Presentation #00:

NWT CIMP Impact on Environmental Decision-making in the Inuvialuit Settlement Region and the Gwich'in Settlement Area

Kanigan, J.
NWT Cumulative Impact Monitoring Program, Government of the Northwest Territories
Julian_Kanigan@gov.nt.ca

The Northwest Territories Cumulative Impact Monitoring Program's (NWT CIMP) mandate is to analyze scientific and traditional knowledge to monitor the cumulative environmental impacts of land and water use in the NWT. Cumulative impacts are changes to the environment caused by human actions or a combination of human actions and natural factors. This abstract provides a brief description of NWT CIMP and outlines two examples of NWT CIMP-supported monitoring in the Inuvialuit Settlement Region (ISR) and the Gwich'in Settlement Area (GSA) that have directly informed current environmental decision-making processes.

Monitoring cumulative impacts is an important part of environmental regulation in the NWT. The legal mandate for NWT CIMP comes from the Gwich'in, Sahtu and Tlicho land claim agreements, and the Mackenzie Valley Resource Management Act. NWT CIMP operates in the ISR through a Memorandum of Understanding with the Inuvialuit Game Council. Aboriginal governments help to guide the program through the NWT CIMP Steering Committee.

NWT CIMP is focused on cumulative impact monitoring that informs environmental decision-making. As such, the program emphasizes the monitoring priorities of land and water boards, review boards and renewable resource boards. The program also strives to include communities in all aspects of cumulative impact monitoring.

Project-specific cumulative impact monitoring starts with good environmental baseline data. The Inuvik to Tuktoyaktuk Highway underwent regulatory review in 2013. NWT CIMP provided the developer with multiple datasets that the program has collected since 2004. These datasets included terrain hazards and ground temperatures along the highway corridor. The data directly contributed to the quality of design and mitigation plans that the developer submitted for review.

NWT CIMP also supports regional-scale cumulative impact monitoring. Since 2010, NWT CIMP has supported work led by Dr. Steve Kokelj (Northwest Territories Geoscience Office) to monitor broad-scale permafrost slumping in the Peel Plateau. Project results help the Gwich'in Renewable Resource Board make informed fish and wildlife management decisions. Results are also being used by the Government of the Northwest Territories to plan mitigations for permafrost slumping along the Dempster Highway.

Results from all NWT CIMP projects are available for download on the NWT Discovery Portal www.nwtdiscoveryportal.enr.gov.nt.ca or by contacting nwtcimp@gov.nt.ca.

Presentation #01:

INUVIALUIT SETTLEMENT REGION –
COMMUNITY-BASED MONITORING PROGRAM (ISR-CBMP)

Knopp*, J.A.[1,], Pokiak, F.[2], Staples, L.[3], Gillman, V.[4], Carpenter, L.[5], Snow, N.[6], Pierce, J.[7] and Tingmiak, K.[1]

(1) Inuvialuit Settlement Region – Community-Based Monitoring Program, Joint Secretariat – ISR, Inuvik NT
(2) Inuvialuit Game Council, Inuvik NT
(3) Wildlife Advisory Management Committee - North Slope, Whitehorse YK
(4) Inuvialuit-Canada Fisheries Joint Management Committee, Inuvik NT
(5) Wildlife Advisory Management Committee – Northwest Territories, Inuvik NT
(6) Joint Secretariat – ISR, Inuvik NT
(7) Environmental Impact Review Board, Inuvik NT
cbmp@jointsec.nt.ca

The ISR-CBMP began in January 2013 and is a partnership that includes the six ISR Hunters and Trappers Committees, the ISR wildlife co-management boards and the Inuvialuit Game Council. The program is a regionally coordinated, community-based approach to monitoring. Community interests and priorities are integral to the design and implementation of the program, along with the management needs and priorities of Inuvialuit organizations, the co-management boards created pursuant the Inuvialuit Final Agreement (IFA) and territorial and federal resource management authorities. The program also builds on, and collaborates with, existing monitoring projects and partnerships in the ISR. Researchers, industry, and other organizations conducting community-based monitoring, are encouraged to work in collaboration with the ISR-CBMP.

Community-Based Monitoring (CBM) focuses on improving resource management decision-making through the collection and application of Inuvialuit Knowledge and local environment-related information. It promotes the interests and role of local communities in:

1. the design of monitoring programs
2. execution of local monitoring programs
3. data interpretation and application.

