through a variety of sub projects at the national, regional and community level including: a more holistic characterization of the Inuit food system through mixed quantitative-qualitative modeling approaches; methods to link and reconcile the contradictions between wildlife management and household food access; the review and development of new rapid assessment tools; the support of community-led food assessment processes and the development, implementation and evaluation of community-led interventions; the characterization of household food "needs" and the impact of access to community food support mechanisms, such as community freezers, in addressing these needs.

Power, Michael (University of Waterloo); Furgal, Chris (Trent University)
Project 4.2 Growth Variability and Mercury Tissue Concentration in Anadromous Arctic Charr *(Arctic Charr)*. Contributes to IRISes 1 & 2.

The project was designed to build on prior work that examined probable climate change related growth and contaminant impacts on land-locked populations of Arctic charr by extending the analysis to include important migratory and land-locked populations of Dolly Varden Charr in the Yukon Territory. There is a notable lack of data dor Dolly Varden charr, despite the importance of the species as a country food resource. Here we plan to use existing archival tissue samples to construct an historical spatial baseline for

THg levels in Dolly Varden charr against which contemporary data can be compared to examine the impacts of climate change and development activities on current THg levels. Work will also be extended to include comparative examination of Dolly Varden charr in the Beaufort and a determination of where and how they function in Beaufort Sea foodwebs likely to be affected by oil and gas exploration activities. The project will also continue important partnering work begun with Nunavik Research to examine the marine life-history phase of Ungava Arctic charr introduced into a previously unoccupied river system. Previously PIT-tagged fish have begun to return in numbers and we are now able to estimate annualized marine growth and compare that growth to monitored water temperatures as a means of estimating site-specific growth temperature relationships using oxygen stable isotope methods. Obtained field results are compared to data gathered in Labrador through collaborations with Fisheries and Oceans Canada. Results and comparisons are critical for assessing the possible impacts of climate change Nunavik Arctic charr and understanding how overall availability of Arctic charr will respond to predicted climate changes. To further improve conceptual understanding of temperature-growth affects location-temperature tags will be inserted into Arctic charr and monitored via acoustic receivers to track temperature use in both the marine and freshwater environments. In concert with growth studies, the project has been monitoring the ecological impacts of Arctic charr introductions and found them to be negligible. This effort represents the first attempt to scientifically evaluate the consequences of northern ecosystem manipulation and has provided important data and insights for management purposes by showing it is possible to proactively manage Arctic charr stocks with minimal ecological consequences. Finally work continues on genetic typing of Arctic charr populations to improve our understanding of how climate change may impact the immunological capabilities of Arctic charr and their abilities to deal with new diseases and pathogens likely to be introduced into northern environments as a result of changing environmental conditions. All study generated information will contribute to the improvement of management abilities to make informed decisions about the risks associated with continued country food consumption in the face of changing conditions in the Arctic. The project also identifies key environmental indicators of changes in Arctic Char (Salvelinus alpinus) growth using both quantitative (ecological) and qualitative (Indigenous Knowledge) data by linking community-based monitoring, local expert Indigenous and ecological knowledge. Arctic Char is a staple subsistence resource for Inuvialuit on Banks and Victoria Islands in the Northwest Territories, Canada. In recent years, significant climate variability and change has been observed in the area, raising local concerns about how this variability will affect subsistence resources. Residents in local communities are the first to directly observe and report these changes and variability in local climate and the effects they have on their land, water and animals. Centuries of knowledge and observations about the environment and natural resources exist among Inuvialuit hunters and fishers. Local expert Indigenous Knowledge (IK) can complement our scientific understanding of environmental variability and change and its effects on Arctic species. Community-based monitoring (CBM) provides an opportunity to better understand the current status of Arctic species and can form the basis for understanding and preparing for future changes in Arctic species in light of projected climate variability and change. Using a mixed-methods research approach is one way in which ecological scientific and Traditional Knowledge can be brought together to

complement one another and provide a more thorough understanding of northern fish species in a changing environment.
Dewailly, Éric (Université Laval)
Project 4.3 Country Foods *Health* Benefits in a Changing Canadian Arctic *(Health Benefits)*. Contributes to all 4 IRISes.

To survive in the Arctic, Inuit had for centuries to rely on fish, mammals and some plants such as wild berries and seaweeds. However, since the 1990's, the consumption of country food has decreased markedly, and the rapid food transition towards a western diet has led to excessive intake of carbohydrate, salt and trans-fatty acids. Global environmental changes also affect Inuit dietary patterns in many ways including the availability of local animal and plant species and/or environmental contaminants.

Once thought to be protected from diabetes and cardiovascular diseases, the current dietary and lifestyle transitions combined to the severe food insecurity context occurring in the Inuit population of Nunavik may change the situation in the near future.

The traditional country food diet in Nunavik is very rich in key protective nutrients such as omega-3 polyunsaturated fatty acids and selenium. Wild berries, seaweed and other plants found in Nunavik may also provide plant-derived nutrients and secondary metabolites that also offer unique potential for the prevention or treatment of metabolic disease and associated cardiovascular complications and to offset some deleterious effects of environmental contaminants exposures. Moreover, specific proteins found in marine country food may contribute to beneficial actions on insulin sensitivity, lipid metabolism and inflammation.

With a better understanding of the overall benefits of nutrients present in the different country foods consumed in Nunavik, we can better develop community-based interventions aiming to improve country food consumption and food security, promote Inuit culture and youth empowerment, minimize the risks from environmental contaminant exposure and the emergence of obesity, diabetes and cardiovascular diseases in this population and across the Arctic.

Allard, Michel (Université Laval); Pollard, Wayne (McGill University)
Project 4.4 Permafrost and Climate Change in Northern Coastal Canada *(Permafrost)*. Contributes to all 4 IRISes.

This project analyzes how permafrost, or permanently frozen ground, responds to the changing climate. Permafrost is the foundation upon which northern ecosystems and communities rest and upon which infrastructure is built. The impact of thawing permafrost is often a function of how much ice is found below the ground surface, so an important component of the project is devoted to mapping ground ice amounts and distribution under landscapes, particularly in sensitive areas such as Inuit communities

and under existing and planned infrastructure. The study of ground ice in the permafrost requires knowledge of surficial geology, periglacial landforms and the heritage of past climate conditions and geological processes; it is done with a variety of techniques which include remote sensing, drilling, laboratory analyses, geocryological characterization and GIS applications. Ultimately an assessment of ground ice at a much better resolution that what currently exists will have to be made to support the development and the environmental safeguard of the Arctic. This project already makes important progresses toward that goal. As a physical component of ecosystems, the sensitivity of permafrost is regulated by numerous factors, including air and soil temperatures, snow cover, surface and subsurface hydrology, organic soil layers, vegetation and snow cover, all factors that are regulated by the climate and affected by change. In this project, changes to the landscape as a result of the changing permafrost temperatures are monitored, including the development of landforms such as landslides, changes in vegetation patterns, modification of drainage patterns, coastal erosion, release of carbon and production of greenhouse gases. In 2013, our research covered those topics, both as fundamental and applied research at many key sites across the Arctic, particularly in southern Baffin island (Hall Peninsula potential mining area and Iqaluit airport), Bylot Island (thermo-erosion and ecological changes), Ward Hunt island (water tracks and ecology), Eureka (massive ground ice, ice wedges and landslides), Hershel island (massive ground ice and coastal erosion), Beaver Creek (Alaska Highway), Salluit (road engineering and ecosystem respiration) and Umiujaq (snow-vegetation-permafrost dynamics). Our mapping and predictions of ground temperature changes in Arctic communities are used to formulate adaptation strategies and for planning land management. The project also incorporates a major education and outreach initiative for training Inuit community managers on permafrost principles and for producing innovative computer-based pedagogical material for schools for training the upcoming generation.

