Arctic Observing Summit

Short Statement

The Canadian Arctic Monitoring and Prediction System (CAMPS) – A Coordinated Knowledge Network to Understand and Anticipate Change in Canada's Northern Ecosystems

2. Implementing and Optimizing a Pan-Arctic Observing System

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A Changing Arctic

It is well acknowledged that climate is warming much more rapidly in the Arctic and Subarctic than in southern latitudes (IPCC, 2014; Serreze et al., 2009) – warming that is driving important changes in the interacting abiotic factors that in large part determine the abundance and health of many northern species. In Arctic coastal-marine systems a decreased sea ice season and warmer seawater are directly impacting sea ice-dependent biota (Eamer et al., 2013; AMAP, 2017), while sea level rise and increased rates of coastal erosion (Forbes, 2011; Gunther et al., 2015; Lantuit et al, 2015) are impacting vulnerable coastal wetlands that provide critical staging and nesting habitats for many migratory shorebird and waterfowl species (Provencher et al. 2018). The degradation of permafrost on exposed lakeshores and riverbanks, and the deepening of soil active layers are impacting biota in freshwater systems (Balzer et al., 2014; Sniderhan and Balzer, 2016), and are changing the quality and quality of river discharge to coastal marine ecosystems - a key determinant of physical processes that directly and indirectly affect coastal marine species (Carmack et al., 2016; Frey et al., 2009; Alkire et al., 2017). In terrestrial ecosystems, warming air and soil temperatures, degrading permafrost, and reduced snow season are causing infilling and changes in the relative dominance of shrubs, with unknown habitat effects (Myers-Smith et al. 2011; Tape et al., 2006; 2012). In some areas historical lemming cycling is reduced or has crashed, with potentially cascading effects on the many species that prey on them (Schmidt et al., 2014). Northern caribou populations are at historic lows (Gunn et al., 2010; Parlee et al., 2018; CARMA, 2018), and disease-driven muskoxen diebacks are occurring in the western Arctic – trends at this time that are largely unexplained (Kutz et al., 2015). Other factors such as ocean acidification (Steinacher et al., 2009; Yamamoto-Kawai, 2009), increased contaminants (Schuster et al., 2018), inevitable invasion by southern species (Lawler et al., 2009), and increased tourism, military activity and development all have the potential to significantly impact northern biota. Taken together, these ongoing changes interact in complex ways across scales to create high levels of uncertainty for government and regional agencies with biodiversity conservation mandates, for communities dependent on country food, and for industrial proponents and operators charged with minimizing and mitigating potential impacts of ongoing and proposed developments.

At the present time in northern Canada, monitoring and research that could contribute effectively to our understanding of these myriad changes is fragmented and uncoordinated. For example, many government departments conduct excellent monitoring programs that are implemented to fulfill their stated mandates, but are not linked to monitoring by academic organizations or communities. Canada is fortunate to have a culture of world-class northern scientists, and, although some academic researchers have managed to maintain long-term, research-level monitoring programs, they are by necessity limited temporally due to funding arrangements, and spatially due to the limited geographic scope of their research areas. Community-based monitoring is occurring in many communities across the Arctic and Subarctic, but they also lack long term sustainability and regional linkages. We propose here that what is needed is a long-term experimental approach that coordinates initiatives, methods and protocols to optimize present programs and attract new investments to support a long term, sustained national (and eventually international) approach to monitoring and research.

The Canadian Arctic Monitoring and Prediction System (CAMPS)

The Canadian Arctic Monitoring and Prediction System (CAMPS) is a proposal to begin to measure, understand and predict biodiversity change and associated abiotic drivers and ecological processes in the Arctic and Subarctic landscapes of Canada. The approach is to use CAMPS to initiate a national dialogue among all northern actors towards the development of a strategic northern knowledge system that coordinates ongoing science initiatives to optimize and coordinate present investments, proposes new science investments as needed, and mobilizes the intellectual capital of Indigenous Knowledge present in northern communities. Key elements of CAOPS include 1) long-term investment to sustain northern research infrastructure utilizing and supporting the present array of research sites to establish and maintain coordinated, long term monitoring experiments, and develop and refine regional predictive models; 2) long-term investment in northern communities to build local capacity, and access Indigenous Knowledge, to establish science-community partnerships that would implement a network of northern community observatories; and 3) coordination of these new initiatives with ongoing surveillance monitoring by agencies, universities, land claim bodies, communities and industry to report the state of Arctic and Subarctic ecosystems, and to make predictions on near- and long-term change.