CBM generates data and knowledge that provide insight into trends and changes in environmental and wildlife conditions over time, for management needs and priorities of resource users, co-management boards, and government agencies.

The ISR-CBMP is building and increasing local capacity in the ISR communities to monitor current conditions and trends with respect to:

- Wildlife and Fish condition, health, abundance, distribution and harvest levels;
- Wildlife and Fish Habitat and related local environmental conditions in areas such as water quality, erosion and permafrost; and,
- Other environmental conditions in areas such as climate-related pathways, vegetation and invertebrates.

Capacity building is a critical component of the ISR-CBMP. The Program is creating a cadre of trained community Resource Technicians prepared to work on priority monitoring needs for decision-makers as well as work directly with researchers and government.

The overall goal of the ISR-CBMP is to support the Inuvialuit Final Agreement institutions mandated "to protect and preserve the Arctic wildlife, environment and biological productivity" to achieve the principles of the IFA and enhance decision-making.

This presentation will provide an overview of the governance and design of the ISR-CBMP as well as provide information on CBM projects that were initiated as part of the two-year pilot program including the Porcupine Caribou Herd Harvest Surveys and water quality CBM.

Presentation #02:

A Multi-Scale Assessment of Cumulative Impacts in the Northern Mackenzie Basin

Marchildon*, C.[1], Lantz, T.[2], Cameron, E.[2] , Fraser, R.[3], Kokelj, S.[4], Binder, R.[5],
(1) Environment and Natural Resources, Government of the Northwest Territories
(2) School of Environmental Studies, University of Victoria
(3) Canada Centre for Mapping and Earth Observation, Natural Resources Canada
(4) Northwest Territories Geoscience Office, Government of the Northwest Territories
(5) Inuvialuit Joint Secretariat
Claire_marchildon@gov.nt.ca

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), but their cumulative effects are extremely poorly understood. In this project, we combined remote sensing data with field observations to document the extent and cause of changes occurring between 1985 and 2012. Using NDVI data derived from LANDSAT, we found that 85% of the Tuktoyaktuk Coastland showed increased vegetation productivity between 1985 and 2011, making this one of the most intensely greening regions in the Arctic. Ongoing comparisons using vertical air photos from 1980 and 2013 show that this greening was associated with increased canopy cover of erect dwarf and tall shrubs and declines in ground lichen cover. Our analyses suggest that these changes have been driven primarily by regional warming.

Over the last several years we have also used field studies to examine the ecological effects of disturbances including: all weather roads, degrading ice wedges, drained lakes, historic seismic lines, tundra fires, thaw slumps, and drilling mud sumps. Our plot-scale field studies show that disturbance can result in positive feedbacks among vegetation, snow pack, and soils that cause the effects of disturbance to persist for centuries. In this presentation we use the example of an all-weather road to illustrate these ecological feedbacks. By comparing plot-based sampling, airphoto disturbance mapping, and changes in vegetation indices derived from LANDSAT imagery, we also characterized the regional impact of disturbance. Our analysis shows that, despite the magnitude of their impacts, disturbances only affect a small portion of the study region. These data are especially relevant to organizations interested in understanding and managing the effects of landscape change on wildlife.

Presentation #03:

Monitoring Environmental Change in the Mackenzie Delta Region: Local Observations and Participatory Multimedia Mapping

Lantz*, T.[1] Tyson, W.[1], Brietzke, C.[1]
(1) School of Environmental Studies, University of Victoria.
tlantz@uvic.ca

The Mackenzie Delta Region is a dynamic environment that is ecologically and culturally significant. This area is experiencing rapid environmental changes that are expected to increase in magnitude with continued climate warming and additional anthropogenic stressors. In some areas changes are occurring so rapidly that maintaining an accurate inventory presents a significant challenge. Inuvialuit and Gwich'in land users in the region are in an excellent position to assess ongoing changes in the environment and contribute to cumulative impacts monitoring.