Côté, Steeve (Université Laval)
Project 4.5 Population Dynamics of Migratory Caribou in Nunavik/Nunatsiavut *(Caribou)*.

Migratory caribou are central to the economy and traditional life of northern peoples. They are also economically important for a major outfitting industry, much of it involving Aboriginals. Scientific and Aboriginal Traditional Knowledge, however, indicate that populations of migratory caribou undergo drastic changes over several decades. Caribou herds are declining almost everywhere in Canada, and the factors responsible for those declines are poorly known. Caribou also face threats from expanding resource-extraction industries, and this will continue to increase with the development of the North, and from climate change. Through the cooperation of government agencies, Aboriginal groups and industry partners we are combining existing long-term data, population genetics studies, monitoring of known-age caribou with satellite collars, satellite-derived information on plant productivity and small-scale climate manipulations to establish how climate and population density affect the food resources of caribou, their habitat use, choice of calving site, body growth and condition, recruitment and age-specific survival. These are the most important factors currently thought to affect caribou abundance and distribution in the Arctic. We are also addressing

the effects of industrial activities on caribou ecology and quantifying the impact of caribou on vegetation in key seasonal ranges. In addition to identifying the factors responsible for changes in population density and distribution, our work will provide managers and Aboriginal Peoples with new tools to monitor the demography of caribou and therefore improve their conservation in the face of climate change.

Bell, Trevor (Memorial University of Newfoundland); Sheldon, Tom (Nunatsiavut Department of Lands and Natural Resources)
Project 4.6 Understanding and Responding to the Effects of Climate Change and Modernization in Nunatsiavut *(Nunatsiavut Nuluak)*

Nunatsiavut Nuluak is addressing Inuit concerns about the impacts of climate change, modernization and contaminants on the health of marine ecosystems and communities of Northern Labrador. The overarching goal is to provide meaningful and timely research on regionally identified priorities while involving Inuit and Inuit Knowledge in all aspects of the project. The first cycle of research activity focused on data collection throughout northern Labrador, with an emphasis on fjord ecology and marine systems along the north coast. In ArcticNet's second cycle the project is concentrated on coastal regions that are, or in the future may be, subject to the dual stressors of climate change and industrial activities. Specifically, Phase III field activities focus on Lake Melville, an estuary downstream from a sanctioned hydroelectric development. The research program, officially called *Lake Melville: Avativut, Kanuittailinnivut* (Our Environment, Our Health), is establishing baseline conditions for Inuit health, community wellbeing and ecosystem integrity prior to industrial hydroelectric development upstream of Inuit territory. It is also developing the science for monitoring the effects of industrial activity on subarctic estuaries and coastal Inuit communities in the context of ongoing climate change impacts.

Dewailly, Éric (Université Laval)
Project 4.7 International Inuit Cohort Study: Developing the Next Phase *(Inuit Health Cohort)*. Contributes to all 4 IRISes.

The International Inuit Cohort was born from an international collaborative effort to gather pertinent data from Inuit circumpolar populations in order to show differences and trends in this population. This cohort study addresses long-standing questions with respect to Inuit health research. Many studies among Inuit populations are limited by a lack of statistical power, weak external validity and absence of temporal links and causality between disease and potential aetiologic factors. Indeed, the small size of communities (between 50 and 5000) living in different regions of the Arctic limits the use of epidemiological studies to determine rates of health outcomes. This initiative is based on three different companion studies conducted among Inuit adults in Canada and Greenland. Each study has a cross-sectional and a longitudinal component. The protocols used were developed in close collaboration and are very similar.

The baseline survey was carried out among adults (≥18 years) with Inuit/Yupik ancestry from across each circumpolar region. From 2004 to 2010, a total of 6223 participants (929 from Nunavik; 2835 from Greenland; 2459 from Nunavut, Inuvialuit and Nunatsiavut) participated in a 3-4 hours session with an English/Inuktittut questionnaire to ascertain a range of various lifestyle habits and health outcomes. All subjects participated in a medical and para-clinical examination and had a blood sample drawn.
The project includes case studies in all four of the ArcticNet IRIS regions. It deals with all aspects of the Cohort, including its constitution as a databank and all activities to further gather data to augment the databank. It builds on previous work on the vulnerabilities of Arctic communities, and it is feasible because of established collaborations with northern people and organizations. The project documents the changing physical, biological and socioeconomic conditions that are affecting people across the circumpolar North and identifies policies and strategies to assist communities in dealing with these changes.

Nickels, Scot (Inuit Tapiriit Kanatami)
Project 4.8 Enabling the coproduction of Inuit and Science knowledge through integrated information management (Inuit Knowledge)

There is a growing need for knowledge sharing and coproduction among Inuit and Northern researchers as the Arctic continues to experience rapid and unprecedented changes and there is a plethora of new information and data becoming available. Initiatives such as the International Polar Year and ArcticNet have allowed for an enormous increase in Arctic research resulting in the production of large amounts of new information and data that are important for Inuit. Led by Inuit Qaujisarvingat: Inuit Knowledge Centre (IQ), the research centre at Inuit Tapiriit Kanatami (ITK), the goal of this project is to develop and maintain an Inuit-specific integrated information management system (IIMS) that supports the ethical collection, discovery, preservation and use of Inuit knowledge and provide access to this information. This project would first identify Inuit needs for environmental, cultural, socio-economic, human health, and other data as well as requirements to develop new ways to manage, interact and share information. Members of the team will consult, develop options, and implement them to meet the needs of all stakeholders (including Northern researchers and Inuit). Feedback from partners, including the Inuit Qaujisarvingat National Committee (IQNC), along with ethical and technical considerations will drive decisions on selection of processes, informational needs, methodologies, and the design of tools. Recognizing that information resources are available from a wide range of sources and locations, and that establishing a ‘central repository’ may be neither desirable nor feasible because of the dispersed nature of Inuit communities and regional initiatives, we will focus on building a distributed model with interoperability at its core. IQ will initially focus on: (1) Procedural tools, (2) Database of funded Arctic research projects, and (3) Data sets including Bibliographic Databases, Inuit Health Data, Local Environmental Knowledge Data. These are areas identified as priorities by the IQNC, are in keeping with the interests of ArcticNet’s mandate, address the priorities of Canada’s Northern Strategy, and connect Inuit interests at the community, regional, national, and international level. Success measures for this project would be the development of an appropriate platform

for the preservation, curation, and sharing of information about Inuit and the Arctic for Inuit, northern researchers, educators, policy- and decision- makers at the community, regional, national and international levels. The development of this IIMS will give Inuit and Northern researchers in Canada and abroad the appropriate levels of data and information required to prepare for the changes to their world. Further, Inuit and Northern researchers will be brought together through the co-production of new and clearly articulated knowledge and processes to access and share information as well as through the production and use of new online tools and communication networks that would grow throughout and beyond the duration of ArcticNet.