CAMPS as it stands now has 3 main components (Figure 1). The foundation of the system is a network of monitoring and prediction observatories, with a Flagship Monitoring Site at the Canadian High Arctic Research Station (CHARS) as the hub. The observatory network would be initiated with existing northern research sites (e.g., research stations organized under the Canadian Network of Northern Research Operators, and the Changing Cold Regions Network, among others) for monitoring terrestrial and freshwater systems, and would be piloted in selected coastal communities, with supporting coastal boats (e.g., with the Arctic Research Foundation) and larger ships (e.g., Canadian Coast Guard icebreakers), for monitoring coastal and ocean ecosystems. Based on the input and direction of relevant science teams and IK experts, each site would implement and maintain co-ordinated, long-term monitoring experiments that link abiotic drivers and ecological processes to biodiversity outcomes in terrestrial, freshwater and coastal/marine ecosystems.

The intermediate level of the system would work to access and incorporate monitoring data from the wide variety of mandate-based monitoring programs conducted by various northern federal and territorial government agencies, land claim co-management boards, academic organizations and community-based monitoring programs (Figure 1). In many cases results from these programs could be used to calibrate and validate regional-scale, remote-sensing based models that reach out from long-term monitoring experiments conducted at the observatory network.

A final level of CAMPS (Figure 1) would use data and models from the observatory network, and data from the intermediate level of mandate-based monitoring programs to develop remote sensing-based models to extrapolate local results to reach out to regional and national scales to make predictions of change in appropriate monitoring measures (e.g., changes in vegetation composition, structure and productivity caused by climate-driven change in soil and site drivers, changes in sea ice biota resulting from sea ice changes and warming water) based on a range of climate scenarios.

The proposal at this time is that CHARS science staff will work with science and community partners to implement a proof-of-concept of CAMPS in the CHARS Experimental and Reference Area (CHARS ERA) in the Kitikmeot Region of Nunavut. This proof-of-concept follows monitoring approaches outlined in more detail in McLennan et al. (in prep). An ecological inventory and mapping system based on a nationally- and internationally- standardized nomenclature for arctic and sub-arctic ecological communities is seen as a critical component that can link monitoring across the North, permitting the broad extrapolation of monitoring and research results, and permitting the development of a national experimental design for the terrestrial components of CAMPNet observatories (McLennan et al., in press). We are beginning to seek input from northern scientists and Kitikmeot communities to develop consensus on appropriate experimental designs and protocols for implementing the intensive long term experiments in the CHARS Intensive Monitoring Area, and for designing the extensive calibration-validation monitoring aspects of the CAMPS in Kitikmeot communities. The long term outcome is that the proof-of-concept will demonstrate the usefulness of CAMPS for predicting likely outcomes and reducing ecological surprise to support decision-making and proactive adaptation approaches, and that this will in turn attract the required investments to implement the system nationally.