The central objective of this research project is to document Inuvialuit and Gwich'in observations of the environment. To accomplish this, we combine participatory photography and video with semi-structured interviews that focus on participants' knowledge of the land. Participant observations, photos, videos, and interviews are organized into web-based maps maintained by the University of Victoria (https://gwitchin.knowledgekeeper.ca and https://inuvialuit.knowledgekeeper.ca/). Between 2010 and 2014, we have worked with 60 monitors to record observations across the Inuvialuit and Gwich'in territories. In 2013/14, monitoring focused on: changes in muskrat populations, hydrology in the Mackenzie Delta, and the effects of human disturbances on terrestrial ecosystems important for traditional harvesting.

In 2014, we also began work to assess the cumulative impacts of disturbance on traditional harvesting in the Inuvialuit Settlement Region (ISR). The first step in this part of the project was to develop a map layer integrating existing data on: 1) the spatial distribution of multiple disturbances in the region, and 2) the magnitude of their effects on ecosystems. The resulting map provides a visualization tool that will help communities, planners, and scientists assess the effects of disturbance at both fine and broad-scales. Preliminary analysis shows that the cumulative impacts of disturbance vary across the ISR. Our ongoing work with this data involves assessing the overlap between disturbance hotspots and important harvesting areas using spatial analysis and Marxan simulations.

Presentation #04:

Arctic Salmon: Monitoring Changes by Local Community Involvement

Dunmall*, K.M.[1], Gruben, M. [2], Mochnacz, N.J.[3], and Reist, J. D.[3]

(1) University of Manitoba, Winnipeg, MB

(2) Aklavik Hunters and Trappers Committee

(3) Fisheries and Oceans Canada, Winnipeg, MB

Karen.Dunmall@gmail.com

Community members in the Northwest Territories are noticing changes in subsistence harvests of Pacific salmon, which may indicate larger changes to the Arctic ecosystem due to climate warming. Specifically, Chum Salmon and Pink Salmon are appearing in greater abundances and in more places in recent years. Increased numbers of salmon may provide future fisheries opportunities or may negatively affect the existing ecosystem and fishes. In this study, Pacific salmon are provided by the subsistence fishers, gathered on a community basis by local organizations, and sent to Fisheries and Oceans Canada for further analyses. A total of 263 salmon were collected in this passive collection program between 2000 and 2010, 229 were collected in 2011, 23 were collected in 2012, 11 were collected in 2013, and up to 50 are projected for 2014 (collections are ongoing at present).

There is concern that these Pacific salmon may compete with native fishes such as chars. Community members, in collaboration with Fisheries and Oceans Canada, monitor the water temperature in char habitat using a recently developed and tested method that monitors substrate and surface water temperatures simultaneously. This method has been used to monitor temperature in char spawning habitat in rivers draining to the Arctic Ocean, tributaries to the Mackenzie River near Ft. McPherson and Norman Wells, NT, and also in the Nahanni National Park near Ft. Simpson, NT. This information, coupled with water temperatures from groundwater springs in the North Slope, has allowed the development of a predictive model to identify watersheds vulnerable to colonization by Chum and Pink salmons along the North Slope. Although species-specific preferred water temperatures will likely limit competition for specific spawning sites, there is some overlap suggesting the possibility of competition for spawning locations close to springs with temperatures near 4^{o}C, as occurs in the Babbage River, NT. Once temperature data are available, this predictive model may be applied to sites farther upstream in the Mackenzie River.

Combining community monitoring of key habitat variables such as water temperature and community-based sampling of fish with scientific research on samples represents a powerful approach to understanding ecosystem changes. Greater understanding regarding changes with respect to Pacific salmon in the Arctic and the development of tools to predict their presence and resulting implications will enhance cumulative impact assessment capabilities of ecosystem-level changes, contribute to ecosystem-based fisheries management in a changing Arctic, and contribute to community conservation plans and management of key fishery resources.

Presentation #05:

Stewardship of Gwich'in lands through management of research materials: oral history and traditional knowledge

Snowshoe*, S.[1], Benson, K.[1]
(1) Gwich'in Social and Cultural Institute
ssnowshoe@gwichin.nt.ca

The Gwich'in Social and Cultural Institute is the culture and heritage arm of the Gwich'in Tribal Council. It is a non-profit society with registered charitable organization status and is governed by a seven member Board of Directors composed of representatives from the four Gwich'in communities and the Gwich'in Tribal Council. The objective of the Institute is to conduct research in the areas of culture, language and traditional knowledge so that this body of knowledge will be recorded and available for future generations and the development of programs appropriate for Gwich'in needs. We believe that this is essential in building new awareness of, and pride in, Gwich'in culture. The GSCI also participates in the review of development permits and research permits. The GSCI received CIMP funding between 2006-2012 funding in support of a series of projects to ensure previously-recorded Gwich'in traditional knowledge and oral history will be accessible to GSCI, Gwich'in communities, and researchers into the future.