Furgal, Chris (Trent University); Sheldon, Tom (Nunatsiavut Government)
Project 4.9 Inuit Knowledge and Geospatial Ontologies in Nunatsiavut *(Inuit Knowledge).*

There is an urgent need to document and share the extensive and valuable knowledge held by Inuit Elders and other Inuit experts with local Arctic decision makers, younger generations, and with members of the scientific community to better to understand pressures on and changes in these systems. In the context of ongoing and impending new development, there is a need to capture and communicate changes in Inuit Knowledge (IK) and use of the land. Geographic Information Systems (GIS) and other spatial data organization and representation technologies have been used for a variety of applications for, with, and by Indigenous groups in recent decades (e.g. land use planning, natural resource management, land claims negotiations, documentation and transmission of IK to younger generations). Processes such as Participatory GIS (PGIS) and the development of geospatial ontologies methods of capturing and representing Indigenous conceptualizations of spatial phenomenon can be empowering and create useful tools to illustrate and communicate IK and concepts of the environments. When focused on current important cases, such as Inuit Knowledge of key species undergoing dramatic change (e.g. caribou), or land use mapping of currently changing, or threatened areas (e.g. lands likely to be impacted by industrial development) efforts of this nature have the potential to create tools that can support local decisions about the environment and its resources, in ways that better reflect local understandings and cultures. This project is conducting a geospatial ontology exercise with expert knowledge holders in the Nunatsiavut Settlement Area. The long term goal is the development of a geospatial ontology application and interface that complements existing GIS for use in land use planning, environment and development decision-making as well as Nunatsiavummiut Knowledge (NK) representation and transmission to a variety of audiences. This project is a partnership between the Nunatsiavut Government (NG), local knowledge holders and University based researchers. The short term results are expected to provide representations of NK on key issues in support of decision making needs around land and development in the region while the longer term results are expected to provide evidence for a different and potentially more culturally-specific way of accessing and using Inuit Knowledge in decisions about land and landscape in Nunatsiavut and other Inuit regions.

Annex 3. Summary of Projects under the Beaufort Regional Environmental Assessment Program (BREA)

The Beaufort Regional Environment Assessment is a multi-stakeholder initiative that provides an opportunity for Inuvialuit communities, industry, federal and territorial governments, academia and regulators to prepare for oil and gas activity in the Beaufort Sea by building a regional socio-economic and scientific knowledge base that: fills regional information and data gaps related to offshore oil and gas activities; as well as supports efficient and effective regulatory decision making.

BREA consists of a research program and multiple working group activities to address priority issues in the region. Twenty-three research projects have been funded, based on priorities identified in earlier analyses (Environmental Studies Research Fund Report #163 and a 2011 Data Mining Report prepared by ArcticNet for Aboriginal Affairs and Northern Development Canada) and subsequently refined collaboratively through multi-stakeholder committees. All projects were selected based on their relevance to the priority research areas, as well as their contribution to regulatory efficiency and community preparedness, the two primary goals of BREA.

Separate working groups are addressing issues related to climate change, cumulative effects, information management, oil spill preparedness and response, social, cultural and economic indicators, and waste management.

The following provides a description of BREA research projects from the period between April 1, 2013 and March 31, 2015.

Active Acoustic Mapping of Fish in the Beaufort Sea, 2011-2013
Louis Fortier (ArcticNet)

This cutting-edge project, led by ArcticNet, uses state-of-the-art fisheries sonar technology to map the distribution and abundance of Arctic Cod and other fish in the offshore Beaufort Sea during the summer months. Arctic Cod is the main food source for seals, whales and birds in the Beaufort Sea Region and this study will be important to supplement existing research into the winter distribution patterns of Arctic Cod.

Fishes, Habitats and Ecosystem Linkages to Oil and Gas Development in the Beaufort Sea, 2011-2015
Jim Reist (Fisheries and Oceans Canada)

Fisheries and Oceans Canada, in collaboration with six Inuvialuit communities, are conducting a four-year study that will include a fishing survey in deeper waters (100 - 1000 m) of the outer continental shelf as well as slope areas of the Beaufort Sea. Researchers are studying both bottom-dwelling and mid-water fish species, documenting

the size of their populations, habitats, diets, roles in the food chain and migratory patterns – something which has never been done before. Increased understanding of the ecosystems on which fish species depend will support environmental assessments and sound decision making regarding fish habitat and offshore oil and gas activities.

Baselines, accumulation, cycling and potential effects of hydrocarbons in Beaufort sediments and biota, 2012-2014
Gary Stern (University of Manitoba)

The purpose of this project is threefold: (i) to establish the background levels of hydrocarbons in sediment, zooplankton, benthic invertebrates and fish, (ii) to establish baseline concentrations of hydrocarbon metabolites in fish, and (iii) to establish background values for indicators of fish health against which the magnitude and extent of potential environmental perturbations can be assessed.

Southern and Northeastern Beaufort Sea Marine Observatories, 2011-2014
Martin Fortier (ArcticNet)

This initiative is establishing three oceanographic observatories, each composed of two moorings, to collect year-round marine observations of the Beaufort Sea using state-of-the-art instruments, including Doppler current meters, sediment traps, ice-profiling sonars, conductivity-temperature sensors and turbidity meters. Researchers are monitoring and interpreting the information generated on sea ice, ocean circulation and biogeochemical fluctuations throughout the region. The four-year project, led by ArcticNet and IMG-Golder (an Inuit-owned environmental and engineering company), is collecting data to gauge the physical conditions and variability of the Canadian Beaufort Sea year over year. This information will provide previously unavailable scientific evidence of oceanic and sea ice conditions, enabling regulators to make informed decisions about potential environmental effects of exploration drilling in the Beaufort Sea.

Forecasting Extreme Weather and Ocean Conditions in the Beaufort Sea, 2011-2015
Fraser Davidson (Fisheries and Oceans Canada)

Drilling operations in the Beaufort Sea are increasingly focused on the shelf break between the deep and shallow parts of the Sea – an area characterized by extreme weather events, ocean currents and waves. This research will develop and implement an integrated ocean-wave-ice-atmosphere prediction system to forecast the changing marine weather, sea ice and ocean conditions. This invaluable information will support the Global Maritime Distress Safety System's warnings and information services for the Arctic. It will be equally vital to oil and gas exploration and development by providing forecasts that will inform operations in the Beaufort Sea.