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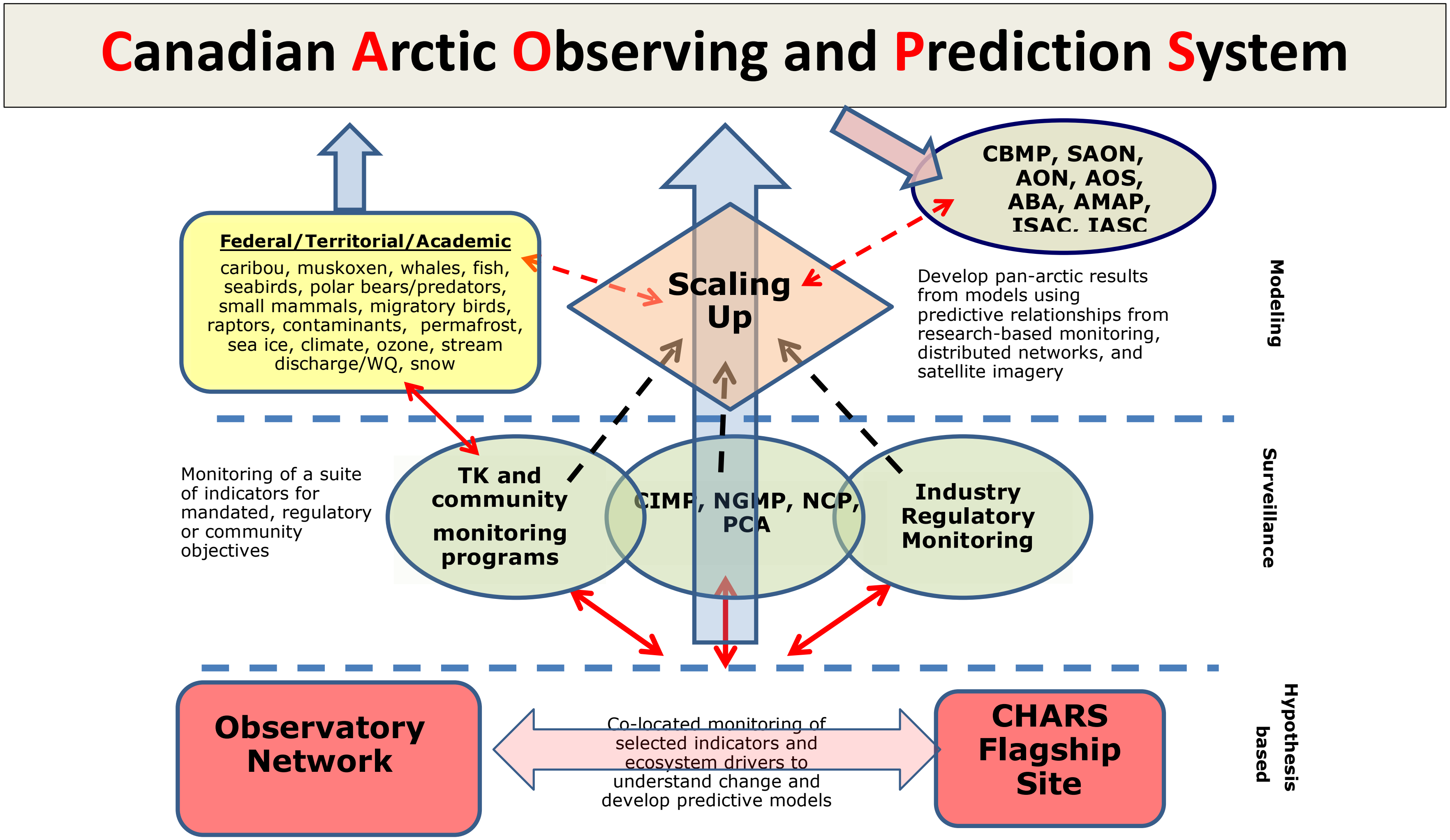
Canadian Arctic Observing and Prediction System
CBMP, SAON, AON, AOS, ABA, AMAP, ISAC, IASC
Federal/Territorial/Academic
caribou, muskoxen, whales, fish, seabirds, polar bears/predators, small mammals, migratory birds, raptors, contaminants, permafrost, sea ice, climate, ozone, stream discharge/WQ, snow
Scaling Up
Develop pan-arctic results from models using predictive relationships from research-based monitoring, distributed networks, and satellite imagery
Modeling
Monitoring of a suite of indicators for mandated, regulatory or community objectives
TK and community monitoring programs
CIMP, NGMP, NCP, PCA
Industry Regulatory Monitoring
Surveillance
Observatory Network
Co-located monitoring of selected indicators and ecosystem drivers to understand change and develop predictive models
CHARS Flagship Site
Hypothesis based