This presentation will include an overview of the GSCI's tasks and outcomes to update, preserve, and ensure the sustainability of research materials. It will also contextualize the project within the GSCI's mandate and processes.

Presentation #06:

Gwich'in Harvest Study

Boxwell*, J.
Gwich'in Renewable Resources Board (GRRB)
jboxwell@grrb.nt.ca

Presentation #07:

The Permafrost of the Peel Plateau

Ecology North

Video presentation

Presentation #08:

Mapping permafrost disturbance and impacts to aquatic ecosystems in the Western Arctic.

Kokelj, S.[1], Segal, R.[2], Lantz*, T.[2], Lamoureux, S.[3], and Schwarz, S.[4]
(1) Northwest Territories Geoscience Office, Government of the Northwest Territories
(2) School of Environmental Studies, University of Victoria
(3) Department of Geography, Queen's University
(4) NWT Centre for Geomatics, Government of the Northwest Territories
tlantz@uvic.ca

Previous research shows that changes in the size and frequency of permafrost disturbances will have a significant impact on the water quality of lakes and streams across the western Arctic. However, relatively little is known about the continental distribution of large permafrost disturbances. In this project we used a grid-based mapping technique to identify areas where retrogressive thaw slumping and catastrophic lake drainage are prevalent. In the first year of this project, we focussed on retrogressive thaw slumps, which are a form of permafrost disturbance that occur where ice-rich permafrost in hilly terrain is exposed and begins thawing.

Thaw slumps were widely distributed throughout study area, with 11% (~140,000 km^2) of the grid cells overlaid on the study region containing active disturbances. Of the impacted grid cells, most (66%) had a low density of active slumps, 24 % had moderate slump density, and 10% had high slump density. The vast majority of slump-impacted terrain occurred in areas of glacial till (till blanket and till veneer) and was bounded by the maximum westward extent of the Laurentide ice sheet. Fluvial (valley-side) environments were the most common geomorphic setting impacted by slumps and often contained a high density of large slumps. To provide a first approximation of the potential impact on streams and rivers, we calculated the proportion of grid cells with fluvial slumps for 68 broad-scale watersheds. We found that the Peel, Southwestern Beaufort, and Arctic (including streams draining the eastern half of Banks Island) watersheds were the most intensively impacted by slumping.
This project provides a quantitative basis for re-evaluating the distribution of ice-cored permafrost terrain and a means to assess the sensitivity of northern landscapes to climate change. Our maps also provide a useful scoping tool for communities, planners, scientists and project proponents. An open file describing our results, including the map data and metadata, is being published as an open file with the Northwest Territories Geoscience Office and will be made available on the NWT Discovery Portal.

Presentation #09:

The influence of slumps on stream water quality and biota in the Peel Plateau, NT

Chin*, K.[1], Maier, K.[2], Levenstein, B[3], Lento, J.[3], Culp, J.[3,4], Kokelj, S.[5], Vaneltsi G.[6]

[1]GNWT - CIMP, Yellowknife, NT

[2]Gwich'in Renewable Resource Board

[3]Canadian Rivers Institute & University of New Brunswick, Fredericton, NB

[4]Environment Canada, Fredericton, NB

[5]GWNT – ITI, Yellowknife, NT

[6]Tetl'it Gwich'in Renewable Resource Council

krista_chin@gov.nt.ca

kmaier@grrb.nt.ca

Permafrost degradation, leading to slope disturbances (slumps) in the ice-rich glaciogenic terrain of northwestern Canada has impacted hundreds of small streams. The disturbances have made large volumes of previously frozen, highly weatherable fine-grained sediments available for leaching and transport to adjacent streams, increasing sediment and solute loads in these systems. To test the effects of increasing sediment and solute loads on the ecology of streams, we explored the relationship between physical and chemical variables on benthic macroinvertebrate communities, organic decomposition, and the relationship between nutrient availability and algae growth in impacted and unimpacted stream reaches in the Peel Plateau in the Northwest Territories. Taxonomic composition and invertebrate abundance distinguished impacted from unimpacted stream reaches. There was evidence of a strong negative relationship between macroinvertebrate abundance and total suspended solids. Organic decomposition was not consistent among sites, further testing is required to explain this finding. Algae growth did not differ between treatments suggesting that nutrients are not limiting in this system. Slumps have a huge impact on stream systems but more research is required to determine threshold levels of disturbance on the stream biota. Lastly, impacts to fish species are being investigated through the use of dietary analysis and occupancy modeling.