Seasonal Forecasting of Ocean and Ice Conditions in the Beaufort Sea, 2011-2015
Gregory Flato (Environment Canada)

Predicting the weather days in advance is standard fare in most parts of the country. But for oil and gas companies considering exploration and drilling activities in the Arctic, anticipating weather conditions over the coming year is extremely important. This project, led by Environment Canada, is creating a high-resolution forecasting system capable of predicting ocean and sea-ice conditions in the Beaufort Sea region from one to twelve months in advance. The research is providing enhanced regional detail in operational seasonal predictions and contributes directly to the development of improved climate prediction products. This will serve both regulators' and industry's operational needs, now and in the future.

Modeling of Freshwater Flows to the Beaufort Sea for Improved Offshore Prediction by the Metarea Ocean Forecast System, 2012-2015
Philip Marsh (Wilfrid Laurier University)

With potential development in the Beaufort Sea offshore, there is a need to implement an operational ocean-ice-atmosphere (OIA) model that includes the Beaufort Sea in order to plan and carry out development in this area in a sustainable fashion. Consideration of the complex interactions of the Mackenzie Delta and Beaufort Sea is necessary in the development and implementation of CONCEPTS robust OIA model. This study is building on activities funded under the International Polar Year and the Program for Energy Research and Development and is developing a hydraulic model of the Mackenzie Delta and link this model to the CONCEPTS OIA model under development by Environment Canada and Fisheries and Oceans Canada. These linked models will be used to consider the interactions of the Mackenzie Delta - Beaufort Sea under both open water and ice covered conditions.

CanICE – A Sea Ice Information Database and Web-Based Portal, 2011-2014
Lina Assad (Environment Canada)

Sea ice exerts important seasonal effects on weather and climate, marine ecosystems, the safety of marine transportation, northern communities and offshore resource development and exploitation. Whether preparing policy or regulations, assessing the impacts of activities on ecosystems, designing sustainable infrastructure, or planning and conducting safe and secure shipping, information about sea ice conditions is vital given the variable and harsh Arctic marine environment. Environment Canada, in partnership with several universities, is creating a publically accessible database that captures existing information on BREA-relevant sea ice features including extent, concentration, type, characteristics and extreme ice hazards. Access to the database will be through the Polar Data Catalogue. The quality-controlled interoperable database will enable online, open access to historical and current sea ice information and will allow others with sea ice information to add data to this central information source.

Deep Water Seabed Geohazards, 2011-2015
Steve Blasco (Natural Resources Canada)

Oil and gas exploration in the deep waters of the Beaufort Sea requires knowledge of seabed stability conditions to ensure safe drilling practices. Under this initiative, the Geological Survey of Canada will conduct a regional assessment of seabed instability conditions, such as mud volcanoes, gas vents and faults, subsea permafrost and the severity of these geohazards. Seabed geohazard research provides baseline knowledge in support of spill prevention and contributes to the preservation of the marine ecosystem and protection of renewable resources. Research findings from this regional assessment will be essential for environmental impact assessments and will support informed decision making in the development of an effective regulatory regime.

Quantifying Sea Ice Dynamics in the Beaufort Sea, 2012-2015
Chris Derksen (University of Waterloo)

Sea ice within the Beaufort Sea region circulates according to the predominantly anti-cyclonic Beaufort Gyre, but very little quantitative information about sea ice motion exists. This project is deriving sea ice motion products for the Beaufort Sea region using the Canadian Ice Service's (CIS) operational archive of RADARSAT-1 and RADARSAT-2 imagery and Environment Canada's new sea ice motion tracking algorithm. The results of this analysis will establish a baseline sea ice motion dataset which can be used to plan and support future offshore operations. Results will also provide BREA with information on regional changes in sea ice dynamics that have occurred within the context of changes in the sea ice regime of the Beaufort Sea region during recent decades, marked by pronounced warming trends in the region. In addition, the ice motion products will serve as validation for a new state-of-the-art atmosphere-ice-ocean model for operational sea ice forecasting in the Beaufort Sea, currently under development at Environment Canada.

Characterizing Deformed Multi-Year Ice in the Beaufort Sea, 2011-2015
Michelle Johnston (National Research Council)

Although there is growing evidence that the polar pack is decreasing in extent and thickness, icebergs, ice islands and thick, deformed multi-year ice continue to pose a hazard. This project, led by the National Research Council of Canada (NRC), is describing the thickness and strength of extreme ice features in the Beaufort Sea at ice depths (up to 12 m) where no information currently exists. The research will provide information needed to better engineer structures to withstand the impacts of deformed multi-year ice. Increased knowledge of dangerous ice features will also enhance the decision making capacity of regulators and industry.

Distribution and Thickness of Different Sea Ice Types and Extreme Ice Features in the Beaufort Sea, 2011-2015
Christian Haas (York University)

Among the most serious challenges to operating in the Beaufort Sea are widely varying sea ice types and severe ice conditions. This project is using electromagnetic surveys and drift beacons to perform large-scale airborne ice thickness surveys to quantify the thickness and regional distribution of multi-year ice and extreme ice features in the Southern Beaufort Sea. The results of this research will improve understanding of how sea ice moves in response to winds and currents, and will contribute to the development of tools to predict ice drift. Being prepared for any and all eventualities is one of the realities facing regulators and industry contemplating offshore oil and gas exploration and drilling.

Radarsat Mapping of Extreme Ice Features in the Southern Beaufort Sea, 2011-2015
David Barber (University of Manitoba)

There is growing global interest in marine shipping and oil and gas development in the Southern Beaufort Sea as ice cover in Arctic waters diminishes over the summer months. However, hazardous ice remains a risk to industrial operations in the region. This research is providing regionally relevant information on extreme ice features along the northwestern flank of the Canadian Arctic Archipelago. The University of Manitoba is leading a team of investigators that is using Radarsat technology to detect, monitor and eventually model the distribution and motion of hazardous ice features and their movement over significant oil and gas exploration licences in the area. This scientific knowledge will be married with information collected by local residents participating in a new community-based pilot program to monitor sea ice thickness.

Regional Synthesis of Coastal Geoscience for Management of Beaufort Oil and Gas Activity, 2012-2014
Dustin Whalen (National Research Council)

The purpose of this project is to provide an inventory of existing knowledge pertaining to regional scale coastal processes affecting the siting, planning and management of coastal infrastructure (from the Alaska/Yukon border to Cape Dalhousie) in support of Beaufort Sea oil and gas activity.

Regional Coastal Monitoring in the Inuvialuit Settlement Region: Ecosystem Indicators, 2012-2015
Vic Gillman / Frank Pokiak (Fisheries Joint Management Committee / Inuvialuit Game Council)

This project is building a baseline understanding of ecosystem structure and function of the Beaufort Sea coastal food web. The project uses food-web biomarkers at a regional scale that captures both estuarine and marine coastal ecosystems in the Inuvialuit Settlement Region. Community relevant coastal programs have been developed to focus on key valued ecosystem components that include: i) coastal fish; ii) beluga, and iii) their supporting ecosystem (habitat) at harvest/hunt sites for each of the six ISR communities. While species monitored may differ among sites, the methods employ a standardized approach by using common indicators that define trophic interactions.