Presentation #10:

Understanding Impacts of Environmental Change on Char in the ISR: Ecological and Inuvialuit Knowledge for Community Monitoring

Knopp*, J.A.[1,2], Furgal, C.[3], Reist, J.D.[4], Sachs Harbour Hunters and Trappers Committee[5]

(1) Environment and Life Sciences Program, and the Health, Environment and Indigenous Communities Research Group, Trent University, Peterborough ON
(2) Inuvialuit Settlement Region – Community-Based Monitoring Program, Joint Secretariat – ISR, Inuvik NT
(3) Department of Indigenous and Environmental Studies, Trent University, Peterborough, Ontario, and the Health Environment and Indigenous Communities Research Group, Trent University, Peterborough ON
(4) Freshwater Institute, Fisheries and Oceans Canada, Winnipeg MB
(5) Sachs Harbour Hunters and Trappers Committee, Sachs Harbour NT
jennieknopp@yahoo.com or jenniferknopp@trentu.ca

Increases in climate variability in the Inuvialuit Settlement Region, and the resulting effects on local environment, flora, and fauna, have led to impacts on local freshwater fish. Inuvialuit who rely on fish as a source of food, will have to adapt to these effects including altered access to fishing locations and changes to size and quality of fish. The purpose of this research was to understand how a changing environment may affect Arctic Char and to create an Arctic Char community-based monitoring (CBM) plan for Sachs Harbour NT.

This presentation overviews the outcomes of a five-year collaborative mixed methods research project integrating local expert knowledge, and ecological and environmental knowledge. Through this approach, we learned: 1) landlocked lake parameters that affect Arctic Char growth and health; 2) local environmental parameters that affect Arctic Char growth; 3) indicators for use in community-based monitoring; and, 4) community needs to carry out effective CBM.

The mixed methods research design used in this project involved a range of data collection and analysis methods. Scoping sessions and semi-directed interviews were conducted with local fish and environment experts. Local experts provided a detailed understanding of changes in local climate and environmental conditions and how these changes affected both Arctic Char and char habitat. Three local landlocked fishing lakes were sampled for water quality, depth and temperature profiles, ice on-off dates, and zooplankton abundance and size. Arctic Char were sampled for length, weight, sex, maturity, stomach contents, parasite loads and otolith (ear bone) age and annual growth analyses. Local expert fishers were directly involved in the research design, determination of study locations and environmental and ecological parameters for scientific sampling, and results analyses.

We learned that Capron Lake had 1/20th the volume, 5X higher zooplankton productivity, and ice-on dates 10-20 days earlier (resulting in a shorter growing season) than the other two study lakes. The oldest chars captured in Capron Lake were

significantly shorter than the oldest chars captured in Middle and Kuptan lakes ($p<<0.001$) however Capron Lake contained the longest char captured of all three lakes. Despite these differences between the three lakes, otolith annual growth analyses on char from all lakes revealed a large increase in growth a decade prior to capture, across a range of age classes. Local experts observed and reported noticeable changes in Arctic Char within the same time frame coupled with observations of low sea-ice coverage and warmer ambient air temperatures within the same years.

Integrating local expert and environmental knowledge to determine similarities and differences in fish growth, condition and habitat among the study lakes, and interpretation of the resulting patterns, supported either lake-specific or regional climate-driven changes in Arctic Char growth. This resulted in the identification of indicators useful in CBM. Regional sea-ice coverage is an indicator relevant for consideration in Arctic Char community-based monitoring along with ambient air temperatures, number of days of lake ice coverage and zooplankton abundance.

Presentation #11:

Community Coastal Based Monitoring: A Regional Approach for the Inuvialuit Settlement Region

Loseto*, L.L.[1,2], Hoover*, C.[1], Ostertag*, S.[1] and Hynes*, K.[3]

(1) Freshwater Institute, Fisheries and Oceans Canada, Winnipeg,

(2) Dept of Environment & Geography, University of Manitoba

(3) Fisheries Joint Management Committee

Lisa.Loseto@dfo-mpo.gc.ca

In efforts to prepare for cumulative impact assessments there is a need to develop a baseline understanding of the marine and coastal ecosystems of the Beaufort Sea. Our program goal is to characterize the ecosystem connectivity to better inform managers/decision makers on ecosystems and their responses to change. Specifically, we take a multi-faceted approach to establishing and developing a long term monitoring plan, and selecting key indicators needed for future decision making. We set four pillars to our approach a) define ecosystem structure, function and health (using beluga and fish as sentinel species), b) build a foundation for long term community monitoring, c) ensure inclusion of Inuvialuit values, perspectives and knowledge, and d) use a modeling approach to span from the coast to offshore and allow for future simulations.

The development of the coastal community based monitoring programs focused on valuable ecosystem components (VECs) of fish and beluga whales while building linkages to habitat. Using approaches that build on the Hendrickson Island beluga program, we expanded efforts to other communities to build capacity for the collection of either beluga and/or fish samples for biomarker indicator analyses. While the program spans

over species and space covering the Mackenzie Estuary and marine coastal areas (e.g. Darnley Bay, Paulatuk), we maintain connectivity by measuring common indicators that define predator prey interactions and ecosystem structure (i.e. food web biomarker stable isotopes, fatty acids, mercury). This provides a baseline understanding of the food web. To date, a total of 18 fish species have been collected in the Mackenzie Estuary coastal system and 13 fish species have been collected from the marine coastal system for morphometric (e.g condition measurements), food web and biomarker analyses.

In early phases of the CIMP community monitoring program, communities requested better incorporation of their knowledge in monitoring programs. As such, we have developed a means to focus on the collection and inclusion of local observational data on beluga health and habitat as part of the monitoring program. This effort will define key local observation indicators that will be built into long term monitoring programs.

While we are largely focusing on belugas and fish as VECs in our monitoring programs, key species may be absent that may indicate changes in the ecosystem. To address this, we are using a Beaufort Sea ecosystem model (Ecosim with Ecopath) to evaluate species sensitivity, keystoneness and redundancy to identify new species requiring monitoring (e.g., key benthic invertebrates). This model will also support the ability to simulate changes in the ecosystem due multiple stressors. Together, these efforts support a streamlined approach to regional coastal ecosystem monitoring for the Inuvialuit settlement region.

Presentation #12:

Smallest voices – Shouts of change: Marine productivity in the coastal Beaufort Sea

Michel, C. and Niemi, A.

Fisheries and Oceans Canada, Freshwater Institute, 501 University Crescent, Winnipeg MB

Christine.Michel@dfo-mpo.gc.ca

Unseen molecules and microscopic organisms form the foundation of marine ecosystems. The “small voices” of marine ecosystems continue to be the best indicators of a changing Arctic. Cumulative impacts of climate change and those associated with industrial development will be first observed at the lowest levels of the marine food web.

Our research focuses on the foundation of water and sea-ice ecosystems including lower-trophic organisms such as phytoplankton, ice algae and bacteria. Our work also describes the chemical components that structure the water and ice habitat, including salinity, nutrients and key tracers of food webs and water origins. Since 2010 we have worked in the coastal Beaufort to enhance baseline knowledge of lower-trophic communities and food web interactions. We have worked to build capacity for lower-

trophic monitoring through community visits, consultations, training and the development of monitoring tools for future community monitoring activities.

Work conducted as part of regional assessments (e.g. Arctic Coastal Ecosystem Studies (ACES) and Beaufort Regional Environmental Assessment (BREA)) has allowed us to assess key indicators (e.g. nutrients and chlorophyll biomass) and emerging trends within the coastal Beaufort Sea. Our results contribute to management plans for the Arctic Marine Protected Areas and provide input for monitoring programs, including winter sampling. Recent observations of high productivity in the Beaufort can be used to inform adaptive management decisions given the potential for shifts in ecosystem resources under current rates of change or under future scenarios of cumulative impacts.

Presentation #13:

Arctic Borderlands Ecological Knowledge Co-op: A platform for community-based cumulative impact monitoring in the north

Amos*, A.
Gwich'in Renewable Resources Board (GRRB)
aamos@grrb.nt.ca