Annex 4. Summary of Projects Conducted under the Cumulative Impact Monitoring Program

Establishing a watershed framework for assessing cumulative impacts of development
Krista Chin (AANDC)

This project aims to develop a cumulative impact monitoring program for aquatic effects of oil and gas exploration in the Sahtu region, in particular, for watersheds draining the eastern foothills of the Mackenzie Mountains. In year 1 of the project, we propose to engage community organizations in the Sahtu (Tulita, Norman Wells, Fort Good Hope) to understand their concerns and perspectives on monitoring and changes to the landscape and evaluating impacts to water resources. We will also work closely with AANDC inspectors and the Sahtu Land and Water board to ensure that research and monitoring questions and study design address key regulatory issues. Through partnership with the Sahtu Renewable Resources Board (SRRB) we will ensure appropriate and coordinated engagement of the RRCs by using and supporting existing knowledge sharing venues. Capacity building and RRC engagement in this work will also be coordinated through the SRRB. The project team will also ensure that efforts are coordinated and complimentary with other ongoing research and monitoring initiatives through CIMP and SRRB, and by keeping contact with regulatory and industry representatives.

A multi-scale assessment of cumulative impacts in the Northern Mackenzie basin
Claire Marchildon (AANDC)

The Northern Mackenzie Basin is an area of enormous ecological and cultural significance that is changing in response to more frequent disturbances (natural and human-caused), and regional temperature increases. These changes are impacting priority valued ecosystem components (VCs). Disturbances like fire, seismic activity, and road construction affect vegetation structure, altering the quality and distribution of caribou habitat. Permafrost disturbances like thaw slumping can increase nutrient and sediment fluxes to lakes and streams, impacting water quality and fish habitat. At present, the cumulative effect of all of these disturbances is extremely poorly understood. For planners and decision makers to deal with this uncertainty, research on the impacts of disturbance needs to be combined with regional-scale data on their extent and location.

In this project, we will combine remote sensing data with field observations to document the extent and cause of changes occurring between 1985 and 2012. Examples of these changes that will be examined include: drained lakes, thaw slumps, tundra fires, tall shrub expansion, ice wedge degradation, mud sumps, seismic trails, roads, gravel pads, airstrips, etc.). In the long-term (2014-2015) our goal is to use this data to develop predictive models that can be used to explore how ongoing changes will impact the ecosystems of the northern Mackenzie.

Arctic Borderlands Co-op: Community based ecological and cumulative impacts and monitoring program
Michael Svoboda (Arctic Borderlands Ecological Knowledge Co-op)

The Co-op is a result of multiple community and government partners coming together to better understand and monitor ecological changes in the MacKenzie Delta region, to the western range of the Porcupine Caribou Herd.. The focus is to meaningfully inform both cumulative impacts frameworks and decision-making within the region. What has transpired has now evolved to a world class model demonstrating how collaborative programs can be effective and productive in the north.

Baseline monitoring of Arctic vegetation and snow changes over the Bathurst caribou habitat using satellite remote sensing and community-based field observations
Wenjun Chen (Canada Centre for Remote Sensing)

Caribou are one of the most important natural resources in Canada's North. Fluctuations in caribou abundance have long concerned northern aboriginal people, many of whom identify themselves as "caribou people". The abundance of caribou is influenced by complex and interacting factors, including habitat, harvest, predators, diseases/parasites, extreme weather and climate change, forest fires, and industrial developments. For example, summer range foliage availability could affect caribou body mass, survival rate, and calf:cow ratio. Winter range and calving ground lichen availability may influence winter weight loss and survival rate, cow milk production, and calf survival rate. Deep snow and delayed melting could hinder caribou spring migration, delay calving, and increase calf mortality. Satellite remote sensing is arguably the most effective technology for monitoring vegetation and snow changes over a large area such as the range of a migratory tundra caribou herd. The proposed study will develop and improve satellite-based methods and products that will enable the systematic monitoring of vegetation and snow changes over the Bathurst caribou habitat. The satellite-based products will be validated, interpreted and improved by the integration of community-based field measurements and knowledge. Over the study period, the study will create geospatial products that identify and characterize the seasonal and long-term foliage availability over the calving grounds and the summer range, the percent cover of lichen in the calving ground, the extent of snow cover along the migratory route, and the area of lichen abundant mature forest in the winter range.

CARMA's knowledge to action: developing and testing thresholds and monitoring for cumulative impacts on caribou
Don Russell (CARMA)

The CARMA network has responded to its members and identified as a high priority, developing decision support tools for the assessment, monitoring and mitigation of cumulative effects on migratory tundra caribou. Towards that goal, CARMA has enhanced an existing energy model for caribou to include protein dynamics and to develop generalized relationships for data-poor environments. Further, because climate has a pivotal role in caribou ecology, CARMA has compiled a 32 year climate database for calving, summer, fall, winter, and spring seasons for all herds. While our approaches refer to data, it is important to realize what 'data' means, not just numbers but can incorporate narrative statements (for example, the caribou are really fat) and we can use spatial modeling to readily incorporate aboriginal knowledge of landscapes.

This proposal will employ these tools to develop a monitoring, and mitigation strategy for cumulative effects on migratory tundra caribou, with special emphasis on the Bathurst Caribou Herd

Understanding and predicting fish mercury levels in the Dehcho region using models of bio-magnification and bio-accumulation
George Low (Dehcho First Nations)

We will determine which variables best predict fish Hg levels in lakes in the Dehcho region. Other researchers are studying temporal trends in fish Hg levels, temporal trends in Hg and other variables in sediment cores, transport and delivery of Hg to lakes, and landscape/permafrost change. We will focus on the bioaccumulation and biomagnification of Hg. There are many biomagnification and bioaccumulation processes that decouple Hg levels in water and sediment from Hg levels in fish. We will study these processes, and integrate our results with those of other researchers (Evans, Stern, Carrie, Palmer, Blais, Quinton) and community monitoring projects (KTFN) to determine why fish Hg levels are so variable among lakes, and why Hg levels are increasing in many lakes. Our results will identify critical variables for future cumulative impact monitoring. Decision-makers will use our results to identify possible mitigation strategies (e.g., intensive fishing) for lakes with high fish Hg.

A watershed-scale sampling protocol for accurate distribution and trend assessment of stream salmonids in the Northwest Territories
Neil Mochnacz (DFO)

The goal of this project is to develop a standardized protocol to accurately monitor the distribution and temporal patterns of occurrence of stream salmonids in the NWT. Specific objectives include: 1) determine the suitability of a distributional monitoring approach to accurately document the occupancy of salmonids in northern streams, 2) test the broad-scale applicability of this approach in the NWT, and 3) develop spatial-statistical models to map the distribution of essential salmonid habitat over broad areas and assess impacts to these areas from cumulative stressors.

Monitoring Pacific salmon to understand cumulative impacts of climate change in the Arctic
Karen Dunmall (DFO)

The overall goal of the project is to assess the cumulative impacts of climate change on the Mackenzie River ecosystem by monitoring the distribution of colonizing Pacific salmon, a biological indicator of ecosystem change, and addressing potential competition between Pacific salmon and native chars for spawning habitat. This project addresses the cumulative impacts of climate change, which is affecting Arctic fishes through competition and interaction with colonizing fish species and changes in the physical parameters of the environment. Pacific salmon may demonstrate the cumulative impacts of climate change in the Arctic by increasing their range and abundance in response to changes in the environment. Therefore, we propose to 1) monitor the distribution of Pacific salmon in the Mackenzie River ecosystem through partnerships with local subsistence harvesters; 2) identify potential geographic overlap in spawning areas between Pacific salmon and native chars (i.e., Dolly Varden and Bull Trout) in the Mackenzie River ecosystem; 3) develop and test a protocol to monitor groundwater temperature in spawning habitat of substrate-spawning salmonids in the Arctic; 4) investigate potential overlap in spawning habitat between Pacific salmon and native chars by monitoring groundwater temperature at selected spawning locations; and 5) develop capacity within local communities through collaboration and training to continue long-term monitoring using Pacific salmon as a proxy for ecosystem change and groundwater temperature as a measurable variable that may assess potential ecosystem impacts of that change. This research can be used to prepare for and adapt to ecosystem change in the Arctic, and will provide information to assist in the management of local and colonizing fish species in the context of climate change.

Integrated ecomonitoring and assessment of cumulative impacts on Great Slave Lake fisheries ecosystems
Xinhua Zhu (DFO)

The overarching objectives of this five-year basin-wise study are designed to address the community and decision makers' concerns of cumulative impacts on the sustainability and ongoing productivity of the GSL fisheries ecosystem. This study strategically focuses to 1) monitor the fishery-relevant components of the GSL, to ***establish the baseline*** conditions and their variability, and to index the annual and decadal changes in the conditions of the ecosystem, 2) explore the effective indicators of environmental and cumulative changes to ***characterize*** the ***aquatic productivity, biodiversity***, and the environmental ***association***, and 3) ***develop*** a ***benchmark*** for capacity building of community-based ecomonitoring module (CBEM) and integrated fisheries ecosystem studies (IFES) so as to support co-management decisions within a precautionary framework.

Community coastal based monitoring: A regional approach for the ISR
Lisa Loseto (DFO)

To develop a regional framework for monitoring key VEC's (beluga, fish, habitat) in the ISR with the purpose of establishing long term monitoring and cumulative impacts monitoring programs. Existing and new indicator data will be used to assess the current framework and test the robustness of this approach. As some indicators may be more sensitive or more variable than others, long term monitoring data is required to develop a baseline understanding to provide advice on regulatory and cumulative impact assessments. For example understanding how VEC's respond to natural variability compared to climate change drivers and anthropogenic stressors is needed for decision making and advice (e.g. regulatory and ecosystem management). We are incorporating new local observation indicators to build into the monitoring framework. Because the goal is to maintain programs over the long term, they are developed in partnership with the communities to ensure long term partnerships on meaningful programs.

Long term monitoring of Great Bear Lake fisheries and the aquatic ecosystem
Kim Howland (DFO)

Fish populations, in particular lake trout, provide an important source of sustenance for the community of Deliné and support a world class sport fishery providing income locally and for the lodge industry. As the major top predator in Great Bear Lake (GBL), lake tout, together with its main prey species, cisco, is a key component in maintaining a balanced and healthy aquatic food web. Lake trout are particularly susceptible to over-exploitation and other anthropogenic impacts, including climate change, due to their low production rates and requirements for cold, well-oxygenated waters. Recent fish assessment studies have provided an excellent baseline from which to begin monitoring changes in lake trout and other large-bodied species, but detailed information on their biology is lacking. Furthermore, knowledge of other components of the lake ecosystem, such as non-harvested forage fish, zooplankton, benthos and primary producers is limited. The goal of the proposed study is to follow up on baseline fisheries assessments by combining continued community-based environmental and biological monitoring of larger-bodied fish species with standardized collection of baseline information (composition, distribution and abundance) on other ecosystem components, in particular lower trophic producers. This ecosystem-level monitoring will be supplemented with research aimed at understanding variability (morphology and life history), habitat use, and food web relationships of lake trout (main predator) and cisco, the main prey species in the lake.

Changing hydrology in the Taiga Shield: Geochemical and resource management implications
Chris Spence (Environment Canada)

The project objectives are to describe and understand the consequences of recent changes in streamflow and geochemical regimes in the North Slave Taiga Shield; specifically this project will determine A) The changes in winter streamflow on the North Slave Taiga Shield; B) the drivers of these recent changes; C) the impacts of these changes on the environment; and D) the implications to water quality.

Monitoring Boreal caribou in the Dehcho
Nic Larter (GNWT-ENR)

Project objectives are to:

- Document and monitor annual calf production, calf survival, and adult survival in order to make annual estimates of λ.
- Provide empirical data to determine areas of secure boreal caribou habitat, given the current human footprint, and for RSF modeling to assist with assessing important habitat types/areas.
- Provide current knowledge of boreal caribou ecology to the PAS for use in the assessment process for candidate areas for protection being evaluated in the Dehcho, and for use with evaluating landuse applications made in the Dehcho.
- Provide empirical data and current knowledge for use in the development of range management plans for boreal caribou as part of the National Recovery Strategy.
- Assess responses of female caribou in relation to their use of space in the landscape as development occurs.
- Continue monitoring diseases and parasites.
- Collect fecal samples to assess alternate methods for estimating population parameters and assessing genetic diversity in boreal caribou, as part of a larger collaborative project with studies in other regions of the NT.

Provide qualitative information on boreal caribou harvest

Spatial distribution of wolves on Bathurst caribou summer range
Dean Cluff (GNWT-ENR)

Objective 1: Evaluate wolf den monitoring and pup survey for trend analysis on the Bathurst caribou summer range.
Objective 2: Investigate changes in spatial distribution of wolf den sites and pup survival on Bathurst caribou summer range.
Objective 3: Investigate wolf pup fecundity and survival in response to the changing distribution and abundance of barren-ground caribou
Objective 4: Investigate winter wolf abundance discrepancies between community and scientific claims on caribou winter range.

Succession and regeneration response on seismic lines with respect to ecology, disturbance factors and time
Lisa Smith (GNWT-ENR)

This project directly addresses Action 4 of the *Action Plan for Boreal Woodland Caribou Conservation in the NWT 2010-2015* to "Determine vegetation regeneration rates and patterns for various types of disturbances across different habitat types and environmental conditions in the NWT to assist development of range management plans." It also addresses Actions 10 and 11 in the Action Plan.

This project addresses the primary management concern identified by the Department of Environment and Natural Resources (ENR) for boreal caribou in the *NWT Wildlife Research and Management Plan 2011-2016* of landscape change due to increased oil and gas development, seismic lines, and timber harvest. Intended project outcomes are information on succession and regeneration on seismic lines with respect to ecology, disturbance factors and time.

Landscape scale flooding in the Great Slave Lake Plain: Expansion of lakes, flooding of wetlands and implications for bison habitat and local land users
Terry Armstrong (GNWT-ENR)

The purpose of this project is use scientific and traditional knowledge to track and understand causes of abrupt landscape scale flooding and ecosystem change in the Great Slave Lake Plain area, assess the cumulative effects of environmental stressors driving this change, and determine the implications for wildlife management, particularly bison and moose, as well as local land use activities. A second purpose is to bring together local land users, researchers and resource managers to evaluate and understand the cumulative effects of environmental stressors that are driving abrupt, broad-scale, ecosystem change in the Great Slave Lake Plain area north-east of Fort Providence, and identify decision-making and resource management needs which will be critical to adapting to long-term changes on the landscape.

Implementing collaborative cross-NWT water quality monitoring to address the needs of water partners, focusing on cumulative impacts and community concerns
Erin Kelly (GNWT-ENR)

The purpose of the project is to collect water quality data to enhance understanding of cumulative impacts and to contribute to decision making in the NWT, in conjunction with implementation of collaborative aquatic monitoring across the NWT. There are three associated objectives:

1) To continue to collect water quality data at the 13 sites sampled in 2012, to assess for trends in total and dissolved metals, presence of hydrocarbons and basic water quality parameters;
2) To conduct additional monitoring at new sites to expand the current water monitoring network and compare sites throughout the NWT; and,

To increase community-capacity for engagement in cumulative effects monitoring

Engaging Fort Resolution youth in cumulative impacts monitoring and assessment – Developing and operationalizing a framework for youth engagement
Jennifer Fresque-Baxter (GNWT-ENR)

The purpose of this proposal is to engage community youth in cumulative impacts assessment, from research design to data collection to decision-making. This project is being developed as a pilot project, with potential to be rolled out to other communities in the future. This project builds on community concerns and supplements and adds value to existing cumulative impact research and monitoring under way in the Fort Resolution area.

The objectives of this project are to:

1. Work with young people to learn and share knowledge about cumulative impacts, environmental change and research and monitoring in their community, from both western science and traditional knowledge perspectives;
2. Building on ongoing research and monitoring and community concerns, work with youth to identify existing cumulative impacts research questions, and the projects and activities that are working to answer those questions;
3. Identify and develop a classroom-led research program, linked to the Experiential Science 30 curriculum, to collect additional environmental data to support cumulative impacts assessment and identified, existing research questions;
4. Work with youth to analyze and assess data from multiple sources to build a holistic understanding of state of the aquatic ecosystem in their community; and,
5. Work with youth to mobilize knowledge on cumulative impacts research and monitoring, both within their community (i.e. with their Elders and their community leadership) and outside of their community (i.e. researchers), and between their community and researchers.

A watershed approach to monitoring cumulative impacts of landscape change
Steve Kokelj (GNWT-ITI)

The Peel Plateau occupies approximately 50 000 km^2 of terrain in northwestern NWT. The region has experienced significant warming and it is one of the most rapidly changing landscapes in Canada. This terrain type is widespread in the Gwich'in Settlement Area and extends into the Inuvialuit and Sahtu regions throughout where it contains important cultural and ecological areas. The Plateau contains the principal transportation link to southern Canada, as well as significant oil and gas reserves and potential mineral interests. Virtually all streams draining the Richardson and Mackenzie Mountains to the Peel and Mackenzie Rivers dissect this landscape. This monitoring project has already shown that the largest permafrost disturbances ever observed are

having significant impacts on terrain and rivers across this part of the NWT and on the Dempster Highway (Figure 2).

This year, the project will focus on three themes central to the cumulative impact monitoring program: A) establishing terrain and ecological thresholds in relation to disturbance; B) developing geospatial datasets required for assessing and monitoring cumulative effects on water resources including a watershed platform on which to summarize these data; C) establishing a community-based monitoring program and strengthening ongoing relationships between the researchers and co-management and land-use decision makers.

Gwich'in Harvest Study
Janet Boxwell (GRRB)

This project's main objective is to assist wildlife managers in determining population status, predicting population and environmental trends for various caribou populations in the GSA, including boreal caribou, which will assist in making management decisions (e.g. harvest limits, habitat protections, protected area, land use & management decisions, etc...) and to assist in assessing cumulative impacts on these populations both within the GSA and outside of it. It will do this by collecting: statistically rigorous and verifiable harvest data that can be used to help assess population mortality rates (a necessary component of assessing population status), population health and distribution; observations of abundance, distribution, parasite loads, overall health; observations of environmental change at the local and landscape level (eg. land slumping or fires affecting caribou distribution; extreme weather events that may be results of climate change may be observed –e.g. icing events and impact to caribou). Finally, this project will assist in facilitating the creation of partnerships in cumulative impact monitoring research between various organizations, the government and communities.

Inuvialuit Settlement Region community-based monitoring program (ISR-CBMP) – Pilot program
Jennie Knopp (IJS)

The program design will be based on guiding principles established by the ISRCBMP Steering Committee, outcomes of community tour and a six community workshop. These principles recognize the past successful efforts by government and the communities to invest in participatory community monitoring. While a key principle will be to emulate the successful features of those programs, this is to be a new program that will improve community capacity while increasing the efficiency and effectiveness of data collections in support of community and agency needs. It is also intended to increase the attention being focussed on current and changing environmental conditions, related cumulative impacts throughout the ISR, improving the state of knowledge with an emphasis on TEK, and acquiring continuing long-term data sets where possible.

Investigating the cumulative effects of environmental change and human activity in the Tathlina watershed
Melaine Simba (KTFN)

The purpose of this project is to:

1) Coordinate monitoring and research efforts in the watershed between the community, government, and universities;
2) Understand current aquatic health of the watershed using water quality, macroinvertebrates, aquatic furbearers and fish as indicators of ecosystem health;
3) Understand historical environmental change and contaminant loading in the watershed using paleoecological techniques from lake sediment cores; and
4) To develop a regional community-based water quality monitoring program for the watershed to monitor disturbance and future change in the watershed.

Ni Hat'ni Dene Program
Gloria Enzoe (LKDFN)

The fundamental purpose of the *Ni hat'ni Dene Program* is to help address the question "How is the natural and cultural environment in and around Thaidene Nene changing over time?" More specific to CIMP, the environmental monitoring aspect of the program seeks to add to the baseline understanding of the ecosystems in Thaidene Nene, as well as monitor how water quality and fish parameters are changing over time in relation to this baseline. It is useful to conceptualize the program as a data gathering mechanism for water quality and fish parameters that will feed directly into analyses under the long-term Great Slave Lake monitoring programs of Dr. Marlene Evans with Environment Canada.

Dene mapping project repatriation and analysis: Understanding valued places at the intersection of caribou ecology and harvesting
Deborah Simmons (SRRB)

This project has three main objectives:
1. The project will repatriate baseline ecological and cultural data (gathered from hundreds of land users during the 1970s and 1980s by the Dene Nation Mapping Project) to Sahtu communities. This rich dataset remains almost unusable due to issues with digital file obsolescence and lack of access to hard copies.
a. Sahtu maps will be identified in storage. They will be conserved and scanned for digitizing.
b. The trails dataset will be updated to modern GIS standards, and all point data will be digitized.
2. The data assessment in year three will focus on caribou as a key subsistence species affected by shale oil and induced development. The Dene Mapping Project dataset will be combined with other spatial datasets (Sahtu Harvest Study and SLUPB current use

study). These datasets will be combined with new information through a regional workshop held in Year 3. Harvester knowledge will be triangulated with historical data to understand the spatial aspects of valued places at the intersection of caribou ecology and harvesting. This socio-ecological work will allow the examination of cumulative impacts from an aboriginal perspective.
3. This project is a pilot project and partnership between the SRRB and the Dene Nation. The Dene Nation currently curates the majority of the Dene Mapping Project research materials. This project will create a roadmap for other communities to follow suit. A short 'how-to' document will be a final deliverable, and will be available through the NWT Discovery Portal. The how-to document will also be sent to other co-management boards, resource councils, or other interested parties at the end of the project.

Marian watershed community-based aquatic effects monitoring program
Kerri Garner (Tlicho Government)

The Tåîchô Lands Moratorium is anticipated to be lifted in May 2013, and development pressure will subsequently increase on Tåîchô Lands. As Tåîchô Lands are in relatively pristine condition, the intent of this study is to begin to collect baseline data at sites prioritized by community members away from specific project footprints in order to analyze the cumulative impacts of development, climate change, and increased access and use on the Marian watershed. Both western and Aboriginal science will be drawn on to obtain a clear picture of baseline conditions in the Marian Watershed. As a joint initiative of the Tåîchô Government (TG) and numerous key project partners (Community of Behchoko, Wek'èezhìi Land and Water Board (WLWB), Wek'èezhìi Renewable Resource Board (WRRB), DFO, GNWT-ENR, and Dr. Lana Miller / Munkittrick Lab UNB, AANDC-Contaminants, AANDC-Waters), this project will provide data to support project partners in decision-making and management-planning related to future developments, water quality and quantity, fish and aquatic life, and waste management in the Tåîchô region. Letters of support from project partners are attached or were submitted directly to CIMP.

Tlicho community based monitoring of Bathurst and Bluenose East caribou
Kerri Garner (Tlicho Government)

The overall objective of this project is to
1) Refine t e met odology to olle t biologi al data based on previous year's experien e and new knowledge, to develop a robust sampling methodology that is achievable for community members.
2) Continue to collect biological data that will improve the community's understanding of herd health indicators.
3) Build capacity, train and educate hunters and students on how hunting is part of a broader monitoring strategy for monitoring cumulative effects on the Bathurst and BNE caribou

4) Inform and educate harvesters and community members about caribou conservation and management

Community-based monitoring of wildlife health phase 2: Stress and pathogens in a changing landscape
Susan Kutz (University of Calgary)

Specific objectives are (i) establish baselines for the health status (including physiological condition, infectious disease, and stress) of woodland caribou and moose in the Sahtu, and (ii) analyze these health indices relative to measures of landscape disturbance. Our research will focus on the Mackenzie Valley and sampling will be targeted to represent a gradient from high to low disturbance.

Monitoring environmental change in the Mackenzie Delta Region: Inuvialuit observations and participatory-multimedia mapping
Trevor Lantz (University of Victoria)

The core goals of this project are to: 1) document Inuvialuit observations of changing environmental conditions and associated impacts, 2) organize these observations into an accessible web-based map, and 3) hold meetings to prioritize and synthesize our findings for planners and decision makers.

Tlicho aquatic ecosystem monitoring project
Jody Snortland (WRRB)

The main objectives are:
• to collaborate with management partners in long term community-based monitoring, including Tåîchô Government, Tåîchô communities, Wek'èezhìi Land and Water Board, Wek'èezhìi Renewable Resources Board and Department of Fisheries and Oceans
• to contribute to long-term datasets for aquatic ecosystem monitoring and an overall Marian Watershed Stewardship Program
• to provide training and educational opportunities for Tåîchô community members including youth, fishers and elders
• to engage schools in educational opportunities related to aquatic ecosystems and environmental monitoring

Snowpack accumulation: influence on caribou distribution, surface water chemistry and lake productivity
Michael English (Wlifrid Laurier University)

An important objective of this project is to maintain/improve partnerships created with residents of the village of Wekweeti including local government, and students and teachers at Alexis Arrowmaker School. One objective is to verify and strengthen our ability to utilize the satellite data to quantify development of the annual snowpack. The

snowpack's cumulative impact on the environment is all encompassing as it influences local, regional and global scale climate through surface energy feedbacks. Accurate SWE maps stemming from high quality ground truthing may assist wildlife managers in evaluating the role of changing snowpack conditions on caribou distribution with some confidence and allow officials in charge of fire suppression to assess which regions have higher probability of forest fires. Having confidence in a tool like this enables us to quantify SWE at very little cost as the satellite data are available at no charge. One of our objectives is to work with Environment and Natural Resources biologists to examine SWE maps which can be produced using consistent satellite data available since 1979 to see if any temporal or spatial correlation with patterns of caribou migration exist. The satellite data can also be used to map the extent of ice layers within the snowpack, which can have a major influence on ungulate foraging. Another objective is to quantify snowmelt contribution to surface water bodies using stable isotopes of water (the snow signature is different from the mean annual water stored in the basin). Snowmelt is linked closely to nutrient export from the terrestrial system, impacting water quality and productivity of downstream ecosystems. Therefore, we propose to examine the impacts of hydrology, climate and human disturbances on lake productivity, which is an important indicator of water quality and fish habitat. Snow plays such a prominent role in northern ecology and the environment that it constitutes a significant focus of the GNWT Water Strategy.

Establishing a water quality dataset for cumulative effects assessment in the North Slave

Todd Slack (YKDFN)

The purpose of this project is to:

1. Compile and consolidate existing water quality information collected from lakes in the North Slave region in a common database. This information will be made publically available for use in resource management activities and cumulative effects assessment.
2. Understand predominant drivers of regional variation in water quality in the North Slave. Multivariate statistical techniques will be used to determine relative influence of landscape condition, ecology, lake size, catchment area and latitude on lake water quality.
3. Examine influence of ice road construction and operation on water quality of lakes along Tibbitt-Contwoyto winter road corridor (Preliminary investigation in Year 1; Focused investigation in Years 2 and 3).